DESIGN-BUILD
RFP CONTRACT BOOK 1
INSTRUCTIONS TO
DESIGN-BUILDERS (ITDB)

TENNESSEE DEPARTMENT OF TRANSPORTATION

I-75 Interchange Modification at I-24, Phase 2 (IA)

Hamilton County- TENNESSEE

CONTRACT NUMBER: DB2101

May 27, 2022

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STANDARD INSTRUCTIONS TO DESIGN-BUILDERS

A. SCOPE OF SOLICITATION / PROJECT DESCRIPTION

1. INTRODUCTION

This **Contract Book 1 (ITDB - Instructions to Design-Builders)** is issued by the Tennessee Department of Transportation (the Department) to all firms and teams of firms ("Design-Builders") that the Department has shortlisted for the Department's Request for Proposals (RFP) to solicit competitive Proposals for **I-75 Interchange Modification at I-24 (Phase 2) (Design Build) (IA), Hamilton County-TN** Design-Build Project (the "Project"). The Department hereby invites such Design-Builders to submit competitive sealed proposals ("Proposals") for design and construction of the Project as more specifically described in the Contract Documents. Design-Builders should not rely on only the limited information contained in this **Contract Book 1 (ITDB - Instructions to Design-Builders)**, but should review and understand the specific information and requirements in the RFP.

This solicitation is a request for competitive proposals. Proposals are only invited from and will only be considered from those entities ("Design-Builders") on the short-list as determined through the evaluation of Statements of Qualifications ("SOQ") submitted in response to the Request for Qualifications ("RFQ").

The Design-Build is advised to familiarize itself with the provisions of Tennessee Code Annotated, Section 67-6-209, entitled "Use of Property Produced or Severed from the Earth-Exemptions", which relates to the payment of taxes on the use of tangible personal property severed from the earth. This tax is in addition to those levied for other tangible personal property.

The Design-Build must have at their disposal the necessary equipment to put on the Project when instructions are issued to begin work, and to do the work within the time specified. In the event the Design-Builder has been awarded contracts for highway work in the past, they shall have financed the work in such a manner that just and proper claims in the discretion of the Department, representing labor and materials entering therein, have not been filed with the Department.

This **Contract Book 1 (ITDB - Instructions to Design-Builders)** contains Technical Proposal, Price Proposal, and other submittal requirements, a description of the procurement process to be used, Technical Proposal evaluation criteria, and other instructions to Design-Builders. This **Contract Book 1 (ITDB - Instructions to Design-Builders)** shall be used by Design-Builders in conjunction with the other Contract Documents for the generation and submission of responsive Technical Proposals, sealed Price Proposals, and other required pre-award submittals.

Submittal of a Price Proposal and the execution by Design-Builders of the signature sheets contained in the RFP, shall constitute the Design-Builder's acknowledgement and understanding of the procurement process, submittal requirements, and evaluation criteria contained herein.

The Contract will include **Contract Book 1 (ITDB - Instructions to Design-Builders), Contract Book 2 (Design-Build Contract),** and **Contract Book 3 (Project Specific Information), Design-Builder Standard Guidance** and all referenced documents, including, but not limited to, the listing in the **Contract Book 2 (Design-Build Contract)** are to set forth the rights and obligations of the Parties and the terms and conditions governing completion of the work.

The Project shall consist of the widening of the I-24 roadway in each direction, on/off ramp modifications as shown in the revised IAR and Functional Plans, and bridge replacements over I-24 at McBrien Road and S. Moore Road in Hamilton County. The roadway improvements shall begin at the Germantown Rd. bridge and extend to a point just west of the I-24/Spring Creek Road bridges as depicted on the Functional Plans.

The Project shall include the widening of the I-75 roadway to include an additional lane in each direction and the replacement of the I-75 bridge over CSX railroad.

The project shall include the milling, resurfacing, and installation of pavement markings and sign modifications within the I-75/24 Interchange to match the lane configurations shown in the IAR.

The Design-Builder's obligations shall include without limitation the following:

- Furnishing all design services, Quality Management, materials, equipment, labor, transportation, and incidentals required to complete the Project according to the approved Plans, the Department's Standard Specifications, as amended, and terms of the Contract;
- Performing the construction work according to the lines, grades, typical sections, dimensions, and other details shown on the approved Plans, as modified by Change Order or other written directive issued by the Department;
- Performing all work determined by the Department to be necessary to complete the Contract; and
- Contacting the Department Alternative Contracting Office for any necessary clarification or interpretation of the Contract prior to proceeding with the affected work.
- All Project components identified in the Contract and performance of all work described in accordance with all Contract requirements. The Design-Builder shall determine the full Project requirements through comprehensive examination of the Contract and the Project Site.
- Designing, furnishing, constructing, and installing all components of the Project, except for those components, if any, as may be stipulated within the **Contract Book 3 (Project Specific Information)** to be furnished and/or installed by the Department or others.

The Design-Builder shall be fully and totally responsible for the accuracy and completeness of all work performed under the Contract, and shall indemnify and hold the Department harmless for any additional costs and all claims against the Department which may arise due to errors or omissions of the Department in the Provided Materials, and of the Design-Builder in performing the work.

2. PROJECT OVERVIEW

Project Description: I-75 Interchange Modification at I-24 (Phase 2) (Design Build) (IA)

This project will consist of:

Segment 1 (I-24 from Germantown Road to just west of Spring Creek Road)

- Reconstruct all concrete pavement and shoulders on I-24 from Germantown Road to Spring Creek Road with asphalt pavement;
- Replace the existing median barrier with a 51-inch single slope concrete median barrier from Germantown Rd. to Spring Creek Rd along I-24;
- Reconstruct the existing interstate access ramps between Germantown Road and Spring Creek Road to the configuration shown on the Functional Plans;
- Replace the storm sewer system from Germantown Rd. to Spring Creek Rd along I-24 for a complete operational system designed in accordance with TDOT's Drainage Manual. Drainage structures that can be retained and reused are limited to the following: STA 91+98 – 30" RCP, STA 99+52 – 36" RCP, STA 145+02 – 24" RCP, STA 155+34 – DBL 8x7 RCBC, STA 175+78 (westbound roadway) - 48" RCP, and STA 176+52 (eastbound roadway) - 48" RCP;
- Widen to add an additional lane eastbound and westbound from Germantown Rd. to S. Moore Rd. and two (2) additional lanes eastbound and westbound from S. Moore Rd. to Spring Creek Rd. along I-24 as shown on the Functional Plans;
- Remove the existing temporary ramps between Germantown Road and Belvoir Avenue from N. Terrace and S. Terrace to I-24;
- Add new noise walls along I-24;
- Replace the S. Moore Road and McBrien Road overpass bridges including new sidewalks and bike lanes as shown on the Functional Plans;
- Mill and resurface all existing asphalt pavement on N. Terrace and S. Terrace from Germantown Road to Spring Creek Road;
- Remove and replace all guardrail. Install new guardrail in accordance with TDOT's Roadway Design Guidelines;
- Clean and place new texture coat on all existing median barrier to be retained;
- Replace all roadway lighting on I-24 between Germantown Road and Spring Creek Road. Replace all roadway lighting on N. Terrace and S. Terrace between Germantown Road and Spring Creek Road. Replace all roadway lighting on S. Moore Road between N. Terrace and S. Terrace. Replace all roadway lighting on McBrien Road between N. Terrace and S. Terrace;

- Coordinate utility relocations in Segment 1;
- Relocate and improve ITS facilities in Segment 1;
- Install new overhead signs and sign structures and update existing signs and sign structures to the ultimate build configuration as shown in the roll plots for Segment 1; and
- Replace control access fence at locations detailed in this RFP for Segment 1.

Segment 2 (I-75 from approximately 455' west of the CSX Railroad Bridge to near E. Brainard Road Interchange)

- Widen I-75 northbound and southbound from approximately 400 ft. south of the CSX Railroad bridge to the East Brainerd Road interchange;
- Replace the existing I-75 bridge over the CSX Railroad with a new structure (no modifications to the existing structure allowed);
- Replace the existing median barrier with a 51-inch single slope concrete median barrier from approximately 750 ft. south of the CSX railroad crossing bridge to approximately 500 ft. north of the CSX Railroad bridge (areas of profile change) along I-75;
- Rehabilitate the existing concrete pavement from approx. 300 ft. north of the CSX Railroad bridge to East Brainerd Road;
- Remove and replace all guardrail. Install new guardrail in accordance with TDOT's Roadway Design Guidelines;
- Clean and place new texture coat on all existing median barrier to be retained on I-75 from 400 ft. south of the CSX Railroad bridge to the East Brainerd Road bridge;
- Replace all lighting on I-75 from 400 ft. south of the CSX Railroad bridge to the East Brainerd Road bridge;
- Coordinate utility relocations in Segment 2;
- Relocate and improve ITS facilities in Segment 2;
- Install new overhead signs and sign structures and update existing signs and sign structures to the ultimate build configuration as shown in the roll plots for Segment 2; and
- Replace control access fence at locations detailed in this RFP for Segment 2.

Segment 3 (Interchange)

- Resurface and restripe the I-75 southbound to I-24 westbound interstate-to-interstate ramp, I-24 eastbound from just west of Spring Creek Road to I-75 northbound interstate-to-interstate ramp and I-75 southbound from 400 ft south of the CSX

Railroad bridge through the interchange to just west of Spring Creek Road to the ultimate build configuration;

- Resurface and restripe the I-75 northbound to I-24 westbound interstate-to-interstate ramp, the I-24 eastbound from just west of Spring Creek Road to I-75 southbound interstate-to-interstate ramp and I-75 northbound through the interchange to 400 ft south of the CSX Railroad bridge to the ultimate build configuration;

- Update and install new signs on the existing sign structures to the ultimate build configuration as shown in the roll plots for Segment 3; and

- Replace control access fence at locations detailed in this RFP for Segment 3.

3. RFP COMMUNICATION

The Department Alternative Contracting Assistant Director is the single point of contact for the Department for the duration of the procurement process, together with address, phone number, fax number, and e-mail address, as set out in the Contract.

a. CORRESPONDENCE

All correspondence and submittals must be submitted electronically, addressed to the Department Alternative Contracting Assistant Director and labeled as set out in Section C.2 of **Contract Book 2 (Design-Build Contract)**.

Return Address – The Design-Builder must also include on the envelope or package the Design-Builder's name and return address.

Any Department designated contact person specified in the **Design-Build Standard Guidance** for a specific technical area will be disclosed to the contracted Design-Builder within the Initial Notice to Proceed (NTP).

b. OTHER MEANS OF COMMUNICATION

The Design-Builders may also communicate with the Department Alternative Contracting Assistant Director by fax, phone, or e-mail (or if the Program Manager is unavailable, as a secondary contact, the Department Director of Construction by telephone at 615-741-2414. Advance copies of submittals delivered to the Department by fax or e-mail are not considered official until the Department receives the hard copy. Official communications will only be disseminated in writing by the Department.

c. COMMUNICATIONS WITH DESIGN-BUILDER; DESIGN-BUILDER'S SINGLE POINT OF CONTACT AND ADDRESS

The Department Alternative Contracting Assistant Director shall be the Design-Builder's single point of contact for all communications during the procurement process prior to the Proposal Due Date. The Design-Builder's single point of contact for communications during the procurement process shall be the only person to request information.

4. THE DEPARTMENT'S DISSEMINATION OF INFORMATION

a. INFORMAL COMMUNICATIONS

The Department may post informal advance notices of Addenda and information on the Project website and may also utilize e-mail alerts (clayton.markum@tn.gov). However, the Design-Builders may not rely on oral communications, or on any other information or contact that occurs outside the official communication process specified herein. Official communications will only be disseminated in writing, by e-mail, or via the website by the Department.

In the event the Department determines that a change of RFP or Contract terms or specifications are warranted, the Department will issue formal written clarifications or Addenda.

b. RESPONSES TO FORMAL REQUESTS

Questions on or modification of provisions of the RFP or any Addenda can be pursued through submittal of Form QR. The Department will provide responses to all:

- Requests for QPL product determination;
- Requests for answers; and
- Requests for change of Contract terms or specifications.

Information that the Department issues to the Design-Builders in writing responding to the questions submitted on Form QR will be posted to the website for all Design-Builders to view.

c. ADDENDA

If the Department determines that a formal request or protest raises an issue that should be resolved by amending an RFP provision, specification or Contract term, the Department will do so by issuing a formal Addendum clearly identifying the change as amending, revising, or modifying the RFP provision, specification or Contract term in question.

The Department may issue Addenda up to five (5) Calendar Days prior to the Proposal Due Date, unless the Department extends the Proposal Due Date concurrent with issuance of the Addendum.

d. REQUESTS FOR QPL PRODUCT DETERMINATION

The Design-Builder may request a product in lieu of a QPL product by identifying the product category included on the QPL. The Design-Builder shall provide sufficient manufacturer's product information, together with supporting documentation such as industry studies and test results, and product demonstration, if relevant, as may be reasonably necessary to enable the Department to make a determination as to the inclusion of said product on the Department's QPL. The Design-Builder shall not submit any proprietary items, unless specified in accordance with 23 CFR 635.411 and approved by the Department prior to the request.

The Department may reject any request without recourse by the Design-Builder. The Department has no obligation but to review the product and shall not be liable for failure to accept or act upon any request. The Department shall be the sole judge of the acceptance or rejection of a product. If an agreement has not been reached by five (5) Calendar Days prior to the Proposal Due Date, the product shall be deemed rejected.

e. QUESTIONS

The Design-Builders may provide questions on RFP provisions, Contract provisions, and specifications that the Design-Builder considers unclear or incomplete. To be considered, the questions must identify the unclear language or omission, or the specific discrepancies between identified provisions that result in ambiguity. All requests shall be submitted to the Department Alternative Contracting Assistant Director and will only be accepted in the format of Form QR in electronic format by e-mail (clayton.markum@tn.gov) or fax. Any questions to addenda issued after the question deadline will be considered and answers issued if time allows.

f. REQUESTS FOR CHANGE OF CONTRACT TERMS OR SPECIFICATIONS

The Design-Builders may submit a request for change of Contract terms or specifications setting out the language for which change is sought and indicating the document title, page, and subsection where the language is located. To be considered, the request must include the reason for the requested change, supported by factual documentation, and the proposed change. All requests shall be submitted to the Department Alternative Contracting Assistant Director and will only be accepted in the format of Form QR in electronic format using MS Word by e-mail (clayton.markum@tn.gov) or fax.

g. PROHIBITED DESIGN-BUILDER COMMUNICATIONS

No member of Design-Builder's organization (employees, agents, Principal Participants, the Designer, Key Personnel or the Technical Manager) may communicate with members of another Design-Builder's organization to give, receive, or exchange information, or to communicate inducements, that constitute anti-competitive conduct in connection with this procurement.

The Design-Builders shall not contact stakeholder staff regarding the RFP content or the requirements for the Project. Stakeholder staff includes employees of the Department, city(ies) and county(ies) in which the Project or any part of it are located.

Prohibited communications do not include contact with regulatory/county/city officials for the limited purpose of obtaining information regarding available detour routes and conditions associated with such use or regulatory/county/city guidelines. Communications with utility companies for the purpose of obtaining information regarding potential conflicts and relocation durations are not prohibited.

5. *PROCUREMENT SCHEDULE/SUBMITTAL DEADLINES*

The Procurement Schedule and submittal deadlines are set out below**.** The Department will not consider requests on any submittal received by the Department after the deadline for its submittal date stated below. The Department will not consider requests on any submittals pertaining to an Addendum after the deadline established in the Addendum.

Deadline for Submittal of Alternate Technical Concepts	***September 12, 2022 4:00 p.m., CT.***
Deadline for Response to Alternate Technical Concepts,	***September 19, 2022 4:00 p.m., CT.***
Deadline for Submittal of Question Requests, and Requests for QPL Determination	***September 9, 2022 4:00 p.m., CT.***
Anticipated Deadline for Issuance of Last Addendum	***September 19, 2022 4:00 p.m., CT.***
Technical Proposal and Price Proposal Due Date and Time	***September 30, 2022 4:00 p.m., CT.***
Public Price Proposal Opening	***October 28, 2022 9:00a.m., CT.***
Anticipated Award of Design-Build contract, or rejection of all proposal	***On or before November 18, 2022***
Anticipated Issuance of Initial Notice to Proceed	***December 9, 2022***

The Department will not consider any late Proposals. Proposals received after the Proposal Due Date will be returned unopened to the Design-Builder. The Department will not consider any Proposal modifications submitted after the Proposal Due Date, nor will the Department acknowledge Proposal withdrawals submitted after the Proposal Due Date. Any such attempted withdrawal will be ineffective.

If the Design-Builder does not submit a Proposal by the Due Date and the Department chooses to issue a new, revised, or modified RFP, the Proposal will be considered non-responsive to the requirements set forth herein. As a result, the Design-Builder will not be eligible to respond to any additional RFP requests from the Department on this project.

6. *CONTRACT DOCUMENTS*

- Contract Book 1 (ITDB - Instructions to Design-Builders);
- Contract Book 2 (Design-Build Contract);
- Contract Book 3 (Project Specific Information);
- Design-Build Standard Guidance and Addendum;
- The Department Standard Specifications;
- The Department Supplemental Specifications;
- The Department Roadway Design Guidelines, and Addendum;

- The Department Structural Design Guidelines, and Addendum;
- The Department Construction Circular Letters;
- The Department Standard Drawings;
- Design Procedures for Hydraulic Structures;
- Drainage Manual;
- FHWA scour publication HEC-18, FHWA publication HEC-21 or HEC-22;
- Exhibit A (Technical Proposal), including any ATCs;
- Change Orders;
- Force Account Work Orders;
- Written Orders and Authorizations Issued by the Department;
- All Other Programmatic Plans or any Other Documents;
- All Material Included by Reference in any of the above Documents.
- The Department Material and Test Standard Operating Procedures.

7. COMPLETION DATES

- Contract Completion Time – The Design-Builder shall specify the number of Calendar Days after receipt of the Initial Notice to Proceed required for completion of the project within their Price Proposal. Completion of the project is completion of all work to be done under the Contract, except for plant/vegetation establishment, and the Department has provided final acceptance as stated in the Department's Standard Specifications. The number of Calendar Days specified by the Design-Builder in their Price Proposal will be placed in the Contract prior to execution of this Design-Build Contract.
- Interim Completion Dates – To be determined by the Critical Path Method (CPM) Schedule.

8. CRITICAL PATH METHOD (CPM)

The Technical Proposal CPM Schedule shall follow the applicable categories within the Schedule of Items and other cost control systems, including the Payment Progress Process.

The CPM Schedule shall include all major activities of work required under the Contract, in sufficient detail to evaluate design and construction process. The Design-Builder shall provide adequate time in the schedule for all parties involved with the Project to complete their work, including inspections, procurement activities, and testing. The Design-Builder's plan, as presented in the CPM, shall adhere to all Contract requirements. The Design-Builder shall include in the CPM schedule the work of subcontractors, vendors, suppliers, utilities, railroads, permitting agencies, the Department, and all other parties associated with the Project. Failure by the Design-Builder to include any element of its work or the work of others required for completion of the Project will not excuse the Design-Builder from completing the Project by the Contract Completion Date(s).

The scheduling compatible software employed by the Design-Builder shall be with the current and any future scheduling software employed by the Department. The

Department's current software in use is Primavera Project Manager (P6). The software shall be compatible provided in an electronic file version of the Project Schedule that can be loaded or imported by the Department using the Department's scheduling software with no modifications, preparation or adjustments.

The CPM Schedule shall show the order in which the Design-Builder proposes to carry on the work, the time frame which it will start the major items of work and the critical features of such work (including procurement of materials, plant, and equipment), and the contemplated time frames for completing the same. For the purposes of developing the CPM Schedule, the Design-Builder shall use ten (10) business days for the Review and Approvals performed by the Department. The CPM Schedule shall include, at a minimum, the following items:

- Controlling items of work, major work and activities to be performed;
- Seasonal weather limitations;
- Land disturbance restrictions;
- Phase duration or milestone events, based on selected option as applicable;
- Specified contract completion time (defined above) from Price Proposal.

The purpose of this scheduling requirement is to ensure adequate planning and execution of the work and to evaluate the progress of the work. The CPM Schedule proposed shall meet or exceed minimum Contract requirements, as determined by the Department in its sole discretion, where all Design-Builder risks are mitigated with schedule logic. The Design-Builder is and shall remain solely responsible for the scheduling, planning, and execution of the work in order to meet the Project Milestones, the Intermediate Contract Times, and the Contract Completion Date(s).

Within ten (10) business days after award of the Contract, the Design-Builder shall assign a percentage of the Pay Item Cost to each activity in the proposed CPM that reflects an accurate percentage value to each activity based on estimated costs plus associated profit and overhead. The profit and overhead assigned to the individual activities shall be equal to or less than the mark-up applied to the work when establishing the Contract Lump Sum Price. The schedule shall be in a suitable scale to indicate graphically the total percentage of work scheduled to be completed at any time.

Review and Comment by the Department shall not be construed to imply approval of any particular method or sequence of construction or to relieve the Design-Builder of providing sufficient materials, equipment, and labor to guarantee completion of the Project in accordance with all Contract requirements. The Department Review and Comment shall not be construed to modify or amend the Contract, Interim Completion Dates, or the Contract Completion Date. The updated CPM Schedule may be utilized to facilitate the Department's Quality Assurance (QA) activities.

If at any time the design of the project potentially affects the approved FHWA NEPA document, the Design-Builder shall cease work and contact the Department Alternative Contracting Office.

The Department's acceptance of any schedule does not relieve the Design-Builder of responsibility for the accuracy or feasibility of the schedule, does not modify the

Contract, will not be construed as an endorsement or validation of the Design-Builder's plan, and does not guarantee that the Project can be performed or completed as scheduled. the Department's acceptance of the Design-Builder's schedules in no way attests to the validity of the assumptions, logic constraints, dependency, relationships, resource allocations, resource availability, manpower and equipment, or any other aspect of the means and methods of performing the work.

The Design-Builder shall produce a schedule that does not contain open-ended activities, except for the first and last activity in the schedule.

9. SUBMITTALS

Design-Build submittals will be based on the approved CPM Schedule. All submittals must be stamped into the Department designated contact office before 12:00 p.m. CST to start the review period that day. If submittals are received after 12:00 p.m. CST, the review period will begin on the following business day. The review period includes only the Department workdays.

Submittals shall be transmitted in a logical order and in accordance with the submittal schedule. All submittals shall be stamped by a Professional Engineer licensed in Tennessee.

B. PREPARATION OF PROPOSAL

1. METHOD OF PROCUREMENT

The Contract will be for Design-Build services to be paid on a lump sum basis for each Pay Item Number. The Department will award the Contract to the Design-Builder that submits a responsive Proposal that is determined by the Department to offer the lowest Adjusted Price considering the evaluation factors set forth in this ITDB.

The procurement process includes two steps:

Step One: RFQ (determination of Short list); and,
Step Two: RFP (selection of Design-Builder from submitting responsive Proposals).

Evaluation of Proposals will be based on information submitted in the Proposals or otherwise available to the Department, and will involve both pass/fail factors and price, as further detailed below.

The Design-Builder shall comply with the Proposal preparation instructions set out in this **Contract Book 1 (ITDB - Instruction to Design-Builders)**, the **Contract Book 2 (Design-Build Contract)**, the **Contract Book 3 (Project Specific Information)**, the **Design-Build Standard Guidance** and any other Contract Documents released for this procurement.

2. ALTERNATIVE TECHNICAL CONCEPTS – SUBMITTAL REQUIREMENTS AND AUTHORIZATION TO USE

a. INFORMATION

To accommodate innovation that may or may not be specifically allowed by the RFP Documents, the Design-Builder has the option of submitting Alternative Technical Concepts.

An Alternative Technical Concept (ATC) is a private query to the Department that requests a variance to the requirements of the RFP or other Contract Documents that is equal or better in quality or effect as determined by the Department in its sole discretion and that have been used elsewhere under comparable circumstances.

The Design-Builder may include an ATC in the Proposal only if the ATC has been received by the Department by the deadline identified in this **Contract Book 1 (ITDB - Instruction to Design-Builders)** and it has been approved by the Department).

The original submittal deadline applies only to initial ATC submittals. Resubmittal of an ATC that has been revised in response to the Department's requests for further information concerning a prior submittal shall be subsequently received as directed by the Department.

An ATC shall in no way take advantage of an error or omission in the RFP. If, at the sole discretion of the Department, an ATC is deemed to take advantage of an error or omission in the RFP, the RFP will be revised without regard to confidentiality.

By approving an ATC, the Department acknowledges that the ATC may be included in the design and RFC (Readiness-for-Construction) plans; however, approval of any ATC in no way relieves the Design-Builder of its obligation to satisfy (1) other Contract requirements not specifically identified in the ATC submittal; (2) any obligation that may arise under applicable laws and regulations; and (3) any obligation mandated by the regulatory agencies as a permit condition.

A proposed ATC is not acceptable if it merely seeks to reduce quantities, performance, or reliability, or seeks a relaxation of the contract requirements. ATCs shall be submitted by the Design-Builder and pre-approved in writing by the Department. All Technical Proposals must include the Department's pre-approval letters for consideration of the ATCs.

b. SUBMITTAL REQUIREMENTS

Each ATC submittal shall include two (2) individually bound copies and shall use Form ATC located in **Contract Book 3 (Project Specific Information)**. Each ATC shall include the following information:

1) Description. A detailed description and schematic drawings of the configuration of the ATC or other appropriate descriptive information (including, if

appropriate, product details [i.e., specifications, construction tolerances, special provisions] and a traffic operational analysis, if appropriate).

2) Usage. Where and how the ATC would be used on the Project.
3) Deviations. References to all requirements of the RFP that are inconsistent with the proposed ATC, an explanation of the nature of the deviations from said requirements, and a request for approval of such variance(s).
4) Analysis. An analysis justifying use of the ATC and why the variance to the requirements of the RFP should be allowed.
5) Impacts. Discussion of potential impacts on vehicular traffic, environmental impacts identified, community impact, safety and life-cycle Project impacts, and infrastructure costs (including impacts on the cost of repair and maintenance).
6) History. A detailed description of other projects where the ATC has been used, the success of such usage, and names and telephone numbers of project owners that can confirm such statements.
7) Risks. A description of added risks to the Department and other entities associated with implementing the ATC; and
8) Costs. A description of the ATC implementation costs to the Department, the Design-Builder, and other entities (right-of-way, utilities, mitigation, long term maintenance, etc.).

The ATC, if approved, shall be included in the Price Proposal if the Design-Builder elects to include it in their Technical Proposal.

c. REVIEW OF ATCs.

A panel will be selected to review each ATC, which may or may not include members of the Design-Build Review Committee. The Design-Builder shall make no direct contact with any member of the review panel, except as may be permitted by the Department Alternative Contracting Assistant Director. Unapproved contact with any member of the review panel will result in a disqualification of that ATC.

The Department may request additional information regarding a proposed ATC at any time. The Department will return responses to, or request additional information from, the within ten (10) business days of the original submittal. If additional information is requested, the Department will provide a response within ten (10) business days of receipt of all requested information.

Under no circumstances will the Department be responsible or liable to the Design-Builder or any other party as a result of disclosing any ATC materials, whether the disclosure is deemed required by law, by an order of court, or occurs through inadvertence, mistake or negligence on the part of the Department or their respective officers, employees, contractors, or consultants.

d. THE DEPARTMENT RESPONSE

The Department will review each ATC and will respond on Form ATC as shown in **Contract Book 3 (Project Specific Information)** with one of the following determinations:

1) The ATC is approved.

2) The ATC is not approved.
3) The ATC is not approved in its present form, but may be approved upon satisfaction, in the Department's sole discretion, of certain identified conditions that shall be met or certain clarifications or modifications that shall be made (conditionally approved).
4) The submittal does not qualify as an ATC but may be included in the Proposal without an ATC (i.e., the concept complies with the baseline requirements of the RFP Documents).
5) The submittal does not qualify as an ATC & may not be included in the Proposal; or
6) The ATC is deemed to take advantage of an error or omission in the RFP, in which case the ATC will not be considered, and the RFP will be revised to correct the error or omission.

e. ATC INCLUSION IN TECHNICAL PROPOSAL

The Design-Builder may incorporate one or more approved ATCs as part of its Technical and Price Proposals. If the Department responded to an ATC by stating that it would be approved if certain conditions were met, those conditions must be stipulated and met in the Technical Proposal. If the ATC is used in the submittal, the approved Form ATC shall be included in the Technical Proposal.

In addition to outlining each implemented ATC, and providing assurances to meet all attached conditions, the shall also include a copy of the ATC approval letter with approved form from the Department in the Technical Proposal within the Appendix and these will not count towards the page limit maximum; however the ATC must be discussed within the Technical Proposal Response Category for scoring.

Approval of an ATC in no way implies that the ATC will receive a favorable review from the Design-Build Review Committee. The Technical Proposals will be evaluated in regards to the evaluation criteria found in this **Contract Book 1 (ITDB - Instructions to Design-Builders)**, regardless of whether or not ATCs are included.

The Price Proposal shall reflect all incorporated ATCs. Except for incorporating approved ATCs, the Technical Proposal may not otherwise contain exceptions to, or deviations from, the requirements of the RFP.

3. SELECTION PROCEDURE

The Department will utilize a ***Meets Technical Criteria (A+B+C)*** selection process in this procurement to award a Contract to the responsible Design-Builder that demonstrates it meets the technical criteria and can deliver the best combination of price and time (A+B+C) in the design and construction of the Project.

Price Proposals will be calculated in accordance with the following method:

Total Contract (A+B+C) = A + (B x TIME) + (C x TIME)
Where, A = Contract Amount
B = the number of Calendar Days (from the Initial Notice to Proceed) indicated by the time needed to complete the Project in their Price

Proposal and will become the contract completion time to be shown in the contract book.

C = the number of Lane Rental Days indicated by the time needed for temporary lane rental(s) within Segment 1 on I-24.

TIME VALUE = Value associated with time of completion on this Project.

B: Calendar Days

Amount of one Calendar Day is $30,000 as stated in Special Provision 108B.

C: Lane Rental Days

Amount of one Lane Rental Day is $50,000 as stated in Special Provision 108B.

It is intended that all construction be completed by the earliest feasible date to minimize public inconvenience and enhance public safety. Should the total number of calendar days that the Design-Builder placed in the Proposal under the "B" portion of the Proposal to be deemed excessive, then the Proposal will be rejected. To this end the Design-Builder shall pursue the work rigorously utilizing the necessary work week, work hours and/or work shift schedules to expedite the work. The total Contract (A+B+C) cost will be used by the Department to determine the Apparent Design-Builder, but reimbursement to the Design-Builder shall be based solely on the Proposal Price total "A" and any incentive or disincentive payment made in accordance with the Contract.

IMPORTANT: The number of Calendar Days "B" and Lane Rental Days "C" are to be placed in the Price Proposal. Failure to enter a value for "B" or "C" will make the Proposal irregular and be cause for rejection.

Calendar days will be charged in accordance with the Contract and time charges will begin on the date shown on the initial NTP letter. Time charges will continue until work is complete, excluding punchlist items and vegetation establishment, on the Project in accordance with the Contract.

Notwithstanding any other provision of this Contract to the contrary, no time adjustments will be allowed for:

- Adverse weather conditions;
- The time required to Review and Approve Shop Drawings;
- The time required to review VECPs;
- The time to process Change Orders or plan revisions requiring additional Review and Approval;
- The time to complete work not on the CPM Schedule;
- Any delays typically encountered during a Project regardless of the source; and
- The time for plan revisions requiring additional Review and Approval if the Design-Builder was unable to work on the controlling item of work without revised plans or shop drawings.

Time adjustments may be considered for:

- The time for ordering and delivery of materials for Extra Work directed by the Department that affects the CPM Schedule;
- Delays encountered due to a catastrophic event, beyond the control of the Design-Builder, that the Department determines adversely affected the progress of work.

The Department reserves the right to reject any or all Proposals, to waive technicalities, or to advertise for new Proposals, if, in the judgment of the Department, the best interests of the public will be promoted thereby. In putting together their Proposals, the Design-Builder should keep in mind and address the Project goals stated herein.

C. RELATIVE WEIGHTS ALLOCATED TO TECHNICAL AND PRICE PROPOSALS

The selection method to be utilized for this Project is "Meets Technical Criteria (A+B+C)". The Technical Proposal will be evaluated on the pass/fail and technical evaluation factors identified herein. A Proposal must achieve a **Pass** rating for RC I, II, III, and IV. The Department shall first determine whether the Proposals are responsive to the requirements of the RFP. Prior to making such determination, the Department may offer a Design-Builder the opportunity to provide supplemental information or clarify its Proposal. Each responsive Technical Proposal shall be evaluated based on the criteria provided herein. After evaluation of the Technical Proposal, the Department, as required by Department Rule 1680-5-4, Procedures for the Selection and Award of Design-Build Contract, will publically open and read the Total Contract Amount (A+B+C). Although the selection will be made on the bid proposal that qualifies as the lowest and best adjusted bid, the cost of the Contract will be the amount received as the Proposal Price "A" and will be placed in **Contract Book 2 (Design-Build Contract)** upon award.

D. TECHNICAL RESPONSE CATEGORIES AND SCORING

Proposal responses for Response Categories I through IV will be evaluated using the rating guidelines set out in this **Contract Book 1 (ITDB - Instruction to Design-Builders)**.

EVALUATION FACTORS	POINTS
RESPONSE CATEGORY I	**PASS/FAIL**
RESPONSE CATEGORY II	**PASS/FAIL**
RESPONSE CATEGORY III	**PASS/FAIL**
RESPONSE CATEGORY IV	**PASS/FAIL**
TOTAL	

During the evaluation period, each Technical Proposal will be reviewed by the Department Design-Build Review Committee (DBRC) individually.

1. RESPONSE CATEGORY I

The submittals required under Response Category I as stated in this **Contract Book 1 (ITBD - Instruction to Design-Builders)** will be evaluated as a matter of responsibility on a pass/fail basis.

a. FORMS

1) All required contract forms filled out. All Response Category forms and any forms specified within a Response Category shall be placed within the appropriate response category below. If any Response Category item requires additional sheets, the form shall indicate at the bottom of the item, see additional sheets. Additional forms can be used, but are not necessary if only one item requires additional sheets.
2) All other forms are to be placed within this Response Category.

b. OTHER

1) City and state where assigned staff will be located, particularly the location(s) of design staff.
2) List of DBEs Contacted and most likely to be utilized (Include identification of the type of work considered).

2. RESPONSE CATEGORY II: DESIGN-BUILDER'S ORGANIZATION AND EXPERTISE

Submit as much of the following for Evaluation on the Response Category II form in **Appendix A**, will be evaluated as a matter of responsibility on a pass/fail basis (be as specific as possible):

a. ORGANIZATION

1) Project-Wide Organizational Chart, including Design and Construction Functions; Key Personnel and Design Professionals.
   - Include responsibilities and reporting relationships or chain of command, clearly identifying the Project Manager, and personnel who will be assigned to the various tasks identified in this RFP.
2) Description of those categories of work which the Design-Builder anticipates will be performed by the Design-Builder's own forces and those categories which will be performed by Subcontractors.
3) Plans and procedures for management of Subcontractors.
4) Personnel Organization

b. PROJECT EXPERTISE

1) The Design-Builder shall identify all major subcontractors in the Technical Proposal.
2) Describe the overall strengths of the Design Team and their ability to fulfill the design requirements of this Project.

3. RESPONSE CATEGORY III: PROJECT CONTROLS AND MANAGEMENT

Submit as much of the following for Evaluation on the Response Category III form in Appendix A will be evaluated as a matter of responsibility on a pass/fail basis (be as specific as possible):

a. PROJECT UNDERSTANDING

1) Describe or outline the objectives, goals, and tasks to show or demonstrate the Design-Builder's view and understanding of the nature of the contract. Consider if the Scope of Services attached to this RFP is sufficient to attain the Department's goals and objectives.
2) Identify any potential right-of-way and utility conflicts.
3) Identify innovative approaches to minimize any impacts to the right-of-way. Describe any temporary impacts and associated minimization approaches.

b. SCHEDULE MANAGEMENT

1) CPM Time Schedule (to be submitted in color) meeting the requirements established in the Contract, and consistent with the Department's Project Sections, and Pay Items identified. See Section A.7 and A.8 of this **Contract Book 1 (ITDB - Instruction to Design-Builders)**.
2) Describe or outline the assumptions upon which the CPM Schedule was based, risks, constraints, contingencies, sequence of work, the controlling operation or operations, intermediate completion dates, milestones, project phasing, anticipated work schedule and estimated resources that impacted the schedule.
    a) The CPM Schedule shall indicate how the Design-Builder intends to:
        - Divide the Project into work segments to enable optimum construction performance and explain the planned sequence of work, the critical path, proposed phasing of the Project, and any other scheduling assumptions made by the Design-Builder.
        - Plans and procedures to insure timely deliveries of materials to achieve the Project schedule.
        - Categories of work that anticipates will be performed by Design-Builder's own direct labor force, those categories that will be performed by Subcontractors, those categories that will be performed by project specific teams, and those categories that will be performed by existing teaming arrangements.
        - An explanation of Design-Builder's methodology for updating it.
    b) The Design-Builder may adjust the list to more accurately reflect planned sequences and methods, although the level of detail shall be similar to that reflected in the list of required Pay Items in the Schedule of Items.
3) Submit a description of Pay Item Breakdowns including the physical features and activities included in the Pay Item, and all work included in the Pay Item Totals as reflected on the Schedule of Items.

For example, but not limited to:

105-01.20 Design-Build Construction Stakes, Lines & Grades

- Field Survey
- Construction Staking

105-01.55 Design-Build Design Services

(All Design Activities shall be included in this item.)

- Definitive Design and Reviews
- Readiness-for-Construction Plans and Reviews, Specification and quantity estimates
- Working Drawings
- As-Built Plans and Reviews

105-08.20 Design-Build Contract Management

- Project Administration
- Project progress (scheduling)
- Contract progress submittals for payment

109-04.50 Design-Build ROW Services

- Appraisal
- Acquiring
- Public meetings if required

109-10.01 TRAINEE

Trainee at the unit price $0.80 per hour for each hour approved training provided, as indicated in SP1240

203-01.95 Design-Build Grading & Roadways

- Road and Drainage excavation
- Borrow excavation (rock)
- Borrow excavation (other than solid rock)
- Undercutting

204-05.50 Design-Build Geotechnical

- Borings
- Geotechnical Investigations
- Sinkholes
- Slide~~Rock Fall~~ Mitigation

209-01.50 Design-Build Environmental Management

- EPSC measures, EPSC installation
- EPSC inspections
- Permit Acquisitions

301-50.50 Design-Build Pavement

- Any aggregate base
- Any Bituminous Plant Mix Base (HM) (A, BM-2, Etc.)
- Any Bituminous Concrete Surface (HM) (D, E)
- Treated Permeable Base Or Lean Concrete Base

- Any Portland Cement Concrete Pavement (≤ 10 in. Thickness)
- Any Portland Cement Concrete Pavement (> 10 in. Thickness)
- Tack, Prime coat

604-10.95 Design-Build Bridges

- Components (steel, deck drains, etc.)
- Bridge
- ABC superstructure units
- Bridge Repairs
- Inspections

604-50.50 Design-Build Minor Structures (Other)

- Removal of Existing Buildings and Improvements
- Box Culvert
- Retaining Walls
- Endwalls
- Wingwalls
- Temporary structures
- Noise Walls
- Minor Structure Repair

610-10.50 Design-Build Drainage

- Catch Basins
- Storm Drainage System
- Side drain
- Under drain

712-01.75 Design-Build Maintenance of Traffic

- Work Zone Safety Plan
- Temporary Barrier Rail
- Concrete Median Barrier
- Guardrail
- Changeable Message Sign
- Traffic Control
- Project photography and videography

714-40.75 Design-Build Utilities and Railroad

- Coordination
- Relocation
- Lighting
- ITS

713-15.25 Design-Build Signing

- Footings
- Installation
- Removal and Disposal

716-99.50 Design-Build Striping/Pavement Markings

- Material
- Raised Pavement Markers
- Snowplowable Raised Pavement Markers

717-99.95 Design-Build Mobilization

730-01.95 Design-Build Traffic Signals

4) Issues Resolution Plan

c. PROJECT MANAGEMENT

1) Describe the administrative and operational structure that would be used to perform the proposed work, including:
   - Describe how design personnel will interface with the construction personnel.
   - Communicating and coordinating between the Department and the Design-Builder. Include the approach for change management during construction for design initiated, field initiated, and the Department-initiated changes.
   - Describe existing design and/or construction quality management plan(s) that the Design-Builder may have already developed, and how it (they) will be implemented into work performed. Describe coordination of design and construction activities to ensure consistency in quality. Explanation of how independence of quality staff and function will be maintained.
   - Approach to managing costs under this Contract while fulfilling required tasks and assuring quality of work.
   - Describe or outline the process for constructability, durability, maintainability, safety, aesthetics and environmental mitigation in the design and construction processes.
   - Describe or outline the process for coordinating design and construction functions, including both design and construction components and all Subcontractor activities. Include a brief description (Construction Management Plan) of the Design-Builder proposes to deal with unexpected disruptions (e.g., weather- or accident-related).
   - Describe or outline the process (Design Review Plan) on how the Design-Builder will facilitate and implement Design Reviews as required under the Contract. Describe how the Designer and the design staff will be involved during construction. Also include the Design-Builder's Construction Staging and Phasing Plan, indicating timing and sequencing of major activities for the Project.
   - Describe or outline the process (Diversity Plan) of the plan to ensure projected subcontracting plan is applied at all tiers. Describe how the Design-Builder will achieve the goal set forth on this project. Participation shall be accomplished by including certified DBEs in any part of the Contract work that is necessary to complete the Contract obligation. A certified DBE may participate as a Design-Builder, subcontractor, joint venture member, material supplier, material manufacturer, or professional

service provider. Identify DBE and EEO representatives and their roles and responsibilities and identification of specific strategies and approaches that will be taken by the Design-Builder to meet the requirements of the Affirmative Action and Equal Employment Opportunity provisions described in **Design-Build Standard Guidance**.

- The Design-Builder will also be responsible for fulfilling FHWA 1273 "Contract Provisions"

d. ENVIRONMENTAL COMPLIANCE

1) Identify any potential environmental impacts.
2) Describe or outline the process for environmental compliance.
3) Describe or outline the approach to Erosion Prevention and Sediment Control for the Project.
4) Describe or outline the understanding of the overall approach to permitting and the comfort level with obtaining the required permit application/ modification within the allowed timeframe.
5) Identify innovative approaches to minimize any impacts in environmentally sensitive areas.

e. INNOVATION

1) Identify any design or construction solutions that the Design-Builder considers innovative and how those solutions will better serve the Project. Include a description of ideas that were considered, whether implemented or not. If this is an alternate technical concept, include only approved ATCs.
2) Identify any potential innovative traffic control and how those solutions will better serve the Project. Describe any temporary impacts and associated with innovations.
3) Will these innovations add to, subtract from or have no effect on the costs?

4. RESPONSE CATEGORY IV: TECHNICAL SOLUTIONS

Submit as much of the following for Evaluation on form Response Category IV form in **Appendix A** (be as specific as possible):

a. It is not the intent of the Department for the Design-Builder to submit design plans. The details submitted shall be of sufficient detail to illustrate color, texture, pattern, emblems, proportion, corridor consistency, complementing details, or other such visual effects. For those details used in multiple locations, typical details will suffice with the locations for their use noted in narrative or graphic form.
b. Conceptual plans, drawings, etc. within the Technical Proposal (these plans are in addition to and are separate from the ROW Acquisition sheets required in **Contract Book 3 (Project Specific Information)**) shall include at a minimum the following:
    1) Show plan view of design concepts with key elements noted.
    2) Show preliminary drawing of bridge elements.
    3) Identify preliminary horizontal and vertical alignments of all roadway elements.
    4) Show typical sections for the mainline of the Project.

5) Identify drainage modifications and designs to be implemented.
6) Identify the appropriate design criteria for each feature if not provided.
7) Identify all bridge types to be constructed, including any special design features or construction techniques needed.
8) Identify any deviations or proposed design exceptions, from the established design criteria that will be utilized. Explain why the deviation is necessary.
9) Describe any geotechnical investigations to be performed by the Design-Builder.
10) Describe how any utility conflicts will be addressed and any special utility design considerations. Describe how the design and construction methods minimize the Department's utility relocation costs.
11) Describe how the design will affect the right-of-way costs.
12) Identify types of any retaining walls and /or noise walls if applicable.

c. The Technical Proposal shall include half-size plan sheets depicting those elements required by the RFP.
d. Describe any traffic control requirements that will be used for each construction phase.
e. Describe how traffic will be maintained as appropriate and describe understanding of any time restrictions noted in the RFP.
f. Describe the safety considerations specific to the Project.
g. Discuss overall approach to safety.
h. Describe any proposed improvements that will be made prior to or during construction that will enhance the safety of the work force and/or traveling public both during and after the construction of the Project.
i. Provide detailed Traffic Analysis and Mitigation Report as described in RFP Form Response Category IV: Technical Solution.

5. INITIAL LIGHTING DESIGN AND RIGHT-OF-WAY ACQUISITION EXHIBIT SUBMITTAL

An Initial Lighting Design and Right-of-Way Acquisition Exhibit submittal containing Item 4.b.2) above and the Right-of-Way Acquisition Sheets is required and is to be submitted in accordance with the Procurement Schedule in Adobe PDF electronic format. Right-of-Way (ROW) Acquisition Sheets comprise the ROW Acquisition Table including all proposed areas of right-of-way and easements and in the format depicted in the Functional Plans along with Property Maps or Present Layouts as needed to clearly depict the proposed acquisitions. The Department will respond with comments in accordance with the Procurement Schedule. The technical proposal shall include Item 4.b.2) above along with the ROW Acquisition Sheets with any comments received from the initial design exhibit review addressed.

E. PROPOSALS

1. MINIMUM CONTRACT REQUIREMENTS

The RFP Contract Documents constitute the minimum Contract requirements established by the Department. Please refer to the **Contract Book 2 (Design-Build Contract)** for the order of precedence established in the Contract. Therefore, those portions of the Proposal that meet or exceed minimum Contract requirements established by the Department, as determined by the Department in its sole discretion, will themselves become minimum Contract requirements upon Contract execution.

The award of the Contract does not in any way imply that the Department will modify, relax, or relieve the Contract Documents in favor of the details of the Technical Proposal submitted by the Design-Builder.

a. TOTAL PROPOSAL SUBMITTAL

The Proposal consists of the Technical Proposal, the Price Proposal, and all required Contract Documents. The Technical Proposal shall be delivered in a sealed container within the mailing package clearly identified, labeled, and addressed as follows:

- **Recipient (the Department) set out in the Contract and "Proposal - Procurement Sensitive"**
- **Return address: Design-Builder's name, contact person's name, mailing address;**
- **Date of submittal;**
- **Contents labeled as "I-75 Interchange Modification at I-24 (Phase 2) (Design Build) (IA)"; and "Design-Build Project (DB2101)" and "Design-Build Technical Proposal".**

The Technical Proposal may be sent by United States Mail or private carrier (i.e., Federal Express, United Postal Service, etc.), or be hand-delivered to the address shown in Section C.2 of **Contract Book 2 (Design-Build Contract)**. The container shall include the packaged sealed manila envelope as follows:

- Technical Proposal Package labeled as such (including required forms) and all other required Contract Documents.

Text for all documents can be single spaced, Times New Roman, 12-point font shown in English units. Font size on tables and figures may be of any size so long as it is easily readable. Pricing shall be in US currency, in current dollars and cents. In each case in which a form is required to be submitted, it will be found in the **Contract Book 2 (Design-Build Contract)** or in **Contract Book 3 (Project Specific Information)** and its use is mandatory. Technical Proposals shall be organized and formatted as specified herein. Each Technical Proposal Response Category shall be preceded by a simple tab divider identifying the Response Category (e.g., "Response Category I," "Response Category II Design-Builder's Organization and Expertise," etc.) with each appropriate Response Category Form.

Technical Proposal pages shall be 8-½ inch x 11-inch white paper. Drawings or sketches shall be submitted on 11-inch x 17-inch and/or 8 ½-inch x 11-inch white paper. Schedule plots shall be on 8-½-inch x 11-inch or 11-inch x 17-inch paper. Double-sided pages shall be used except for pre-printed information, such as corporate brochures, and the original copy of all signed forms, which shall be single-sided.

The Technical Proposal should present information clearly and concisely. Text or other information that is difficult to read may be disregarded, potentially resulting in either a lowered score or rejection of the Proposal as non-responsive.

All Technical Proposal responses shall be easily reproducible by normal black and white photocopying machines. Color photographs, renderings and brochures shall be adequately bound and suitably protected for handling and circulation during review.

Three (3) originals and eight (8) copies of the Technical Proposal. Label the original Technical Proposals "ORIGINAL" and label each copy "COPY ___ of 8".

Price Proposals shall be submitted using Internet bidding with electronic bid bond. The Design-Builder shall not submit a hardcopy Price Proposal to the Department. The Internet bid and electronic bid bond executed by the Design-Builder and their Surety will be considered as a complete Price Proposal and will be printed at the time of the public opening. Letters recognizing the addenda to the RFP and amendments to the electronic bidding file will be posted on the Bid Express website. Design-Builder must acknowledge addenda by completing the Technical Proposal Signature Page (Form TPSP) found in RFP **Contract Book 2 (Design-Build Contract)** and placed within your Technical Proposal. Also, by submitting the EBS bid file within your Price Proposal you are also acknowledging all addenda associated with the Price Proposal. It is the bidder's responsibility to notify all affected manufacturers, suppliers and subcontractors of any change. Failure to acknowledge receipt of Addenda or to apply any applicable amendments to the electronic bidding file is grounds for rejection. The electronic bid "A" shall be the Total Bid Amount using the ATC.

There will be projects that will have numerous alternates. The will be required to bid on only one alternate for each construction item. The proper procedure for entering alternate bids is to enter prices for the intended alternate item(s) of construction and leave the undesired alternate item(s) of construction blank.

Additionally, one (1) electronic copy of the Technical Proposals and the ROW Acquisition sheets required in **Contract Book 3 (Project Specific Information),** shall be submitted in Adobe .pdf format on flash drive, organized and numbered consistent with the required organization.

1) TECHNICAL PROPOSAL

Place the required Technical Proposal forms, except the Response Category Forms, in Technical Proposal Response Category I after a tab labeled "Forms."

Technical Proposal Response Category I – There is *no page limit* on the information required to be submitted under Response Category I.

Technical Proposal Response Categories II through IV – Proposal responses to Response Categories II through IV shall be limited to the combined maximum total of 75 page count (not pages), not including section dividers and tabs, certain contract forms (Response Category Forms will be counted toward the total page count). The forms provided for response shall be used for the information requested. All information submitted in Response Categories II through IV will be counted in calculating page count, regardless of format or medium, including all materials attached to section dividers and tabs.

2) PROPOSAL PRICE

Design-Builders are cautioned that the total of price proposed in the Price Proposal "Schedule of Items" (the "A") shall become the Contract Amount upon Contract execution, and shall constitute total compensation to the selected for performing the Contract, including but not limited to all minimum Contract requirements. Therefore, the fact that a selected Design-Builder's Technical Proposal may contain elements that do not meet or exceed all minimum Contract requirements, as determined by the Department in its sole discretion, shall not entitle the selected to receive compensation in excess of the amount of the Proposal Price as a condition of performing the minimum Contract requirements or any other Contract obligation. Nor shall such fact entitle the selected to perform below minimum Contract requirements or fail to perform any other Contract obligation.

2. PROPOSAL OPENING

a. TECHNICAL PROPOSALS

The Department Alternative Contracting Assistant Director and the Design-Build Review Committee will open the Technical Proposal Package from each Design-Builder. They will determine responsiveness and the Pass/Fail rating for RC I to RC IV. Responsive and Passing Technical Proposals that meet all minimum criteria will be opened at the Proposal Due Date and time set out in this **Contract Book 1 (ITBD - Instruction to Design-Builders)** Section A.5, page 7. All technical proposals deemed non-responsive or failing to meet the minimum criteria will be notified prior to the public opening of the price proposals.

b. PRICE PROPOSALS; PUBLIC OPENING

Upon concluding its evaluation and scoring of the Technical Proposals, the Department will conduct a public opening of the Price Proposals for each responsive bid at the following location:

505 Deaderick Street, J.K. Polk Bldg.

Suite 700, Nashville, TN 37243, 7th floor Large Conference Room.

on the date and time set out in above in Section A.5, page 8.

Totals read at the opening of the Price Proposals are not guaranteed to be correct and no final award of the Contract will be made until Proposals have been checked and re-checked.

On all projects which are financed in whole or in part by funds received through Federal agencies and other third parties, the awarding of Contracts by the Department will be subject to approval or concurrence by the party or parties through which funds are received. The Department reserves the right to reject any Proposal which is not acceptable to any such third party set out above, although such bid proposal would otherwise qualify as the best Proposal in accordance with the Contract. It shall be the responsibility of the Department to determine which projects are so financed in part by third parties, such information being available upon request from the Department.

3. PROPOSAL STIPEND

A stipulated fee of **$150,000** will be awarded to each eligible Design-Builder on the short-list that provides a responsive bid, but unsuccessful, Proposal. If a contract award is not made, all Design-Builder's on the short-list that submits a responsive Proposal shall receive the stipulated fee. If the Department chooses to continue the process by revising, modifying, or issuing a new RFP, or issuing a Best and Final Offer, the stipend will only be paid to each eligible responding to the additional request and/or requirement. The Department Alternative Contracting Assistant Director will be notified of the opportunity to request to invoice for the stipulated fee from each eligible Design-Builder within thirty (30) days after the award of the Contract or the decision not to award. If the Design-Builder requests and accepts the stipulated fee, the Department reserves the right to use any ideas or information contained in the Proposals in connection with any contract awarded for the Project, or in connection with any subsequent procurement, with no obligation to pay additional compensation to the unsuccessful Proposers. Unsuccessful Design-Builders may elect not to invoice and thus refuse payment of the stipulated fee to retain any rights to its Proposal and the ideas and information contained therein.

The decision to issue a new RFP, a modified/revised RFP, or a "Best and Final Offer" indicates the Departments decision to continue with the award on or not to cancel the project; therefore the stipend will only be paid once after the conclusion of the entire procurement process.

F. PRICE PROPOSAL EVALUATION

1. PRICE PROPOSAL EVALUATION METHODOLOGY

a. PRELIMINARY EVALUATION

1) PRICE REALISM AND REASONABLENESS

The Department will make a preliminary evaluation of the Price Proposal to determine if the prices set forth reflect Price Realism and Price Reasonableness in comparison with the Departments cost estimate. In making this evaluation,

the Department may require review of Price Documents. In such case, the Design-Builder shall make itself available upon the Department's request to conduct a joint review of the Price Documents. If the Department concludes that the Price Proposal does not reflect Price Realism or Price Reasonableness, the Department will consider the Price Proposal non-responsive.

2) UNBALANCED PRICING

The Department will prepare a cost estimate prior to accepting Price Proposals. This will be used as a basis for a preliminary evaluation of the Price Proposal to determine if any of the prices are significantly unbalanced to the potential detriment of the Department. An unbalanced Proposal is considered to be one containing lump sum which does not reflect reasonable actual costs plus a reasonable proportionate share of the Design-Builder's anticipated profit, overhead costs, and other indirect costs which are anticipated for the performance of the items in question in comparison with the Departments cost estimate.

G. TECHNICAL PROPOSAL RESPONSE CATEGORIES AND REQUIRED TECHNICAL PROPOSAL CONTENT

Additional information or requirements for each Response Category, or modifications to the Response Category instructions and requirements set out below, will be identified in the **Contract Book 3 (Project Specific Information)**. **Design-Builders are therefore advised to download this Contract Book 1 (ITDB - Instruction to Design-Builders) and the Contract Book 3 (Project Specific Information) and read them together.**

Regardless of the score assigned to any Technical Proposal evaluation factor or Response Category, and notwithstanding the fact that a Proposal is selected for award, only those portions of Sections II through IV of the Technical Proposal that meet or exceed the Department's minimum Contract requirements, as determined by the Department in its sole discretion, shall be incorporated into the resulting Contract. Those portions that do not meet or exceed the stipulated criteria, as determined by the Department in its sole discretion, shall not be incorporated into the resulting Contract or modify any of the terms and conditions of the Contract.

1. RESPONSE CATEGORY I through IV

The submittals required under Response Category I through IV will be evaluated as a matter of responsibility on a pass/fail basis. Submit responses for each element of Category I through IV using the required forms as instructed acknowledging receipt of RFP, all Addenda and responses to questions, if any, issued by the Department.

a. COVER LETTER

The Design-Builder shall provide with its Technical Proposal a cover letter (maximum two pages) indicating its desire to be considered for the Project and stating the official names and roles of all Principal Participants, the Designer, and Project Manager. The Design-Builder shall identify a single point of contact and

the address and telephone and fax numbers and e-mail address to which communications should be directed. An authorized representative of the Design-Builder's organization shall sign the letter. If the Design-Builder is not yet a legal Entity or is a joint venture or general partnership, authorized representatives of all Principal Participants shall sign the letter. Additionally, if the Design-Builder wishes to add, delete, or substitute a Principal Participant, or wishes to substitute its Designer or any Key Personnel that it identified in its SOQ, the Design-Builder must make such request in this cover letter. In addition to including such a substitution or change request in its cover letter, the Design-Builder must follow the procedures and submit the information required under this RFP.

The Design-Builder shall attach to the cover letter the Acknowledgment of Receipt acknowledging receipt of RFP, all Addenda and responses to questions, if any, issued by the Department.

b. FORMS

Form Question Request (QR), Form Alternate Technical Concepts (ATC), and Response Category Forms are located in **Appendix A**. All other contract forms are located within **Contract Book 2 (Design-Build Contract) Appendix C**.

c. EVIDENCE OF CORPORATE EXISTENCE; CERTIFICATE OF AUTHORITY

Submit the following, as applicable:

- A Certificate of Good Standing issued by the Design-Builder's state of residence; or
- For Entities not residents of the State of Tennessee, a Certificate of Authority to transact business in Tennessee.

d. EVIDENCE OF AUTHORITY TO ENTER INTO JOINT VENTURE; EXECUTE JOINT-VENTURE AGREEMENT

If the Design-Builder is a joint venture; submit a copy of the joint venture agreement. Also, for each joint venturer submit the partnership agreement or corporate resolution authorizing it to enter into the joint venture and authorizing named individuals to execute the joint venture agreement on the joint venturer's behalf.

e. EVIDENCE OF PROPOSAL SIGNATORY AUTHORITY

Submit bylaws, or the corporate resolution, partnership agreement, or joint venture agreement evidencing authority of each signatory to the Technical Proposal Signature Page and Proposal Firm Offer to execute it on behalf of the Design-Builder. NOTE: If the is a joint venture or partnership, each joint venture or partner must sign the Technical Proposal Signature Page (Form TPSP).

H. PRICE PROPOSAL RESPONSE CATEGORIES AND REQUIRED PRICE PROPOSAL CONTENT

Submit responses for each element below, using the required forms where instructed. All prices quoted shall be in U.S. currency.

1. PRICE PROPOSAL CONTENTS

Design-Builders shall include each of the following in the Price Proposal:

- Electronic Price Proposal (including specified Contract Completion Time); and
- Electronic Proposal Security in the amount of five (5%) percent of the Proposal Price. Proposal Security may be submitted in the form of a Proposal Bond or Proposal Guarantee issued by an insured institution or certified check payable to the Department of Transportation.

2. INSTRUCTIONS REGARDING PREPARATION OF SCHEDULE OF ITEMS

Design-Builders shall complete and submit in compliance with the following instructions:

a. Provide a lump-sum price for each Pay Item Total in each Pay Item. The lump-sum price shall represent the total price to complete and integrate all work represented by that Pay Item into the Project, inclusive of associated overhead, labor, materials, equipment, tools, transportation and Project administration. These are not bid items and will be used as a basis in developing the cost-loaded CPM after award.
b. Utilize the same titles, contents, and limits as are shown on Schedule of Items.
c. Price Proposal supporting documentation may be requested by the Department.

I. FORMS

The following forms are required to be used in preparation of the Proposal. They are located within **Contract Book 2 (Design-Build Contract)** and **Appendix A**. The Design-Builders shall download the forms and complete them in accordance with the instructions contained in the forms and the text of this **Contract Book 1 (ITDB - Instruction to Design-Builders)** or the **Contract Book 2 (Design-Build Contract)** in which the forms are referenced.

1. DESIGN-BUILDER QUESTIONS

- FORM QR, Question Request Form.

2. TECHNICAL PROPOSAL FORMS

- RESPONSE CATEGORY FORMS II THRU IV;
- ATC FORM;
- FORM AT, ATTESTATION RE PERSONNEL USED IN CONTRACT
- FORM COI, CONFLICT OF INTEREST DISCLOSURES;
- FORM TPSP, TECHNICAL PROPOSAL SIGNATURE PAGE FORM;

3. BONDS AND FORMS TO BE SUBMITTED BY THE APPARENT DESIGN-BUILDER

- FORM CP&PB, CONTRACT PAYMENT AND PERFORMANCE BOND (submitted after award of the Contract).
- FORM LC, LOBBYING CERTIFICATE

J. PROPOSAL MEETINGS

The Department may elect to hold meetings with all Design-Builders. The Design-Builders are strongly encouraged to attend, and will be expected to bring (a) appropriate members of its anticipated Key Personnel, and if required by the Department, (b) senior representatives of the proposed Designer and proposed Technical Manager. The Department shall provide sufficient time to the Design-Builder's for travel and preparation for the meetings.

The information received by the Department will be part of the procurement process and will not be disclosed by the Department until award of the Contract, at which time the information will be subject to disclosure except as to information that is subject to exemption from disclosure under the Tennessee Open Records Law.

1. MANDATORY PRE-PROPOSAL MEETINGS

The Department does not expect to hold a pre-proposal meeting on this project; however, the Department may hold one or more mandatory pre-proposal meetings with all Design-Builder's prior to the Proposal Due Date, to provide additional opportunity for questions and comments. Failure of a Design-Builder to attend any such meetings will result in elimination of that Design-builder from the shortlist, and any Proposal submitted by that will be rejected. The decision to hold pre-proposal meetings will be disclosed by the Department no later than the date shown in Section A.5 for the anticipated deadline for issuance of the last addendum

The Department will respond, orally or in writing, to Design-Builders' questions, if any, raised at the meetings. In the event the Department determines that formal answers or change of the RFP, specifications or Contract terms is warranted, the Department will issue formal written clarifications or Addenda in accordance with the terms of **Contract Book 2 (Design-Build Contract)**.

2. ORAL PRESENTATIONS AFTER SUBMISSION OF PROPOSALS

The Department may elect, in its sole discretion, to require each to make a one-on-one oral presentation regarding the Technical Proposal. The oral presentations will be mandatory, and failure of a Design-Builder to appear and make the presentation will result in elimination of that Design-Builder from the Short-List. The Department will give no further consideration to that Design-Builder's Proposal, and that Design-Builder will be ineligible for a stipend. If the Department elects to require oral presentations, the Department will notify the Design-Builders in writing or by e-mail of the dates, times and locations, rules, requirements and protocols for the oral presentation.

The oral presentation will be an opportunity for the Design-Builders to either explain or present their Technical Proposals and respond to the Department requests for clarification, but such presentations will not be a substitute for, nor be a means to modify or augment, any part of the Technical Proposal. The oral presentations will be used by the Department to assist in the evaluation of the Technical Proposals, and the information from the oral presentations may be used by the Department to evaluate the Technical Proposal Score.

K. CHANGES IN DESIGN-BUILDER'S ORGANIZATION AFTER SUBMITTAL OF SOQ

Key Personnel identified in the SOQ shall not be modified in the Technical Proposal without written approval of the Department. Any request for modification shall be sent to the Department Alternative Contracting Assistant Director. The written approval to modify the Key Personnel shall be included in Technical Proposal Response Category I. Failure to comply with this requirement may be justification for removing the Design-Builder from further consideration for this Project.

The must submit with any request the same information about the proposed Principal Participant or team member that was originally required to be submitted in the SOQ, including legal and financial information (pass/fail) and Technical evaluation information. If a Major Participant is being added, deleted, or substituted, the must submit such additional information as may be required by the Department to demonstrate that the changed organization still meets the RFQ criteria upon which short-list selection was based.

L. MODIFYING A PROPOSAL PRIOR TO PROPOSAL DUE DATE

1. ERASURES, INTERLINEATIONS, STRIKEOUTS

If the initial Proposal has been modified by hand-written interlineations, strikeouts, or erasures, **EACH** such alteration must be initialed in blue ink by the signatory to the Technical Proposal and submitted to the Department Alternative Contracting Assistant Director.

2. SUBSEQUENT TO THE INITIAL SUBMITTAL

Subsequent to Proposal submittal, a Design-Builder may submit written modifications identified either by redlined text or on Design-Builder's letterhead indicating the revisions with reference to the Proposal or form section, subsection, paragraph (if applicable) and page number. The must submit with its Proposal modifications an affirmation signed by each of the original signatories that the modifications amend the terms of the Proposal previously submitted and submitted to the Department Alternative Contracting Assistant Director.

M. WITHDRAWING A PROPOSAL

1. BY WRITTEN NOTICE

A Design-Builder may withdraw its Proposal prior to the Proposal due date by submitting written notice to the Department Alternative Contracting Assistant Director on the Design-Builder's letterhead signed by an authorized representative. The notice must include the name and telephone number of the Design-Builder's representative that will be contacted to arrange for the Design-Builder to retrieve the withdrawn Proposal.

2. IN PERSON

A Design-Builder may withdraw its Proposal in person prior to the Proposal Due Date upon presentation of identification and evidence of authorization to act for the Design-Builder. If possible, the Department will return all Proposal materials at the time an in-person withdrawal is presented. However, Proposals are in the possession of one individual and are available only when that person is present.

3. SUBSEQUENT PROPOSAL SUBMITTAL NOT PRECLUDED

Withdrawal of a Proposal will not preclude a Design-Builder from subsequently submitting a new Proposal, so long as that new Proposal is properly submitted and received by the Department's Alternative Contracting Assistant Director prior to the Proposal Due Date.

If the Design-Builder withdraws their Proposal and the Department chooses to issue a new, revised, or modified RFP after the Proposal Due Date (as stated in Section T), the Design-Builder must state within their withdraw written notice their request to be considered eligible to submit a Proposal in this instance. If the withdrawal is in person or the written notice does not state this request, the Design-Builder will no longer be considered eligible for the Project.

N. CONFLICT-OF-INTEREST DISCLOSURE REQUIREMENTS

If the Design-Builder finds that a Principal Participant, Design Professionals, or any Key Personnel listed in its SOQ is no longer eligible to be part of its organization or team for this procurement due to a conflict of interest (as defined in 23 CFR 636), if the Design-Builder's organization has changed since submittal of the Design-Builder's SOQ, or if additional potential conflicts of interest have developed since the Design-Builder's submittal of its SOQ, the Design-Builder shall comply with the following disclosure requirements.

1. THE DESIGN-BUILDER ORGANIZATION CHANGE OR ADDITIONAL POTENTIAL CONFLICTS OF INTEREST

If the Design-Builder's organization has changed and the change has been approved by the Department per Section G., or additional potential conflicts of interest have developed since the Design-Builder's RFQ submittal, the Design-Builder shall submit

with its Proposal a new RFQ submittal for that SOQ Section and making a full disclosure of all potential 23 CFR 636 organizational conflicts of interest other than those already disclosed in the SOQ. If the Design-Builder's organization has not changed and no additional potential conflicts of interest have developed since initial submittal of the Design-Builder's SOQ, the Design-Builder shall submit a signed statement that no potential 23 CFR 636 organizational conflicts currently exist other than those already disclosed within the Design-Builder's SOQ. Also see **Design-Build Standard Guidance**, and the COI Guidelines provided with Form COI regarding State conflict of interest standards and disclosure regarding former the Department employees.

2. SUBCONTRACTORS

The Design-Builder shall include in its subcontracts a completed Conflict of Interest statement from each Subcontractor for whom the Design-Builder will utilize on the Project. The Design-Builder shall provide each Subcontractor with the Department's "Conflict of Interest Guidelines, and Disclosure Process" attached hereto.

O. PROPOSALS RESPONSIVENESS, RESPONSIBILITY AND REJECTION

1. SUBSTANTIAL COMPLIANCE REQUIRED

The Department may in its discretion reject any Proposal that does not substantially comply with the requirements set forth in the RFP, including this **Contract Book 1 (ITDB – Instruction to Design-Builders)**, and applicable public procurement procedures.

2. RESPONSIVENESS

The Department has determined that failure to properly submit the following items (all contract forms are located in **Contract Book 2 (Design-Build Contract)**) and in **Contract Book 3 (Project Specific Information)** will render the Proposal non-responsive:

- Technical Proposal;
- Technical Proposal Response Category Forms;
- Technical Proposal approved ATC Form, if utilizing ATC (In Appendix);
- Electronic Bid Price Proposal Schedule of Items;
- Electronic Proposal Bond or Electronic Proposal Guarantee; and
- USB drive with the Technical Proposal and the ROW Acquisition sheets.

3. COMPLETENESS

The following items must be properly submitted for a complete Proposal:

- Technical Proposal Forms (In RC Category I)
  - Form QR (This is the most current FORM QR with all Department answers);
  - Form AT;

- Form COI;
- Form TPSP;
- Form LC (Submit Blank if not applicable);

4. UNINTENTIONALLY INCOMPLETE OR OMITTED PROPOSAL RESPONSES

Unless the Department, in its discretion, determines that a submitted Proposal is not in substantial compliance with RFP requirements, unintentionally incomplete, qualified, or omitted responses to the Technical Proposal, unlike the omission of any required submittals above, will be dealt with as a matter of Proposal scoring/review as opposed to responsiveness.

5. THE DEPARTMENT"S RIGHT TO SEEK CLARIFICATION; WAIVER

As permitted by Law, the Department Points of Contact may seek clarification of or discuss any response with the Design-Builder, in the Department's sole discretion, and the Department may waive minor informalities and irregularities it deems necessary or advisable that the best interest of the Department and/or the public will be promoted thereby.

As permitted by Law, the Department may hold meetings and conduct discussions and correspondence with one or more of the Design-Builders responding to this RFP to seek an improved understanding and evaluation of the responses to this RFP.

6. RESPONSIBILITY AND REJECTION OF PROPOSALS

The Department will reject any Proposal submitted by a Design-Builder that does not meet the applicable standards of responsibility.

7. REJECTION IN THE PUBLIC INTEREST

The Department reserves the right to reject any Proposal at its discretion. The Department may reject all Proposals for good cause upon a finding that to do so is in the public interest.

P. CONFIDENTIALITY

Documents submitted pursuant to this RFP will be subject to the Tennessee Open Records Law, TCA §§ 10-7-503 to 10-7-506, et. seq. Information submitted will be kept confidential until award by the Department, unless otherwise provided by law. The State shall not be liable for disclosure or release of information when authorized or required by Law to do so. The State shall also be immune from liability for disclosure or release of information.

Q. PROPOSAL BOND

1. REQUIREMENTS

- Each Proposal must be accompanied by a Design-Builders bidder's bond, in an amount of equaling not less than five (5%) percent of the Proposal Price electronically through Bid Express.
- If the Design-Builders bidder's bond is offered as guaranty, the bond must be made by a surety company, qualified and authorized to transact business in the State of Tennessee and must be acceptable to the Department.

R. APPARENT DESIGN-BUILDER REQUIRED SUBMITTALS

Within ten (10) Calendar Days of the date of the delivery of the Contract by the Department, the apparent Design-Builder shall provide the Department, in writing the following:

1. PAYMENT AND PERFORMANCE BOND

A Contract Payment and Performance Bond, in the amount of 100 percent of the Contract Amount on the form furnished by the Department (Form CP&PB).

2. INSURANCE CERTIFICATES

Insurance certificates evidencing the required insurance coverage. (Refer to the **Design-Build Standard Guidance**).

3. EVIDENCE OF AUTHORITY

- The names of all signatories to the anticipated Contract, their capacities and the names of their respective principals if not already provided.
- Corporate Resolutions or Bylaws evidencing the authority of each named signatory to act for its principal in executing the Contract and bind the principal to the terms of the Contract, if not already provided.

4. LICENSES

Evidence that the Apparent Design-Builder and its personnel are properly licensed to perform the work, unless previously provided.

5. ATC BREAKDOWN COST SAVINGS

Price Proposal ATC Breakdown, only if an approved ATC was submitted (format will be a one page summary of the Contract Amount including the original cost for Base Technical Concept cost minus ATC cost savings).

S. MODIFICATION OF CONTRACT

The Department may make modifications to the Contract as it may determine, in the exercise of its sole discretion, to be necessary to fully incorporate the terms of the Apparent Design-Builder's Proposal, to correct any inconsistencies, ambiguities, or errors that may

exist in the Contract, and to clarify Contract terms, including technical requirements and specifications, if any. If, in the Department's sole discretion, it determines that the parties will be unable to reach a mutually-acceptable Contract, the Department may terminate discussions with the Apparent Design-Builder. The Department will then continue the process of discussion with the next highest-ranked Design-Builder until the Department either successfully executes a Contract or cancels the procurement.

The Department may investigate the qualifications of any Design-Builder under consideration, may require confirmation of information furnished by a Design-Builder, and may require additional evidence of qualifications to perform the Work described in this RFP.

T. MODIFIED OR NEW RFP ISSUANCE

The Department reserves the right, in its sole and absolute discretion, to:

- Reject any or all Proposals.
- Issue new RFP.
- Cancel, modify, or withdraw the RFP in their entirety.
- Solicit subsequent "Best and final offer" (BAFO) from Design-Builders.
- Modify the RFP process (with appropriate notice to Design-Builders).

A BAFO is a change to a design-builder's technical and/or price proposal made at the request of, or as allowed by, the Department within a best and final offer RFP after the solicitation closing date when all price proposals exceed an acceptable range of the Department's estimate. In the event initial price proposals exceed an acceptable range of the Department's Estimate may choose to make amendments to the details of the RFP and request a Best and Final Offer within a new RFP called a "Best and Final Offer" RFP.

Alternately, the Department reserves the right to redistribute a new or modified RFP for the project, outside the issuance of a BAFO RFP, to the eligible shortlisted firms if in the judgment of the Department that the best interest of the Department or the public will be promoted.

This may occur at any time prior to the execution by the Department of the Design-Build Contract, without incurring any obligations or liabilities.

U. CONTRACT EXECUTION; DELIVERY OF REQUIRED DOCUMENTS

1. BY APPARENT DESIGN-BUILDER

The Apparent Design-Builder must execute three (3) originals of the Contract and return the executed originals, together with (a) the rest of the Contract (Technical (*Exhibit A*) and Price Proposals) and (b) the Apparent Design-Builder required submittals set out above in this **Contract Book 1 (ITDB - Instruction to Design-Builders)**, to the Department within ten (10) Calendar Days of the date of the delivery of the Contract by the Department, or within such longer period as the Department may set in writing prior to or during the response period established herein. The Apparent

Design-Builder's failure to execute and deliver the duly-executed Contract, Contract, and required submittals to the Department within the response period, will result in (a) forfeiture of the Proposal Security as Liquidated Damages payable to the Department, and (b) the Department's commencement of discussions with the second highest-ranking Design-Builder. If the Apparent Design-Builder is a joint venture or partnership, each joint venture member or partner must sign the Contract on behalf of both itself and Design-Builder.

2. BY THE DEPARTMENT

If the Department fails to execute the Contract and deliver to the Apparent Design-Builder an original of the Contract within forty-five (45) Calendar Days following receipt of the Apparent Design-Builder's duly-executed Contract, and other required submittals, the Design-Builder shall have the right to withdraw the Proposal without penalty.

The following information applies to Federal-Aid construction projects:

To report bid rigging activities call: 1-800-424-9071

The U.S. Department of Transportation (DOT) operates the above toll-free "hotline" Monday through Friday, 8:00 a.m. to 5:00 p.m. eastern time. Anyone with knowledge of possible bid rigging, bidder collusion, or other fraudulent activities should use the "hotline" to report such activities.

The "hotline" is part of the DOT's continuing effort to identify and investigate highway construction contract fraud and abuse and is operated under the direction of the DOT Inspector General. All information will be treated confidentially and caller anonymity will be respected.

Nothing in this **Contract Book 1 (ITDB - Instruction to Design-Builders)** shall be construed to obligate the Department to enter into a Contract with any Design-Builder.

APPENDIX A

CONTRACT BOOK 1 (ITDB - INSTRUCTIONS TO DESIGN-BUILDERS) FORMS

FORM NAME	FORM DESIGNATION
ALTERNATE TECHNICAL CONCEPTS (ATC) SUBMITTAL	FORM ATC
RFP QUESTION REQUEST	FORM QR
RESPONSE CATEGORY II	FORM RC II
RESPONSE CATEGORY III	FORM RC III
RESPONSE CATEGORY IV	FORM RC IV
Receipt of Addenda/Clarifications	FORM C

ALTERNATE TECHNICAL CONCEPTS (ATC) SUBMITTAL

For TDOT use only					
The ATC:					
☐	Is Approved	☐	Does not qualify as an ATC, but may be included in the Proposal without an ATC.	☐	Is Conditionally approved with identified conditions attached.
☐	Is Not approved	☐	Does not qualify as an ATC and may not be included in the Proposal.	☐	Is Deemed to take advantage of an error or omission in the RFP and will not be considered. The RFP will be revised to correct this.

1. Design-Builder Name:

2. Name of Project: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (DB2101)

3. Description. A detailed description (attach schematic drawings) of the configuration of the ATC or other appropriate descriptive information (including, if appropriate, product details [i.e., specifications, construction tolerances, special provisions] and a traffic operational analysis, if appropriate).

4. Usage. Where and how the ATC would be used on the Project.

5. Deviations. References to all requirements of the RFP those are inconsistent with the proposed ATC, an explanation of the nature of the deviations from said requirements, and a request for approval of such variance(s).

6. Analysis. An analysis justifying use of the ATC and why the variance to the requirements of the RFP should be allowed.

7. Impacts. Discussion of potential impacts on vehicular traffic, environmental impacts identified, community impact, safety and life-cycle Project impacts, and infrastructure costs (including impacts on the cost of repair and maintenance).

8. History. A detailed description of other projects where the ATC has been used, the success of such usage, and names and telephone numbers of project owners that can confirm such statements.

9. Risks. A description of added risks to TDOT and other entities associated with implementing the ATC.

10. Costs. A description of the ATC implementation costs to TDOT, the Design Builder, and other entities (right-of-way, utilities, mitigation, long term maintenance, etc.).

RFP QUESTION REQUEST
FORM QR

PROJECT: I-75 Interchange Modification at I-24, Phase 2 (IA)

DB CONTRACT No.: DB2101 DATE:

RFP Book No. and Section ID	Question	Reserved for Agency Response

RFP QUESTION REQUEST
FORM QR

RFP Book No. and Section ID	Question	Reserved for Agency Response

RESPONSE CATEGORY II: ORGANIZATION

1. Design-Builder Name:

2. Name of Project: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (DB2101)

3. Describe responsibilities and reporting relationships or chain of command clearly identifying assignments of various tasks for Design and Construction Functions, Key Personnel and Design Professionals. ☐ Organizational Chart included.

4. Description of those categories of work which the Design Builder anticipates will be performed by the Design Builder's own forces and those categories which will be performed by Subcontractors.

5. Plans and procedures for management of Subcontractors

RESPONSE CATEGORY II: PROJECT EXPERTISE

1. Design-Builder Name:

6. Name of Project: I-75 at I-24 Interchange Modification, Hamilton County (DB1801)

2. The Design-Builder is encouraged to identify all major subcontractors in the Technical Proposal as omission of this information may affect the evaluation under this evaluation criterion.

3. Describe the overall strengths of the Design Team and their ability to fulfill the design requirement of this Project.

RESPONSE CATEGORY III: PROJECT UNDERSTANDING

1. Design-Builder Name:

2. Name of Project: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (DB2101)

3. Describe or outline the objectives, goals, and tasks to show or demonstrate the Design Builder's view and understanding of the nature of the contract. Consider if the Scope of Services in this RFP is sufficient to attain the Department's goals and objectives.

4. Identify any potential right-of-way and Utility impacts or state no potential impacts. If impacts, identify innovative approaches to minimize any impacts to the right-of-way and/or to the Utility.

RESPONSE CATEGORY III: SCHEDULE MANAGEMENT

1. Design-Builder Name:

2. Name of Project: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (DB2101)

3. Describe or outline the assumptions upon which the CPM Schedule was based, risks, constraints, contingencies, sequence of work, the controlling operation or operations, intermediate completion dates, Milestones, project phasing, anticipated work schedule and estimated resources that impacted the schedule.

   ☐ CPM Schedule included in the Proposal.

   The CPM Schedule shall indicate how the Design Builder intends to:

   - Divide the Project into work segments to enable optimum construction performance and explain the planned sequence of work, the critical path, proposed phasing of the Project, and any other scheduling assumptions made by the Design Builder.
   - Plans and procedures to insure timely deliveries of materials to achieve the Project schedule.
   - Categories of work that Design Builder anticipates will be performed by Design Builder's own direct labor force, those categories that will be performed by Subcontractors, those categories that will be performed by project specific teams, and those categories that will be performed by existing teaming arrangements.

   Provide an explanation of Design Builder's methodology for updating the CPM.

4. Describe Pay Item Breakdowns, including the physical features and activities included in the Pay Item, and all work included in the Pay Item Totals as reflected on the Schedule of Items.

5. Describe the Design Builder Issue Resolution Plan

RESPONSE CATEGORY III: PROJECT MANAGEMENT

1. Design-Builder Name:

2. Name of Project: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (DB2101)

3. Describe how the Design Builder would bring experience, expertise, innovation, and "not business as usual" skills in leadership and technical ability.

4. Describe the administrative and operational structure that would be used to perform the proposed work, including:

   - Management plan to attain the necessary staff required.

   - Describe how design personnel will interface with the construction personnel.

   - Communicating and coordinating between TDOT and the Design Builder. Include the approach for change management during construction for design initiated, field initiated, and TDOT-initiated changes.

   - Describe existing design and/or construction quality management plan(s) that the Design Builder may have already developed, and how it (they) will be implemented into work performed. Describe coordination of design and construction activities to ensure consistency in quality. Explanation of how independence of quality staff and function will be maintained. Indicate the minimum number of inspectors that will be supplied at different stages during the Project duration.

   - Approach to managing costs under this Contract while fulfilling required tasks and assuring quality of work.

   - Describe or outline the process for constructability, durability, maintainability, safety, aesthetics and environmental mitigation in the design and construction processes.

   - Describe or outline the process for coordinating design and construction functions, including both design and construction components and all Subcontractor activities. Include a brief description (Construction Management Plan) of the Design Builder proposes to deal with unexpected disruptions (e.g., weather- or accident-related).

RESPONSE CATEGORY III: PROJECT MANAGEMENT

- Describe or outline the process (Design Review Plan) on how the Design Builder will facilitate and implement Design Reviews as required under the Contract. Describe how the Designer and the design staff will be involved during construction. Also include the Design Builder's Construction Staging and Phasing Plan, indicating timing and sequencing of major activities for the Project.

- Describe or outline the process (Diversity Plan) of the plan to ensure projected subcontracting plan is applied at all tiers. Describe how the Design Builder will achieve the goal set forth on this project. Identify DBE and EEO representatives and their roles and responsibilities and identification of specific strategies and approaches that will be taken by the Design Builder to meet the requirements of the Affirmative Action and Equal Employment Opportunity provisions described in **DB Standard Guidance**.

RESPONSE CATEGORY III: ENVIRONMENTAL COMPLIANCE

1. Design-Builder Name:

2. Name of Project: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (DB2101)

3. Identify any potential environmental impacts.

4. Describe or outline the process for environmental compliance.

5. Describe or outline the approach to Erosion Prevention and Sediment Control for the Project.

6. Describe or outline the understanding of the overall approach to permitting and the comfort level with obtaining the required permit application/ modification within the allowed timeframe.

7. Identify innovative approaches to minimize any impacts in environmentally sensitive areas.

8. A description of instances on projects within the last three years where there has been success in meeting and/or exceeding environmental performance standards and permit conditions. If none, state none.

9. A description of instances on projects within the last three years where the Design-Builder, including Major Participants and Subcontractors have not met environmental performance standards and permit conditions. For each of these instances, describe the non-compliance act, the reason(s) the non-compliance act occurred, plans implemented to correct the non-compliance act and lessons learned from these instances, and internal procedures developed to ensure similar issues do not occur on future projects. If none, state none.

RESPONSE CATEGORY III: INNOVATION

1. Design-Builder Name:

2. Name of Project: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (DB2101)

3. Identify any innovative design or construction solutions that the Design Builder considers innovative and how those solutions will better serve the Project. Include a description of ideas that were considered, whether implemented or not.

4. Identify any potential innovation in traffic control and how those solutions will better serve the Project. Describe any temporary impacts and associated with innovations.

5. Will these innovations add to, subtract from or have no effect on the costs?

RESPONSE CATEGORY IV: TECHNICAL SOLUTION

1. Design-Builder Name:

2. Name of Project: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (DB2101)

3. Conceptual Plans, Drawings:
   - ☐ Plan View of design concepts with key elements noted included.
   - ☐ Preliminary horizontal and vertical alignments of all roadway elements included.
   - ☐ Typical Sections included.

4. Identify drainage modifications and designs to be implemented.

5. Identify the appropriate design criteria for each feature if not provided.

6. Identify all bridge types to be constructed, including any special design features or construction techniques needed.

7. Identify any deviations or proposed design exceptions, from the established design criteria that will be utilized. Explain why the deviation is necessary. Describe any geotechnical investigations to be performed by the Design-Builder.

8. Describe how any utility conflicts will be addressed and any special utility design considerations. Describe how the design and construction methods minimize TDOT's utility relocation costs. If none, state none.

9. Describe how the design will affect TDOT right-of-way costs. If none, state none.

10. Identify types of any retaining walls and /or noise walls if applicable. If none, state none.

11. Identify any aspects of the design or construction elements that are considered innovative. Include a description of alternatives that were considered, whether implemented or not. Attach a copy of any approved ATCs used in this Technical Proposal. If none, state none.

RESPONSE CATEGORY IV: TECHNICAL SOLUTION

12. Describe any traffic control requirements that will be used for each construction phase. Describe how traffic will be maintained as appropriate and describe understanding of any time restrictions noted in the RFP. Specifically describe how business and residential access will be maintained, if applicable. Describe any required road closures and duration thereof.

13. Describe the safety considerations specific to the Project. Discuss overall approach to safety. Describe any proposed improvements that will be made prior to or during construction that will enhance the safety of the work force and/or traveling public both during and after the construction of the Project.

Form C
Receipt of Addenda/Clarifications

Design-Build Project: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (DB2101)

Design-Builder's Name: _____

The undersigned acknowledges receipt of the addenda to the RFP as indicated below.

ADDENDA

Addendum/Clarification No.	_____	Dated	_____
Addendum/Clarification No.	_____	Dated	_____
Addendum/Clarification No.	_____	Dated	_____
Addendum/Clarification No.	_____	Dated	_____
Addendum/Clarification No.	_____	Dated	_____

Failure to acknowledge receipt of all addenda may cause the Proposal package to be considered non-responsive to the solicitation. Acknowledged receipt of each addendum must be clearly established and included with response to this RFP.

By: _____ Print Name: _____

Title: _____ Date: _____

DESIGN-BUILD
RFP CONTRACT BOOK 2
DESIGN-BUILD CONTRACT

TENNESSEE DEPARTMENT OF TRANSPORTATION

I-75 Interchange Modification at I-24, Phase 2 (IA)

Hamilton County- TENNESSEE

CONTRACT NUMBER: DB2101

May 27, 2022

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DESIGN-BUILD CONTRACT

THIS Design-Build Contract is entered into by and between the State of Tennessee, acting by and through the Department of Transportation (the "Department") and---------- (the "Design-Builder"), (collectively, the **"**Parties**"**) as of the Effective Date of the Contract.

RECITALS

WHEREAS, the Department requires the improvements for the project known as the **I-75 Interchange Modification at I-24, Phase 2 (IA) Hamilton County** - TENNESSEE Design-Build Project (the "Project") more particularly described in **Contract Book 1 (ITDB - Instructions to Design-Builders)** and **Contract Book 3 (Project Specific Information)**. The Project will be funded with state and federal dollars, thereby requiring that the Design-Builders adhere to all pertinent state, federal, and local requirements.
and

WHEREAS, the parties intend for the Contract to be a lump-sum Design-Build contract obligating the Design-Builder to perform all work necessary to complete the Project by the deadlines specified herein, for the Contract Amount, subject only to certain specified limited exceptions. To allow the Department to budget for the Project and to reduce the risk of cost overruns, the Contract includes restrictions affecting Contractor's ability to make claims for an increase to the Contract Amount or an extension of the Completion Deadlines. The Department may require additional related work within the general vicinity of the Project which, if required, shall be included in the Project and added to the Contract by Change Order;

and

WHEREAS, the Department requires a Design-Builder competent to perform all work necessary to complete the Project in accordance with the terms and conditions of the Contract, and able to do so within the Contract Time allocated herein. If the Design-Builder fails to complete the Project within the time limitations set forth in the Contract, then the Department will suffer substantial losses and damages. The Contract therefore provides that a deduction shall be made from monies due the Design-Builder, not as a penalty, but as Liquidated Damages, as stated in **Contract Book 3 (Project Specific Information),** if such completion is delayed;

and

WHEREAS, Design-Builder asserts that it is competent and prepared to perform all work necessary to complete the Project in accordance with the terms and conditions of the Contract, and that it is able to do so within the Contract Time allotted herein;

WHEREAS, the Department is authorized under Section 54-1-119 of the Tennessee Code Annotated to enter into this Contract;

NOW, THEREFORE, in consideration of the mutual promises contained herein, and for other good and valuable consideration, the Department and the Design-Builder agree as follows:

AGREEMENT

A. GENERAL CONTRACT PROVISIONS, DEFINED TERMS AND GENERAL SCOPE OF WORK

1. INCORPORATION OF RECITALS

The foregoing Recitals incorporated herein and made a part hereof for all purposes as if fully set forth constitute additional promises or representations and warranties of the Parties.

2. CONTRACT DOCUMENTS

The Contract Documents, made a part hereof for all purposes as if fully set forth, are intended to reflect the complete understanding of the Parties concerning their respective rights and responsibilities under the Contract.

3. EFFECTIVE DATE

The Contract shall become effective on the date on which each Party has signed this Contract and all approvals have been obtained (the "Effective Date").

4. THE CONTRACT

The Contract, which includes this **Contract Book 2 (Design-Build Contract)** and all other Contract Documents, forms the entire agreement between the Parties.

5. DEFINED TERMS AND ACRONYMS

Defined terms and acronyms utilized in **Contract Book 1 (ITDB - Instructions to Design-Builders)**, this **Contract Book 2 (Design-Build Contract), Contract Book 3 (Project Specific Information)** and in the other Contract Documents are either set forth in **Design-Build Standard Guidance**, or defined in the text accompanying the term.

6. APPLICABLE VERSION OF LAW OR STANDARD

All work shall be performed pursuant to the applicable law and in accordance with the standards in effect at the time of the RFP issuance, including addenda, unless otherwise specified in the Contract or by amendment.

7. MINIMUM CONTRACT REQUIREMENTS

a. DEPARTMENT SUPPLIED

Among the Contract, the Department has mandated certain Contract requirements from which the Design-Builder may not deviate in the scope of the work, except as instructed by the Department. The Department has also established certain minimum Contract requirements that set a minimum standard of performance or quality that the Design-Builder must meet or exceed in performance of the Contract.

b. DESIGN-BUILDER SUPPLIED

Design-Builder has established certain minimum Contract requirements located in *Exhibit A* (Design-Builder's Technical Proposal), consisting of those provisions of its Proposal that meet or exceed minimum Contract requirements established by the Department and upon which the Department has relied in awarding the Contract to the Design-Builder.

Any non-standard Department specification or provision shall be considered the Design-Builder-supplied Contract provisions and requires Department Review and Approval which will obligate the Design-Builder within this the Contract.

c. MANAGEMENT PLANS

A Transportation Management Plan is required, pursuant to the **Design-Build Standard Guidance**. A Quality Plan, Safety Plan and Health, Environmental Compliance Plan or other management plans (e.g. a Project Management Plan), pursuant to the **Design-Build Standard Guidance,** have to be submitted under this Contract.

8. RIGHT- OF-WAY/UTILITY COORDINATION SERVICES

Right-of Way (ROW) and Utility Coordination and acquiring services are expected under this Contract. See **Contract Book 3 (Project Specific Information)** for information on ROW services, ROW acquisition and ROW acquisition cost and/or Utility Coordination services required for the Design-Builder's Technical Proposal.

9. DESIGN SERVICES

The design services required under the Contract shall include, at a minimum, each of the following:

- Performance of all design services, including but not limited to roadway design, pavement design, geotechnical design, environmental design, drainage design, structural design, hydraulic/hydrologic design, traffic control and survey;
- Performance of all other engineering design services required under the Contract and/or otherwise necessary to complete the work in accordance with all Contract requirements; and
- All Design Documents and Design Reviews shall be provided by the Design-Builder and performed in accordance with the Design Review schedule established in the Critical Path Method (CPM) Schedule, and in accordance with all Contract requirements.

All design services to be performed under the Contract are appurtenant to construction services being provided by the Design-Builder.

a. LICENSE REQUIREMENTS; STANDARD OF CARE

Whether the Design-Builder is a design professional, has a design professional as a member or on staff, or will otherwise provide an outside source to perform the services of a design professional, all design services (whether constituting the

practice of architecture, the practice of engineering, the practice of surveying, or the practice of other design services) referred to in this Contract shall be provided by duly-licensed and competent design professionals employed or otherwise retained by the Design-Builder. The design professionals currently designated to provide such design services are listed in Subsection 3.4. All design services shall be performed by a design professional of the appropriate professional discipline in accordance with the degree of skill and care ordinarily used by competent practitioners of the same professional discipline under similar circumstances, taking into consideration the contemporary state of the practice and the project conditions.

b. DESIGN DOCUMENTS

The Design-Builder shall generate and provide to the Department all Design Documents. The Design-Builder shall make a comprehensive design check and Design Review at the following five (5) stages of design development, stated in more detail within **Design-Build Standard Guidance**:

- Definitive Design;
- Interim designs;
- Readiness-for-Construction Plans, Specification and quantity estimates;
- Working Plans;
- As Built Plans.

1) READINESS-FOR-CONSTRUCTION PLANS AND SPECIFICATIONS

Upon completion of the Definitive Design Reviews, Working Plan Design Reviews, Interim Design Reviews (if any), and Readiness-for-Construction Design Reviews, as specified in the **Design-Build Standard Guidance**, the Design-Builder shall finalize the Readiness-for-Construction Plans and Specifications. In performing these services, the Design-Builder shall meet the following requirements:

- Readiness-for-Construction Plans and Specifications shall comply with all applicable Laws and all Contract requirements.
- Readiness-for-Construction Plans and Specifications shall be a complete, fully coordinated, integrated package, without any significant modifications or further clarifications required.
- The Design-Builder shall file all documents required for the approval of Authorities having jurisdiction over the Project, shall obtain all necessary permits not obtained by the Department, and shall pay for all associated fees, including application, filing, plan review, and appeal fees.
- The Design-Builder shall provide the Department with written certification and all Design Documents required for the Readiness-for-Construction certification, in accordance with **Design-Build Standard Guidance**.

- The Design-Builder shall submit to the Department all documentation and Design Quality Records required under **Design-Build Standard Guidance**.
- The Design-Builder shall submit to the Department As-Built Plans and the Design-Builder Specifications, compiled and organized in accordance with all Contract requirements that incorporate all changes in the design and construction of the Project.
- The Design-Builder shall prepare and deliver to the Department all As-Built Plans, the Design-Builder Specifications, and other Design Documents, information, and data required under the Contract to be provided to the Department.

2) VALUE ENGINEERING COST PROPOSALS

During development of the Design Documents, the Design-Builder and the Department may collaborate on identifying, evaluating and implementing value engineering cost proposal (VECP) options in accordance with **Design-Build Standard Guidance**. The Design-Builder's development of the Design Documents and completion of the Readiness-for-Construction Plans and Specifications shall not preclude further identification and implementation by the Design-Builder and the Department of additional cost-reduction options during construction. VECPs adopted by the Department will be implemented through Change Orders pursuant to **Design-Build Standard Guidance**.

10. CONSTRUCTION SERVICES

The construction services required under the Contract shall include, at a minimum, each of the following:

- Performance of all construction services, including but not limited to construction and removal, if required, of temporary and/or permanent roadway, structures, and erosion prevention and sediment control, materials testing, signing, traffic control, paving and pavement markings;
- Protection of environmental resources, including plant and animal life and associated habitats; and
- Performance of all other construction services required under the Contract and/or otherwise necessary to complete the work in accordance with all Contract requirements

The Design-Builder shall provide all necessary work to furnish to the Department complete, fully-functional road improvements specified in **Design-Build Standard Guidance**, capable of being fully utilized for the purposes described in the Contract, and constructed in compliance with all Contract requirements. The Design-Builder shall perform the construction services as follows:

- The Design-Builder shall supervise and administer all construction activities in accordance with Contract requirements.

- In the event of the existence of any dispute between the Parties under the Contract, the Design-Builder shall continue to perform in accordance with the Contract terms and seek resolution in accordance with **Design-Build Standard Guidance.**
- The construction work shall be of good quality, free from faults and defects, and in conformance with all Contract requirements. At its own expense, the Design-Builder shall correct construction work that does not conform to these requirements.
- The Design-Builder shall utilize new materials and equipment in the work, unless otherwise specified in the Contract.
- The Design-Builder shall pay all taxes, fees, and costs associated with the acquisition of tools, equipment, materials, and the performance of the work, in accordance with **Design-Build Standard Guidance**.
- The Design-Builder shall comply with all applicable laws.
- The Design-Builder shall keep the work location and its vicinity free from accumulation of waste materials and rubbish caused by the Design-Builder's operations.
- The Design-Builder shall notify the Department when the work or an agreed upon portion thereof has been completed, in accordance with **Design-Build Standard Guidance**.
- The Design-Builder shall maintain, on the work location, a copy of all approved Management Plans, environmental permits, approved design documents, project records and the entire Contract and any other document required in accordance with **Design-Build Standard Guidance.**
- As the Project constitutes "Highway construction" utilizing Federal funds, the Design-Builder shall comply with any Federal requirements and appropriate Department Special Provisions as provided by **Design-Build Standard Guidance** and **Contract Book 3 (Project Specific Information)**, respectively. Consistent with **Design-Build Standard Guidance**, the Design-Builder shall be fully responsible for initiating, maintaining, and supervising safety precautions and programs in connection with the work, including but not limited to, taking reasonable precautions to ensure the safety of, and prevention of damage, injury, or loss to:
  - Employees of the Department present on or in the vicinity of a work location, employees of the Design-Builder and other persons performing work on or in the vicinity of a work location, and other persons, including the traveling public, who may be affected;
  - Materials and equipment to be incorporated into the Project;
  - Portions of the Project under construction or completed; and
  - Other property within or adjacent to a work location.
- The Design-Builder shall be liable for damage to or loss of property at work locations and on private property affected by the Design-Builder's activities, pursuant to **Design-Build Standard Guidance**. This subparagraph shall in no way affect the applicability or coverage of the bonds and insurance required under Section 7.0 of this Contract.

- The Design-Builder shall deliver to the Department all notices regarding completion of the work pursuant to **Design-Build Standard Guidance**.
- The Design-Builder shall perform all other construction work required to complete the Project in conformance with all Contract requirements, including Legal Requirements.

11. QUALITY MANAGEMENT SERVICES

Quality Management services will include performance, at a minimum, of all activities and obligations, including preparation of all documentation, described in **Design-Build Standard Guidance**, and as otherwise necessary to ensure that the work is performed in accordance with all Contract requirements.

12. PROJECT MANAGEMENT SERVICES

Project management services shall be integrated with the design services and construction services described herein and in the Contract, and shall include, at a minimum, the following:

- Project Controls (including Risk Management, Scheduling, Reporting and Document Management).
- Construction management;
- Contract management;
- Safety management; and
- Traffic management.

B. GENERAL STANDARDS FOR PERFORMANCE OF THE WORK

1. GOOD FAITH

The Design-Builder shall provide and perform all design services, quality management, project management, and construction services in good faith and as expeditiously as is consistent with the applicable standards of skill and care ordinarily exercised by members of the profession under similar conditions and circumstances, and the orderly prosecution of the work.

2. PERFORMANCE STANDARDS

Where specific performance standards for any aspect of the work have been established in the Department Special Provisions as stated in Appendix B, pursuant to **Contract Book 3 (Project Specific Information),** the work shall be performed so as to meet or exceed such standards.

3. CRITICAL PATH METHOD (CPM) SCHEDULE

The CPM Schedule establishes the schedule and deadlines for Contract performance, with which the Design-Builder must comply. The CPM Schedule, as it may be modified during the course of the Project pursuant to the **Design-Build Standard Guidance**, shall anticipate and accommodate such periods of time shown in **Contract Book 1 (ITDB - Instructions to Design-Builders)** as may be required for the Department's review of Design Documents, and for approval by Authorities having jurisdiction over the Project of any required submissions, including but not limited to, applications for permits and environmental impact evaluations. Since time is of the essence in the Design-Builder's successful completion of its assignment, the Design-Builder agrees to begin work on each work location immediately after receiving authorization from the Department to proceed with its work efforts.

4. REVIEW AND COMMENT, OR ACCEPTANCE

The Department's consideration, Review and Comment, or Acceptance of any matters, or the Department's authorization of any action, will not be deemed or construed as relieving the Design-Builder of its sole responsibility for, and its complete and exclusive control over the means, methods, sequences and techniques for, performance of the work in accordance with the terms of the Contract.

5. EXTRA WORK TO BE PROVIDED BY THE DESIGN-BUILDER

The Design-Builder shall perform Extra Work in accordance with **Design-Build Standard Guidance**.

C. RELATIONSHIP AND ROLES OF THE PARTIES

1. INDEPENDENT ENTITY

The Design-Builder is an independent entity and not an officer, employee, or agent of the Department.

2. DEPARTMENT REPRESENTATIVE AND CONTACT INFORMATION

The Department's representative for this Project is

Clayton Markham
CONSTRUCTION DIVISION REPRESENTATIVE

Address: **TENNESSEE DEPARTMENT OF TRANSPORTATION**
505 DEADERICK STREET, SUITE 700
NASHVILLE, TN 37243

E-mail: **Clayton.Markham@tn.gov**

Telephone Number: **(615) 350-8332** **Fax Number**: **(615) 741-0782**

3. DESIGN-BUILDER REPRESENTATIVE

The Design-Builder's representative for this Project is

_____
Design-Builder's Project Manager

Address: _____

_____

_____

E-mail: _____

Telephone Number: _____

Fax Number: _____

4. KEY PERSONNEL AND DESIGN PROFESSIONALS

The Design-Builder's Key Personnel, Design Professionals, shall perform the functions established under the Contract for the duration of the Contract and are listed below.

a. KEY PERSONNEL

Design-Builder's Project Management Personnel (Level "1" Personnel) shall consist of the following:

- Project Manager: _____
- Design Manager: _____
- Construction Manager/Superintendent: _____
- Traffic Engineering Manager: _____
- Traffic Control Supervisor: _____
- Environmental Compliance Manager: _____

b. DESIGN PROFESSIONALS

The Design-Builder's design professionals (Level "2" Personnel) shall consist of the following:

- Utilities Design Engineering/Coordination Supervisor: _____
- Design Lead Engineer - Structures: _____
- Design Lead Engineer - Roadway: _____
- Design Lead Engineer – Geotechnical:
- Erosion Prevention/Sediment Control Inspector: _____

5. SUBSTITUTION OF KEY PERSONNEL AND/OR DESIGN PROFESSIONALS

The Parties agree that each Key Personnel, Design Professional and Subcontractor is unique, and that the Department has relied upon their qualifications in selecting the Design-Builder to perform the Contract. Therefore, the Design-Builder shall not replace any Key Personnel or Design Professional during the term of the Contract. Notwithstanding the foregoing, in those limited circumstances in which the Department elects to consider substitutions, the process shall be governed by the provisions of **Design-Build Standard Guidance**. In the event the Department approves a substitution request, the Department retains the right to strictly enforce this Section C.5 in the event of future requests for substitution. No individual substitution approval or pattern of substitution approvals shall constitute a waiver of this requirement. Should the Department, in its sole discretion, elect to authorize a substitution, such authorization shall not relieve the Design-Builder of its sole responsibility under the Contract to complete all work and deliver the Project in accordance with all Contract requirements.

D. DATE OF COMMENCEMENT AND COMPLETION OF SERVICES

1. TIME FOR PERFORMANCE

The Contract shall take effect on the Effective Date and shall be performed by the Parties according to its terms, unless earlier terminated, until Final Acceptance by the Department in accordance with **Design-Build Standard Guidance.**

2. COMMENCEMENT OF SERVICES

The Design-Builder is authorized to commence the work within the Contract for post award submittals pursuant to **Design-Build Standard Guidance**. The Design-Builder shall not perform any services beyond post award submittal until the issuance of first Notice to Proceed (NTP) and for each subsequent phase requiring a Review and Approval NTP.

3. COMPLETION DATES

The Design-Builder shall complete all work to be done under the Contract, except for plant/vegetation establishment, by / / and not later than **October 31, 2026.**

The Design-Builder shall specify the number of calendar days for completion of the project within their price proposal. The number of calendar days specified by the Design-Builder in their price proposal will be placed in the Contract above prior to execution of this Design-Build contract.

E. COMPENSATION

1. CONTRACT AMOUNT

The Department agrees to compensate the Design-Builder for all work performed under the Contract for a fixed price of **$_____** the "Contract Amount"). The Contract Amount includes the entire cost of completing the Project in accordance with all Contract requirements as contemplated by the Parties under the Contract, and further includes all contingencies and the Design-Builder's overhead and profit. The Contract Amount shall be payable in accordance with **Design-Build Standard Guidance.**

2. PROGRESS PAYMENTS

The Department shall make progress payments to the Design-Builder in accordance with **Design-Build Standard Guidance**. Progress payments shall be based upon the Design-Builder's Schedule of Items submitted with the Price Proposal, which shall include the cost of all work. The Department's payment of progress payments shall not be deemed by either Party to constitute Acceptance or Approval of any Pay Item covered by such payment, or a waiver of a claim or demand for repair of any defects therein.

3. ADJUSTMENTS TO THE CONTRACT AMOUNT

The Contract Amount shall only be adjusted through issuance of properly-authorized Change Orders.

4. PAYMENTS FOR EXTRA WORK

The Department will make payments for Extra Work in accordance with the provisions of **Design-Build Standard Guidance.**

5. DEDUCTIONS FROM MONIES DUE

The Department may deduct from monies due or to become due the Design-Builder, as follows:

- Amounts representing price adjustments authorized under the provisions D**esign-Build as specified in Contract Book 3 (Project Specific Information)**;
- Amounts representing recoupment of damages, including but not limited to Liquidated Damages as stated in **Contract Book 3 (Project Specific Information)**;
- Amounts assessed by Authorities (e.g., fines and penalties) for which the Design-Builder is responsible under the terms or the Contract or by law;
- Amounts the Department is compelled by court order or other legal mandate to withhold and/or tender to Authorities or third parties; and
- Any other amounts authorized under the Contract or by law to be deducted.

F. CHANGES IN THE WORK

Changed work and Extra Work shall be authorized by the Department only under the circumstances set forth in, and pursuant to the terms of, **Design-Build Standard Guidance**. The Design-Builder shall not begin performance of any Changed work or Extra Work until the Department has issued a properly-authorized Change Order, and the Design-Builder shall perform all such work strictly in accordance with the terms of the Change Order.

G. INSURANCE AND BONDING REQUIREMENTS

1. INSURANCE REQUIREMENTS

During the term of the Contract, the Design-Builder shall maintain in full force, at its own expense, from insurers holding a current certificate of authority to transact the business of insurance in the State of Tennessee, all of the insurance coverage's required under **Design-Build Standard Guidance.**

The Design-Builder, being an independent contractor, agrees to maintain errors and omissions insurance in such an amount (**$ 1,000,000.00 minimum**) and form as are agreeable to the Department.

2. BONDING REQUIREMENTS

During the term of the Contract, the Design-Builder shall maintain in full force, at its own expense and from Sureties licensed to do business in Tennessee, Performance and Payment Bond in the full Contract Amount. The Parties understand and agree that the obligation of the Design-Builder's Surety for the faithful performance of the Contract shall include not only all construction, but also the performance of all design services under the Contract.

3. INDEMNIFICATION

The Design-Builder shall assume full responsibility for the quality of the Design-Builder's work and its conformance with all applicable law, rules, regulations and orders governing said work. The Design-Builder shall hold harmless and indemnify the Department for all claims and damages which result from the failure of the Design-Builder to perform its duties in conformance with the reasonable standard of care within the State of Tennessee. Said indemnification shall include, but not be limited to, costs for the redesign of plans and the preparations of new specifications as well as the costs for repairs to the construction work itself. This requirement of indemnification shall be a continuing obligation of the Design-Builder and shall survive the termination of the Contract regardless of cause.

H. OWNERSHIP AND USE OF WORK PRODUCT OF THE DESIGN-BUILDER

All work product of the Design-Builder arising from performance of the Contract shall be the exclusive property of the Department, as more particularly provided for under **Design-Build Standard Guidance**.

Plans, specifications and any maps prepared or obtained under the terms of this Contract shall be delivered to and become the property of the Department pursuant to **Design-Build Standard Guidance**. Basic design notes and sketches, charts, computations, all original drawings, and other data prepared or obtained under this Contract shall be made available, upon request, to the Department without restriction or limitation of their use.

I. PROJECT RECORDS

1. FINANCIAL AND OTHER PROJECT RECORDS

The Design-Builder shall maintain complete Project Records as described in **Design-Build Standard Guidance**, in the manner required under the terms of the Contract. The Design-Builder shall keep full and detailed accounts and exercise such controls as may be necessary for proper financial management of the Project. The accounting and control systems shall be satisfactory to the Department.

2. RECORD RETENTION PERIOD

The Design-Builder shall retain and preserve all Project Records for a period as stated in **Design-Build Standard Guidance**, after final payment or for such longer period as may be required by law (the "Record Retention Period").

3. ACCESS TO RECORDS

The Department, the Department's representatives and FHWA shall be afforded reasonable and regular access to the Project Records for the duration of the Contract and the Record Retention Period. This requirement to make Project Records available to the Department shall be a continuing obligation of the Design-Builder and shall survive the termination of the Contract regardless of cause.

4. SUBCONTRACT RECORD RETENTION REQUIREMENTS

The Design-Builder shall require each Subcontractor to retain its Project Records for the Record Retention Period, and to provide equivalent access to Project Records to the Department, the Department's representatives and FHWA. The Design-Builder shall require each Subcontractor to include in lower-tier subcontracts the same Project Record retention and access requirements.

5. LOCATION

The Design-Builder shall maintain all Project Records at the locations required under the terms of the Contract for the duration of the Contract. Subsequent to Contract completion, the Project Records shall be maintained for the Record

Retention Period with suitable security, protection against damage and casualty loss, and access to the Department.

J. TERMINATION OR SUSPENSION

1. TERMINATION FOR CONVENIENCE AND NO FAULT; PAYMENT

The Contract may be terminated for convenience by the Department in accordance with Department Standard Specifications, as amended. In such case, the Department will make payment in accordance with **Design-Build Standard Guidance.** However, the amount to be paid to the Design-Builder shall in no event exceed the Contract Amount.

2. TERMINATION FOR CAUSE; AMOUNTS PAYABLE

The Contract may be terminated by the Department for default in accordance with Department Standard Specifications, as amended, and **Design-Build Standard Guidance**. In addition to the acts listed in the above documents the following shall also be considered defaults for which the Contract may be terminated:

- The Design-Builder or its Design Professionals no longer hold the licenses or certificates required to perform the work or any portion thereof;
- The Design-Builder so fails to perform any agreed-upon portion of the work or Contract item or applicable standard of care as to materially affect the Design-Builder's performance under the Contract in accordance with its terms, and such breach, default or failure is not cured within the requirements of **Design-Build Standard Guidance**; or
- The Design-Builder made knowing or reckless misrepresentations, concealed facts, or failed to disclose information in Design-Builder's Proposal. Such shall constitute fraudulent inducements, and shall entitle the Department to recover reliance damages, in addition to any other available remedies to which it may show itself entitled.

In case of termination for cause, the Department will make payment consistent with the payment provisions included in **Design-Build Standard Guidance** and at the Department's option, including payment for materials left on hand, in accordance with Department Standard Specifications, as amended.

3. CONTRACT NOTICE OF CONTRACT TERMINATION

The Department may terminate the Contract, in whole or in part, immediately upon notice to the Design-Builder, or at such later date as the Department may establish in such notice, in accordance with Department Standard Specifications, as amended.

4. QUALITY OF THE WORK

In the event of the Department's termination of the Contract, regardless of reason, the Design-Builder shall remain responsible for the quality of the work performed through the date of termination.

5. LITIGATION

In the event of litigation instigated by the Design-Builder in accordance with the Contract or by the Department for breach of contract or fraudulent inducement, the Department may pursue both recoupment and set-off in addition to its other available remedies.

K. ENUMERATION OF CONTRACT

The Contract includes the following:

1. ***CONTRACT BOOK 1 (INSTRUCTIONS TO DESIGN-BUILDERS - ITDB);***
2. ***CONTRACT BOOK 2 (DESIGN-BUILD CONTRACT);***
3. ***CONTRACT BOOK 3 (PROJECT SPECIFIC INFORMATION);***
4. ***DESIGN-BUILD STANDARD GUIDANCE AND ADDENDUM;***
5. ***THE DEPARTMENT STANDARD SPECIFICATIONS;***
6. ***THE DEPARTMENT SUPPLEMENTAL SPECIFICATIONS;***
7. ***THE DEPARTMENT DESIGN GUIDELINES, AND ADDENDUM;***
8. ***THE DEPARTMENT CONSTRUCTION CIRCLULAR LETTERS;***
9. ***THE DEPARTMENT STANDARD DRAWINGS;***
10. ***THE DEPARTMENT MATERIAL AND TEST STANDARD OPERATING PROCEDURES;***
11. ***EXHIBIT A (TECHNICAL PROPOSAL);***
12. ***CHANGE ORDERS;***
13. ***FORCE ACCOUNT WORK ORDERS;***
14. ***WRITTEN ORDERS AND AUTHORIZATIONS ISSUED BY THE DEPARTMENT;***
15. ***ALL OTHER PROGRAMMATIC PLANS OR ANY OTHER DOCUMENTS; IN ANY FORM, REQUIRED TO BE SUBMITTED TO THE DEPARTMENT PURSUANT TO THE TERMS OF APPLICABLE CONTRACT.***
16. ***ALL MATERIAL INCLUDED BY REFERENCE IN ANY OF THE ABOVE DOCUMENTS.***

L. ORDER OF PRECEDENCE

All Contract Documents are intended to be complementary. Conflicts, if any, will be resolved utilizing the following descending order of precedence.

1. ***CONTRACT BOOK 3 (PROJECT SPECIFIC INFORMATION) AND ADDENDA;***
2. ***CONTRACT BOOK 2 (DESIGN-BUILD CONTRACT);***
3. ***CONTRACT BOOK 1 (INSTRUCTIONS TO DESIGN-BUILDERS - ITDB);***
4. ***THE DEPARTMENT SUPPLEMENTAL SPECIFICATIONS;***
5. ***THE DEPARTMENT CONSTRUCTION CIRCLULAR LETTERS;***
6. ***THE DEPARTMENT STANDARD SPECIFICATIONS;***
7. ***THE DEPARTMENT DESIGN GUIDELINES AND ADDENDUM;***

8. ***THE DEPARTMENT STANDARD DRAWINGS;***
9. ***DESIGN-BUILD STANDARD GUIDANCE;***
10. ***ALL OTHER PROGRAMMATIC PLANS OR ANY OTHER CONTRACT DOCUMENTS;***
11. ***ALL MATERIAL INCLUDED BY REFERENCE IN ANY OF THE ABOVE DOCUMENTS.***

M. DESIGN-BUILDER CERTIFICATIONS AND DISCLOSURES

1. NONDISCRIMINATION

The Design-Builder shall follow the nondiscrimination provisions as provided in this **Contract Book 2 (Design-Build Contract)**.

2. DBE COMPLIANCE

The Design-Builder shall follow the DBE provisions as provided in the Special Provisions provided in this **Contract Book 2 (Design-Build Contract)**. The Design-Builder shall comply with the Department DBE requirements in the **Design-Build Standard Guidance**, and shall require that all Subcontractors so comply. The Design-Builder shall include the Department DBE requirements in all subcontracts.

3. ILLEGAL IMMIGRANTS

The Design-Builder shall follow the Illegal Immigrant provisions as provided in this **Contract Book 2 (Design-Build Contract)**.

4. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS - PRIMARY COVERED TRANSACTIONS

The Design-Builder shall follow the debarment, suspension, and other responsibility matters provisions as provided in this **Contract Book 2 (Design-Build Contract)**.

5. CERTIFICATION FOR GRANTS, LOANS, AND COOPERATIVE AGREEMENTS.

The Design-Builder shall follow the provisions as provided in this **Contract Book 2 (Design-Build Contract)**.

The Design-Builder agrees that if any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Contract, the Design-Builder shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

6. GOALS AND TARGETS

There is a DBE Utilization Goal of **9%** for this Project. If a goal is stated, the Design-Builder shall follow the DBE provisions as provided in **Contract Book 2 (Contract)**.

N. MISCELLANEOUS PROVISIONS

1. EMPLOYMENT OF DEPARTMENT WORKERS

The Design-Builder shall not engage, on a full, part-time, or other basis during the period of this Contract, any professional or technical personnel who are or have been at any time during the period of the Contract in the employ of the Department, except regularly retired employees, without the written consent of the Department.

2. COVENANT AGAINST CONTINGENT FEES

The Design-Builder warrants that it has not employed or retained any company or person other than a bona fide employee working solely for the Design-Builder to solicit or secure this Contract, and that it has not paid or agreed to pay any company or person, other than a bona fide employee working solely for the Design-Builder, any fee, commission, percentage, brokerage fee, gifts, or any other consideration, contingent upon or resulting from the award or making of this Contract. For breach or violation of this warranty, the Department shall have the right to deduct from the Contract Amount or consideration, or otherwise recover, the full amount of such fee, commission, percentage, brokerage fee, gifts, or contingent fee.

3. ENERGY POLICY AND CONSERVATION ACT

Under this Contract, the Design-Builder shall give due consideration to and, as applicable, comply with the standards, orders, and requirements relating to energy efficiency contained in the Department energy conservation plans issued in compliance with the Energy Policy and Conservation Act (P.L. 94-165).

4. ADDITIONAL EMPLOYMENT REGULATIONS

The Design-Builder shall comply with the Vocational Rehabilitation Act of 1973 as approved by Congress on September 26, 1973, herein incorporated by reference, which prohibits employment discrimination against physically handicapped persons. Further, the Design-Builder shall comply with Section 2012 of the Vietnam Era Veterans Readjustment Act of 1974 which requires the Design-Builder to take affirmative action to employ and advance in employment qualified veterans of the Vietnam Era.

5. COPYRIGHTING

The Design-Builder shall be prohibited from copyrighting any papers, reports, forms or other material which is a part of any work under this Contract without written approval from the Department. Publication rights to any documents produced are reserved by the Department.

6. GOVERNING LAW; JURISDICTION; VENUE

The Design-Builder is assumed to be familiar with and observe and comply with those Federal, State, and local laws, ordinances, and regulations in any manner affecting the conduct of the work and those instructions and prohibitive orders issued by the Department and Federal Government regarding fortifications, military and naval establishments and other areas. The Design-Builder shall observe and comply with those laws, ordinances, regulations, instructions, and orders in effect as of the date of this Contract.

This Contract shall be governed by and construed in accordance with the laws of the State of Tennessee. The Design-Builder agrees that it will be subject to the exclusive jurisdiction of the courts of the State of Tennessee in actions that may arise under this Contract. The Design-Builder acknowledges and agrees that any rights or claims against the Department or its employees hereunder, and any remedies arising there from, shall be subject to and limited to those rights and remedies, if any, available under TCA § 9-8-101 through 9-8-407.

7. CONTRACT INTERPRETATION

Notwithstanding anything in the Contract to the contrary, no field explanations or interpretations provided by the Department at any meetings, and no comments by the Department on Design Documents or Construction Documents, shall be deemed, construed or interpreted to (a) amend, supersede or alter the terms, requirements, limitations or meaning of any Contract Document or (b) release or relieve the Design-Builder from full responsibility for the design of the Project in accordance with the Contract. However, written interpretive engineering decisions from the designated Department contact person(s) pursuant to the Contract may be relied upon to provide information, and interpretations of ambiguous or uncertain requirements set forth in the Contract.

8. NOTICES

Notices to be given hereunder shall be given in writing by personal delivery, facsimile, e-mailing or mailing the same, postage prepaid, to the Design-Builder or the Department at the addresses or numbers set forth in Sections C.2 and C.3, or as either Party may hereafter indicate pursuant to this Section. Any notice delivered by facsimile and email shall be deemed to be received when confirmation of successful transmission is generated by the transmitting machine. Any notice so mailed, personally delivered, facsimile or e-mail transmission shall be the sole responsibility of the Design-Builder to track and confirm receipt by the Department and shall be confirmed by telephone notice to the Department for the Project. Any notice shall be effective as to the Design-Builder upon delivery into the possession of one of the Design-Builder's designated management personnel, and as to the Department, upon delivery to the Department. Regular, day-to-day communications may be transmitted through one of the methods set forth above, in person, by e-mail, or by other similar electronic transmission.

9. DISCLOSURE OF TAX IDENTIFICATION NUMBER

The Design-Builder shall provide its federal tax ID number to the Department. The Tax Identification Number provided pursuant to this authority will be used for the administration of State, Federal and local tax law.

10. SEVERABILITY

The Parties agree that if any term or provision of the Contract is declared by a court of competent jurisdiction to be illegal or otherwise invalid, the validity of the remaining terms and provisions shall not be affected, and the rights and obligations of the Parties shall be construed and enforced as if the Contract did not contain the particular term or provision held to be invalid.

11. NO WAIVER

The failure of the Department to enforce any provision of the Contract shall not constitute a waiver by the Department of that provision or any other provision of the Contract.

12. MEDIA CONTACTS; CONFIDENTIALITY

Unless otherwise specifically authorized in writing, the Design-Builder shall provide no news release, press release, or any other statement to a member of the news media regarding this Project without the Department's prior written authorization. The Design-Builder shall require this clause within all Subcontractors agreements.

13. ORGANIZATIONAL CONFLICTS OF INTEREST

The Design-Builder shall identify all relevant facts relating to past, present, or planned interest(s) of the Design-Builder's (including the Major Participants, proposed Design-Builder members, and their respective chief executives, directors, and Key Personnel) which may result, or could be viewed as, an organizational conflict of interest in connection with this Project.

The Design-Builder shall disclose:

a. any current contractual relationships with the Department (by identifying the Department contract number and project manager);
b. present or planned contractual or employment relationships with any current Department employee;
c. any current relationships between the Major Participants, Key Personnel. and/or Design Professionals of the Design-Builder on other Department projects; and
d. any other circumstances that might be considered to create a financial interest in the contract for the Project by any current Department employee if the Design-Builder is awarded the contract.

The Design-Builder must also disclose any current contractual relationships where the Design-Builder is a joint venture. The foregoing is provided by way of example, and shall not constitute a limitation on the disclosure obligations.

For any fact, relationship, or circumstance disclosed in this Section 14.13, the Design-Builder must identify steps that have been or will be taken to avoid, neutralize, or mitigate any organizational conflicts of interest.

In cases where Major Participants on different Design-Builder organizations belong to the same parent company, each Design-Builder must describe how the participants would avoid conflicts of interest through the qualification and proposal phases of the Project. All Organizational Conflicts of Interest shall be addressed on Form COI.

14. THE DEPARTMENT'S INSURANCE

The State of Tennessee is self-insured and such insurance shall cover the Department's operations and activities under the Contract.

15. JOINT VENTURES AND PARTNERSHIPS

If the Design-Builder is a joint venture or a partnership, each joint venture member or partner is executing this Contract on behalf of both itself and the Design-Builder, and each joint venture member or partner and Design-Builder shall be jointly and severally liable under this Contract.

16. MERGER CLAUSE

The Contract constitutes the entire Contract between the Parties on the subject matter addressed herein. The terms of this Contract cannot be waived or amended, in any manner whatsoever, except by written instrument signed by the Parties and containing all required State of Tennessee approvals. Any waiver, if made, shall be effective only in the specific instance and for the specific purpose given. There are no understandings, agreements, or representations, oral or written, regarding this Contract except as contained or incorporated by reference herein.

THIS CONTRACT is executed in three (3) original copies, of which one is to be delivered to the Design-Builder, and the remainder to the Department.

The Design-Builder's authorized representative, by his/her signature below, hereby acknowledges that he/she has read this Contract, understands it, and can affirm that the Design-Builder agrees to be bound by its terms and conditions. This Contract may be executed in several counterparts, each of which shall be an original, and all of which shall constitute but one and the same instrument.

IN WITNESS WHEREOF, the Parties have executed this Contract, which shall be effective as of the Effective Date.

DESIGN-BUILDER NAME: _____

_____	_____	_____
Company Officer Signature	Printed Name and Title	Date

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

This Contract is accepted this _____ day of _____, _____, and

is effective on the _____ day of _____, _____.

_____
Joseph Galbato III, Interim Commissioner

_____
John Reinbold, General Counsel
Approved as to Form and Legality

APPENDIX A

SUPPLEMENTAL SPECIFICATIONS TO THE STANDARD SPECIFICATIONS

The following, revised as noted, incorporates the Supplemental Specifications by reference for bidding purposes and will be printed with the contract after award. These Supplemental Specifications may be obtained from the Department's website:

https://www.tn.gov/tdot/tdot-construction-division.html

Supplemental Specifications to the Standard Specifications Revision Date

Supplemental Specification to Section 100 ---------- 12/15/2021
Supplemental Specification to Section 400 ---------- 12/15/2021
Supplemental Specification to Section 600 ---------- 12/15/2021
Supplemental Specification to Section 700 ---------- 12/15/2021
Supplemental Specification to Section 900 ---------- 12/15/2021

S T A T E **O F** **T E N N E S S E E**
(Rev. 9-7-21) January 1, 2021
(Rev. 12-15-21)

Supplemental Specifications – 100SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 104.03.B & C (pg. 23-24), 9-7-21; **Contract Change Notification; B & C;** Revise subsections:

B. Written Acknowledgement by Engineer

The Engineer will provide written acknowledgement of the Contractor's written notice within ten (10) calendar days.

C. Written Response by Engineer

The Engineer will provide a written response within the specified number of calendar days based on the requested contract change:

1. For requested changes to the contract time in excess of one hundred eighty (180) days or requested changes that alter the original contract amount by more than $200,000, the Engineer will respond within thirty (30) days of receiving the Contractor's written notice.

2. For requested changes to the contract time in excess of ninety (90) days but less than or equal to one hundred eighty (180) days, or requested changes that alter the original contract amount by more than $100,000 but less than or equal to $200,000, or by more than ten percent (10%) of the original contract, whichever is less, the Engineer will respond within twenty-one (21) days of receiving the Contractor's written notice.

3. For all other requested changes to the contract, the Engineer will respond within fourteen (14) calendar days of receiving the Contractor's written notice.

The written response to the Contractor's written notice will include one of the following:

1. Confirmation that a change is necessary in accordance with **104.02**, and direction on how the Work will proceed.

2. A denial of the request for a change, which will include references to the Contract as to why the condition does not represent a change.

3. A request for additional information stating the specific information needed and the date by which it must be received. The Engineer will respond to the additional information provided within fourteen (14) calendar days.

When a change is necessary, the Engineer will make appropriate adjustments to the Contract price and time, if warranted, in accordance with **108.07**, **109.04**, **109.05.A**, and **109.06**. If the Contractor disagrees with the Engineer's decision or does not agree with the Contract adjustments, the Contractor may pursue the issue as a claim in accordance with **105.16**.

Subsection 106.06.A.1 (pg. 61), 12-15-21; **Field Laboratory, Type A;** Revise No. 1:

1. Scales of appropriate capacity and design to weigh the required samples. Scales are to be sensitive to within 0.1% of the sample to be weighed. Provide standard weights for scale calibration. Scale calibration shallould be completed annually every six months, by an independent sourcewith no calibration exceeding 6 months to the day.in .

Subsection 108.01 (pg. 79, 80), 12-15-21; **Subletting of Contract;** Revise Item list:

Item 105-01 – Construction Stakes, Lines and Grades
Item 202-01.02 – Removal of Asbestos
Item 203-40 – Rock Anchors, Anchor Blocks, Tie Back Anchors
Item 209 – Project EPSC
Item 411-12 - .** Shoulder Scoring
Item 411-33 – Stamped Asphalt
Item 501-03.12 – Concrete Shoulder Rumble Strip
Item 503-01 – Grinding Concrete Pavement
Item 602-03 – Steel Structures
Item 602-04 – Steel Structures
Item 602-10.13 / .14 – Navigational Lighting
Item 602-10.81 – Heat Straightening
Item 603-02 – Repainting Steel Structures
Item 603-05 – Containment and Disposal of Waste
Item 604-04.01 – Applied Texture Finish (New Structures),
Item 604-04.02 – Applied Texture Finish (Existing Structures)
Item 604-04.10 – Graffiti Protection
Item 604-04.20&.21 – Painting or Staining Concrete Surfaces
Item 604-04.62 – Clean and Texture Finish Median Barrier
Item 604-05.31 – Bridge Deck Grooving (Mechanical)

Item 604.07 – Retaining Wall
Item 604-42.01 – Underwater Divers
Item 606-26.05 – Core Drilling for Piles (Abandoned)
Item 617 – Bridge Deck Sealant
Item 619 – Polymer Modified Concrete Overlay
Item 624 – Retaining Wall ~~Items~~
Item 625-01.08,10,11 – Inclinometer, Camera Drilled Shaft Inspections
~~Item 640 – Weigh Station Items~~
Item 705 – Guardrail~~, Anchors, etc.~~
Item 706 – Guardrail Adjusted, Removed and Reset~~Items~~
Item 707 – Fences~~ing Items~~
Item 712 – Temporary Traffic Control ~~Items~~
Item 713 – Highway Signing ~~Items~~
Item 714 – Roadway and Structure Lighting ~~Items~~
Item 716 – Pavement Markings ~~Items~~
~~Item 720-03, 720-04, 720-05, 720-06, 720-07, 720-08, 720-09 – Railroad Highway Crossing~~
~~Item 721-01.06 – Irrigation System Repair~~
Item 721~~-10, 721-11.20, 721-11.30, 721-12~~ – Landscape and Irrigation
Item 724 – Landscape Lighting
Item 725 – ITS items
Item 730 – Traffic Signals ~~Items~~
Item 740 – Geosynthetics
Item 79* – Utilities~~y Items~~
~~Item 750.01 – Mitigation Site~~
Item 801 – Seeding
Item 802 – Landscape~~ing Items~~ Plantings
Item 803~~-01~~ – Sodding
Item 805 – Erosion Control
Item 806 – Project Mowing

Subsection 108.03.A, B, & C (pg. 81,82,85,87,88), 9-7-21; **Contract Change Notification; A & B;** Revise Heading,
C.1.c; Add new No.vi, **C.3;** Revise last paragraph, **C.4;** Revise last paragraph & add sentence**:**

A. Project Durations Less Than 9 Months

B. Project Durations 9 Months to 24 Months

C.1.c Narrative report in PDF file format fit to 8.5x11 inch paper and including:…

vi. The quantity and estimated daily production rate for controlling activities;

vii. Description of the calendars including identification of workdays per week, holidays, number of shifts per day, and number of hours per shift;

viii. Description of how the schedule accommodates adverse weather days for each month; and

ix. Description of execution plan, including number and type of crews, a list of subcontractors' crews, and expected equipment, but not limited to large equipment transport and delivery, transportation permits for oversized/overweight loads, and availability.

3. Baseline CPM Schedule.

The Engineer and Contractor will review the draft baseline CPM schedule at a meeting specific for the review of the schedule. The Engineer will accept the draft baseline CPM schedule, provide review comments, or request additional information. Make appropriate adjustments or provide additional information within 14 calendar days. The Engineer's acceptance is based solely on whether the baseline schedule meets the requirements of **108.03**. Review comments made by the Engineer on the initial schedule will not relieve the Contractor from compliance with the Contract. The Contractor is responsible for scheduling, sequencing, and prosecuting the Work to comply with the Contract requirements.

4. Schedule Updates.

Submit the updated schedule electronically to the Engineer in accordance with the requirements of this subsection. The Engineer reserves the right to reject any schedule updates because of changes in relationships between activities on the critical path, inadequate or inaccurate narrative updates, or other deficiencies in the schedule updates as required in this subsection.

The Department will measure and pay for CPM Project Schedule in accordance with **108.11** and **108.12** respectively.

Subsection 108.11 (pg. 99), 9-7-21; **Method of Measurement;** Add subsection **108.11:**

108.11 Method of Measurement

The Department will measure construction CPM Project Schedule as a percentage of the lump sum price bid for the completion of the work specified in **108.03.C** and partial payment will be made according to the schedule in Table 108.11-1.

Table 108.11-1: Payment Schedule for CPM Project Schedule

Estimate Number or Percent of Total Contract Amount of Previous Estimate	Total Percent of CPM Project Schedule Lump Sum Bid Item
Estimate # 1	20%
Estimate # 3	40%
20%	50%
40%	60%
60%	70%
80%	80%
95%	100%

Subsection 108.12 (pg. 99), 9-7-21; **Method of Measurement;** Add subsection **108.12:**

108.12 Basis of Payment

The Department will make partial payments for CPM Project Schedule on the basis of a percentage of the lump sum price bid in accordance with the schedule shown in Table 108.11-1.

If the Contractor fails to provide monthly schedule updates, or address the Engineer's comments regarding the monthly schedule update, within 10 calendar days following the progress estimate pay period cutoff date, the Engineer will withhold payment for CPM Project Schedule and may withhold up to an additional 5% of the monthly estimate payment, until such time as an acceptable update has been provided.

No additional payments will be made for schedule revisions as requested per **108.03.D**.

Such payment is full compensation for meeting all requirements of **108.03.C** and **D**.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-15-21) January 1, 2021

Supplemental Specifications – 400SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 403.04 (pg. 286), 12-15-21; **Preparing Surface;** Revise Paragraph:

Prepare the designated surface as specified in **4054.05**. Ensure that the surface is dry when applying tack coat.

Subsection 403.05.C (pg. 286), 12-15-21; **Fog Sealing;** Revise 1st Paragraph:

When the Contract requires bituminous material for fog sealing of shoulders, provide emulsified asphalt meeting **403.02** or an item from QPL 40A. Apply diluted emulsified asphalt at a rate of 0.10 to 0.15 gallons per square yard based on a dilution rate of one part emulsified asphalt to one part water. This application may require two equal increments if run-off occurs. Apply fog seal when the ambient air temperature or the surface temperature is a minimum of 50°F.

Subsection 407.09 (pg. 326-327), 12-15-21; **Weather Limitations;** Revise No. 2 & 3:

2. The bituminous plant mix is placed according to the temperature limitations specified in Table 407.09-1 and when weather conditions otherwise allow the pavement to be properly placed, compacted, and finished. Placement may proceed if either the air or surface temperature is met except for 411-TL, 411-TLD, 411-TLE, and 411-OGFC mixtures.

   Measurement of the surface temperature shall be done on pavement that is shaded from direct sunlight unless no shaded location exists. If paving based on the air temperature, stop work once the air temperature falls below the minimum threshold. Do not start paving if the surface temperature does not meet the requirements and the air temperature is forecast to fall below the minimum temperature within 4 hours of starting work.

Table 407.09-1: Temperature Limitations

Compacted Thickness	Minimum Air or Surface Temperature (°F)	
	Unmodified mixes (PG 64, 67)	Modified mixes (PG 70, 76, 82)
≤ 1.5 inches	45	55
> 1.5 inches to < 3.0 inches	40	50
≥ 3.0 inches	35	45

3. For 411-TL, 411-TLD, 411-TLE, and 411-OGFC mixtures, placement shall proceed only when the pavement surface temperature and the air temperature are a minimum of 55° F and rising. Stop paving if the air temperature falls below 55°F immediately. Placement of these mixtures is restricted to the period between April 1 and October 31.

   For all other mixtures, ~~D~~do not place bituminous plant mix, with a compacted thickness of 1.5 inches or less, between November 30 and April 1. Do not place bituminous plant mix, with a compacted thickness greater than 1.5 inches, between December 15 and March 16. ~~Only place 411-TL, 411-TLD, 411-TLE, and 411-OGFC mixtures when the pavement surface temperature and the ambient air temperature are a minimum of 55 °F and rising; limit placement to the period from April 1 to November 1.~~ If the temperature meets the above requirements, outside of normal paving season, a request for a seasonal limitation waiver may be submitted for Departmental consideration. Requests shall be submitted in writing at least one week before the anticipated need.

Subsection 407.15.C (pg. 336-337), 12-15-21; **Test Strips;** Revise 1st Paragraph:

Construct test strips for all ~~A, B, BM, BM-2, C, CW, D, and E~~ mixtures that require density testing to establish rolling patterns, to accommodate the Department to calibrate nuclear gauges, to verify that the base course or surface course mixture meets the density requirements of the specifications, and for mix design and production verification as required. ~~A test strip is not required for mixes AS, A-CRL, CS, TL, TLD, and TLE, but a~~Adjustments to the roller pattern may be made at the direction of the Engineer for mixtures that do not require density testing.

Subsection 407.20.C.3 (pg. 346-347), 12-15-21; **Loss on Ignition (LOI);** Revise 2nd & Remove 4th Paragraph:

If the percent of LOI in the aggregate differs by plus or minus 2% from the LOI indicated in the JMF, the Department will make a payment deduction in the price bid for the mix applied to the entire days production, not as a penalty but as liquidated damages. The percent of total payment to be deducted will be 5 times the percent that the LOI exceeds the JMF tolerance of plus or minus 2%.

~~To determine the deduction, the Department will use lots of approximately 5,000 square yards. The Department inspector will perform sampling and testing to establish the LOI according to the Department's sampling and testing procedures. If the initial tests indicate a variation in the LOI of plus or minus 2% than the value shown on the mix design, the Contractor shall perform the additional sampling necessary to establish the LOI of the aggregate in each lot, with the cost of the sampling being included in the contract unit prices bid for the paving items.~~

Subsection 411.03.B (pg. 353), 12-15-21; **Proportioning;** Revise Table 411.03-01:

Table 411.03-1: Proportions of Total Mixture, Percent by Weight

Surface Course	Effective Combined Mineral Aggregate	Asphalt Cement
Grading D	93.0 – 94.3	5.7 – 7.0 (1)
Grading E (2)	93.0 – 94.3	5.7 – 7.0 (1)
Grading E (shoulders)	93.5 – 94.0	6.0 – 6.5 (1)
Grading TL	92.5 – 94.3	5.7 – 7.5 (1)
Grading TLD	93.0 – 94.3	5.7 – 7.0 (1)
Grading TLE	93.0 – 94.3	5.7 – 7.0 (1)
Grading TLE (shoulders)	93.5 – 94.0	6.0 – 6.5 (1)
Grading OGFC	92.0 – 94.0	6.0 – 8.0 (1)

(1) If the effective combined specific gravity of the aggregate exceeds 2.80, the above proportions may be adjusted as directed by the Engineer. The upper limit for flow values shall not apply to mixes with modified asphalt liquids.

(2) The minimum allowable asphalt cement content for 411E low volume mixtures is 5.3%.

Subsection 411.03.C.1 (pg. 358), 12-15-21; **Recycled Asphalt Pavement;** Revise 2nd Paragraph:

All mixes shall contain at least 80% virgin asphalt, except for 411E Shoulder and 411TLE Shoulder Mixtures, which shall have at least 65% virgin asphalt.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-15-21) January 1, 2021

Supplemental Specifications – 600SS

of the

Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 602.04.A (pg. 429), 12-15-21; **Shop Inspection;** Revise A:

Fabricators of steel bridges shall hold the following certifications in accordance with the AISC Certification Program – Bridge QMS Certification ~~for Structural Steel Fabricators – Standard for Steel Bridges~~:

1. As a minimum, all fabricators shall be certified in the category of ~~intermediate bridges~~ Certified Bridge Fabricator – Intermediate Bridge (IBR) with applicable supplemental requirements.
2. Fabricators of advanced type bridges, as defined in the AISC Standard for Steel Bridges, shall be certified in the category of ~~advanced bridges~~ Certified Bridge Fabricator – Advanced (ABR) with applicable supplemental requirements.
3. Fabricators of diaphragms, cross-frames, floor beams, stringers (rolled beams) and laterals shall be certified in the category of Certified Bridge Fabricator – Intermediate Bridge (IBR)~~Intermediate bridges~~, as a minimum.
4. Fabricators of bridge bearings, expansion joints, sign structures and other metal highway components as listed in the AISC standard shall hold certification ~~under the AISC Certification Program – Standard for Bridge and Highway Metal Component Manufacturers. As an alternative, fabricators of bridge bearing or expansion joints may hold certification in the category of Intermediate bridges under the Standard for Steel Bridges.~~ under the AISC Certification Program – Bridge Component QMS Certification (CPT). As an alternative, fabricators of bridge bearing or expansion joints may hold certification under the Bridge QMS Certification in the category of Certified Bridge Fabricator – Intermediate Bridge (IBR).

Subsection 607.02.B (pg. 579), 12-15-21; **Materials, Pipe Culverts, Cross Drains, Side Drains, & Storm Drains;** Remove 1st Sentence:

B. Pipe Culverts, Cross Drains, Side Drains, & Storm Drains

~~Where Pipe Culverts (Cross Drains & Median Drains) are specified, provide them in accordance with the following:~~

Subsection 607.07 (pg. 582), 12-15-21; **Joining Pipe:** Revise 5th paragraph.

HDPE, PP, SRTRP, and PVC pipe shall be joined in accordance with ASTM D3212 and meet the performance requirements for ~~soil tightness, unless~~ water-tight~~ness is specified~~. Install joints so that the connection of pipe sections, for a continuous line, will be free from irregularities in the flow line.

Subsection 619.04.A (pg. 652-653), 12-15-21; **Volumetric Continuous Mixers;** Revise No. 3 & Ticket List:

3. The volumetric mixing plant shall be operated and calibrated by a Volumetric Mixer Operator ~~certified by VMMB and holds~~ with a TDOT Concrete Field Testing Technician Certification or equivalent. In the presence of the Engineer, perform the calibration of gate settings according to the manufacturer's recommendations for the mix design to be used before starting work. The calibration procedure shall account for the moisture content of the aggregates. The yield shall be maintained within a tolerance of plus or minus 1% and verified using a minimum 2 cubic feet container every 50 cubic yards. Recalibrations will be necessary when indicated by the yield checks, and at any other times the Engineer deems necessary to ensure proper proportioning of the materials.

Each load of concrete produced by a volumetric continuous mixing plant shall be accompanied by a Concrete Delivery Ticket. The ticket shall include as a minimum the following:

a. Date
b. Contract number
c. County
d. Class of concrete
e. Concrete design number
f. Number of cubic yards
g. Load number
h. Truck number
i. Maximum water allowed by design
j. Total water added
k. Water-cementitious materials ratio
l. Time loaded
m. Time discharged
n. Signature of producer's ~~VMMB Certified~~ Volumetric Mixer Operator

Subsection 623.02.C.1 (pg. 673), 12-15-21; **Modular Roadway Expansion Joints, Fabrication and Construction;** Revise No. 1:

1. Construct the expansion joint systems as shown on the shop drawings. Meet the tolerance requirements included in AASHTO specifications. Perform all welding according to AWS specifications and by certified welders only. Ensure that fabricators are certified ~~under the AISC Quality Certification, Category I, Simple Steel Bridges, SBR-1B.~~ under the AISC Certification Program – Bridge Component QMS Certification (CPT). As an alternative, fabricators of bridge bearing or expansion joints may hold certification under the Bridge QMS Certification in the category of Certified Bridge Fabricator - Intermediate Bridge (IBR).

Subsection 623.03.C.2 (pg. 676, 677), 12-15-21; **Strip Seal Expansion Joints, Fabrication and Construction;** Revise No. 2:

2. Shop drawings shall also supply information regarding material specifications, geometry, a table of variable temperature and dimensions, and a bill of material. The maximum joint opening shall be 4 inches. Construct the expansion joint systems in accordance with the details shown on the shop drawings. Tolerance requirements shall be in accordance with AASHTO Specifications. Perform all welding in accordance with AWS specifications and by certified welders only. Ensure that fabricators are certified ~~under the AISC Quality Certification, Category I, Conventional Steel Structures.~~ under the AISC Certification Program – Bridge Component QMS Certification (CPT). As an alternative, fabricators of bridge bearing or expansion joints may hold certification under the Bridge QMS Certification in the category of Certified Bridge Fabricator - Intermediate Bridge (IBR).

S T A T E **O F** **T E N N E S S E E**

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Supplemental Specifications – 700SS

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Standard Specifications for Road and Bridge Construction

January 1, 2021

Subsection 705.06 (pg. 698), 12-15-21; **Installation of Posts; Add new 7th Paragraph:**

When an underground structure or utility prevents proper post installation for a run of guardrail, posts may be omitted ,along the run of guardrail only as detailed in the Department's Standard Drawings. A post will not be omitted from any end terminal or transition. If the conditions noted for omitting posts cannot be used, then the use of a guardrail footing or weak post attachment to culvert may be used as detailed in the Department's Standard Drawings

Subsection 705.10 (pg. 700), 12-15-21; **Basis of Payment; Add new 7th Paragraph:**

When posts are omitted from a run of guardrail, payment shall be as noted in the Standard Drawings.

a. For 1 post being omitted, the Department will pay the contract unit price for W Beam Guardrail (Type 2) MASH TL-3.

b. For 2 or 3 posts being omitted, the Department will pay for the linear feet of nested W Beam rail as detailed in the Standard Drawings at a rate equal of 1.5 times the contract unit price for W Beam Guardrail (Type 2) MASH TL-3.

c. If a guardrail footing or attachment to culvert was used, the Department will pay for work as noted in the Standard Drawings.

Subsection 712.02 (pg. 731-732), 12-15-21; **Materials; Revise List:**

Aluminum	916.02
~~Reflective Sheeting~~	~~916.06~~
Paint	910.02~~6.09~~
Cold Rolled Carbon Steel -16 gauge	ASTM A1008
Non-metallic Drums and Barricades	QPL
Reflective Sheeting	916.06

Subsection 712.02.B (pg. 732), 12-15-21; **Temporary Pavement Marking Material; Revise 1st Paragraph:**

Unless otherwise specified, the material for pavement marking ~~line~~ shall be either temporary pavement marking tape listed on the Department's QPL, or reflectorized paint with raised reflective pavement markers placed as shown on the Plans

Subsection 712.02.E (pg. 733), 12-15-21; **Portable Impact Attenuators; Revise Heading & 1st Paragraph:**

E. ~~Portable Impact Attenuators~~Temporary Work Zone Crash Cushions

~~Portable impact attenuators~~ Temporary work zone crash cushions shall be in accordance with the Plans and Specifications, meet the requirements for the appropriate test level, and meet the requirements of and be listed on the Department's QPL or Standard Drawings.

Subsection 712.04.B (pg. 735-736), 12-15-21; **THP Troopers and Uniformed Law Enforcement Officers; Revise 2nd Paragraph:**

When a THP Trooper is not available, the Contractor may provide a Uniformed Law Enforcement Officer if approved by the Engineer and the Regional Safety Coordinator or Regional Operations Office. All Uniformed Law Enforcement Officers shall provide a marked Federal, State, County, City, or Metropolitan government law enforcement vehicle equipped with blue lights and have the authority to write traffic tickets and make arrests within the project site. The Uniformed Law Enforcement Officer shall maintain a detailed written log of enforcement activities and shall submit the log to the Engineer for verification each month.

Subsection 712.06 (pg. 743), 12-15-21; **Temporary Marking; Revise Heading, Add No. 2, & Revise No. 1 & 3:**

712.06 Temporary Pavement ~~Centerline and Lane~~ Marking

Unless otherwise specified, install temporary pavement marking as follows:

1. Provide 4-inch wide pavement marking (line) for center, edge, lane and barrier lines~~-~~ as shown on the Plans for projects that will have traffic maintained overnight. For temporary pavement ~~line~~ markings (line) on intermediate layers of pavement, use reflective tape, reflectorized paint, and raised pavement markers, or a combination thereof as shown on the Plans or as required by the Engineer, and install meeting **716, 910.02, 919.04**, or Department's QPL at the end of each day's work.~~to permanent standards before dark hours.~~ Short, unmarked sections will not be allowed. ~~The Department will measure and pay for these markings as Painted Pavement Marking (Line) in accordance with 716.08 and 716.09.~~ Preserve established no-passing zones, if any, on the existing pavement; if no-passing zones have not previously been established, establish them before beginning the work. Mark two-lane, two-way highways with 10-foot long center lines applied on 40-foot centers and appropriate no-passing barrier lines.

2. When required, provide temporary pavement markings at intersections for temporary pavement markings on intermediate layers of pavement. The Department will require temporary intersection pavement markings to be reflectorized paint, or removable pavement marking meeting **716, 910.02, 919.04**, and or Department's QPL.

3~~2~~. Where required on the completed permanent pavement surface, ~~for 10-foot lane lines, no-passing barrier line, and edge line, use reflectorized paint applied as specified in 716.~~meet **716.03**.

Subsection 712.09 (pg. 744, 745), 12-15-21; **Method of Measurement; Revise No. 5, 7, 8 & Add 9:**

5. Warning Lights and Flashing Arrow Boards by the unit, Changeable Message Signs per each for the type designated. Payment will be based on the maximum number in place at one time.

7. ~~Portable Impact Attenuators~~Temporary Work Zone Crash Cushion based on the initial installation of each ~~portable impact attenuator~~. No additional payment will be made for removal, moving, and reinstalling ~~impact attenuators~~ at other locations on the Project as directed by the Engineer. Payment will be based on the maximum number ~~of portable impact attenuators~~ in place at one time.

8. Temporary pavement marking (line) for edge, center, lane and barrier lines will be measured as listed in the plans,~~as described for~~ complete in place and accepted, as Painted Pavement Marking (Line) ~~in 716.07~~ regardless of whether the lines are painted, taped markings, or raised pavement markers, or a combination of the above as shown on the Plans or as required by the Engineer.~~, except that Removable Pavement Marking (Line) will be measured by the linear foot of installed line.~~ Only the marked line will be measured for payment.

9. Temporary pavement markings at intersections will be measured as listed in the plans complete in place and accepted as Painted Pavement Marking (Description) or Removable Pavement Marking (Description)

Subsection 712.10 (pg. 746, 747), 12-15-21; **Basis of Payment; Revise Item List & Paragraphs 4, 5, 9, Remove Paragraph 8:**

Item	*Pay Unit*
Traffic Control	Lump Sum
Portable Barrier Rail	Linear Feet
~~Portable Impact Attenuator~~Temporary Work Zone Crash Cushion	Each
Signs	Square Feet
~~Vertical Panels~~	~~Square Feet~~
Flexible Drums	Each
Temporary Barricades (Type)	Linear Feet
Removable Pavement Marking (Description)	Linear Feet
Changeable Message Sign Unit	Each
Arrow Board (Type C)	Each
Barrier Rail Delineator	Each
Temporary Flexible Tubular Delineator	Each

Payment for ~~Portable Energy Absorbing Terminals~~ Temporary Work Zone Crash Cushion will be made at the contract price ~~per Portable Energy Absorbing terminal~~, complete in place, with total payment based on the maximum number ~~of portable energy absorbing terminals~~ in place at one time as specified in **712.09**.

Payment for Signs (Construction) ~~and Vertical Panels~~ is full compensation for providing sign panels with proper sheeting and legend, erecting on proper supports, furnishing all mounting hardware, covering when not in use, relocating, handling, and maintaining until Project completion. Vertical Panels will be paid as Signs (Construction).

~~The Department will pay for 10-foot lane line/center line and solid barrier line as Painted Pavement Marking (Line) in accordance with 716.08.~~

Payment for Removable Pavement Marking items ~~Line, 8-inch Barrier Line, Channelization Striping or Stop Line, is~~ shall be full compensation for the installation, maintenance, and removal of the marking line when it is no longer required.

Subsection 716.03.B (pg. 790), 12-15-21; **Application; Revise No. 3 & Add No. 4:**

3. **Temporary Pavement Marking (Line).** When thermoplastic is used on the final pavement surface, the Contractor may use reflectorized paint for the center, edge, lane and barrier lines installed meeting **716.07** and **910**~~to permanent standards~~ at the end of each day's work and then install the permanent pavement marking after the paving operation is completed. Short, unmarked sections are not allowed. The Department will not directly measure and pay for temporary markings for the final surface, and will consider the costs thereof to be incidental to the item for the permanent thermoplastic pavement markings (line).

4. **Temporary Pavement Markings at Intersections**. When required, temporary pavement markings at intersections are to be installed with reflectorized paint meeting **716.07** and **910.** The Department will measure and pay as noted in **712.09** and **712.10,**

Subsection 716.07.A (pg. 793), 12-15-21; **Application; Revise 11th Paragraph:**

When reflectorized paint is required for temporary or final marking, install the paint meeting **910.02**~~to permanent standards~~ at the end of each day's work. Do not leave any short, unmarked sections.

S T A T E O F T E N N E S S E E

(Rev. 12-15-21) January 1, 2021

Supplemental Specifications – 900SS
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Subsection 904.03 (pg. 931-934), 12-15-21; **Emulsified Asphalt;** Revise Table 904.03-1(c):

Table 904.03-1(c): Test Requirements for Emulsified Asphalt

Practices	AASHTO Test Method	CRS-2P	RS-2	RS-1	CRS-1
Saybolt-Furol Viscosity @ 77 °F, seconds	T59	n/a	n/a	20-100	n/a
Saybolt-Furol Viscosity @ 122 °F, seconds	T59	100-400	75-400	n/a	20-100
Storage Stability Test, 24- h, %	T59	1 Max	1 Max	1 Max	1 Max
5-day Settlement, %	T59	n/a	n/a	n/a	n/a
Particle Charge	T59	Positive	n/a	n/a	Positive
Sieve Test, %	T59	0.1 Max	0.1 Max	0.1 Max	0.1 Max
Residue by	T59	Evaporation	Distillation	Distillation	Distillation
Residue, %	T59	65 Min	63 Min	55 Min	60 Min
Demulsibility, %	T59	40 Min	60 Min	60 Min	40 Min
Distillate, %	T59	n/a	n/a	n/a	n/a
Oil Test, %	T59	n/a	n/a	n/a	3.0 Max
Stone Coating	T59	n/a	n/a	n/a	n/a
Float Test, seconds	T50	n/a	n/a	n/a	n/a
Penetration	T49	75-175	100-200	100-200	100-250
Elastic Recovery, % (1)	T301	50 Min	n/a	n/a	n/a
Ductility @ 77 °F, cm	T51	40 Min	40 Min	40 Min	40 Min
Ductility @ 40 °F, cm	T51	n/a	n/a	n/a	n/a
R&B Softening Point, °F	T53	125 Min	n/a	n/a	n/a
Original G*/sind @ 82 °C	T315	n/a	n/a	n/a	n/a

(1) Straight-sided mold, 20-cm elongation, 5min hold, 25 °C

Subsection 916.06 (pg. 988), 12-15-21; **Reflective Sheeting;** Revise Subsection:

Provide reflective sheeting from the Department's QPL conforming to AASHTO M 268 and the supplementary requirements for fungus resistance of AASHTO M 268. The sheeting material shall have a precoated adhesive backing or a heat and pressure activated adhesive backing protected by a removable liner.

For all signs with a SILVER-WHITE and ORANGE background when used on temporary barricades and channelizing drums, provide reflective sheeting ~~of~~ that meets or exceeds AASHTO M 268, Type B. ~~or better as specified by AASHTO M 268.~~

For all permanent panel signs with a SILVER-WHITE, YELLOW, RED, GREEN, BROWN, or BLUE background, provide reflective sheeting ~~of Encapsulated Lens or Microprismatic Lens material~~ that meet~~sing~~ or exceed~~sing the minimum requirements for~~ AASHTO M 268, Type ~~D~~B~~, or better as specified by AASHTO M 268.~~

For overhead permanent signs attached to sign structures which overhang travel lanes and are not illuminated with sign lighting, provide reflective sheeting that meets AASHTO M 268, Type D.

For all other sign types, provide reflective sheeting that meets or exceeds AASHTO M 268, Type B.

For FLOURESCENT ORANGE background~~, material~~ provide reflective sheeting that ~~shall~~ meets or exceeds ~~the requirements for~~ AASHTO M 268, Type B~~, as specified by AASHTO M 268.~~

Subsection 916.07 (pg. 988,989), 12-15-21; **Legends, Borders, and Accessories;** Revise Subsection:

Provide letters, numerals, symbols, borders, and route markers conforming to the MUTCD.

A. Type "A" Class I (Demountable)

Provide silver-white letters, numerals, symbols, borders, and route markers of a pre-coated pressure sensitive or a tack-free heat-activated adhesive reflective sheeting permanently adhered to the sign panel. ~~The reflective sheeting shall meet the requirements of **916.06** (Type B or better as specified by AASHTO M 268).~~
For all permanent panel signs, provide reflective sheeting that meets AASHTO M 268, Type D.

Mechanically apply the reflective sheeting to the properly prepared sign panel with the equipment and in a manner prescribed by the sheeting manufacturer. Letters, numerals, symbols, borders, and route markers shall be 0.032 inch thick aluminum sheet of 3003 H14 Alloy or approved composite material. Properly degrease and etch aluminum, or treat with a light, tight, amorphous chromate type coating.

Supply each letter, numeral, symbol, and route marker with mounting holes, and secure to the sign surface with corrosion-resistant screws, bolts, or rivets.

B. Type "A" Class 2 Cut-Out (Direct Applied Reflective Sheeting Copy)

Provide silver-white cut-out letters, numerals, symbols, borders, and route markers of a pre-coated pressure sensitive or a tack-free heat-activated adhesive reflective sheeting. ~~The reflective sheeting shall meet the requirements of **916.06** (Type B or better as specified by AASHTO M 268).~~

For all permanent panel signs, provide reflective sheeting that meets AASHTO M 268, Type D.

For all other sign types, provide reflective sheeting that meets or exceeds AASHTO M 268, Type B.

APPENDIX B

SPECIAL PROVISIONS

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S T A T E **OF** **T E N N E S S E E**
Rev: October 10, 2016 January 1, 2021

SPECIAL PROVISION

REGARDING

EMPLOYING AND CONTRACTING WITH ILLEGAL IMMIGRANTS

The State shall endeavor to do business only with those contractors and subcontractors that are in compliance with the Federal Immigration and Nationality Act. This policy shall apply to all State Contractors including subcontractors. This policy statement is issued to establish implementation guidance to procuring state agencies and contractors reflecting the requirements of *Tennessee Code Annotated* §12-3-309 regarding the employment of illegal immigrants in the performance of state contracts.

1. The Contractor hereby attests, certifies, warrants, and assures that the Contractor shall not knowingly utilize the services of an illegal immigrant in the performance of this Contract and shall not knowingly utilize the services of any subcontractor who will utilize the services of an illegal immigrant in the performance of this Contract. The Contractor shall reaffirm this attestation, in writing, by submitting to the State a completed and signed copy of the "Attestation form" provided by the Department, semi-annually during the period of this Contract.

2. Prior to the use of any subcontractor in the performance of this Contract, and semi-annually thereafter, during the period of this Contract, the Contractor shall obtain and retain a current, written attestation that the subcontractor shall not knowingly utilize the services of an illegal immigrant to perform work relative to this Contract and shall not knowingly utilize the services of any subcontractor who will utilize the services of an illegal immigrant to perform work relative to this Contract.

3. The Contractor shall maintain records for its employees used in the performance of this Contract. Said records shall include a completed federal Department of Homeland Security Form I-9, *Employment Eligibility Verification*, for each employee and shall be subject to review and random inspection at any reasonable time upon reasonable notice by the State.

The Contractor understands and agrees that failure to comply with this section will be subject to the sanctions of *Tennessee Code Annotated* § 12-3-309 for acts or omissions occurring after January 1, 2007. This law requires the Chief Procurement Officer, Department of General Services, to prohibit a contractor from contracting with, or submitting an offer, proposal, or bid to contract with the State of Tennessee to supply goods or services for a period of one year after a

contractor is discovered to have knowingly used the services of illegal immigrants during the performance of this contract.

For the Purposes of this policy, “illegal immigrant” shall be defined as a non-citizen who has entered the United State of America without federal government permission or stayed in this country beyond the period allowed by a federal government-issued visa authorizing the non-citizen to enter the country for specific purposes and a particular time period.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-15-20) January 1, 2021

SPECIAL PROVISION

REGARDING

TENNESSEE DEPARTMENT OF TRANSPORTATION STANDARD

SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION

Description

Any and all references concerning the January 1, 2015 Standard Specifications for Road and Bridge Construction shall be interpreted as the January 1, 2021 Standard Specifications for Road and Bridge Construction.

STATE OF TENNESSEE

SPECIAL PROVISIONS RELATIVE TO PROTECTION OF RAILROAD PROPERTY, RAILROAD FLAGGING, AND INSURANCE REQUIREMENTS

Project Information: PIN#: 114174.01; Legislative; I-75, Interchange at I-24, Phase 2 (IA); Underpassing; CSXT Railroad Crossing (DOT#: 350029M); Fed. Proj. No.(s): IM/NH-75-1(131); CSXT OP#: TN0597.

Tennessee Project Number(s):
PE: 33005-1185-44
Construction: 33005-3181-44
ROW: 33005-2185-44

County: **Hamilton**

Railroad Company: CSX Transportation, Inc. (CSXT)
P.O. Box 45052
Jacksonville, FL 32232-5052

AUTHORITY OF CSXT ENGINEER:

The authorized representative of the railroad, hereinafter referred to as CSXT Engineer, shall have final authority in all questions affecting his railroad operations, and the contractor must be governed accordingly.

All engineering correspondence, scheduling of work, and request for pre-construction representation shall be addressed to the CSX Transportation, Inc. Project Manager contact (See sheet number 8 for name and address).

PRECONSTRUCTION MEETING:

A preconstruction meeting will be scheduled by Department personnel prior to the Department's contractor starting work. The Department shall notify CSXT when the preconstruction meeting is scheduled so that a CSXT representative may attend. The Department will document the notification requesting CSXT attendance in the project file.

CSXT SCHEDULE I

The Department's contractor shall execute a CSXT Schedule I agreement prior to starting work.

INTERFERENCE WITH RAILROAD OPERATIONS:

The Department or its contractor shall so arrange and conduct their work that there will be no interference with railroad operations, including train, signal, telephone and telegraphic services, or damage to the property of the railroad, or to wires or other facilities of the tenants on the rights-of-way of the railroad.

The use of any scaffolding or other temporary framework that effects horizontal or vertical clearance must first be approved by the railroad CSXT Engineer and in no case exceed the approved clearances.

If conditions arising from or in connection with the Project require that immediate and unusual provisions be made to protect train operation or CSXT's property, the Department or its Contractor shall make such provision. If the CSXT Representative determines

that such provision is insufficient, CSXT may, at the expense of the Department or its Contractor, require or provide such provision as may be deemed necessary, or cause the Work to cease immediately.

DAMAGE TO RAILROAD PROPERTY:

Should any damage occur to railroad property as a result of the contractor's unauthorized or negligent operations, and the railroad superintendent deems it necessary to repair such damage or perform any work for the protection of its property, the required materials, labor and equipment shall be furnished by the railroad and the contractor shall reimburse it for the costs incurred.

TEMPORARY GRADE CROSSINGS:

If the contractor desires access across railroad's right-of-way and tracks at other than an existing and open public road crossing in or incident to construction of the project, the railroad may permit such contractor access across said right-of-way and tracks at such location as shall be mutually agreed upon by CSXT and contractor, provided contractor first executes a license agreement satisfactory to the railroad and agrees to bear all costs and liabilities related to such access, including reimburse the railroad for the flagmen expenses, cost of providing and removing any temporary grade crossing, and other costs which CSXT deems necessary for protection of its property and operations. Contractor shall at no time cross the railroad's right-of-way or tracks with vehicles or equipment of any kind or character, except at such crossing or crossings as may be established pursuant to this subsection.

WATCHMEN:

The railroad shall have the right to assign a watchman to the site of the project to perform inspection services for protection of its railroad operations, whenever, in the opinion of CSXT, such inspection may be necessary to prevent interference with railroad operations, such as but not necessarily limited to obstruction of track clearances and roadbed drainage, foreign substances on or adjacent to the rails and disturbance of surface and alignment of track, but such inspection shall not relieve the contractor from liability. The cost incurred by the railroad for furnishing a watchman to perform such inspection services will be reimbursed by TDOT.

FLAGGING SERVICES:

Any flagging service required, when in the opinion of CSXT that such service is necessary for the safety of its operations because of work being performed by the contractor or in connection therewith, will be provided by the railroad. The requirements of the railroad are as follows:

The services of two flagmen whenever the contractor's men or equipment are, or are liable to be, working within the specified track clearances, or over the tracks, or when work has disturbed the surface and alignment of any operated track to such extent that movement of trains should be controlled by flagging.

The Department or contractor shall give a minimum of thirty (30) days advance notice to CSXT for anticipated need for flagging service. No work shall be undertaken until the flag person(s) is/are at the job site. If it is necessary for CSXT to advertise a flagging job for bid, it may take up to 90 days to obtain this flagging service, and CSXT shall not be liable for the cost of delays attributable to obtaining this flagging service.

The Department will reimburse the Railroad directly for all costs incurred for flagging services by railroad personnel. The Railroad has officially allotted 300 flagging days to the Contractor for the resurfacing of the above described project. In the event that flagging services are required in excess of the officially allotted days, the Department will reimburse the Railroad for the additional cost of flagging services and such costs deducted from monies due the Contractor. No adjustments will be made to costs of flagging services that are required in excess of the allotted days. These additional flagging costs assessed against the Contractor will be made under the following item:

105-03	Railroad Flagging (Deduct)	Dollar

The payment of flagging services will be based on invoices received from the Railroad. The Engineer shall sign the invoice in order to verify the flagging service performed by the Railroad.

Estimated flagging rate for this contract is $504.00 per day per flagman based on a twelve hour work day.

Overtime rate 16 hours = 2.0 x regular hourly rate.

Holiday rate = 1.5 x regular hourly rate up to 16 hours and = 2.0 x regular hourly rate over 16 hours.

In addition to the above rate there will be an additive of 223.00% of direct labor for vacation, holiday, sickness, pension, administration, etc.

Minimum + hours per call out is eight (8) hours and notification to start or to terminate flagman must be given at least five (5) days in advance or else contractor might be billed for flagman whether he is working or not working.

The Contractor and Department will review and sign the Railroad flagman's time sheet attesting that the flagman was present during the time recorded. Flagmen may be removed by Railroad if form is not signed. If flagman is removed, the Contractor will not be allowed to re-enter the Railroad right-of-way until the issue is resolved. Any complaints concerning flagman or flagmen must be resolved in a timely manner. If need for flagman or flagmen is questioned, please contact CSX Transportation, Inc. Flag Request Contact. (See sheet number 8 for name and address). All verbal complaints must be confirmed in writing by the Contractor within 5 working days with copy to the Highway Engineer. All written correspondence should be addressed to CSX Transportation, Inc. Project Manager contact (See sheet number 8 for name and address).

The Railroad flagman assigned to the project will be responsible for notifying the State Project Supervisor upon arrival at the job site on the first day (or as soon thereafter as possible) that flagging services begin and on the last day that he performs such services for each separate period that services are provided. The State Project Supervisor will document such notification in the project records. When requested, the State Project Supervisor will also sign the flagman's diary showing daily time spent and activity at the project site.

Upon completion of all work within the Railroad right-of-way, the State Project Supervisor shall notify the Railroad for final inspection of this work. The Department shall give the Railroad 120 calendar days from the date of the on-site final inspection, in which the work is accepted by the Department and the Railroad, to submit all invoices for which flagging services are to be reimbursed. Department will not be liable for any payment of flagging charges received after 120 calendar days.

USE OF EXPLOSIVES:

Explosives shall not be used on or adjacent to any track or other railroad property without the prior written approval of CSXT, but such approval will not relieve the contractor from any liability. If the use of the explosives are permitted, the blasting shall be done with light charges under supervision **of a responsible employee of the Department or contractor. No blasting shall be done without the presence of an authorized representative of CSXT. At least ten (10) business days advance notice to either the CSXT Construction Manager contact or the CSXT Roadmaster is required to arrange for the presence of an authorized CSXT representative and any flagging that CSXT may require.** Every precaution shall be taken to avoid damage to property, injury to persons and interruption of railroad operations. **Electronic detonating fuses shall not be used because of the possibility of premature explosions resulting from operation of two-way train radios.** Blasting shall be discontinued immediately on notice from CSXT that it is too hazardous.

The Department or contractor must have at the Project Site adequate equipment, labor and materials, and allow sufficient time to (i) clean up (at the Department's expense) debris resulting from the blasting without any delay to trains; and (ii) correct (at the Department's expense) any track misalignment or other damage to CSXT's property resulting from blasting, as directed by CSXT Representative, without delay to trains. If Department's or Contractor's actions result in delay of any trains, including Amtrak passenger trains, Department shall bear the entire cost thereof. In the event that the Contractor does not restore the Railroad's track and/or related train traffic facilities to their pre-blasting condition, and/or the Contractor's actions result in any delay of train traffic CSXT's costs to mitigate such damages and/or train traffic delays that are charged to the Department by CSXT shall be reimbursed to the Department from monies due the Contractor.

The Department or Contractor shall not store explosives on CSXT property.

STORAGE OF MATERIALS:

The contractor shall not store or pile materials or equipment on the right-of-way of the railroad without having first obtained permission from CSXT, and in no case shall they be stored closer than 13' 0" from the centerline on any railroad track measured at right angles thereto. Such permission will be with the understanding that the railroad will not be liable for any damage to such materials or equipment from any cause and that CSXT may move, or require the contractor to move, at the contractor's expense, such materials and equipment. **The contractor shall store materials so as to prevent trespassers from causing damage to trains or CSXT property.**

CLEANING UP:

The contractor will be required upon completion of the work, to remove from within the limits of the railroad's right-of-way, all machinery equipment, surplus materials, falsework, rubbish, debris, or temporary buildings of said contractor, and to leave the right-of-way in a neat condition, satisfactory to CSXT. The contractor will be required to provide the project engineer with a letter of release from CSXT before final acceptance of the project by the State.

NOTICE OF STARTING WORK:

The contractor shall notify the CSXT Engineer of the railroad in writing at least ten (10) business days in advance, when he expects to start work on railroad's right-of-way and **thirty (30)** days in advance of flagging services.

COOPERATION AND DELAYS:

The contractor shall cooperate with others participating in the construction project, to the end that all work may be carried on to the best advantage. No charge or claim of the contractor against either the State or the railroad will be allowed for hindrance or delay on account of railroad traffic or any work done by the railroad or others, incident to or necessary for safe operation or maintenance of railroad traffic, facilities, and property, or completion of the project, but due consideration of any such delay will be taken into account in counting the working days to be charged against the project.

During construction of the footings of piers or other supports or structures adjacent to any track of the railroad, the contractor shall make adequate provisions against sliding, shifting, sinking, or in any way disturbing the railroad embankment and track operations, by driving temporary sheeting, and/or providing temporary shoring in a manner satisfactory to the State Project Supervisor, the railroad Project Manager (**See sheet number 8 for name and address**) and the railroad Staff Engineer.

Before commencing work on any pier or structure adjacent to any track, the contractor shall submit prints of the proposed shoring and bracing details for the protection of the railroad company's track to the State Project Supervisor for his approval. This submittal shall include the proposed method of installation and be accompanied by supporting data, including design computations, soil descriptions, and other pertinent information.

After approval by the State Project Supervisor, four prints of the proposed shoring and bracing details bearing the seal of a registered structural or professional engineer, together with supporting documents, shall be forwarded to the railroad Project Manager (**See sheet number 8 for name and address) or his engineering designate** for review and approval.

The contractor shall notify the railroad Engineering Consultant Designee and Project Manager (in writing) not less than one (1) week in advance of the proposed time of the beginning of the construction of the piers, supports or structures adjacent to the track.

INSURANCE:

In addition to any other forms of insurance or bonds required under the terms of the contract and specifications, the contractor will be required to carry insurance of the following kinds and minimum amounts:

(1.) Commercial General Liability insurance coverage with limits of not less than **$5,000,000.00** in combined single limits for bodily injury and or property damage per occurrence. Said policy shall include "explosion, collapse, and underground hazard" ("XCU") coverage, shall be indorsed to name Railroad specified in item 2.C. below as an additional insured, and shall include a severability of interest provision, and shall be addressed directly to **CSXT Risk Management contact (See sheet number 8 for name and address).**

(2.) Statutory Worker's Compensation and Employers Liability Insurance with limits of not less than **$1,000,000.00**, which insurance must contain a waiver of subrogation against CSX Transportation, Inc. and its affiliates.

(3.) Commercial automobile liability insurance with limits of not less than **$1,000,000.00** combined single limit for bodily injury and/or property damage per occurrence, and such policies shall name CSX Transportation, Inc. as an additional named insured.

Railroad's Protective Public Liability and Property Damage Liability Insurance:

(4.) The contractor will be required to furnish Railroad Protective Insurance to protect CSX Transportation, Inc. in connection with operations to be performed on or adjacent to CSX Transportation's right-of-way. Questions concerning CSX Transportation Insurance requirements shall be addressed directly to **CSXT Risk Management contact (See sheet number 8 for name and address).** These are CSXT specifications for proper evidence of insurance:

A. The insurer must be financially stable and rated B+ or better in Best's Insurance Reports.

B. The policy must be written using the ISO/RIMA Form of Railroad Protective Insurance - Insurance Services Office (ISO) Form CG 00 35.

C. Named Insured Railroad and Address:

CSX Transportation, Inc.
Risk Management (C-907)
500 Water Street
Jacksonville, FL 32202

Electronic mail should be sent to:

Victoria.Matts@stvinc.com

D. Limits of Liability:.

$5,000,000.00 per occurrence combined single limit for bodily injury and property damage, subject to a $10,000,000.00 annual aggregate limit is required because a significant number of hazardous materials trains (a total of 20 Train Movements at 40 MPH along this track per day) are in the area of construction).

E. **CSX Transportation must be named as the named insured on the Railroad Protective Policy.**

F. Name and address of the contractor and TDOT must be shown on the Declarations page.

G. Name and address of the Project Sponsor, being the State of Tennessee, Department of Transportation must be shown on the Declarations page.

H. Description of operations must appear on the Declarations page and must match the project description, including project or contract identification numbers.

I. Authorized Endorsements:

1. Must Include:

a) Pollution Exclusion Amendment – CG 28 31

(Not necessary with Form CG 00 35 version 96 and later)

b) Delete Common Policy Conditions – CL/CG 99 01

If policy jacket does not include Common Policy Conditions this endorsement is not necessary.

2. Acceptable:

a) Broad Form Nuclear Exclusion – IL 00 21

b) 30-Day Advance Notice of Non-renewal or cancellation

c) Required State Cancellation Endorsement

d) Quick Reference or Index – CL/IL 240

3. Unacceptable:

a) Any Pollution Exclusion Endorsement except CG 28 31

b) An Endorsement that excludes TRIA coverage

c) An Endorsement that limits or excludes Professional Liability coverage

d) A Non-Cumulation of Liability or Pyramiding of Limits Endorsement

e) A Known Injury Endorsement

f) A Sole Agent Endorsement

g) Any Punitive or Exemplary Damages Exclusion

h) Any "Common Policy Conditions" Endorsement

i) Any endorsement that is not named in I (1) or I (2) above.

j) Policies that contain any type of deductible.

J. Additional Terms:

1. The Contractor must submit its original insurance policies and two copies and all notices and correspondence regarding insurance policies directly to the **CSX Risk Management Contact (See sheet Number 8 for electronic/e-mail address).**

2. Neither TDOT nor the Contractor may begin work on the Project until it has received CSXT's written approval of the required insurance policies.

GENERAL

All insurance herein-before specified shall be carried until all work required to be performed under the terms of the contract has been satisfactorily completed within the limits of the right-of-way of the railroad, as evidenced by the formal acceptance by the State.

Insuring companies may not cancel insurance except by permission of the State and railroad insured, or on thirty (30) days written notice to the State and the railroad.

RAILROAD CONTACTS NAME AND ADDRESS

Mr. Todd Allton
Project Manager - Public Projects

CSX Transportation, Inc.

1590 Marietta Blvd. NW
Atlanta, GA 30318
O. 404.350.5134
E. Todd_Allton@csx.com

Mr. Tony Bellamy
Director, Project Management Public Projects

CSX Transportation, Inc.

SC/J-301
500 Water Street
Jacksonville, FL 32202
O. 904.359.7601
F. 904.245.2824
E. tony_bellamy@csx.com

Insurance Risk Management

E. Victoria.Matts@stvinc.com

FLAGGING REQUEST

Mr. Patrick Proud
Construction Manager
STV, Inc.
5200 Belford Rd., Suite 400
Jacksonville, FL 32256
M. 678.350.6750
E. Patrick.Proud@stinc.com
Charge Flagging to:
CSXT OP#: TN0597

*Railroad Contacts For Pre-Con Meeting Notification And For Coordination of Construction Work:

TDOT Construction Contact:
Ken Flynn– Region 2 Operations Engineer
7512 Volkswagen Dr.
Chattanooga, TN 37416
Phone: 423-510-1217
Email: Ken.Flynn@tn.gov

Railroad's Engineering Consultant Designate:
Mr. Randy Frederick – Engineering Director
STV, Incorporated
5200 Belfort Rd., Suite 400
Jacksonville, FL 32256-6054
PHONE: (904) 383-3913
CELL: (904) 254-2692
EMAIL: RANDY.FREDERICK@STVINC.COM

*Ms. Vicki Matts – Project Manager
STV, Incorporated
5200 Belfort Rd., Suite 400
Jacksonville, FL 32256-6054
PHONE: (904) 383-3919
CELL: (904) 651-0902
FAX: (904) 730-7766
EMAIL: VICTORIA.MATTS@STVINC.COM

TN TDOT Department of Transportation

DOT Crossing Number(s) Information:

Date: 3/22/22

DOT#:	350029M
Average Trains/Day:	20
Maximum Train Speed:	40

SPECIAL NOTES

The contractor shall provide the Railroad Protective Insurance Policy and Certificates of Insurance by e-mail within (20) calendar days of Notification of Award.

Failure to provide the above within the specified time may subject the award to annulment and forfeiture of the bid guarantee, not as a penalty, but as liquidated damages.

SCHEDULE I

TDOT PROJECT NO.: 114174.01
CSXT OP NO.: TN0597

CONTRACTOR'S AGREEMENT

This CONTRACTOR'S AGREEMENT is made as of _____, _____, by _____ ("Contractor"), to and for the benefit of CSX Transportation, Inc. ("CSXT") and to induce CSXT to permit Contractor on or about CSXT's property, for the purposes of performing work in connection with the above-referenced project for Tennessee Department of Transportation.

In consideration of CSXT's consent to permit Contractor on or about CSXT's property for such purposes, and other good and valuable consideration, the receipt and sufficiency of which are acknowledged by Contractor, Contractor hereby agrees as follows:

1. CSXT Special Provisions. Contractor agrees to abide by and observe the terms and conditions of the CSXT Special Provisions (which is incorporated by referenced into this Agreement).
2. Insurance Requirements. Contractor shall acquire and maintain the insurance described by the Special Provisions, and shall submit proof of insurance to CSXT in accordance with the Special Provisions, satisfactory to CSXT, prior to commencement of work on or about CSXT's property.
3. Indemnification.

Contractor further specifically agrees as follows:

(a) Contractor shall indemnify, defend and save harmless CSXT and its affiliates from all suits or claims of any character brought because of any injuries or damage received or sustained by any person, persons, or property, in whole or in part, on account of the operations of Contractor or any subcontractor or sub-subcontractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials or workmanship in constructing the work; or because of any act or omission, neglect, or misconduct of Contractor or any subcontractor or sub-subcontractor; or because of any claims or amounts recovered from any infringements of patent, trademark or copyright; or for failing to pay, when and as due, all bills and other legitimate charges, including lawful claims for labor performed or materials, equipment and supplies furnished for use in and about the construction of the work under contract; or from any claims or amounts arising or recovered under the Worker's Compensation Act, or any other law, ordinance or decree. The foregoing indemnification obligation shall not be limited to the insurance coverage required by this Agreement.

(b) Contractor shall comply with any federal, state or local laws, statutes, codes ordinances, rules, and regulations applicable to its construction and maintenance of

the project. Contractor shall indemnify, defend, and CSXT and its affiliates harmless with respect to any fines, penalties, liabilities, or other consequences arising from breaches of this Agreement.

(c) For the purpose of this Agreement, CSXT's affiliates include CSX Corporation and all entities, directly or indirectly, owned or controlled by or under common control of CSXT or CSX Corporation and their respective officers, directors, employees and agents.

(d) Contractor shall notify CSXT promptly of any loss, damage, injury or death arising out of or in connection with the Project work.

(e) The provisions of this agreement shall survive the termination or expiration of the Agreement.

IN WITNESS WHEREOF, Contractor has executed and delivered this Agreement as of the date set forth below.

CONTRACTOR

_____

BY: _____

Print: _____

Date: _____ Title: _____

S T A T E **O F** **T E N N E S S E E**

(Rev. 6-20-11) January 1, 2021

SPECIAL PROVISION

REGARDING

BUY AMERICA REQUIREMENTS

All manufacturing processes for iron and steel products, and coatings applied thereon, used in this project shall occur in the United States except that if the proposal has bid items for furnishing domestic and foreign iron and steel, the bidder will have the option of (1) submitting a bid for furnishing domestic iron and steel, or (2) submitting a bid for furnishing domestic iron and steel and a bid for furnishing foreign iron and steel. If option (2) is chosen, the bid will be tabulated on the basis of (a) the total bid price using the bid price for furnishing domestic iron and steel and, (b) the total bid price using the bid price for furnishing foreign iron and steel.

For the total bid based on furnishing foreign iron and steel to be considered for award, the lowest total bid based on furnishing domestic iron and steel must exceed the lowest total bid based on furnishing foreign iron and steel by more than 25 percent. The 25 percent differential applies to the total bid for the entire project, not just the bid prices for the steel or iron products.

Iron and steel products are defined as products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated or otherwise similarly processed from iron and steel made in the United States. Iron products are included, however, pig iron and processed, pelletized, and reduced iron ore may be purchased outside the United States.

Manufacturing begins with initial melting and continues through the coating stage. Any process which modifies chemical content, physical size or shape, or the final finish is considered a manufacturing process. Coatings include epoxy, galvanizing, painting or any other surface protection that enhances the value and/or durability of a material.

The contractor shall provide a certification to the Engineer with each shipment of iron and steel products to the project site that the manufacturing processes for the iron and steel products occurred in the United States. No steel shall be placed until the contractor ensures the requirements of this Special Provision are met.

The above requirements do not prevent a minimal use of foreign materials, if the cost of such materials used does not exceed 0.1 percent of the total contract cost or $2,500.00, whichever is greater. If steel not meeting the requirements of this Special Provision is used, the contractor shall provide a written statement to the Department prior to its use indicating where the steel will be incorporated in the work,

the value of the steel, the percentage of the contract amount, and the appropriate invoices shall be submitted as documentation.

The contractor shall be responsible for all cost associated with any steel that is permanently incorporated into the project that does not meet the requirements of this Special Provision without prior written approval from the Department, up to and including removal and replacement.

S T A T E **O F** **T E N N E S S E E**

September 10, 2020 January 1, 2021

SPECIAL PROVISION

REGARDING

PROHIBITION ON CERTAIN TELECOMMUNICATION AND VIDEO

SURVEILLANCE SERVICES OR EQUIPMENT

Installation of telecommunication and video surveillance equipment, services or systems shall contain no components from providers as listed in Title 2 Code of Federal Regulations (CFR) Part 200.216.

The prohibition on certain telecommunication and video surveillance services or equipment regulation in Title 2 CFR 200.216 shall apply to this contract. Take all necessary and reasonable steps in accordance with Title 2 CFR 200.216 to ensure that no prohibited telecommunication and video surveillance services or equipment are included in any of the work in this contract. As defined in Title 2 CFR 200.471, the regulation provides clarity that the telecommunications and video surveillance costs associated with Title 2 CFR 200.216 are unallowable for services and equipment from the providers.

It is prohibited from installing equipment, services, or systems that use covered telecommunications equipment or services from providers described in section 889 of the National Defense Authorization Act for Fiscal Year 2019 (NDAA 2019).

As described in section 889 of the NDAA 2019, “covered telecommunications equipment or services” means:

- Telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities);
- Video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities);
- Telecommunications or video surveillance services provided by such entities or using such equipment; or
- Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country. The term “covered foreign country” means the People’s Republic of China.

Any prohibited equipment installed must be removed and replaced at the contactor’s expense with acceptable equipment.

S T A T E **O F** **T E N N E S S E E**

(Rev 9-3-13) January 1, 2021

SPECIAL PROVISION

REGARDING

AIR QUALITY FOR MOWING

Description. The contractor will be required, absent an immediate safety issue determined by the Engineer, to cease mowing operations in the non-attainment counties listed below on Air Quality Action or Alert days within those counties. The appropriate TDOT representative will direct the contractor to suspend mowing operations upon the notification that an Action/Alert day forecast has been issued. Forecasts are issued by AIRNOW the day before the Action/Alert Day in the afternoons at the following web address:

http://airnow.gov/index.cfm?action=airnow.fcsummary&stateid=50

This will be the only authority for notifications used by TDOT. TDOT notification to the contractor will be made by the Close of Business (COB) the day prior to the Action/Alert Day.

The cessation of mowing operations will apply to any Action/Alert day forecast notification. The cessation of mowing operations shall remain in place until the Action/Alert day forecast is terminated. On these days, the contractor may mow outside of the non-attainment counties if the contract includes mowing in additional counties not listed below. Also, no trimming operations with weed trimmers will be allowed during these Action/Alert days. All working days that the contractor must cease mowing operations shall be added to the total number of days the contractor has to complete the disrupted mowing cycle.

Basis of Payment. All costs associated with the cessation of work caused by an Air Quality Action or Alert days will be compensated, on a per day basis, at the unit price bid for Item Number 717-10.01, INVOLUNTARY WORK SUSPENSION.

Payment will be made only when the contractor is actively mowing in one of the listed counties when an Air Quality Action/Alert day in that county has been declared and he is directed to cease mowing operations.

No payment will be made for any Air Quality Action/Alert day that occurs after mowing operations have been completed for a cycle. In addition, no payment will be made if after mobilizing for a mowing cycle an Air Quality Action/Alert day is declared before the contractor commences mowing operations.

Non-Attainment Area **Counties**
CHATTANOOGA REGION
Hamilton
CLARKSVILLE REGION
Montgomery
NASHVILLE REGION
Davidson
Rutherford
Sumner
Wilson
Williamson
KNOXVILLE REGION
Anderson
Jefferson
Knox
Loudon
Roane (only areas around TVA Plant)
MEMPHIS REGION
Shelby
GREAT SMOKY MTNS.
Blount
Cocke (only areas within Park)
Sevier

S T A T E **O F** **T E N N E S S E E**

March 29, 2021 January 1, 2021

SPECIAL PROVISION

REGARDING

CONTRACTOR PAYROLL REQUIREMENTS IN

AASHTOWARE PROJECT CIVIL RIGHTS & LABOR (CRL)

In accordance with Special Provisions 1273 and 1280 and the Standard Specifications Subsection **107.20**, submit and certify payrolls for each week in which any contract work is performed. All payrolls shall be submitted electronically through the website using AASHTOWare Project Civil Rights & Labor (CRL) software.

Register for payroll access and develop a method of import prior to the Preconstruction Conference. Detailed information can be found on the TDOT Labor Compliance webpage at www.tn.gov/content/tn/tdot/tdot-construction-division/transportation-construction-division-resources/tdot-labor-compliance.html.

Ensure each subcontractor, including all Disadvantaged Business Enterprises (DBE), certified Small Business Enterprises (SBE), and DBE or SBE haulers, has registered for payroll access and developed their method of import prior to commencing work.

Assume all responsibility for ensuring all payrolls and all subcontractor payrolls are submitted and certified electronically in CRL for each week in which any contract work is performed. If all payrolls are not received in this timeframe, the progress payment shall be withheld until all necessary payrolls have been received.

There will be no direct payment for recording and reporting of this information. All cost associated with this provision shall be considered incidental.

S T A T E **O F** **T E N N E S S E E**

(Rev. 2-8-21) January 1, 2021

SPECIAL PROVISION

REGARDING

WATER QUALITY AND STORM WATER PERMITS

Description

This work consists of the conditions that apply to all construction activities on the project pursuant to the following:

1. Section 404 of the Federal Clean Water Act (33 U.S.C. §1344), and all implementing regulations, including without limitation regulations of the U.S. Army Corps of Engineers governing permits for discharges of dredged or fill material into waters of the United States in 33 CFR Part 323; and
2. The Tennessee Water Quality Control Act (T.C.A. §69-3-101, et seq.) and all implementing regulations, including without limitation the Rules of the Tennessee Department of Environment and Conservation governing NPDES permits in Chapter 400-40-10, and Aquatic Resource Alteration permits in Chapter 400-40-7; and
3. Section 26a of the TVA Act of 1933 as amended (49 Stat. 1079, 16 U. S. C. sec. 831y1.) and all implementing regulations, including without limitation the regulations of the Tennessee Valley Authority governing construction in the Tennessee River System in 18 C.F.R., Part 1304; and
4. The Tennessee Wildlife Resources Agency Reelfoot Lake Watershed Management permit program (T.C.A. section 70-5-1,), and all implementing regulations, including without limitation regulations authorizing any activity, practice, or project which has or is likely to have the effect of diverting surface or subsurface water from the Lake or have the effect of draining or otherwise removing water from Reelfoot Lake; and
5. Coast Guard Bridge Permit (USCG) (Section 9 of the Rivers and Harbors Appropriation Act of 1899) and all implementing regulations, including but not without limitation for projects which impact streams deemed navigable by the U.S. Coast Guard.

Responsibility

Assume all responsibilities of the permittee as indicated in the permit that relates to protection of the "waters of the United States" and/or "waters of the State of Tennessee."

Obtain any additional permits required by the Contractor for off-site waste and/or borrow areas and associated off project work areas.

Sign the Notice of Intent (NOI) form, provided by the Department, indicating acceptance of the stipulations contained in the permit. Submit the signed NOI to the TDOT HQ Construction Division by email within 10 calendar days after submittal of the contract proposal or the Department may at its discretion cancel the award with the Contractor forfeiting the bid bond.

Implement the provisions of the Water Quality (including, but not limited to, TDEC ARAP, USACE 404, TVA Section 26a, Coast Guard, TWRA) and Storm Water [including, but not limited to, National Pollution Discharge Elimination System (NPDES), Statewide Stormwater Management Plan (SSWMP)] Permits and requirements that pertain to construction activities.

Review of the permit provisions, including NPDES Permit provisions the site specific SWPPP, the contract plans, Standard Specifications and contract Special Provisions and find the permit requirements and erosion prevention and sediment control (EPSC) procedures to be reasonable, workable, and binding.

The Contractor shall not be released from the project site responsibilities under the NPDES permit provisions until the Notice of Termination (NOT) is submitted to TDEC by the TDOT Regional Operations Engineer. The NOT is a certification that the construction project is permanently stabilized, and all construction related discharges have ceased. This means that the use of EPSC measures to alleviate concerns of surface erosion and transport of sediment to surface water conveyances or to waters of the state is no longer necessary. Furthermore, it means that permanent controls, hard surfaces and/or vegetation, used on the project are deemed adequate to prevent erosion and sediment transport and no other potential sources of construction-related pollution are on the project.

The Contractor shall not be released from any warranty provided for EPSC plantings, including sod and trees. If the entire project is complete as outlined in **105.15** of the Standard Specifications, the tree plantings shall still be required to meet the requirements of **802** Standard Specifications**.**

NPDES Permit Required Action

Accompany the TDOT EPSC inspector or TDOT consultant on all EPSC inspections of the entire construction project including permitted locations and potentially impacted streams, and attend all QA/QC Project Assessments.

EPSC Inspections shall be conducted as required in the most current TN Construction General Permit.

EPSC inspections shall be performed on the schedule established in the TN Construction General Permit until the site is permanently stabilized to determine if the permit requirements are being met. Where sites or portion(s) of the construction project have been temporarily stabilized, the inspections only have to be conducted once per month until construction activity resumes. Written

notification of the intent to change the inspection frequency and the justification for such request must be submitted to the TDOT District Supervisor and the TDEC Central Office before proceeding.

A representative who holds a current TDEC "*Fundamentals of Erosion Prevention and Sediment Control Level I"* certification shall accompany the TDOT EPSC inspector on all required EPSC inspections. The project supervisor(s) shall also hold a current TDEC "*Fundamentals of Erosion Prevention and Sediment Control Level I"* certification. Proof of required personnel training for the individual(s) shall be provided to the TDOT District Supervisor prior to beginning of construction.

The TDOT EPSC inspector shall document all deficiencies on the required current TDOT EPSC Inspection Report form. Sign the TDOT EPSC Inspection Report form and any supporting documentation indicating that there is agreement with the report, recommendations and repair schedule as stated in the documentation.

Make necessary maintenance and repairs relative to deficiencies in these permit conditions or requirements within 24 hours after an inspection identifies the maintenance or repair need, and/or as directed by the TDOT District Supervisor, unless conditions make a particular activity impracticable. Any such conditions that make immediate repairs impracticable shall be documented on the inspection report and provided to the TDOT District Supervisor, and be accompanied by an expected repair schedule based on forecasted weather conditions.

Review the site specific SWPPP that will be made available prior to or at the pre-construction conference, for any additional EPSC requirements. Sign and submit two copies of the SWPPP signature page provided by the Department in the site specific SWPPP. Submit for review and approval any changes/revisions to the SWPPP to prevent erosion and sediment transport at any time after contract execution. Rejection of any submittals by the Department does not relieve the liability for appropriate Best Management Practices (BMPs).

If at any time during this contract, the requirements for the Water Quality Permits and/or the Storm Water Permits for Construction Related Activities are changed/revised/updated, the Contractor shall be notified in writing by the Department of such requirements. Comply with the new requirements within 30 days of the Department notification.

If at any time that sedimentation is occurring or has occurred in streams impacted by the project, immediately notify the TDOT District Supervisor to evaluate the EPSC measures employed. A determination of the cause for sedimentation will be made by the Department. Immediately repair or replace defective EPSC measures and install, as applicable, additional or other EPSC measures with the goal of eliminating future sedimentation. Once a remediation plan is provided by the Department, within 24 hours after notification, begin the remediation as required. Based on the cause of sedimentation, the Department will determine if the cost of remediation will be performed at the Contractor's expense.

Failure to Comply

In the event a Notice of Noncompliance, Notice of Violation, Notice of Deficiency, or Order is issued by any State or Federal Agency on this project, any required corrective action and all fines

will be the sole responsibility of the Contractor as outlined in **107.01** of the Standard Specifications.

Failure to comply or take immediate corrective actions required within 24 hours, unless documented conditions make a particular maintenance or repair activity impracticable immediately, shall be reason for the TDOT District Supervisor to suspend all other work on the Project, except EPSC and traffic control. The Department will apply non-refundable deductions of monies from the Contract per calendar day from monies due to the Contractor for any EPSC work on the Project. This deduction can be made for each location, as determined by the TDOT District Supervisor, for each calendar day that the deficiency is allowed to remain and charged as item description *"Failure to Comply with Permit Deduction"*. A deduction shall be made from monies due the Contractor, not as a penalty, but as liquidated damages, as indicated in **108.09** of the Standard Specifications.

If the necessary corrections/adjustments are not done in a timely manner as required, the Department will implement the provisions of **209.07** and **109.08** of the Standard Specifications that provides for the Department making repairs and recovering the costs thereof from the Contractor.

The Department will not participate in any payment or reimbursement for fines and will not authorize time extensions due to delays in project progress for work stoppage, to remedy the violations stated within the NOV, required by the TDOT District Supervisor as stated in **105.01** of the Standard Specifications**.**

Spill Prevention, Control, and Countermeasure

To help prevent the discharge of oil into navigable waters, the U.S. Environmental Protection Agency (EPA) developed the Spill Prevention, Control, and Countermeasure (SPCC) Program. The SPCC Program is under the authority of Section 311 (j)(1)(C) of the Federal Water Pollution Control Act (Clean Water Act) in 1974. The rule may be found at Title 40, Code of Federal Regulations (CFR), Part 112. Additional information regarding the preparation and requirements of a SPCC Plan can be found at: http://www.epa.gov/oem/content/spcc/.

If applicable based upon the total aggregate capacity of aboveground oil storage, develop a site specific SPCC Plan per EPA requirements. This plan shall be provided to the TDOT District Supervisor as part of the required submittals during the project Pre-Construction Meeting or at which time the conditions on the project site meet the applicable criteria. Shall be responsible for obtaining any other necessary local, state, and federal permits as applicable. The SPCC Plan and/or permits shall be kept on-site.

Comply with all aspects of the site specific SPCC Plan including but not limited to performing any required inspections as directed by the SPCC Plan as well as implementing material and spill management practices per the project's SWPPP. In the event, where a release containing a hazardous substance in an amount equal to, or in excess of a reportable quantity established under either 40 CFR 117 or 40 CFR 302 occurs during a 24 hour period, immediately notify the TDOT District Supervisor.

S T A T E **O F** **T E N N E S S E E**

April 21, 2022

Hamilton County

Contract No. DB2101

SPECIAL PROVISION

REGARDING

PROJECT COMPLETION AND LIQUIDATED DAMAGES

The project shall be completed in its entirety as set forth in the Contract.

Daytime lane closures shall not be allowed at any time, unless otherwise specified herein or as directed by the Engineer.

Temporary lane closures on I-75, I-24, and ramps, will be allowed Sunday thru Thursday, between 9:00 p.m. and 6:00 a.m. All temporary lane and ramp closures on I-75, I-24, and local streets must be approved in advance by the Engineer. All requests must be made a minimum of seven days in advance of the anticipated closures. There will be periods when the Design-Builder will not be allowed to have any type of closures due to holidays as specified in subsection 104.04 of the Standard Specification and during major events. Major events and known periods when lanes cannot be closed include, but are not limited to: Riverbend, SEC Championship, and Chattanooga marathons/triathlons that use SR29 and/or SR153. The Department may deny any request for lane closures. For each hour or portion thereof, which any traffic lane remains closed in conflict with the restricted period, the sum of **$6,000** per hour per lane shall be deducted from monies due the Design-Builder, not as a penalty, but as liquidated damages.

Temporary lane closures on local roads shall only be allowed nightly between 9:00 p.m. and 6:00 a.m. For each hour or portion thereof, which any local road lane remains closed in conflict with the times defined above; the sum of **$1,800** per hour per lane shall be deducted from monies due the Design-Builder, not as a penalty, but as liquidated damages.

Rolling roadblocks are permitted during blasting operations, the erection/construction of overhead signs and setting of bridge beams, demo of existing bridges, or other short-term impacts as approved by the Engineer. These roadblocks shall be conducted by law enforcement agencies. Rolling roadblocks will only be allowed at night between 9:00 p.m. and 6:00 a.m. with a maximum duration of 30 minutes. Design-Builder to allow 30 minutes between each rolling roadblock, or until traffic has reached free-flow, whichever happens first. For each 15-minute period, or portion thereof, in excess of the allotted 30-minute period that any traffic lane remains closed, the sum of **$3,000** per lane shall be deducted from the monies due the Design-Builder, not as a penalty, but as liquidated damages.

Weekend Work

The Design-Builder will be allowed up to four (4) weekend closures for I-24, S. Germantown Road, and portions of North and South Terrace to complete project tie-in at S. Germantown Road. The Design-Builder shall provide a detour for I-24 with a minimum of two-lanes in each direction. The Design-Builder shall provide a detour for all affected local roads. These closures are bound by the existing permanent and temporary ramps at S. Germantown Road. A weekend is defined as between Friday at 9:00 p.m. to Monday at 5:00 a.m. outside of the holidays, and major events. In connection to any weekend closures, North and South Terrace will be allowed to have lane closures during the daytime on Friday (6:00 a.m. to 9:00 p.m.), to help for preparations of the weekend closures. For each hour, or portion thereof, in which a full weekend closure is not completed and open to traffic, the sum of **$6,000** per hour per lane (I-24, S. Germantown Road, North/South Terrace) shall be deducted from the monies due to the Design-Builder, not as a penalty, but as liquidated damages. The Design-Builder shall provide the Department with a sixty (60) day notice prior to any weekend closures.

The Design-Builder will be allowed temporary lane closures on I-75 for up to ten (10) weekends. A minimum of two-lanes shall remain open at all times and only one direction can be impacted by closures each weekend. A weekend is defined as between Friday at 9:00 p.m. to Monday at 5:00 a.m. outside of the holidays, and major events. For each hour, or portion thereof, in which weekend temporary lane closures are not completed and open to traffic, the sum of **$6,000** per hour per lane shall be deducted from the monies due to the Design-Builder, not as a penalty, but as liquidated damages. The Design-Builder shall provide the Department with a thirty (30) day notice prior to any temporary weekend lane closures.

Lane Rental

On I-24, the Design-Builder will be allowed to rent one lane for a maximum duration of nine (9) consecutive days in each direction. The Design-Builder will not be allowed to rent lanes in both directions at the same time. If the Design-Builder does not use all days bid, they will not be allowed any additional closures for unused days. The Design-Builder shall begin work associated with lane rentals on a Friday at 9:00 p.m. However, the lane rental period will not start until Saturday at 6:00 a.m. For each hour or portion thereof, which any traffic lane remains closed past the lane rental period, the sum of **$6,000** per hour per lane shall be deducted from monies due the Design-Builder, not as a penalty, but as liquidated damages. The Design-Builder shall provide the Department with a sixty (60) day notice prior to any use of lane rentals.

The table below summarizes the liquidated damages referenced above.

Route Name/Type	Temporary Lane Closures Liquidated Damages	Weekend Work Liquidated Damages	Lane Rental	Rolling Roadblock Liquidated Damages
I-24	$6,000 per hour per lane	$6,000 per hour per lane	$6,000 per hour per lane	$3,000 per 15 min. per lane
I-75	$6,000 per hour per lane	$6,000 per hour per lane	N/A	$3,000 per 15 min. per lane
Local Streets including State Routes	$1,800 per hour per lane	$6,000 per hour per lane	N/A	N/A

Welcome Center

The Design-Builder shall not restrict access to or disrupt the normal operations of the Welcome Center located on I-75 north of the Ringgold Road interchange. Additionally, the Design-Builder shall not use any portion of the Welcome Center for construction related activities. Any impacts to the Welcome Center will result in liquidated damages of $1,200 per calendar day, or portion thereof, until full access and normal operations are restored.

Potholes

The Design-Builder shall mitigate potholes greater than or equal to 1 square foot and 1.25 inches deep or an equivalent volume of size, shape and location that presents a hazard to the traveling public within 24 hours of discovery or notification. Failure to complete pothole mitigation within the 24-hour period will result in the sum of $1,000 per occurrence per day (or portion thereof) until pothole mitigation is complete. These deductions are not penalties but are liquidated damages.

ITS

The Design-Builder shall ensure continuous operation of the fiber optic lines within the construction limits. Temporary disconnect of communication shall not exceed forty-eight hours. Failure to restore communication within the allowed forty-eight hours will result in liquidated damages of **$500** per hour until communication is restored.

The Design-Builder shall ensure continuous operation of the dynamic message signs (DMS) within the construction limits. Temporary loss of DMS operation during construction activities shall not exceed thirty calendar days. Failure to restore full operation within the allowed thirty calendar days will result in liquidated damages of **$500** per day/per DMS until full operation of the DMS is restored. Full operation is defined as the DMS being installed, integrated with TMC software and accessible/controllable by TMC personnel. If necessary, multiple DMS may be down at the same time.

The Design-Builder shall ensure continuous operation of all CCTV cameras affected by construction activities. Temporary loss of CCTV camera operation during construction activities shall not exceed forty-eight hours. Failure to restore full operation within the allowed forty-eight hours will result in liquidated damages of **$500** per hour/per CCTV until full operation of the camera is restored. Full operation is defined as the CCTV camera being installed, integrated with TMC software and accessible/controllable by TMC personnel. If necessary, multiple CCTV cameras may be down at the same time.

The Design-Builder shall ensure continuous operation of the radar detection systems (RDS) within the construction limits. Temporary loss of RDS operation during construction activities shall not exceed fourteen calendar days. Failure to restore full operation within the allowed fourteen calendar days will result in liquidated damages of **$500** per day/per RDS until full operation of the RDS is restored. Full operation is defined as the RDS being installed, integrated with TMC software and accessible/controllable by TMC personnel. If necessary, multiple RDS may be down at the same time

The table below summarizes the liquidated ITS-related damages referenced above.

ITS Device Type	Allowable Down Time	Liquidated Damages
Fiber Network	48-Hours	$500 per hour
DMS	30 Calendar Days	$500 per day per DMS
CCTV	48-Hours	$500 per hour per CCTV
RDS	14 Calendar Days	$500 per day per RDS

Project Completion

The Design-Builder shall complete all work to be done under the Contract on or before the Design-Builder's completion date, set forth in RFP Book 2 Section D.3. If the Design-Builder fails to complete all work specified in the Contract, except for plant/vegetation establishment and punch list items (as defined in TDOT's Design-Build Standard Guidance), on or before the Design-Builder's completion date, a sum of money equal to **$30,000** per Calendar Day, for the first 30 calendar days after the Design-Builder's completion date, shall be deducted from monies due to the Design- Builder, not as penalty, but as liquidated damages. For each calendar day thereafter, a sum of money equal to **$100,000** shall be deducted from monies due to the Design-Builder, not as a penalty, but as liquidated damages.

Where provisions of this Special Provision conflict with Subsection 108.09 of the Standard Specifications, as amended, this Special Provision prevails. Additionally, RFP Book 3 contains additional information regarding mandatory closure concurrence and advance notice.

At the time of this project being let, there will be many active TDOT construction projects within the project area. Please refer to Subsection 105.08 of the Standard Specifications, Cooperation between Design-Builders, as communication and cooperation between all parties will be necessary to ensure successful projects.

S T A T E **O F** **T E N N E S S E E**

(Rev. 2/11/21) January 1, 2021

SPECIAL PROVISION

REGARDING

LIQUIDATED DAMAGES FOR CEI ADMINISTERED CONTRACTS

For each calendar day over and above the stipulated completion date on which any portion of the Work remains incomplete, the Department will deduct a sum of money from monies due the Contractor, not as penalty but as liquidated damages. The amounts to be deducted shall be as specified in the Table.

Table: Liquidated Damages for Failure to Complete the Work on Time

Original Contract Amount ($)	Daily Charge ($/day)
0 to 2,000,000	740.00
> 2,000,000 to 10,000,000	1,400.00
> 10,000,000 to 20,000,000	2,200.00
> 20,000,000 to 50,000,000	3,200.00
> 50,000,000 to 100,000,000	4,000.00
> 100,000,000	10,000.00

Allowing the Contractor to continue and finish the Work or any part of it after the completion date, or after the date to which the time for completion may have been extended, will in no way waive the rights of either party under the Contract.

S T A T E **OF** **T E N N E S S E E**

(Rev. 1-3-13) January 1, 2021

SPECIAL PROVISION
REGARDING
PAYMENT ADJUSTMENT FOR FUEL

This special provision covers the method of payment adjustment for fuel price increases or decreases. Payment adjustments will be made in monthly increments based on the estimated fuel consumed on major items of work, the estimated price per gallon of fuel at the time of letting, and the percentage change of the Producer Price Index for Light fuel oils, Series ID Number WPU0573, published by the U.S. Department of Labor, Bureau of Labor Statistics.

The estimated price per gallon of fuel for this contract is **$3.87**.

The March 2022 Price Index (Ib) for light fuel oils shall be used for this contract. Adjustments will be based on the price index in effect for the month in which the item was installed.

Fuel consumption for payment adjustment shall be based on the following:

Item Number	Description of Work	Gallons per unit	Unit of measure
203	Any Road and Drainage Excavation	0.25	Cubic Yard
203	Any Borrow Excavation (Rock)	0.36	Cubic Yard
203	Any Borrow Excavation (Other than Solid Rock)	0.25	Cubic Yard
203	Any Borrow Excavation (Rock)	0.16	Ton
203	Any Borrow Excavation (Other than Solid Rock)	0.11	Ton
203-05	Undercutting	0.25	Cubic Yard
203	Any Embankment (in-place)	0.25	Cubic Yard
303, 309, 312	Any Aggregate Base	0.79	Ton
313, 501	Treated Permeable Base or Lean Concrete Base	0.10	Square Yard
307	Any Bituminous Plant Mix Base (HM)	2.98	Ton
411	Any Bituminous Concrete Surface (HM)	2.98	Ton
501	Any Portland Cement Concrete Pavement		
	≤ 10 in. thickness	0.25	Square Yard
	> 10 in. thickness	0.30	Square Yard

No payment adjustment for fuel shall be made on any item of work which is not listed above.

No payment adjustment for fuel shall be made unless the price index varies 5% or more from the index indicated in this Special Provision.

Where the price index varies 5% or more, the payment adjustment will be made as follows:

$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$

Where:

PA =Payment Adjustment (may be plus or minus)
Ic =Index for Current Month
Ib =Index for Bidding
Fe =Estimated Fuel in Gallons used based on above table and work paid for during adjustment month. [$\sum$ (Pay quantity x Gallons per unit)= Fe]
Fp = Fuel Price for Bidding

The Project Engineer will compute the payment adjustment for fuel on work sheets similar to the one attached and will furnish a copy of the calculations upon request to the prime contractor and approved subcontractors.

Upon the expiration of the allocated working time, as set forth in the original contract or as extended by Change Order, payment adjustments for fuel will continue to be made only when the "Index for Current Month" is **less** than the "Index for Bidding" and varies 5% or more.

Payment adjustment, for fuel provided after the expiration of the allocated working time and where the “Index for Current Month” **exceeds** the “Index for Bidding”, will **not** be made until after the contract records have been approved by Final Records (FR)/Materials & Tests (MT) and a Final Estimate is ready to be processed. Upon contract record approval by FR/MT, fuel payment adjustments shall be calculated for each month where the allocated working time has expired, the “Index for Current Month” **exceeds** the “Index for Bidding”, and the indices vary 5% or more. The calculation of the fuel payment adjustment shall be made using the “Index for Current Month” or the “Index for Contract Completion Date” in accordance with the following formulas:

The “Index for Contract Completion Date” is the fuel index in effect on the allocated Contract Completion date or the completion date as extended by Change Order.

“Index for Current Month” is **less** than “Index for Contract Completion Date”

$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$

“Index for Current Month” is **greater** than “Index for Contract Completion Date”

$PA = [(Icd \div Ib) - 1] \times Fe \times Fp$

Where:

PA = Payment Adjustment (may be plus or minus)

Ic = Index for Current Month
Ib = Index for Bidding
Icd= Index for Contract Completion Date (or as extended by Change Order)
Fe = Estimated Fuel in Gallons used based on above table and work paid for during adjustment month. [∑ (Pay quantity x Gallons per unit)= Fe]
Fp = Fuel Price for Bidding

Payment Adjustment for fuel will be made under:

Item No.	Description	Pay Unit
109-01.01	Payment Adjustment for Fuel	Dollar

Monthly Payment Adjustment for Fuel Worksheet

Project No._____ Contract No._____

County_____

Fuel Price (Fp)_____Price Index Bidding (Ib)_____Current Price Index (Ic) _____

Index for Contract Completion Date (or as extended by Change Order) (Icd)_____

Estimate Period: Work Performed_____Adjustment Paid_____
(Month/Yr)

Item	Unit	Quantity		Fuel Factor		Total Fuel
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____
_____	____	_____	x	_____	=	_____

Total Fuel for Month (Fe)_____

$PA = [(Ic \div Ib) - 1] \times Fe \times Fp$
$PA = [(Icd \div Ib) - 1] \times Fe \times Fp$

S T A T E **O F** **T E N N E S S E E**

(Rev. 05-16-16) January 1, 2021
(Rev. 04-01-19)
(Rev. 11-08-19)

SPECIAL PROVISION

REGARDING

PAYMENT ADJUSTMENT FOR BITUMINOUS MATERIAL

This Special Provision covers the method of payment adjustment for bituminous materials.

100% Virgin Bituminous Material
A payment adjustment will be made to compensate for increases and decreases of 5% or more in the contractor's bituminous material cost. The normal bid items in the contract covering the bituminous material shall not be changed. Payment adjustments (+/-) shall be paid under "Payment Adjustment for Bituminous Material" and calculated as described herein:

A "Basic Bituminous Material Index" will be established by the Tennessee Department of Transportation prior to the time the bids are opened. This "Basic Bituminous Material Index" is the average of the current quotations on P.G. 64-22 from suppliers furnishing asphalt cement to contractors in the State of Tennessee. These quotations are the cost per ton f.o.b. supplier's terminal.

The "Basic Bituminous Material Index" for this project is **$586.25** per ton.

The "Monthly Bituminous Material Index" is also established on the first day of each month by the same method. A payment adjustment shall be made provided the "Monthly Bituminous Material Index" varies 5% or more (+/-) from the "Basic Bituminous Material Index".

Where the price index varies 5% or more, the payment adjustment will be made as follows:

PA = [Ic - Ib] x T

Where:

PA = Price Adjustment for Adjustment Month
Ib = Basic Bituminous Material Index
Ic = Monthly Bituminous Material Index
T = Tons bituminous material for Adjustment Month

Payment adjustment will be applied to all asphalt cement, asphalt emulsion, or bituminous material used for paving on this project.

Upon the expiration of the allocated working time, as set forth in the original contract or as extended by Change Order, payment adjustments for bituminous material will continue to be

made only when the "Monthly Bituminous Material Index" is **less** than the "Basic Bituminous Material Index" and varies 5% or more.

Payment adjustment, for bituminous material used after the expiration of the allocated working time and where the "Monthly Bituminous Material Index" **exceeds** the "Basic Bituminous Material Index", will **not** be made until after the contract records have been approved by Final Records (FR)/Materials & Tests (MT) and a Final Estimate is ready to be processed. Upon contract record approval by FR/MT, payment adjustments for bituminous material shall be calculated for each month where the allocated working time has expired, the "Monthly Bituminous Material Index" **exceeds** the "Basic Bituminous Material Index", and the indices vary 5% or more. The calculation of the bituminous payment adjustment shall be made using the "Monthly Bituminous Material Index" or the "Bituminous Material Index for Contract Completion Date" in accordance with the following formulas:

The "Bituminous Material Index for Contract Completion Date" is the Monthly Bituminous Material Index in effect on the allocated Contract Completion Date or on the completion date as extended by Change Order.

The "Monthly Bituminous Material Index" is **less** than the "Bituminous Material Index for Contract Completion Date".

PA = [Ic - Ib] x T

The "Monthly Bituminous Material Index" is **greater** than the "Bituminous Material Index for Contract Completion Date".

PA = [Icd - Ib] x T

Where:

PA =	Price Adjustment for Adjustment Month
Ib =	Basic Bituminous Material Index
Ic =	Monthly Bituminous Material Index
Icd =	Bituminous Material Index for Contract Completion Date (or as extended by Change Order)
T =	Tons

FOR REFERENCE ONLY

SiteManager calculates the price adjustment based on the actual amount of asphalt cement (residue) in the emulsion using the following percentages:

-tack coats and shoulder sealants (e.g. SS-1, SS-1h, CSS-1, Css-1h)	63% residue
-prime coats (e.g. AE-P)	54% residue
-scrub seals and microsurfacing (e.g. CQS-1HP)	65% residue
-chip seals (e.g. CRS-2, CRS-2P)	69% residue
-hot in-place recycle (ARA-3P)	63% residue

Mixes Containing Recycled Bituminous Material

The quantity of virgin asphalt cement in tons subject to payment adjustment in recycled mixes shall be the product of the total tons of each mix multiplied by the difference between (1) the percent of asphalt cement specified for bidding purposes and (2) the percent of asphalt cement obtained from the recycled asphaltic material (RAP) used in each mix. No payment adjustment under this special provision for increases and decreases in the contractor's cost for virgin asphalt cement in recycled mixes will be allowed for asphalt cement content in excess of the percent specified for bidding purposes, as all payment adjustments for asphalt cement in the mix design of recycled mixes in excess of the percent of asphalt cement specified for bidding purposes will be made in accordance with the Standard Specifications.

No payment adjustment for bituminous material containing RAP shall be made unless the "Monthly Bituminous Material Index" varies 5% or more from the "Basic Bituminous Material Index" indicated in this Special Provision.

Where the price index varies 5% or more, the payment adjustment will be made as follows:

$$PA = [Ic - Ib] \times \frac{[BA - RA]}{100} \times Tm$$

PA =	Price Adjustment for Adjustment Month
Ib =	Basic Bituminous Material Index
Ic =	Monthly Bituminous Material Index
BA =	Percent asphalt specified for bidding purposes
RA =	Percent asphalt obtained from recycled asphaltic material used in each mix
Tm =	Tons asphalt mix for adjustment month

Upon the expiration of the allocated working time, as set forth in the original contract or as extended by Change Order, payment adjustments for bituminous material containing RAP will continue to be made only when the "Monthly Bituminous Material Index" is **less** than the "Basic Bituminous Material Index" and varies 5% or more.

Payment adjustment, for bituminous material containing RAP provided after the expiration of the allocated working time and where the "Monthly Bituminous Material Index" **exceeds** the "Basic Bituminous Material Index", shall **not** be made until after the contract records have been approved by Final Records (FR)/Materials & Tests (MT) and a Final Estimate is ready to be processed. Upon contract record approval by FR/MT, payment adjustments for bituminous material containing RAP shall be calculated for each month where the allocated working time has expired, the "Monthly Bituminous Material Index" **exceeds** the "Basic Bituminous Material Index", and the indices vary 5% or more. The calculation of the bituminous payment adjustment shall be made using the "Monthly Bituminous Material Index" or the "Bituminous Material Index for Contract Completion Date" in accordance with the following formulas:

The "Bituminous Material Index for Contract Completion Date" is the Monthly Bituminous Material Index in effect on the allocated Contract Completion Date or on the completion date as extended by Change Order.

The "Monthly Bituminous Material Index" is **less** than the "Bituminous Material Index for Contract Completion Date".

$$PA = [Ic - Ib] \times \frac{[BA - RA]}{100} \times Tm$$

The "Monthly Bituminous Material Index" is **greater** than the "Bituminous Material Index for Contract Completion Date".

$$PA = [Icd - Ib] \times \frac{[BA - RA]}{100} \times Tm$$

Where:

PA =	Price Adjustment for Adjustment Month
Ib =	Basic Bituminous Material Index
Ic =	Monthly Bituminous Material Index
Icd =	Bituminous Material Index for Contract Completion Date (or as extended by Change Order)
BA =	Percent asphalt specified for bidding purposes
RA =	Percent asphalt obtained from recycled asphaltic material used in each mix
Tm =	Tons asphalt mix for adjustment month

S T A T E **O F** **T E N N E S S E E**

October 19, 2020 January 1, 2021

SPECIAL PROVISION

REGARDING

ELECTRONIC TICKET DELIVERY SYSTEM

FOR ASPHALT

Description

This work shall consist of the use of an Electronic Ticket Delivery System (e-ticketing) for certified weights of asphalt mixtures delivered to the project site. Using an automated real time process with no direct personnel interaction necessary, the e-ticketing system shall monitor and report the point of loading at the asphalt plant and the transfer point into the paving train at the project site.

Construction Requirements

Provide electronic Certified Public Weigher e-tickets for each load of asphalt mixtures that are delivered to the project. E-tickets shall be automatically generated using a combined software and hardware fleet management system or an e-ticketing delivery system. Fully integrate the e-ticketing system with the load read out scale system used to weigh the mixture being delivered.

The system shall be capable of maintaining the data offline due to loss of power or connectivity.

Provide real time continuous ticketing system access to the Department for the duration of the project using a web based application. E-ticketing delivery system shall be identified and access granted after an agreement has been reached between the Contractor and Department to allow the e-ticketing delivery system chosen. Provide on-site technical assistance as needed during the project to operate the system. Do not deliver any mixture to the project that will use the e-ticketing system before an agreement has been reached.

The e-ticketing system shall allow individual certified e-tickets and generate daily summary sheets to be exported as PDF files by the Department. The system shall be designed so data inputs from scales cannot be altered by either the Contractor or the Department. The Department shall have the ability to make notes on each e-ticket for documentation of tests, comments or rejection of load. At the end of each asphalt paving placement shift, generate a shift summary sheet of the e-tickets and make available for the Engineer within 24 hours of the shift ending. The e-tickets shift summary sheet shall list all the required information in tabular form and be

signed by a Certified Public Weigher. Any loads in excess of the legal weight limit shall be rejected and no payment will be issued.

The certified e-tickets for asphalt mixtures shall be accessible real time at any point during or after placement of the mixture. The certified e-tickets and shift summary sheets shall include the following:

1. Mixture Type, Item Description
2. TDOT Mix design number
3. Project Number, County, Route
4. Date
5. Ticket number
6. Gross weight of the loaded truck
7. Tare weight of the truck
8. Net weight of the mixture to be paid
9. Running Daily Total for the particular mixture
10. Truck number
11. Truck Legal limit
12. Time Loaded
13. Time offloaded (detected at placement site)
14. Engineer Comments (if applicable)

Method of Measurement

Utilize an electronic ticket delivery system (e-ticketing) for asphalt as specified. If any e-tickets or the shift summary sheets are not available for the Engineer, payment may be withheld for the items of work on the monthly estimate.

Basis of Payment

The Department will not directly pay for the electronic ticket delivery system (e-ticketing) separately. The contract unit prices for the asphalt mixtures that e-tickets are required to be used shall be full compensation for all activities, including materials, equipment, labor, and any incidentals to complete the work as specified.

S T A T E **O F** **T E N N E S S EE**

Rev. 07-07-14 January 1, 2021

SPECIAL PROVISION

REGARDING

REMOVAL OF ASBESTOS CONTAINING MATERIAL (ACM)

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SECTION 011100

SUMMARY OF WORK

1.0. PART 1 - GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

A. Description

This Special Provision addresses the abatement of Asbestos-Containing Materials (ACM) in various structures on TDOT projects. The location and type of ACM will be defined in the contract plans. TDOT may provide estimated quantities based on an inspection for ACM by a licensed Tennessee Asbestos Inspector. The contractor is required to verify ACM quantities and confirm location.

Engineering controls which include, but are not limited to, negative pressure enclosures, amended water, and wet-cleaning methods, shall be utilized to prevent airborne asbestos fibers from migrating to other areas within or surrounding the work area(s) during all removal activities.

B. Location

The work is located as shown on contract plans.

C. Method of Measurement

The work shall be completed on a lump sum for completion of all work or measurement shall be square foot area and/or linear foot of pipe insulation, as follows:

1. Work Area A, Floor Tile and Mastic, Sq. Ft.

2. Work Area B, Roofing and Roof Flashing, Sq. Ft.

3. Work Area C, Thermal System Insulation, Linear Feet.

4. Work Area D, Cementitious Deck Drains (located in situ on existing bridge), Linear Feet.

5. Work Area E, Cementitious Deck Drains (located in rubble), Linear Feet.

6. Work Area F, Guardrail Caulking, Linear Feet.

7. Work Area G, Beam Bearing Pads, Sq. Ft.

8. Work Area H, Bridge Coatings and/or Concrete Bridge Components, Sq. Ft.

D. Basis of Payment

ACM abatement, complete, in accordance with this document, shall be paid for on a lump sum basis or by the unit described in the contract plans.

1.2 EXISTING FINISHES AND FACILITIES

Perform all work in such a manner as to prevent injury or damage to any portions of existing finishes, or any other portions of the building structure, which are to remain. Repair or replace portions of existing finishes which have been damaged or altered during construction operations to match existing or adjoining work, as approved by the Engineer. At the completion of operations, existing finishes shall be in a condition equal to or better than that which existed before new work started, unless otherwise specified in the contract documents.

1.3 DEFINITION OF WORK AREAS

A. Asbestos-Containing Materials

9. Work Area A is defined as the removal of all asbestos-containing Floor Tile and Mastic.

10. Work Area B is defined as the removal of all asbestos-containing Roofing and Roof Flashing.

11. Work Area C is defined as the removal of all asbestos-containing Thermal System Insulation.

12. Work Area D is defined as the removal of all asbestos-containing Cementitious Deck Drains (located in situ on existing bridge).

13. Work Area E is defined as the removal of all asbestos-containing Cementitious Deck Drains (located in rubble).

14. Work Area F is defined as the removal of all asbestos-containing Guardrail Caulking.

15. Work Area G is defined as the removal of all asbestos-containing Beam Bearing Pads.

16. Work Area H is defined as the removal of all asbestos-containing Bridge Coatings and/or Concrete Bridge Components.

END OF SECTION

SECTION 013300

SUBMITTALS

1.0. PART 1 - GENERAL

1.1. WORK INCLUDED

Make submittals required by the Contract Documents in a timely manner and at approximate times in the execution of the Work to allow for sufficient and prompt review by the Engineer and distribution to the TDOT Environmental Division. Revise and resubmit as necessary to establish compliance with the specified requirements.

A. Related Work

1. Section 014529 – Testing Laboratory Services

2. Section 028200 – Asbestos-Containing Materials Abatement

1.2. DESCRIPTION

A. Submittals

1. At the Pre-construction Conference, the successful bidder(s) shall submit three three-ring bound sets of "Pre-Job Submittals" to the Engineer for review.

2. Submit three, three-ring bound sets of any new or additional Pre-Job Submittals to the Engineer for his review prior to mobilization at the project site. The Work may not proceed until the complete Pre-Job Submittal package has been reviewed and approved in writing by the Engineer.

3. Submit three, three-ring bound sets of "Post-Job Submittals" to the Engineer for his review following the final completion of the Work.

4. Identify individual submittals by name and include a table of contents in each submittal package.

1.3. NUMBER OF COPIES

Provide three, three-ring bound sets of each submittal package to the Engineer for his review and distribution. Contractor shall also maintain one full set of pre-job submittals at each job site for the duration of the work.

1.4. QUALITY ASSURANCE

A. Coordination of Submittals

1. Carefully review all aspects of each item being submitted.

2. Verify that each item and its appropriate submittal conform in all respects with the specified requirements.

3. Certify, by affixing signature of Contractor's authorized representative to the cover sheet of each submittal package, that this coordination has taken place.

1.5. SUMMARY OF WORK

A. Pre-Job Submittals

1. Submit complete information relative to the following:

   NOTIFICATIONS
   PERMITS
   SAMPLE DAILY LOG

   As detailed below:

   a. Notice of impending commencement of asbestos removal work, where required, in writing to the appropriate regulatory agency:

      Using SF – 1 of these specifications, not fewer than thirty days before work commences on the Project. Include copy of notification in submittal package.

   b. All required permits and arrangements for transport and disposal of asbestos-containing or contaminated materials, supplies, etc.

   c. A sample copy of daily in/out log form to be used.

2. Submit complete information relative to the following:

   DECONTAMINATION UNIT
   SECURITY PROCEDURES
   WORK PROCEDURES
   NEGATIVE EXPOSURE ASSESSMENT
   MATERIALS CERTIFICATIONS
   EQUIPMENT CERTIFICATIONS

As detailed below:

a. Written description and/or sketch of the plans for construction of a worker and barrel/equipment decontamination enclosure system and for isolation of the work areas.

b. Written description and/or sketch of the security procedures plan to be utilized. Work procedures or practices to be utilized on the Project.

c. Submit a written, detailed plan of how the Contractor intends to remove asbestos-containing material from each work area. Details are to include wetting methods, visible emission minimization methods, segregation criteria, any cutting, abrading or physical methods, and all transport and disposal methods.

d. Negative Exposure Assessment (NEA): Provide a negative exposure assessment (NEA) as described in 29 CFR 1926.1101 for each work activity, including, but not limited to, work area preparation, removal of ACM, work area cleaning(s) and disposal at the landfill. In order to generate the NEA, obtain both PEL and excursion limit air sampling results from either prior asbestos projects within the last 12 months or from initial exposure monitoring from this project.

   Note that air sample data must include documentation indicating that the data was obtained during activities which closely resemble the processes, type of ACM, control methods, work practices and environmental conditions associated with this project. Also, include documentation that the training and experience of the workers on the prior asbestos projects was no more extensive than that of the workers to be used on this project. Documentation shall be sufficient to determine that the prevailing conditions on this project will, with a high degree of certainty, not result in employee exposures above the PEL or excursion limit.

e. Manufacturer's certification or independent test reports confirming that materials to be utilized on this Project meet or exceed all performance criteria specified in the Contract Documents. Contractor’s and Manufacturer’s affidavits stating that all materials replaced on the project do not contain asbestos or lead.

f. Certification that the diminished air filtration system to be utilized meets the requirements of the Contract Documents.

g. All special equipment, techniques, etc. to be used on the Project.

3. Submit complete information relative to the following:

   SUPERVISOR NAMES AND TRAINING
   WORKER TRAINING
   WORKER'S RELEASE
   RESPIRATORY TRAINING
   MEDICAL SURVEILLANCE

   As detailed below:

   a. Names of supervisory personnel and their qualifications and training. Refer to Sections 028200 for additional details.

   b. Alphabetized list of workers and their training. Refer to Sections 028200 for additional details.

   c. Individually signed Worker's Release forms for each and every worker to be utilized on the project by the Contractor or subcontractor (Form SF-3).

   d. Individually signed forms by each and every worker to be utilized on the Project by the Contractor or subcontractor documenting that each is actively involved in a company employee respiratory protection program and has had appropriate training in respiratory protection (Form SF-2).

   e. Individually signed forms by each and every worker to be utilized on the Project by the Contractor or subcontractor documenting that each is actively involved in a company employee medical surveillance program for asbestos (Form SF-4). Include copies of medical examination records (Doctor's respirator opinion, spirometry, radiograph, interpretation, etc.).

   f. Copies of each individual’s (working on the project) training certificate(s) with accompanying update certificates in accordance with state and federal statutes.

It shall be the responsibility of the Contractor to translate in writing all special forms requiring an individual signature (Special Forms SF-2, SF-3, SF-4) into a language that the individual worker can understand, if other than English, and to make sure that the individual worker fully understands the contents of the special form prior to signing.

B. Post-Job Submittals

Submit complete information relative to the following:

1. All submittals required by the General Requirements.

2. Waste shipment record as required by state and federal regulations. In addition, submit landfill receipts.

3. Copies of daily logs showing the following: date, entering and leaving time, company or agency represented, and reason for entry for all persons entering the work area.

4. Copies of employee air monitoring results relative to OSHA respiratory protection level compliance.

5. An alphabetized list of all employees utilized on the project.

6. Copies of pressure differential recordings the negative pressure abatement work areas. These recordings shall be clearly marked with location, pressure levels and dates and time of day, on an hourly basis, from start of removal until acceptance of clearance air testing by Testing Laboratory.

C. "Or Equivalent," "Approved Equivalent," "Other As Approved," etc.

1. Where the phrases "or equivalent," or "equivalent as approved by the Engineer," or similar wording occurs in the Contract Documents, specific materials, equipment, or methods will not be considered as equivalent unless the item has been specifically so approved for this Work by the Engineer.

2. Wherever a particular item is listed by manufacturer's name, model number or other identifying information, it shall be interpreted to include equivalent products of other manufacturers whether "approved equivalent," etc. is stated or not.

3. Whenever a manufacturer's product is specified to the exclusion of all other products, it shall be so identified and declared.

4. Decision of the Engineer shall be final.

2.0. PART 2 - PRODUCTS

2.1. SAMPLES

If requested by the Engineer, provide samples of all materials or articles proposed to be installed as a part of the Work. Identify as described under "Identification of Submittals" below.

2.2. MANUFACTURER'S LITERATURE

Where contents of submitted literature from manufacturers include data not pertinent to the submittal, clearly show which portions of the contents is being submitted for review. Submit a minimum of three copies to the Engineer for his review and file.

3.0 PART 3 - EXECUTION

3.1 IDENTIFICATION OF SUBMITTALS

Number consecutively and clearly identify all submittals. Show on at least the first page of each submittal and elsewhere as necessary for positive identification of the submittal. Accompany each submittal package with a letter of transmittal showing all information required for identification and checking.

3.2 GROUPING OF SUBMITTALS

Group submittals into packages identified as "Pre-Job Submittals" and "Post-Job Submittals". Partial submittals may be rejected for noncompliance with the Contract Documents.

3.3 TIMING OF SUBMITTALS

Make submittals not less than 14 days prior to scheduled dates for commencement, execution or installation to provide time required for reviews, for securing necessary approvals, for possible revisions and resubmittals, and for placing orders and securing delivery. Allow in scheduling, at least five working days for review by the Engineer following his receipt of pre-job submittals. Contractor will be held responsible for delays occasioned by incomplete submittal packages.

3.4 ENGINEER'S REVIEW

Review by the Engineer does not relieve the Contractor from responsibility for errors which may exist in the submitted data. Make revisions if required by the Engineer and resubmit for approval.

END OF SECTION

SECTION 014529

TESTING LABORATORY SERVICES

1.0. PART 1 - GENERAL

1.1 DESCRIPTION

Contractor will provide a qualified Testing Laboratory to perform routine and special testing of the Work performed under the Contract Documents and to monitor general compliance therewith. The Testing Laboratory employed by the Contractor shall perform testing for compliance with applicable codes, regulations, and requirements as specified in this Section and elsewhere in the Contract Documents. The Testing Laboratory employed by the Contractor shall be responsible for employee air monitoring relative to OSHA respiratory protection level compliance, daily area air monitoring to determine effectiveness of engineering controls, and negative pressure enclosure readings and documentation, and final clearance sampling, if required by these specifications.

The Contractor shall cooperate with the Testing Laboratory in all aspects of the testing in order to expedite testing and results. Provide Testing Laboratory access to the Work at all times and in all locations requested as necessary to perform testing.

The Engineer reserves the right to hire, direct, and compensate his own Testing Laboratory, separate and distinct from the Contractor. The Engineer's test results may be made available to Contractor at the Engineer's sole discretion.

A. Related Work

1. Section 013300 – Submittals

2. Section 028200 – Asbestos-Containing Material Abatement

1.2 QUALITY ASSURANCE

All asbestos air testing shall be performed in general accordance with the procedures outlined in the National Institute for Occupational Safety and Health (NIOSH) methods 7400 for samples analyzed by Phase Contrast Microscopy (PCM) and in general accordance with the EPA AHERA protocols for samples analyzed by Transmission Electron Microscopy (TEM) and also guidelines issued by EPA for detection limits. Consider work areas clean and ready for reoccupancy when air testing shows 0.01 or less fibers per cubic centimeter of air (f/cc), for each sample obtained using standard NIOSH Method No. 7400 for PCM. This standard must be met for the work area to pass clearance.

A. Payment for Testing

Testing Services shall be paid for as follows:

1. Initial Services: Contractor will pay for initial air clearance testing services required by Contract Documents.

2. Retesting: When initial air clearance tests indicate noncompliance with the Contract Documents, subsequent retesting shall be performed by the same testing agency, and costs will be absorbed by the Contractor.

B. Scheduling

1. Testing by the Testing Laboratory shall be performed in areas and at times during the Work as deemed necessary by the Engineer or as specified in the Contract Documents.

2. Contractor shall schedule, and make the Engineer aware of, air clearance testing at least 24 hours prior to desired time of testing.

3. Coordinate scheduling with Testing Laboratory as necessary.

C. Results

1. All testing and analysis will be performed promptly and results issued expeditiously in order to minimize any possible delay in the progress of the Work.

2. Test results will be made available to the Engineer as follows:

    a. Air sample results for Asbestos (Phase Contrast Microscopy) - as quickly as possible but not later than 24 hours following conclusion of sampling event.

    b. Results of other tests deemed necessary - as quickly as possible but not later than 24 hours following completion of test(s).

END OF SECTION

SECTION 028200

ASBESTOS-CONTAINING MATERIAL ABATEMENT

1.0. PART 1 - GENERAL

1.1 DESCRIPTION

A. Responsibilities of the Contractor

1. Perform all planning, administrative, execution, and cleaning requirements necessary to safely remove all asbestos-containing materials from all Work Areas indicated in the Contract Documents. Approval of or acceptance by the Engineer of various construction activities or methods proposed by the Contractor does not constitute an assumption of liability by the Engineer for inadequacy or adverse consequences of said activities or methods.

2. Contractor (or subcontractor engaged to perform the Work of this Section) shall:

   a. Be a licensed asbestos abatement contractor in accordance with State of Tennessee Statutes. Submit documentation confirming current licensure.

   b. Have a record of not less than five years successful experience in asbestos removal and related work similar in scope and magnitude to this Project. Submit list of successfully completed projects for verification.

3. Maintain on site a Superintendent and one Head Foreman, each on permanent staff and each having no less than two years of full-time experience in responsible charge of asbestos removal operations similar in scope and magnitude to this Project within the three year period preceding start of Project. Adequate evidence of experience and skill of the Superintendent and Head Foreman must be demonstrated prior to the start of the Work and shall not be changed. Head Foreman shall remain inside of the work area at all times the Work is in progress. Submit experience of Superintendent and Head Foreman in the pre-job submittal package.

4. Provide one experienced Job Foreman with a minimum of two years successful experience in asbestos removal operations similar in scope and magnitude to this Project for every ten asbestos removal workers (laborers) utilized on the Project. Foreman shall remain inside of work area(s) at all times that the Work is in progress. Submit notarized experience of each Job Foreman in the pre-job submittal package.

5. Submit certification for each and every worker to be utilized on the project by the Contractor or subcontractor(s) documenting that each has successfully completed (including examinations and applicable refresher courses) a training course for asbestos abatement workers approved by the State of Tennessee. Contractor shall also submit documentation confirming federal approval for each training center represented in the submittals.

6. Submit certification for each and every supervisor to be utilized on the project by the Contractor or subcontractor(s) documenting that each has successfully completed (including examinations and applicable refresher courses) a training course approved by EPA and State of Tennessee for asbestos abatement supervisors.

B. Reference Standards

1. Acknowledge, by the executing of the Contract, awareness and familiarity with the contents and requirements of the following regulations, codes, and standards, and assume responsibility for the performance of the Work in strict compliance therewith and for every instance of failure to comply therewith.

2. The current issue of each document shall govern. Where conflict among requirements or with the Contract Documents exists, the more stringent requirements shall apply.

    a. U.S. Environmental Protection Agency (EPA) Regulations for Asbestos (Code of Federal Regulations Title 40, Part 61, Subparts A and B).

    b. U.S. EPA Regulations for Asbestos in Schools, Asbestos Hazard Emergency Response Act (AHERA), (Code of Federal Regulations Title 40, part 763, Subpart E).

    c. U.S. EPA Regional National Emissions Standards for Hazardous Air Pollutants (NESHAPS).

    d. U.S. Occupational and Safety and Health Administration (OSHA) Asbestos Regulations (Code of Federal Regulations Title 29, Part 1926, Section 1926.1101).

    e. U.S. EPA Office of Pesticide and Toxic Substances Guidance Document, "Guidance for Controlling Friable Asbestos-Containing Materials in Buildings", EPA 56015-85-024, June, 1985.

    f. U.S. Department of Transportation, Hazardous Substances: Final Rule (Code of Federal Regulations Title 49 Parts 171 and 172), Federal Register November 21, 1986 and corrected February 17, 1987.

    g. All state, county, and city codes and ordinances as applicable. Make available for review at the site one copy of EPA, OSHA, and applicable State, County, and City Regulations governing the Work.

    h. U.S. Environmental Protection Agency – 40 CFR, Part 763, Subpart G – Asbestos Worker Protection

    i. U.S. Environmental Protection Agency – 40 CFR, Park 61, Subpart M – National Emission Standards for Hazardous Air Pollutants

j. U.S. Occupational Safety and Health Administration – 29 CFR, Part 1910.1001 – Asbestos Standard for Industry

k. Tennessee Department of Environment and Conservation, Bureau of Environment, Division of Air Pollution Control – Chapter 1200-03-11, Hazardous Air Contaminants.

l. Tennessee Department of Environment and Conservation, Bureau of Environment, Division of Air Pollution Control – Chapter 1200-01-20, Asbestos Accreditation Requirements.

m. Tennessee Department of Environment and Conservation, Bureau of Environment, Division of Solid and Hazardous Waste Management – Chapter 1200-01-07, Solid Waste Processing and Disposal

n. Tennessee Department of Labor and Workforce Development, Division of Occupational Safety and Health (TOSHA) – Chapter 0800-01-01, Occupational Safety and Health Standards for General Industry.

o. Tennessee Department of Labor and Workforce Development, Division of Occupational Safety and Health (TOSHA) – Chapter 0800-01-06, Occupational Safety and Health Standards for Construction.

C. Patent/Copyright Compliance

The Contractor shall fully comply with patent and copyright requirements associated with this Contract. The Contractor shall defend all suits for or claims of infringement of said patent rights and shall save the Engineer and Testing Laboratory harmless from loss on account thereof, fully indemnifying the Engineer and Testing Laboratory from same and any and all associated claims without exception or limitation.

D. Test Reports

1. Results of tests of asbestos-containing materials (which are specifically excluded as a part of this Contract) taken from surfaces within the scope of this Project are available for review at the office of the Engineer.

   However, the Contractor or subcontractor is cautioned that, should interpretations be made, opinions be formed, and conclusions be drawn as a result of examining the test results, those interpretations, opinions, and

conclusions will be those made, formed, and drawn solely by the Contractor or subcontractor.

2. In as much as randomly and/or arbitrarily selected areas were sampled, the Department makes no representation, warranty, nor guarantee that the conditions indicated by the test reports either are representative of those conditions existing throughout the area, or that unforeseen developments may not occur, or that materials other than, or in proportions different from, those indicated may not exist.

1.2. SUMMARY OF WORK

A. Work Covered by Contract Documents

The Contractor shall inform himself of the conditions for the project, and is responsible for verifying the quantities and locations of all work to be performed as outlined in this section. Failure to do so shall not relieve the Contractor of his obligation to furnish all materials and labor necessary to carry out the provisions of the Contract.

1. **SCOPE OF WORK**: The scope of work to be performed is the removal and disposal of asbestos-containing materials as defined and quantified in the Drawings. The work of the contract shall be performed in compliance with the specifications.

2. **START OF WORK**: Work shall be started no earlier than the date indicated on written authorization from the Engineer and shall be performed only during the hours as stated below.

3. **WORKING HOURS**: All work by the abatement contractor shall be performed during the days and hour as defined in the contract documents.

B. Definitions

1. Abatement - procedures to decrease or eliminate fiber release from asbestos- containing building materials. Includes encapsulation, enclosure and removal.
2. AHERA - Asbestos Hazard Emergency Response Act (40CFR763).

3. Airlock - system for permitting ingress and egress without permitting air movement between a contaminated area and an uncontaminated area, typically consisting of two curtained doorways at least three feet apart.
4. Amended water - water to which a surfactant is added.

5. Air Monitoring - the process of measuring the fiber content of a specific volume of air in a stated period of time.

6. Clean Room - an uncontaminated area or room which is part of the worker decontamination enclosure system, with provisions for storage of workers' street clothes and protective equipment. Also known as the "Change Room".

7. Curtained Doorway - a device to allow ingress and egress from one room to another while minimizing air movement between the rooms. Typically constructed by placing two overlapping sheets of plastic over an existing or temporarily framed doorway and securing each along the top of the doorway, with the vertical edge of one along one vertical side of the doorway, and the vertical edge of the other along the opposite vertical side. Two curtained doorways spaced a minimum of three feet apart form an airlock.

8. Decontamination Enclosure System - a series of connected rooms, with curtained doorways between any two adjacent rooms, for the decontamination of workers or of materials and equipment. A decontamination enclosure system always contains an airlock.

9. Encapsulation - the sealing of asbestos surfaces involving application of a material (encapsulant/sealant) that will envelop or coat the fiber matrix and minimize fiber fallout and protect against contact damage.

10. Enclosure - procedures necessary to completely enclose material containing asbestos behind airtight, impermeable, permanent barriers.

11. Engineer – where the word Engineer is used, the word Architect shall be interchangeable.

12. EPA - United States Environmental Protection Agency.

13. Equipment Decontamination Enclosure System - a decontamination enclosure system for materials and equipment, typically consisting of a designated area of the work area, a washroom, and an uncontaminated area.

14. Equipment Room - a contaminated area or room which is part of the worker decontamination enclosure system, with provisions for storage of contaminated clothing and equipment.

15. Fixed Object (immovable object) - a unit of equipment or furniture in the work area which cannot be removed from the work area.

16. Glove Bag - A relatively small, clear plastic enclosure which can completely encompass short sections of pipe. It shall be capable of allowing the removal of asbestos- containing materials without any of the materials escaping from the enclosure.

17. HEPA Filter - a High Efficiency Particulate Air (HEPA) filter capable of trapping and retaining 99.97 percent of asbestos thermally generated DOP particles 0.3 microns in diameter.

18. HEPA Vacuum Equipment - High Efficiency Particulate Air filtered vacuuming equipment with a filter system capable of collecting and retaining asbestos fibers. Filters should be 99.97 percent efficient for retaining thermally generated DOP particles 0.3 microns in diameter.

19. Holding Area - a chamber between the washroom and uncontaminated area in the equipment decontamination enclosure system. The holding area comprises an airlock.

20. Movable Object - a unit of equipment or furniture in the work area which can be removed from the work area.

21. NIOSH - National Institute for Occupational Safety and Health.

22. OSHA - Occupational Safety & Health Administration.

23. Plastic Sheeting - plastic sheet material used for protection of walls, floors, etc. and used to seal openings into work areas. The thickness of the material shall be as specified.

24. Asbestos Containing Material (ACM) Removal - the act of removing asbestos-containing or contaminated materials from a structure and depositing in a suitable disposal site.

25. Scaffolding - self-supporting and load bearing temporary structure.

26. Shower Room - a room constituting an airlock, between the clean room and the equipment room in the worker decontamination enclosure system, with hot and cold or warm running water suitably arranged for complete showering during decontamination.

27. Surfactant - a chemical wetting agent added to water to improve its penetrating ability, thus reducing the quantity of water required to saturate asbestos- containing materials.

28. Waste Generator - a source covered by EPA NESHAP regulations whose act or process produces asbestos-containing waste.

29. Wet Cleaning - the process of eliminating asbestos contamination from building surfaces and objects by using cloths, mops, or other cleaning tools which have been dampened with amended water, and by afterwards disposing of these cleaning tools as asbestos-contaminated waste.

30. Washroom - a room between the work area and the holding area in the equipment decontamination enclosure system. The washroom comprises an airlock.

31. Work Area - area or areas of project which undergo "abatement" or are contaminated.

32. Worker Decontamination Enclosure System - a decontamination enclosure system for workers, typically consisting of a clean room, a shower room, and an equipment room.

1.3. WORKSITE CONDITIONS

Worker and Visitor Procedures: The Contractor is hereby advised that asbestos has been determined by the U.S. Government to be a CANCER-CAUSING AGENT and Contractor shall provide workers and visitors with respirators which as a minimum shall meet the requirements of OSHA 29CFR 1926.1101, and protective clothing during preparation of system of enclosures, prior to commencing, during actual asbestos removal, and until final clean-up is completed.

1.4 PERSONNEL PROTECTION

Prior to commencement of work, all workers shall be instructed by the Contractor and shall be knowledgeable, in the appropriate procedures of personnel protection and asbestos removal. Contractor acknowledges and agrees that he is solely responsible for enforcing worker protection requirements at least equal to those required by federal regulations.

A. Respiratory Protection

1. Contractor shall provide workers with personally issued and marked respiratory equipment approved by NIOSH and OSHA and as a minimum

suitable for the asbestos exposure level in the work areas according to OSHA Standard 29 CFR 1926.1101.

2. Where respirators with disposable filters are used, provide sufficient filters for replacement as necessary by the workers, or as required by applicable regulations.

3. Provide respiratory protection from the time the first operations involved in the Project require contact with asbestos-containing materials (including construction of airtight barriers/barricades, and placing of plastic sheeting on walls) until acceptance of final air test results by Testing Laboratory. Should conditions be encountered where the exposure level, after application of the appropriate protection factor of the respiratory equipment in use, exceeds 0.01 fibers per cubic centimeter of air (f/cc), substitute respiratory equipment with protection factors which reduce worker exposure levels below 0.01 f/cc. As a minimum, Contractor shall use respirators as follows:

	ACTIVITY	MIN. RESPIRATORY PROTECTION
a.	Construction of Airtight Barriers/Barricades	Half-Mask Air Purifying
b.	Placing of Plastic Sheeting	Half-Mask Air Purifying
c.	Pre-cleaning	Half-Mask Air Purifying
d.	Removal Using Glovebag Procedures	Half-Mask Air Purifying
e.	Removal of Non-Friable Materials	Half-Mask Air Purifying
f.	Removal of Friable Materials	Powered Air Purifying (PAPR)
g.	Second Phase Cleaning	Half-Mask Air Purifying
h.	Anytime fiber concentrations reach or exceed 0.10 f/cc by NIOSH Method #7400 regardless of activity being performed.	Type C, Supplied Air, Pressure Demand

4. Provide emergency backup air supply for each worker in work area at all times when "Type C" (supplied air) respirators are required. Provide emergency backup equipment with air supply of sufficient duration for all workers to safely exit work area. Locate emergency equipment so that it is readily accessible to each worker in work area following interruption of normal air supply.

5. All supplied air (Type C) respiratory equipment shall supply as a minimum, Grade D air. Contractor shall maintain on- site documentation and submit certified test results that air supplied to work area is Grade D or better. Documentation will include, as a minimum, equipment serial numbers, or panel numbers, and shall have been certified within the six months prior to project startup date.

6. Ambient air pumps shall not be used for Type C supplied air systems.

B. Additional Protective Measures

1. Permit no visitors, except for governmental inspectors having jurisdiction, or as authorized by Engineer, in the work areas after commencement of asbestos disturbance or removal. Provide authorized visitors with suitable respirators.

2. Provide workers with sufficient sets of protective disposable clothing, consisting of full-body coveralls, head covers, gloves, and foot covers; of sizes to properly fit individual workers.

3. Provide authorized visitors with a set of suitable protective disposable clothing, headgear, eye protection, and footwear of sizes to properly fit visitors whenever they are required to enter the work area, to a maximum of six sets per day.

4. Provide, in addition to respirators and protective clothing provided for authorized visitors, protective clothing and respirators for use by Testing Laboratory's representative. Furnish protective clothing in as many sets as required for full-time monitoring by Testing Laboratory.

5. Provide and post in the Equipment Room and the Clean Room the asbestos removal decontamination and work procedures to be followed by workers.

2.0. PRODUCTS

2.1 MATERIALS

A. Material Requirements

Materials to be used by the Contractor shall meet the following requirements:

1. Plastic sheeting - shall be of the thicknesses specified, in sizes to minimize the frequency of joints. Opaque plastic sheeting shall be utilized, in thicknesses specified, where work areas are adjacent to public access areas.

2. Tape - shall be glass fiber or other type capable of sealing joints of adjacent sheets of plastic and for attachment of plastic sheet to finished or unfinished surfaces of dissimilar materials under both dry and wet conditions.

3. Surfactant (wetting agent) - Shall consist of resin materials in water base which have been tested to indicate material is nontoxic and nonirritating to skin and eyes, and noncarcinogenic. Approved Materials and Manufacturers:

    a. "Dust-Set Amended Water Base" and its sprayer mixing head amended water generator manufactured by Matheson Chemical Corporation, 1025 East Montgomery Avenue, Philadelphia, PA, 19125, telephone (215) 423-3200.

    b. Equivalent products by other manufacturers will be considered for approval if submitted with appropriate information not later than five days prior to the scheduled time for the material to be used. Minimum information shall include Material Safety Data Sheet, OSHA Form No. 20; toxicological reports, and installation recommendations for use on asbestos- containing materials.

4. Tile Adhesive Removal Solvent: - Provide a water based slow drying solvent intended to remove tile adhesive. The chemical shall, at a minimum, have a closed cup flash point of greater than 140 degrees F., contain no chlorinated compounds, and contain no compounds which could render the waste as a hazardous waste for disposal. Specifically, the mastic removal chemical shall not contain any ingredient which is subject to the reporting requirements of Section 313 Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) or 40 CFR 372. Contractor shall, whenever feasible, use "low odor" products in an effort to minimize complaints during the project and following demobilization. Approved materials and manufacturers:

a. "De-Solv-It", manufactured by Orange Sol, Inc., P.O. Box 306, Chandler, Arizona 85244, Telephone (602) 497-8822. "De-Solv-It" is formulated for the removal of asphaltic and multi-purpose adhesives.

b. "ADL-1" manufactured by Orange Sol, Inc., P.O. Box 306, Chandler, Arizona 85244, Telephone (602) 497-8822. "ADL-1" is formulated for latex adhesive removal.

c. Equivalent products by other manufacturers will be considered for approval if submitted with appropriate information not later than five days prior to the scheduled time for the material to be used. Minimum information shall include Material Safety Data Sheet, OSHA Form No. 20; toxicological reports, and installation recommendations for use on asbestos-containing materials.

5. Sealant (encapsulant) - Shall be manufactured by reputable, established manufacturer of encapsulant/sealant materials and be approved specifically for use in asbestos-contaminated environments. Shall be compatible with the temperature conditions on surfaces to which sealant is to be applied. It is the responsibility of the Contractor to determine compatibility of the sealant with materials and conditions.

6. Impermeable containers - Shall be suitable to receive and retain asbestos-containing or contaminated materials until disposal at an approved site and shall be labeled in accordance with OSHA Regulation 29 CFR 1926.1101, and U.S. DOT 49 CFR 171 and 172, containers shall be both air and water- tight. Use a minimum of two types of impermeable containers: 1) six mil plastic bags sized to fit within the drum 2) metal or fiber drums with tightly fitting lids.

7. Warning labels and signs - Shall be as required by OSHA regulation 29 CFR 1926.1101 (and U.S. DOT 49CFR 171 and 172 for impermeable containers).

8. Other materials - Provide all other materials, such as lumber, nails and hardware, which may be required to construct and dismantle the decontamination area and the barriers that isolate the work area(s).

9. Caulking - Shall be non-shrinking caulk to be used where insulated pipes continue through walls, ceilings, etc. Contractor shall determine and submit proof that caulk proposed for use is compatible with the temperature conditions and fire ratings of the surfaces to which it is to be applied. Caulking shall be certified as not containing asbestos in any amounts.

2.2 PRODUCT HANDLING

A. Product Delivery and Storage

1. Deliver all materials as described in Part 2 in the original packages, containers, or bundles bearing the name of the manufacturer and the brand name.

2. Store all materials subject to damage off the ground, away from wet or damp surfaces, and under cover sufficient to prevent damage or contamination.

3. Remove from the premises all damaged or deteriorating materials. Dispose of materials that become contaminated with asbestos in accordance with applicable regulatory standards.

2.3 TOOLS AND EQUIPMENT

A. Suitable tools for asbestos removal

1. Water sprayer - Use airless or other low pressure sprayer for amended water application.

2. Air purifying equipment (for internal recirculation in the work area) - Shall be HEPA Filtration Systems or Electronic Precipitators. Ensure that no internal air movement system or purification equipment exhausts contaminated air from the work area(s) outside the work area.

3. Diminished air pressure equipment - comply with ANSI 29.2-7, local exhaust ventilation.

4. Scaffolding - Shall be as required to accomplish the specified work and shall meet all applicable safety regulations.

5. Transportation - As required for loading, temporary storage, transit, and unloading of contaminated waste without exposure to persons or property.

6. Communication equipment - Shall be suitable for interroom communications, such as "walkie-talkies".

7. First Aid Supplies - Comply with governing regulations and recognized recommendations within the construction industry.

8. Fire Extinguishers - Provide Type "A" fire extinguishers for temporary offices and similar spaces where there is minimal danger of electrical or

grease-oil-flammable liquid fires. In other locations provide type "ABC" dry chemical extinguishers, or a combination of several extinguishers of NFPA recommended types for the exposures in each case.

9. Water Hoses - Employ either rigid copper tubing or heavy-duty abrasion-resistant hoses with a pressure rating greater than the maximum pressure of the water distribution system to provide water into each work area and to each Decontamination Unit.

10. Water Heater - Provide UL rated electric water heater to supply hot water for the Decontamination Unit shower. Provide with relief valve compatible with water heater operation; pipe relief valve down to drip on floor. Wiring of the water heater shall be in compliance with NEMA, NEC, and UL standards.

11. Electrical Distribution Equipment - Provide circuit and branch wiring, with area distribution boxes located as necessary to perform the Work. Wiring shall be in compliance with NEMA, NEC and UL standards. All branch circuits shall originate from a ground fault circuit interrupter located outside the containment(s).

12. Lighting - Provide adequate artificial lighting for all areas of the Work.

13. Extension Cords - Use only grounded extension cords. Use "hard-service" cords where exposed to abrasion or traffic. Use single lengths or water proof connectors to connect separate lengths when single lengths do not suffice.

14. Temporary Cooling and Heating - Provide temporary cooling and heating as necessary to maintain adequate environmental conditions to facilitate the progress of the work, to meet specified minimum conditions for material installation, and to protect materials and finishes from damage due to temperature or humidity.

3.0. EXECUTION

3.1. PREPARATION AND WORK AREA ENCLOSURE

A. Preparation Procedure A - For use with the full enclosure, gross removal of the following asbestos-containing materials:

- Floor Tile and Mastic (Contractor shall remove all floor tile and mastic from work area(s). Non-asbestos tile and multiple layers of tile may be present in some areas. All floor tile and mastic shall be treated as asbestos-containing.)

1. Coordinate with the Engineer to disable heating, ventilating and air conditioning (HVAC) systems or any other systems bringing air into or out of the work area(s). These systems shall remain disabled for the duration of abatement activities.

2. Temporary electrical power must be obtained from outside the work area(s) and shall be equipped with ground fault circuit interrupt protection. The Contractor is to provide generators for temporary electrical power and all water required by the job. All costs associated with providing temporary power and water shall be the responsibility of the Contractor.

3. Completely segregate the work area(s) from all other portions of the complex with temporary partitions. Partitions shall be of softwall construction as explained further in this section:

    a. Softwall partitions shall be constructed of a 6 mil minimum thickness plastic sheeting attached to a 2" x 4" enclosure framework using 2" x 4" supports where necessary to prevent collapse of the enclosure system.

    b. All partitions shall be removed at the conclusion of the work and all surfaces shall be restored to original condition, unless otherwise approved by the Engineer. All locations and configurations of softwall partitions shall be reviewed by the Engineer prior to installation.

    c. Ensure that all barriers and plastic enclosures remain effectively sealed and taped for the duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually inspect enclosures at the beginning and end of each work period. Use smoke methods to test the effectiveness of barriers when directed by the Engineer.

4. Remove, properly decontaminate using wet-cleaning and HEPA vacuuming as appropriate, and inventory any and all movable items remaining in the work area(s) not previously removed by the Department.

5. Identify location and amount of all asbestos-containing materials to be removed.

6. Isolate the work areas until clearance testing is accepted by the Contractor’s Testing Laboratory, by completely sealing off with critical barriers all openings such as doorways, skylights, crawlspace openings, ducts, grills, diffusers, plenum areas and any other penetrations of the work areas with two layers of six mil plastic sheeting sealed with tape.

7. Seal wall-mounted electrical panels, switchboxes, etc. with minimum two layers of six mil plastic sheeting prior to placement of wall plastic.

8. Clean, prior to placing plastic sheeting on walls, the work area(s) using HEPA vacuum equipment or wet-cleaning methods as appropriate. Do not use methods that raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filtration. The Engineer shall be notified for observation of the critical barrier placement and cleaning of the work area prior to application of additional plastic sheeting.

9. Preclean immovable objects within the proposed work area(s), using HEPA vacuum equipment and/or wet cleaning methods as appropriate. Following cleaning, completely seal all immovable items with two layers of six mil plastic sheeting.

10. Construct worker and barrel/equipment decontamination units in compliance with EPA guidelines concerning number, size and placement of airlocks, etc. Shower in worker decontamination unit shall open on two sides and open into airlock on both contaminated and uncontaminated sides. Construct decontamination units of appropriate materials including plastic sheeting (to provide airtight barriers) and plywood or other suitable rigid materials to allow continuous diminished pressure to be maintained in work areas. Supply sufficient number of lockers, in worker decontamination unit change or "clean" room, for workers' clothing. Reserve one locker for Testing Laboratory personnel. Post OSHA decontamination procedures in change room for duration of Project.

11. Plastic Enclosures

    a. In work areas where asbestos-containing floor coverings are to be removed, Contractor shall place six mil plastic "splash guards" on walls at perimeter of work area(s). Plastic sheeting "splash guards" shall extend, from floor level, a minimum of four feet up wall areas.

    b. Ensure that all barriers and plastic enclosures remain effectively sealed and taped for duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually inspect enclosures at the beginning of each work period. Use smoke methods to test effectiveness of barriers when directed by the Engineer.

12. Diminished Pressure

    a. Place each work area under diminished air pressure utilizing HEPA filtration systems which comply with 028200, Part 2.02, A,3.

Allow no air movement system or air filtering equipment to discharge unfiltered air outside the work area. Maintain a diminished air pressure on the work area continuously (24 hours per day) from the start of asbestos removal and until the area has been decontaminated and certified as such by the required air testing. Accomplish a minimum of eight air changes per hour in the work area and maintain a minimum of 0.02 inches of water diminished pressure. Demonstrate diminished air pressure compliance during the removal of friable materials by monitoring and recording the pressure differential with a continuous read-out, strip-chart differential pressure recorder. Exhaust all filtered and discharged air outside the building away from any air intake devices.

b. Exhaust ducts from diminished air machines shall be flexible polyethylene ducts manufactured for this purpose and sized to fit the outlet of the machines. Ducts field fabricated from plastic sheeting will not be permitted. If direction of discharge from fan unit is not aligned with duct, use sheet metal elbow to change direction.

c. Supplemental Make-Up Air Inlets: Where required for proper air flow through the work area(s), install HEPA-filtered make-up air inlet(s) at the perimeter of the enclosure(s) that allows air from outside into the work area. Locate make-up air inlets as far as possible from the exhaust unit(s). Air inlets shall be designed to reseal automatically if the diminished pressure system should shut down for any reason. Location of make-up air inlets must be approved by the Project Engineer.

13. Maintain emergency and fire exits from the work areas, or establish alternative exits satisfactory to fire officials.

14. Provide temporary power, lighting and heating, utilizing ground fault protection devices, to maintain a comfortable work environment and to keep utilities from freezing. Normal water and electric utilities to be supplied by the Engineer.

15. Notify the Engineer for observation of the preparation of jobsite prior to any removal of asbestos-containing material. Prior to notification, complete plasticizing of work area(s) and construction of worker and barrel/equipment decontamination enclosure systems, and store all equipment required for Project.

16. Maintain for the duration of the Project from the first activity requiring disturbance of asbestos-containing materials, a sign in/out log in the

immediate area of the change room. Log shall be utilized by every person and each time upon entering and leaving the work area(s). Submit copies of this log to the Engineer for permanent file upon completion of Project.

17. Trap, filter using filters having a pore size of not larger than five microns, and drain shower wastewater into a sanitary sewer. Replace contaminated filters when they become clogged but not less than every third day. Dispose of filters as contaminated waste. Contractor may dispose of as contaminated material, at his option, rather than filtering and draining into sanitary sewer.

B. Preparation Procedure B - For use with the following asbestos-containing materials:

- Roofing and Roof Flashing

1. Remove, properly decontaminate using wet-cleaning and HEPA vacuuming as appropriate, and inventory any and all movable items remaining in the work areas not previously removed by the Department.

2. Identify location and amount of all asbestos- containing materials to be removed.

3. Preclean exhaust vents, fan hoods, etc. in the vicinity of the proposed work area(s), using HEPA vacuum equipment and/or wet cleaning methods as appropriate. Following cleaning, completely seal in plastic.

4. Perimeter Enclosure

   a. Erect warning tape at perimeter of work area to establish caution barrier.

   b. Ensure that all barriers remain in good condition for duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually inspect perimeter of the work area at the beginning and end of each work period.

5. Maintain emergency and fire exits from the work areas, or establish alternative exits satisfactory to fire officials.

6. Notify the Engineer for observation of the preparation of jobsite prior to any removal of asbestos-containing material. Prior to notification complete plasticizing of work area(s) and construction of remote worker and barrel/equipment decontamination enclosure systems, and store all equipment required for Project.

7. Maintain for the duration of the Project from the first activity requiring disturbance of asbestos-containing materials, a sign in/out log in the immediate area of the change room. Log shall be utilized by every person and each time upon entering and leaving the work area(s). Submit copies of this log to the Engineer for permanent file upon completion of Project.

C. Preparation Procedure C - For use with the following asbestos-containing materials:

- Thermal Systems Insulation (TSI) – Using Glovebag Procedure:

1. Disable and lock out applicable utility services to and through the work area(s) (if present) for the duration of abatement activities. Temporary electrical power shall be obtained from outside the work area(s) and shall be equipped with ground fault circuit interrupt protection.

2. Identify location and amount of all asbestos-containing materials to be removed. Confirm with the Engineer that the materials to be removed are suitably located so as to facilitate glovebag removal.

3. Isolate the work area(s) until clearance testing is accepted by the Contractor's Testing Laboratory, by completely sealing off work area(s) with one layer of six mil plastic sheeting sealed with tape.

4. Clean, prior to placing plastic sheeting on floors and walls (if applicable), the work area(s) using HEPA vacuum equipment or wet-cleaning methods as appropriate. Do not use methods that raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filtration. The Engineer shall be notified for observation of the critical barrier placement and cleaning of the work area prior to application of additional plastic sheeting.

5. Preclean immovable objects within the proposed work area(s), using HEPA vacuum equipment and/or wet cleaning methods as appropriate. Following cleaning, completely seal in plastic all immovable items with one layer of six mil plastic sheeting.

6. Perimeter Enclosure

   a. Erect warning tape at perimeter of work area to establish caution barrier.

   b. Ensure that all barriers remain in good condition for duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually

inspect perimeter of the work area at the beginning and end of each work period.

c. Place one layer of six mil plastic sheeting on ground areas beneath work area(s). Width shall not be less than material height from ground or ten feet, whichever is greater.

7. Maintain emergency and fire exits from the work areas, or establish alternative exits satisfactory to fire officials.

8. Notify the Engineer for observation of the preparation of jobsite prior to any removal of asbestos-containing material. Prior to notification complete plasticizing of work area(s) and construction of remote worker and barrel/equipment decontamination enclosure systems, and store all equipment required for Project.

9. Maintain for the duration of the Project from the first activity requiring disturbance of asbestos-containing materials, a sign in/out log in the immediate area of the change room. Log shall be utilized by every person and each time upon entering and leaving the work area(s). Submit copies of this log to the Engineer for permanent file upon completion of Project.

D. Preparation Procedure D - For use with the following asbestos-containing materials:

- Cementitious Deck Drains (located in situ on existing bridge)

1. Remove, properly decontaminate using wet-cleaning and HEPA vacuuming as appropriate, and inventory any and all movable items remaining in the work areas not previously removed by the Department.

2. Identify location and amount of all asbestos- containing materials to be removed.

3. Perimeter Enclosure

    a. Erect warning tape at perimeter of work area to establish caution barrier.

    b. Ensure that all barriers remain in good condition for duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually inspect perimeter of the work area at the beginning and end of each work period.

4. Maintain emergency and fire exits from the work areas, or establish alternative exits satisfactory to fire officials.

5. Maintain for the duration of the Project from the first activity requiring disturbance of asbestos-containing materials, a sign in/out log in the immediate area of the change room. Log shall be utilized by every person and each time upon entering and leaving the work area(s). Submit copies of this log to the Engineer for permanent file upon completion of Project.

E. Preparation Procedure E - For use with the following asbestos-containing materials:

- Cementitious Deck Drains (located in rubble)

1. Remove, properly decontaminate using wet-cleaning and HEPA vacuuming as appropriate, and inventory any and all movable items remaining in the work areas not previously removed by the Department.

2. Identify location and amount of all asbestos- containing materials to be removed.

3. Perimeter Enclosure

a. Erect warning tape at perimeter of work area to establish caution barrier.

b. Ensure that all barriers remain in good condition for duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually inspect perimeter of the work area at the beginning and end of each work period.

4. Maintain emergency and fire exits from the work areas, or establish alternative exits satisfactory to fire officials.

5. Maintain for the duration of the Project from the first activity requiring disturbance of asbestos-containing materials, a sign in/out log in the immediate area of the change room. Log shall be utilized by every person and each time upon entering and leaving the work area(s). Submit copies of this log to the Engineer for permanent file upon completion of Project.

F. Preparation Procedure F - For use with the following asbestos-containing materials:

- Guardrail Caulking

1. Remove, properly decontaminate using wet-cleaning and HEPA vacuuming as appropriate, and inventory any and all movable items remaining in the work areas not previously removed by the Department.

2. Identify location and amount of all asbestos- containing materials to be removed.

3. Perimeter Enclosure

a. Erect warning tape at perimeter of work area to establish caution barrier.

b. Ensure that all barriers remain in good condition for duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually inspect perimeter of the work area at the beginning and end of each work period.

4. Maintain emergency and fire exits from the work areas, or establish alternative exits satisfactory to fire officials.

5. Maintain for the duration of the Project from the first activity requiring disturbance of asbestos-containing materials, a sign in/out log in the immediate area of the change room. Log shall be utilized by every person and each time upon entering and leaving the work area(s). Submit copies of this log to the Engineer for permanent file upon completion of Project.

G. Preparation Procedure G - For use with the following asbestos-containing materials:

- Beam Bearing Pads

1. Remove, properly decontaminate using wet-cleaning and HEPA vacuuming as appropriate, and inventory any and all movable items remaining in the work areas not previously removed by the Department.

2. Identify location and amount of all asbestos- containing materials to be removed.

3. Perimeter Enclosure

   a. Erect warning tape at perimeter of work area to establish caution barrier.

   b. Ensure that all barriers remain in good condition for duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually inspect perimeter of the work area at the beginning and end of each work period.

4. Maintain emergency and fire exits from the work areas, or establish alternative exits satisfactory to fire officials.

5. Maintain for the duration of the Project from the first activity requiring disturbance of asbestos-containing materials, a sign in/out log in the immediate area of the change room. Log shall be utilized by every person and each time upon entering and leaving the work area(s). Submit copies of this log to the Engineer for permanent file upon completion of Project.

H. Preparation Procedure H - For use with the following asbestos-containing materials:

- Bridge Coatings and/or Concrete Bridge Components

1. Completely segregate the work area(s) from all other portions of the complex with temporary partitions. Partitions shall be of softwall construction as explained further in this section:

   a. Softwall partitions shall be constructed of a 6 mil minimum thickness plastic sheeting attached to a 2" x 4" enclosure framework using 2" x 4" supports where necessary to prevent collapse of the enclosure system.

   b. All partitions shall be removed at the conclusion of the work and all surfaces shall be restored to original condition. All locations and configurations of softwall partitions shall be reviewed by the Engineer prior to installation.

   c. Ensure that all barriers and plastic enclosures remain effectively sealed and taped for the duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually inspect enclosures at the beginning and end of each work period. Use smoke methods to test the effectiveness of barriers when directed by the Engineer.

2. Remove, properly decontaminate using wet-cleaning and HEPA vacuuming as appropriate, and inventory any and all movable items remaining in the work area(s) not previously removed by the Department.

3. Identify location and amount of all asbestos-containing materials to be removed.

4. Isolate the work areas until final air clearance testing conducted by the Contractor’s Testing Laboratory, by completely sealing off the work area(s) with two layers of six mil plastic sheeting sealed with tape.

5. Seal all active wall-mounted electrical panels, switchboxes, etc. with minimum two layers of six mil plastic sheeting prior to placement of wall plastic.

6. Clean the work area(s) using HEPA vacuum equipment or wet-cleaning methods as appropriate. Do not use methods that raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filtration. The Engineer shall be notified for observation of the critical barrier placement and cleaning of the work area prior to application of additional plastic sheeting.

7. Preclean immovable objects within the proposed work area(s), using HEPA vacuum equipment and/or wet cleaning methods as appropriate. Following

cleaning, completely seal all immovable items with two layers of six mil plastic sheeting.

8. Construct worker and barrel/equipment decontamination units in compliance with EPA guidelines concerning number, size and placement of airlocks, etc. Shower in worker decontamination unit shall open on two sides and open into airlock on both contaminated and uncontaminated sides. Construct decontamination units of appropriate materials including plastic sheeting (to provide airtight barriers) and plywood or other suitable rigid materials to allow continuous diminished pressure to be maintained in work areas. Supply sufficient number of lockers, in worker decontamination unit change or "clean" room, for workers' clothing. Reserve one locker for Testing Laboratory personnel. Post OSHA decontamination procedures in change room for duration of Project.

9. Plastic Enclosures

   a. In work areas where asbestos-containing floor coverings are to be removed, Contractor shall place six mil plastic "splash guards" on walls at perimeter of work area(s). Plastic sheeting "splash guards" shall extend, from floor level, a minimum of four feet up wall areas.

   b. Ensure that all barriers and plastic enclosures remain effectively sealed and taped for duration of asbestos removal and subsequent cleaning. Repair damaged barriers and remedy defects immediately upon discovery. Visually inspect enclosures at the beginning of each work period. Use smoke methods to test effectiveness of barriers when directed by the Engineer.

10. Diminished Pressure

   a. Place each work area under diminished air pressure utilizing HEPA filtration systems which comply with 028200, Part 2.02, A,3. Allow no air movement system or air filtering equipment to discharge unfiltered air outside the work area. Maintain a diminished air pressure on the work area continuously (24 hours per day) from the start of asbestos removal and until the area has been decontaminated and certified as such by the required air testing. Accomplish a minimum of eight air changes per hour in the work area and maintain a minimum of 0.02 inches of water diminished pressure. Demonstrate diminished air pressure compliance during the removal of friable materials by monitoring and recording the pressure differential with a continuous read-out, strip-chart differential pressure recorder. Exhaust all filtered and

discharged air outside the building away from any air intake devices.

b. Exhaust ducts from diminished air machines shall be flexible polyethylene ducts manufactured for this purpose and sized to fit the outlet of the machines. Ducts field fabricated from plastic sheeting will not be permitted. If direction of discharge from fan unit is not aligned with duct, use sheet metal elbow to change direction.

c. Supplemental Make-Up Air Inlets: Where required for proper air flow through the work area(s), install HEPA-filtered make-up air inlet(s) at the perimeter of the enclosure(s) that allows air from outside into the work area. Locate make-up air inlets as far as possible from the exhaust unit(s). Air inlets shall be designed to reseal automatically if the diminished pressure system should shut down for any reason. Location of make-up air inlets must be approved by the Engineer.

11. Maintain emergency and fire exits from the work areas, or establish alternative exits satisfactory to fire officials.

12. Provide temporary power, lighting and heating, utilizing ground fault protection devices, to maintain a comfortable work environment and to keep utilities from freezing. Normal water and electric utility service to be supplied by the Deparment.

13. Notify the Engineer for observation of the preparation of jobsite prior to any removal of asbestos-containing material. Prior to notification, complete plasticizing of work area(s) and construction of worker and barrel/equipment decontamination enclosure systems, and store all equipment required for Project.

14. Maintain for the duration of the Project from the first activity requiring disturbance of asbestos-containing materials, a sign in/out log in the immediate area of the change room. Log shall be utilized by every person and each time upon entering and leaving the work area(s). Submit copies of this log to the Engineer for permanent file upon completion of Project.

15. Trap, filter using filters having a pore size of not larger than five microns, and drain shower wastewater into a sanitary sewer. Replace contaminated filters when they become clogged but not less than every third day. Dispose of filters as contaminated waste. Contractor may dispose of as contaminated material, at his option, rather than filtering and draining into sanitary sewer.

3.2. REMOVAL OF ASBESTOS-CONTAINING MATERIAL

Properly remove and dispose of all asbestos-containing materials indicated to be removed as described in the Contract Documents in accordance with the methods and procedures outlined in the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) Asbestos Regulation (Code of Federal Regulations Title 29, Part 1926, Section 1926.1101) or as more stringently specified herein.

If asbestos-containing materials are made to become friable during removal activities, or additional friable materials are encountered during removal activities, the Contractor will be required to stop work and contact the Engineer immediately. Removal work shall resume only after approval is given by the Engineer.

A. Removal Procedure A - For use with the removal of the following asbestos-containing materials:

- Floor Tile and Mastic

1. Prepare Work Areas as previously specified.

2. Spray areas of resilient floor covering material and/or adhesive backing with amended water, using spray equipment recommended by surfactant manufacturer capable of providing a "mist" application to reduce the release of fibers. Wet the material sufficiently to saturate it but do not allow water to accumulate or travel on floor. Spray the asbestos material repeatedly during removal to maintain wet condition but do not use excessive amounts of water.

3. Where carpeting is present in floor tile and, or adhesive backing work area(s), remove and properly dispose of carpeting as contaminated material. Following carpet removal, or in areas containing no carpet, remove individual tiles by wedging a scraper under one edge of the tile and exerting a prying, twisting force as it is moved under the tile until the tile releases from the floor. Do not break tiles. If tiles do not release easily, a mallet or hammer may be used to strike the scraper and force it under the tile. Place tiles immediately in disposal containers as they are removed. Ensure that containers are not subject to penetration by sharp edges of floor tile.

4. As small areas are cleared of tile, scrape up remaining adhesive backing and deposit scrapings in disposal bags. Clean floor of all adhesive residue by repeated wet mopping with an approved solvent.

B. Removal Procedure B - For use with the removal of the following asbestos-containing materials:

- Roofing and Roof Flashing

1. Prepare Work Areas as previously specified.

2. The contractor will spray asbestos materials with amended water, using airless spray equipment capable of providing a "mist" application to reduce the release of fibers. The asbestos material will be sprayed with water mist containing a wetting agent to enhance penetration. The wetting agent will be a commercial product produced specifically as an asbestos wetting agent. A fine spray of the amended water will be applied to reduce fiber release preceding the removal of the asbestos material.

3. In order to maintain asbestos concentrations at a minimum, the wet asbestos will be removed in manageable sections. Materials will not be allowed to dry out. Material drop will not exceed 8 feet. For heights up to 15 feet provide inclined chutes or scaffolding to intercept drop. For heights exceeding 15 feet provide enclosed dust-proof chutes.

4. The contractor will place danger labels on containers in accordance with OSHA standard 29 CFR 1910.1001 (g) (2) if not already pre-printed on containers.

C. Removal Procedure C - For use with the removal of the following asbestos-containing materials:

- Thermal Systems Insulation (TSI) – Using Glovebag Procedure

1. Wrap any damaged areas of pipe insulation in one layer of 6-mil plastic. Seal seams and ends with duct tape.

2. Place one layer of duct tape around pipe insulation at points where glovebag will be attached.

3. Attach and use glovebag in accordance with manufacturer's instructions, unless more stringently specified herein.

4. Insert wand from garden sprayer through water sleeve. Duct tape water sleeve tightly around the wand to prevent leakage.

5. Use smoke tube and aspirator bulb to test seal. Gently squeeze glovebag and look for smoke leaks. Seal leaks and retest. Perform test in presence of the Engineer.

6. Wet the asbestos-containing material within the glovebag with amended water prior to removal. Utilize two (2) asbestos workers per glovebag.

7. Carefully cut and remove asbestos-containing materials within the glove bag. Exercise care while cutting asbestos-containing materials from piping.

8. Thoroughly wet removed material, bag and piping with amended water. Scrub exposed piping with a bristle or nylon brush. Remove visual accumulations of debris from piping. Allow mist to settle.

9. Seal exposed ends of pipe insulation not removed and exposed piping in glove bag with encapsulant.

10. Remove tools, through gloves or tool pouch by inverting, twisting glove, taping at twist to seal, and severing glove at midpoint of tape.

11. Collapse glove bag by inserting HEPA-vacuum. Twist bag several times at the top of bag. Twist and tape to secure.

12. Place appropriately labeled 6-mil bag around glove bag. Score glovebag above taped seal to remove from pipe and place inside 6-mil bag. Seal 6-mil bag around disassembled glove bag.

D. Removal Procedure D - For use with the removal of the following asbestos-containing materials:

- Cementitious Deck Drains (located in situ on existing bridge)

1. Saw cut full depth concrete sections a minimum of twelve inches away from ACM so as to separate deck drains from non-ACM without contacting ACM. Separate saw cut pieces from bridge.

2. Do not allow material to fall. Handle carefully and continuously wet.

3. Continually spray all debris matrix created by saw cutting activities with water as needed to minimize dust.

4. A designated, trained worker (minimum OSHA Class I, 40-hour worker training) shall continuously observe the matrix for readily identifiable fragments of asbestos-containing deck drain.

5. The designated worker will remove any identifiable fragments from the matrix and separate them safely away from the existing bridge decking.

6. Wrap all pieces of ACM encased in concrete after saw cutting with two layers of polyethylene sheeting. Contractor shall load these wrapped pieces directly into dump trucks. The designated worker will observe continuously for other fragments and remove any that are found.

7. In areas in which the matrix or large, intact pieces of concrete have been freed of the bridge decking, similar steps will be taken to segregate pieces containing ACM from those that do not. Segregating shall be done by a trained worker, as described above.

8. Contractor shall load pieces (not already bagged or in a drum) of concrete or other debris matrix, visually verified to contain asbestos-containing deck drain, directly into a dump truck for transport. All such trucks must be prepared for such use by pre-lining the bed and all four sides of the truck with two layers of six mil poly. All seams and overlaps (minimum 12 inches) shall be sealed with duct tape so as to prevent contaminated water migration. Once loaded, poly is to be folded over and a leak-tight seal created over all the debris matrix. This poly "cocoon", created for transport, is to be deposited in its entirety in the landfill, without being breached.

E. Removal Procedure E - For use with the removal of the following asbestos-containing materials:

- Cementitious Deck Drains (located in rubble)

Before being transported off site for any use or purpose, concrete decking debris known to contain or suspected of containing fragments of asbestos-containing deck drain pipe will be sorted to remove visibly identifiable fragments of the pipe from the matrix. The procedure to be followed is generally as follows:

1. Handle carefully and continuously wet. Continually spray all debris matrix created by saw cutting activities with water as needed to minimize dust.

2. A designated, trained worker (minimum OSHA Class I, 40-hour worker training) shall observe the debris field for readily identifiable fragments of asbestos-containing deck drain.

3. The designated worker will remove any identifiable fragments from the matrix and separate them safely away from the existing bridge decking.

4. Identify, segregate, and wrap all pieces of ACM encased in concrete with two layers of polyethylene sheeting. Contractor shall load these wrapped pieces directly into dump trucks. The designated worker will observe continuously for other fragments and remove any that are found.

5. In areas in which the matrix or large, intact pieces of concrete have been freed of the bridge decking, similar steps will be taken to segregate pieces containing ACM from those that do not. Segregating shall be done by a trained worker, as described above.

6. Contractor shall load pieces (not already bagged or in a drum) of concrete or other debris matrix, visually verified to contain asbestos-containing deck drain, directly into a dump truck for transport. All such trucks must be prepared for such use by pre-lining the bed and all four sides of the truck with two layers of six mil poly. All seams and overlaps (minimum 12 inches) shall be sealed with duct tape so as to prevent contaminated water migration. Once loaded, poly is to be folded over and a leak-tight seal created over all the debris matrix. This poly “cocoon”, created for transport, is to be deposited in its entirety in the landfill, without being breached.

F. Removal Procedure F - For use with the removal of the following asbestos-containing materials:

- Guardrail Caulking

1. The contractor will spray asbestos materials with amended water, using airless spray equipment capable of providing a "mist" application to reduce the release of fibers. The asbestos material will be sprayed with water mist containing a wetting agent to enhance penetration. The wetting agent will be a commercial product produced specifically as an asbestos wetting agent. A fine spray of the amended water will be applied to reduce fiber release preceding the removal of the asbestos material.

2. In order to maintain asbestos concentrations at a minimum, the wet asbestos will be removed in manageable sections.

3. The contractor will place danger labels on containers in accordance with OSHA standard 29 CFR 1910.1001 (g) (2) if not already pre-printed on containers.

4. Wrap all pieces of removed ACM with two layers of polyethylene sheeting.

G. Removal Procedure G - For use with the removal of the following asbestos-containing materials:

- Beam Bearing Pads

1. The contractor will spray asbestos materials with amended water, using airless spray equipment capable of providing a "mist" application to reduce the release of fibers. The asbestos material will be sprayed with water mist containing a wetting agent to enhance penetration. The wetting agent will be a commercial product produced specifically as an asbestos wetting agent. A fine spray of the amended water will be applied to reduce fiber release preceding the removal of the asbestos material.

2. In order to maintain asbestos concentrations at a minimum, the wet asbestos will be removed in manageable sections. Materials will not be allowed to dry out.

3. The contractor will place danger labels on containers in accordance with OSHA standard 29 CFR 1910.1001 (g) (2) if not already pre-printed on containers.

4. Wrap all pieces of removed ACM with two layers of polyethylene sheeting.

H. Removal Procedure H - For use with the removal of the following asbestos-containing materials:

- Bridge Coatings and/or Concrete Bridge Components

1. Spray areas of asbestos-containing material with amended water, using spray equipment recommended by surfactant manufacturer capable of providing a "mist" application to reduce the release of fibers. Wet the material sufficiently to saturate it but do not allow water to accumulate or travel on floor. Spray the asbestos material repeatedly during removal to maintain wet condition but do not use excessive amounts of water.

2. In order to maintain asbestos concentrations at a minimum, the wet asbestos will be removed in manageable sections. Materials will not be allowed to dry out.

3. The contractor will place danger labels on containers in accordance with OSHA standard 29 CFR 1910.1001 (g) (2) if not already pre-printed on containers.

3.3 CLEAN-UP AND CLEARANCE TESTING

Aggressive clearance air testing will be conducted in accordance with EPA Guide Document (EPA 600/4-85-049) "Measuring Airborne Asbestos Following An Abatement Action." for all Work Areas for which an enclosure has been erected and negative air pressure has been established. Before sampling pumps are started, the Contractor's Testing Laboratory representative will sweep the exhaust from forced air equipment (leaf blower with at least 1 horsepower electric motor) against walls, ceilings, floors, ledges and

other surfaces (temporary or permanent) in the work area(s). This procedure will be continued for approximately 5 minutes per 5,000 cubic feet of work area volume. In addition, the use of 20 inch diameter box fans will be placed one per 5,000 cubic feet of work area volume. The Contractor shall provide all forced air equipment required to facilitate aggressive clearance air testing.

A. Equipment

The Contractor shall supply the following equipment for his Testing Laboratory's use during the Work:

1. Electric Leaf Blowers; Minimum one horsepower, 110 mile per hour air velocity, 280 cubic feet per minute.

2. Ground Fault Interrupter (GFI) Protected Extension Cords: In lengths and locations sufficient for clearance testing.

3. Fans; 20-inch standard window box fans. All other test equipment and supplies.

Clearance testing for work areas shall be conducted using phase contrast microscopy (PCM) in general accordance with NIOSH 7400 method. Consider enclosed work areas placed under negative air pressure and all other decontaminated and cleaned areas clean and ready for reoccupancy when air testing performed by the Contractor's Testing Laboratory, shows 0.01 or less fibers per cubic centimeter of air (f/cc), for each sample obtained using standard NIOSH Method No. 7400 for PCM.

B. Clean Up Sequence A - For use with enclosed Work Areas for which negative air pressure has been established.

1. Remove all visible accumulations of asbestos material and debris.

2. Wet clean and/or HEPA vacuum all surfaces in the work area(s). Continue this cleaning until there is no visible debris from removed materials or residue on plastic sheeting or other surfaces.

3. Clean all sealed impermeable containers and all equipment (excluding that which will be needed for further cleaning) used in the work area(s) and remove from work area(s) via the equipment decontamination enclosure system.

4. After determining that the area is free of standing water and that surfaces are dry to the touch, notify the Engineer. This step may be waived if non-friable materials were removed and were not rendered friable during the removal process.

5. Following cleaning and acceptance of cleanliness by Contractor’s Testing Laboratory, all surfaces shall receive one coat of sealant to seal existing surfaces as follows:

    a. Misting, spraying and pumping equipment, as recommended by the encapsulant material's manufacturer, shall be used.

    b. Encapsulant, compatible with finish material and conditions specified in other Divisions, shall be installed in procedures as recommended by the manufacturer's written instructions if found to be compatible with temperature conditions.

6. Contractor shall not use sealant sprayed into the air as a means of reducing fiber levels after plastic sheeting is removed.

7. Allow sealant sufficient time to dry prior to proceeding with clearance air testing.

8. Clearance Air Testing

    a. Contractor’s Testing Laboratory will test for Air Quality Clearance in the Work Area(s) upon notice from Contractor that the Work Areas and all other decontaminated and cleaned areas are ready. The standard for Clearance will be as is set forth in paragraph 3.3.A of this section.

    b. Reclean at Contractor's expense all areas which do not comply with the standard of cleaning for Clearance. Continue cleaning until the specified final air quality clearance level is achieved by the Contractor’s Testing Laboratory. Contractor shall bear cost of all follow-up tests necessitated by failure to meet the specified standard of cleaning for clearance.

9. Following acceptance of the Air Quality Clearance test results and after Contractor finds areas to be visually decontaminated:

    a. Dismantle and remove sturdy barriers and plastic seals on all openings and wet clean immediate areas.

    b. Dismantle decontamination enclosure systems and thoroughly wet clean immediate areas.

    c. Dispose of debris, used cleaning materials, unsalvageable materials used for sturdy barriers, and any other remaining materials.

C. Clean Up Sequence B - For use in Work Areas for which no enclosure has been built, nor any negative air pressure established.

1. Remove all visible accumulations of asbestos material and debris.

2. Following acceptance of visual inspection of removal by the Contractor's Testing Laboratory, and the Contractor's Testing Laboratory finds areas to be visually decontaminated:

   a. Wet clean immediate areas.

   b. Dispose of debris, used cleaning materials, unsalvageable materials used for sturdy barriers, and any other remaining materials.

3. Acceptance of Work Area to be documented by Contractor's Testing Laboratory. Acceptance of removal practices and results to be based on visual observation only.

3.4. STORAGE AND DISPOSAL OF CONTAMINATED WASTE

A. Waste Storage and Disposal Requirements

1. No less frequently than at the end of each work day, the designated worker(s) shall place all collected ACM into an appropriate container (6-mil poly bags, drums, or closed roll-off box), which shall be stored in a secure location pending disposal. Periodically, the container or containers of collected ACM shall be transported to and disposed in a licensed landfill that is authorized to receive such materials. The contractor shall submit a copy of each waste disposal manifest to TDOT.

2. In handling, transporting and disposing of ACM waste, the contractor shall segregate friable ACM waste from non-friable ACM waste and manage each waste type as required by applicable regulations. Remove sealed and labeled containers of contaminated material and wastes and dispose of in approved sanitary landfill as follows:

3. Notify the Engineer not less than 48 hours prior to the proposed time of removing and delivery of contaminated waste to the landfill. The Engineer may elect to observe this operation.

4. Provide completed Asbestos Waste Shipment Record (as required by 40 CFR 61, Subpart M) including, but not limited to, the following information:

   - The name, address, and telephone number of the waste generator.

- The name and address of the local, state, or EPA Regional office responsible for administering the asbestos NESHAP program.

- The approximate quantity in cubic yards.

- The name and telephone number of the disposal site operator.

- The name and physical site location of the disposal site.

- The date transported.

- The name, address, and telephone number of the transporter(s).

- A certification that the contents of the consignment are fully and accurately described by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and government regulations.

5. Disposal Bags: Provide 6 mil thick leak-tight polyethylene bags labeled as follows:

a.

DANGER
CONTAINS ASBESTOS FIBERS
AVOID OPENING OR BREAKING CONTAINER
BREATHING ASBESTOS IS HAZARDOUS TO YOUR HEALTH

OR

b.

DANGER
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD

and, in addition to fulfilling the above labeling requirements, the Contractor shall also fulfill all applicable Department of Transportation requirements and label each waste disposal bag/container with the name of the waste generator and the location at which the waste was generated.

6. Load all asbestos-containing waste material in disposal bags or leak-tight drums. All materials are to be contained in one of the following:

- Two 6 mil thick disposal bags, or

- One 6 mil thick disposal bags and a fiberboard drum, or

- Sealed steel drum with no bag.

7. Protect interior of truck or dumpster with Critical and Primary Barriers.

8. Do not store bagged waste material adjacent to the Work Area. Take bags from the Work Area directly to a sealed truck or storage container.

9. No material, other than properly packaged ACM waste, shall be placed in the waste storage container.

10. Transport bagged ACM waste from the Work site to the transportation vehicle or storage container in a covered cart or vehicle. Mark vehicles during loading and unloading of waste so that the signs are visible. The markings must conform to the requirements Section 61.149(d) of the appropriate NESHAP section for asbestos.

11. All ACM waste storage containers, including transportation vehicles, shall remain secure or guarded at all times while containing ACM waste.

12. Exercise care during storage and transport, to insure that no unauthorized persons have access to the material.

13. Do not transport waste in open trucks. Label drums with same warning labels as bags. Uncontaminated drums may be reused. Treat drums that have been contaminated as asbestos-containing waste and dispose of in accordance with this specification

14. Provide a completed copy of the waste shipment record to the disposal site Manager at the same time as the asbestos-containing waste material is delivered to the disposal site. A copy of this waste shipment record, signed by the Manager of the designated disposal site will then, within 35 days of the initial transport date, be returned to the waste generator.

15. At the disposal site, sealed plastic bags and other containerized waste may be carefully unloaded from the truck. Rebag broken or damaged bags. Do not throw bags.

16. Retain receipts from landfill or processor for materials disposed of.

3.5. FIELD QUALITY CONTROL

A. Quality Control Requirements

1. A Testing Laboratory shall be provided by the Contractor to perform final clearance air monitoring and visual observations to document completion.

The Contractor will supply his own testing agency for personnel air monitoring.

2. The Testing Laboratory will conduct area final clearance air monitoring following removal and cleaning operations.

3. The Testing Laboratory will perform air sampling in general accordance with methods prescribed by Section 1926.1101 of OSHA CFR Title 29 and analyze the samples in general accordance with the procedures outlined by NIOSH Method #7400 for Phase Contrast Microscopy (PCM).

4. The Testing Laboratory employed by the Contractor will perform Final Air Clearance testing only following removal activities. Such testing does not relieve the Contractor of providing necessary testing required by other regulations, codes, and standards for the protection of his workers, or for any other purposes.

5. The Testing Laboratory will conduct Final Air Clearance Tests inside of work areas following removal activities, and test results will be made available to the Engineer or other designated entities. The Contractor will be responsible for performing air tests required for his evaluation of the safety of his employees.

6. A preliminary visual observation will be performed in the work areas by the Contractor when said areas have been properly cleaned. Areas will be observed for the presence of visible dust, dirt and debris.

7. Tests will be performed inside work areas after clean up, execution of final clearance monitoring and visual observation to document compliance with specifications.

8. Test results will be reported in terms of total fiber count per cubic centimeter of air (f/cc) for air samples analyzed by Phase Contrast Microscopy (PCM).

9. All air samples collected during final clean-up operations will be collected within 48 hours after completion of the final cleaning when possible.

10. A visual observation may be performed by the Engineer after cleanup to inspect for visible dust, dirt, debris and areas of damage.

11. Contractor shall perform additional cleaning of area(s) if, in the sole opinion of the Engineer, previous clean-up operations were determined to be inadequate.

12. Any area whose air test results fail will be retested following recleaning of the area(s). Contractor shall pay all costs associated with retesting.

END OF SECTION

State of Tennessee
Department of Environment and Conservation
Division of Air Pollution Control
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 15th Floor
Nashville, Tennessee 37243-1531

NOTIFICATION OF DEMOLITION AND/OR ASBESTOS RENOVATION

SUBMIT 10 WORKING DAYS PRIOR TO ACTIVITY

Email to **Asbestos.NESHAP.Program@tn.gov**

Operator Project #	Postmark	Date Received	Notification #

I. TYPE OF NOTIFICATION ☐ Original ☐ Revision ☐ Courtesy ☐ Annual ☐ Cancellation

II. FACILITY INFORMATION

Owner Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Contact: _____ Telephone: (_____) _____

Asbestos Removal Contractor: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Contact: _____ Telephone: (_____) _____

Other Contractor/Operator: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Contact: _____ Telephone: (_____) _____

III. TYPE OF OPERATION ☐ Demolition ☐ Renovation ☐ Ordered Demolition ☐ Emergency Renovation

IV. IS ASBESTOS PRESENT? ☐ Yes ☐ No **Please provide a copy of inspection report.**

V. FACILITY DESCRIPTION

Building Name: _____

Address: _____

City: _____ State: TN Zip Code: _____ County: _____

Site Location: _____

Building Size (square feet) _____ # of Floors: _____ Age in years: _____

Present Use: _____ Prior Use: _____

VI. PROCEDURE AND ANALYTICAL METHOD USED TO DETECT THE PRESENCE OF ASBESTOS MATERIAL

(Identify any consultant or inspector involved in building inspection)

VII. AMOUNT OF ASBESTOS MATERIALS:

	RACM to be Removed	Nonfriable Asbestos Material			
		To be Removed		NOT to be removed	
		Category I	Category II	Category I	Category II
Pipes (linear feet)					
Surface Area (square feet)					
Facility Components (cubic feet)					
Other					

VIII. SCHEDULED DATES FOR PREPARATION Start: _____ Complete: _____

SCHEDULED DATES FOR ASBESTOS REMOVAL Start: _____ Complete: _____

Days of the Week:	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Hours of Operation:							

IX. SCHEDULED DATES FOR DEMOLITION OR RENOVATION Start: _____ Complete: _____

Failure to notify the Division of a change in the start date (sections VIII and IX above) prior to activity may result in enforcement action.

X. DESCRIPTION OF PLANNED DEMOLITION OR RENOVATION ACTIVITIES:

XI. DESCRIPTION OF WORK PRACTICES & ENGINEERING CONTROLS TO BE USED TO PREVENT EMISSIONS OF ASBESTOS:

XII. WASTE TRANSPORTER #1

Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Contact: _____ Telephone: (_____) _____

WASTE TRANSPORTER #2

Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Contact: _____ Telephone: (_____) _____

XIII. TEMPORARY WASTE STORAGE LOCATION: _____

WASTE DISPOSAL SITE

Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Contact: _____ Telephone: (_____) _____

XIV. ORDERED DEMOLITION

1. Attach a copy of the government issued order.
2. Name of authority issuing order: _____ Title: _____
3. Date of Order: _____ Date Ordered to Begin: _____

XV. EMERGENCY RENOVATION (Attach a separate sheet with the following information.)

1. Date and Hour of the emergency.
2. Description of the Sudden, Unexpected Event
3. Explanation of how the event caused unsafe conditions, equipment damage, and/or an unreasonable financial burden.

XVI. DESCRIBE THE PROCEDURES TO BE FOLLOWED IN THE EVENT THAT UNEXPECTED RACM IS FOUND. EXPLAIN HOW NONFRIABLE ACM WILL BE REMOVED WITHOUT RENDERING IT FRIABLE (CRUMBLED, PULVERIZED, OR REDUCED TO POWDER).

XVII. I CERTIFY THAT AN INDIVIDUAL TRAINED IN ACCORDANCE WITH 40 CFR PART 61, SUBPART M WILL BE ONSITE DURING THE STRIPPING AND REMOVAL DESCRIBED BY THIS NOTIFICATION AND EVIDENCE THAT THE REQUIRED TRAINING HAS BEEN COMPLETED BY THIS PERSON WILL BE AVAILABLE FOR INSPECTION.

Printed Name of Owner or Operator: _____

Signed Name of Owner or Operator: _____ Date: _____

XVIII. I CERTIFY THAT THE ABOVE INFORMATION IS CORRECT. AS SPECIFIED IN TENNESSEE CODE ANNOTATED SECTION 39-16-702(a)(4), THIS DECLARATION IS MADE UNDER PENALTY OF PERJURY.

Printed Name of Owner or Operator: _____

Signed Name of Owner or Operator: _____ Date: _____

Submit completed form to **Asbestos.NESHAP.Program@tn.gov**. Call (615) 532-0554 with any questions.

INSTRUCTIONS

NOTIFICATION OF DEMOLITION OR ASBESTOS RENOVATION ACTIVITY (FORM CN-1055)

This form serves as a written notification of a facility demolition and/or an asbestos renovation as defined and required by 40 CFR 61.145 and Tennessee Division of Air Pollution Control Regulation 1200-03-11-.02(2)(d). This notification form is required for the following activities:

1. All demolition projects (including intentional burning). Demolition means the wrecking or taking out of any load-supporting structural member of a facility together with any related handling operations. **This form is required for a demolition project even if no asbestos is present at the site.**

2. All renovation projects that include the removal of regulated asbestos containing material (RACM) equaling or exceeding 260 linear feet on pipes, 160 square feet on facility components, or 35 cubic feet where the amount of RACM could not be measured prior to the renovation.

All demolition and renovation projects are subject to the regulations insofar as owners and operators must determine if and how much asbestos is present at the site. All information pertinent to the removal, renovation and/or demolition must be completed by the building owner/operator or designee and mailed electronically to Asbestos.NESHAP.Program@tn.gov or delivered to the following address by at least 10 working days prior to commencement of activity:

Department of Environment and Conservation
Division of Air Pollution Control
William R. Snodgrass Tennessee Tower
312 Rosa L. Parks Avenue, 15th Floor
Nashville, Tennessee 37243-1531

Holidays that fall between Monday and Friday count as "working days." Saturday and Sunday does not count as a working day.

If information contained in the original notice has changed, a notification must be revised as soon as possible after it is realized a revision is necessary. For example, you must revise the notification if you change the start date of an operation. If the change relates to the amount of material involved, you need only revise the notification if the amount changes by more than 20 percent. If you revise the start date of a project, the revised notification must be postmarked or delivered no later than the original start date, and at least 10 working days before the revised start date.

Include the following in the notice:

(I) TYPE OF NOTIFICATION: Indicate original, revision, courtesy, annual, or cancellation.

(II) FACILITY INFORMATION: Identify the owner of the facility, address, telephone number, and contact person.

ASBESTOS REMOVAL CONTRACTOR: If RACM is to be removed, identify the name, address and telephone number of the asbestos removal contractor.

OTHER CONTRACTOR/OPERATOR: Where demolition of the facility immediately follows the removal of RACM, or when no asbestos removal is required prior to demolition, identify the demolition contractor's name, address and telephone number.

(III) TYPE OF OPERATION: Demolition, Ordered Demolition, Renovation, or Emergency Renovation.

(IV) Indicate whether or not asbestos is present in the building. **Provide a copy of the inspection report.**

(V) FACILITY DESCRIPTION: Identify the building name of the facility to be renovated or demolished, the physical address including street number, street name, city, state, and county. Asbestos removal site location should include the building number, floor and room number(s). Include the building size in square feet, number of floors, age, and present and prior use of the facility.

(VI) Describe the procedure, including analytical methods, used to detect the presence of RACM, category I and category II nonfriable ACM. **If an asbestos survey was conducted, please submit a copy of it with the notification form.** Materials may be assumed to be RACM and therefore handled as such.

(VII) AMOUNT OF ASBESTOS IN WORK AREA: Indicate the approximate amount of RACM to be removed from the facility in terms of linear feet for pipes, square feet for surface area, or cubic feet if otherwise not measurable. Also, estimate the amount of Category I and Category II nonfriable ACM in the affected part of the facility that will or will not be removed during renovation or before demolition.

(VIII) SCHEDULED DATES - ASBESTOS REMOVAL: Indicate the scheduled starting and completion dates of asbestos removal work. Include dates for any other activity, such as site preparation, that would break up, dislodge, or similarly disturb asbestos material in a demolition or renovation. Planned renovation operations involving individual nonscheduled operations shall only include the beginning and ending dates of the report period. **This notification is required to be submitted at least 10 working days prior to the start date.** Circle all days when asbestos removal activities are to occur. Indicate the working hours that asbestos removal activities will be conducted (i.e., 7:00 AM – 5:00 PM).

(IX) SCHEDULED DATES – DEMOLITION: Indicate the scheduled starting and completion dates of demolition or renovation. **This notification is required to be submitted at least 10 working days prior to the start date.**

(X) Describe the planned work methods to be performed and types of machinery to be used during demolition or renovation.

(XI) Describe the work practices and engineering controls to be used to prevent emissions of asbestos during asbestos removal and waste-handling at the demolition/renovation site.

(XII) ASBESTOS WASTE TRANSPORTER: Identify the name, address, phone number and contact of the firm who will transport the asbestos material to the waste disposal site. If a second transporter is involved, also list this firm.

(XIII) ASBESTOS WASTE DISPOSAL SITE: Identify the name, location, and telephone number of the waste disposal site where the asbestos-containing waste material will be deposited.

(XIV) IF DEMOLITION ORDERED BY GOVERNMENT AGENCY: Identify the name, title, and authority of the state or local government representative who has ordered the demolition, the date that the order was issued, and the date on which the demolition was ordered to begin. A copy of the order shall be attached to the notification.

(XV) EMERGENCY RENOVATIONS: Attach a separate sheet that Indicates the date and hour that the emergency occurred. Describe the sudden, unexpected event resulting in the emergency. Explain how the event caused an unsafe condition or would cause equipment damage or an unreasonable financial burden.

(XVI) Describe the procedures to be followed in the event that unexpected RACM is found. Explain how nonfriable ACM will be removed without rendering it friable (crumbled, pulverized, or reduced to powder) during a renovation or demolition operation.

(XVII) A certification that only a person trained as required by Division Rule 1200-3-11-.02(2)(d)3(viii) will supervise the stripping and removal described by this notification.

(XVIII) The signature of the Owner/Operator and the date certifying that the notification information is correct.

RESPIRATOR TRAINING CERTIFICATION

I hereby certify that I have been trained in the use each type of respiratory protection equipment required for use on this Project. The training included the following:

1. Explanation of dangers related to misuse.
2. Instruction on putting on, fitting, testing and wearing the respirator.
3. Instruction on inspection, cleaning and maintaining respirator.
4. Instruction on emergency situations.

I further certify that I understand the use, care and inspection of the respirator and have tested and worn the unit.

Name: _____
(Please Type or Print)

Signed: _____

Date: _____

Notary: _____
(Signature)

(Submit one copy for each employee prior to starting work)

CERTIFICATE OF WORKER'S RELEASE (ASBESTOS)

DATE: _____

TO:

RE: _____
(Insert Project Name and Address)

1. In consideration of my employment by _____in connection with the removal
(Contractor)
and disposal of asbestos, or other work in asbestos-contaminated and lead-contaminated work areas, and in consideration of the sum of ONE AND NO/100 ($1.00) DOLLAR and other good and valuable consideration in hand paid, at and before the sealing and delivery of these presents, the receipt, sufficiency, and adequacy of which are hereby acknowledged, the undersigned does hereby acknowledge, warrant, represent, covenant, and agree as follows:

(a) I acknowledge and understand that I have been or will be employed in connection with the removal of, disposal of, or other work in asbestos-contaminated and lead-contaminated work areas, and I acknowledge that I have been advised of and I understand the dangers inherent in handling asbestos and breathing asbestos dust, including, but not limited to, THE FACT THAT ASBESTOS CAN CAUSE ASBESTOSIS AND IS A KNOWN CARCINOGEN AND CAN, THEREFORE, CAUSE VARIOUS TYPES OF CANCER.

(b) I acknowledge and understand that ANY CONTACT WITH ASBESTOS, WHETHER IT CAN BE SEEN OR NOT, MAY CAUSE ASBESTOSIS AND VARIOUS FORMS OF CANCER, WHICH MAY NOT SHOW UP FOR MANY YEARS, and I covenant and agree faithfully to take all precautions required of me.

_____
Signature of Worker
(as acknowledgement of reading this
Page 1 of this two-page Certificate)

(c) I knowingly assume all risks in connection with potential exposure to asbestos and I do hereby covenant not to sue, and to release and forever discharge the Engineer, Testing Laboratory or Architects and Engineers employed by the Project Engineer or Testing Laboratory and all of their directors, officers, employees, nominees, personal representatives, affiliates, successors, and assigns for, from and against any and all liability whatsoever, at common law or otherwise, except any rights which the undersigned may have under the provision of the applicable workmen's compensation laws. Except as specifically set forth herein I hereby waive and relinquish any and all claims of every nature which I now have or may have or claim to have which are in any way, directly or indirectly, related to exposure to asbestos and asbestos-containing materials.

(d) I hereby warrant and represent that I have not been disabled, laid-off, or compensated in damages or otherwise, because of the disease of asbestosis.

(e) I represent that I can read the English language, or that I have had someone read this instrument to me, and that I understand the meaning of all the provisions contained herein.

Name/SS#: _____
(Please Type or Print)

Signature _____

Signed in presence of_____

Notary _____
(Signature)

CERTIFICATE OF INVOLVEMENT IN

MEDICAL SURVEILLANCE PROGRAM (ASBESTOS)

I hereby certify that I am actively involved in the employee medical surveillance program in conformity with U. S. Department of Labor, Occupation Safety and Health Administration, Title 29 CFR Part 1926.1101.

By my signature below, I acknowledge receipt of the following documents pertaining to my physical examination(s):

1. Physicians' Written Opinion Form
2. Physical Examination Record
3. Roentgenographic Interpretation
4. Asbestos Initial Medical Questionnaire
5. Spirometer Data Record

Name of Contracting Firm: (Please Print) _____

Employee Name: (Please Print) _____

_____
Employee Signature

_____
Notary

Date:_____

STATE **OF** **TENNESSEE**

(Rev. 3-24-10) January 1, 2021

SPECIAL PROVISION

REGARDING

SCALING AND TRIMMING

The work covered by this special provision consists of scaling and trimming the existing slopes to a safe, stable condition by removing all loose spalls and rocks not firmly keyed into the slopes. Some rock in the slope may appear resistant to removal by some mechanical means. The Contractor will be required to scale and trim the existing slopes within the limits shown on the plans and as determined by the Engineer and dispose of all material removed resulting from the scaling and trimming operation.

Scaling is the removal of loose and unstable rock and debris from an existing cut slope by using manual devices such as pry-bars, removal by hand, as well as the use of hydraulic, pneumatic or other jacks, expansive grout or materials, hydraulic hammers and mechanical means using metal bars, "slushers" and "dozer tracks" which are drug across the face of a cut slope. For certain projects, some scaling techniques (i.e. dozer scaling track) may not be acceptable. Methods which are specifically disallowed for a project will be shown on the plans. If a particular scaling technique is ineffective, other scaling techniques must be employed at no additional cost to the state. Trimming is the process of removing overhangs of loose and unstable rock from a cut slope by mechanical percussion and/or blasting methods. This includes "blast scaling" and air cushion blasting. Where air cushion blasting is used, blast holes must be 2 inches or less in diameter.

The rock slopes shall be thoroughly scaled and trimmed by manual and/or mechanical means. If mechanical means prove insufficient and if directed by the engineer the slopes shall be traversed by laborers using hand tools to ensure that all potentially hazardous protrusions have been successfully removed to the satisfaction of the Engineer.

In the event the Contractor is directed to perform scaling and trimming on a slope previously approved as complete by the Engineer, the additional scaling and trimming will be measured and paid for at the contract unit price for "Scaling and Trimming". Scaling and trimming operations may require multiple scaling efforts across the slope during a project. For example, this may be required to safe up areas for other work, or where blasting will be conducted scaling may be required after blasting is complete. No additional payment shall be made for these multiple scaling efforts across the same surface

area unless the scaling operations were approved by the Engineer as complete for the project. No additional payment shall be made if the Engineer approves the scaling operations as complete for a particular step in the sequence of work if additional work may subsequently require scaling operations after future steps in the sequence of work.

The contractor is advised that since scaling and trimming operations will entail considerable hazards due to falling rock and debris, the traveling public shall be adequately protected from falling rocks and debris by installing, before scaling and trimming operations are started, temporary rockfall barriers or other devices as approved by the Engineer. The height of the temporary measures shall be a minimum of 8'-0". Traffic, personnel, equipment, and structures shall be protected from falling or blasted rock, falling debris, or other falling material caused by the work completed for this project. Temporary measures may not be required in the case of a roadway that is completely closed where there is no other equipment, personnel, traffic or structures that will be impacted by the falling rock and debris. The existing roadway outside the working area shall be protected from falling or blasted rock. These temporary measures are to be paid by the contractor and considered part of the item Scaling and Trimming. Contractor shall not be entitled to additional reimbursement for temporary measures used to protect the roadway, traffic or other structures during scaling and trimming operations. Any area (Roadway, shoulders and side slopes) that is disturbed outside of the construction area during the project shall be repaired by the contractor at his own expense in kind and quantity.

The quantity of scaling and trimming existing slopes to be paid for will be the actual area in square yards of existing slopes which have satisfactorily been scaled and trimmed, with the scaled and trimmed material being moved to the roadway level. Additional payment will also be made under Road and Drainage Excavation unclassified for the volume of material that is hauled off as a result of the scaling and trimming operations. Road and Drainage Excavation unclassified shall be paid for by the actual cubic yard of material hauled, measured by the cubic yard placed in the waste area.

The quantity of scaling and trimming existing slopes, measured as provided for above, will be paid for at the contract unit price per square yard for "Scaling and Trimming" and for Road and Drainage Excavation (Unclassified) by the cubic yard. Such price and payment will be full compensation of furnishing all labor, tools, equipment, and all incidentals necessary to complete the work, including any drilling and blasting required to scale and trim rock from the slopes and/or to break down large blocks of scaled rock to facilitate disposal of material. It shall also include the cost of protecting the traveling public, personnel, equipment and structures from falling rock and debris. This protection may include, but is not limited to temporary barriers, temporary rockfall fences, providing a cushioning layer of rock at the roadway level for energy reduction, blasting mats, draped mesh used to direct falling material, or other means to provide a barrier, energy reduction, redirection or direction of falling material so that it does not impact traffic.

Payment will be made under:

Item No.	Pay Item	Pay Unit
203-11	Scaling and Trimming	Square yard
203-01	Road and Drainage Excavation(Unclassified)	Cubic Yard

S T A T E **O F** **T E N N E S S E E**

(Rev. 08-22-11) January 1, 2021

SPECIAL PROVISION

REGARDING

COMPACTION GROUTING

DESCRIPTION OF WORK

The work to be performed under this Specification consists of grouting above the rock surface to reduce future sinkhole risk. The grouting is intended to fill voids and displace soft soils in an effort to improve the support to the upper soils and the overlying roadway structure. The work entails the injection of a low slump grout using compaction grouting equipment. The work shall consist of furnishing all labor, project control, tools, equipment, materials, and supervision necessary to carry out the work. Specifically, includes submitting, prior to mobilization, a detailed description of the planned procedures for review by the Engineer, injection of the grout as described in the Plans and Specifications, and providing experienced personnel to supervise the grouting operations.

QUALIFICATIONS

The Contractor shall submit in writing to the Engineer his qualifications to perform the work, or those of his grouting subcontractor. When a grouting subcontractor is used, this information is required for the subcontractor approval process.

Those qualifications shall include, but are not limited to, the following:

(a) Records of the Contractor's past successful experience in performing compaction grouting of soil overlying limestone or other carbonate rock. A minimum of five projects within the last five years is required. Experience with slurry grouting, penetration grouting, slab jacking or other types of grouting shall not be accepted as meeting this requirement. The documentation should include project locations, names of clients, costs, and volume of grout used.

(b) Documentation of the experience of the grouting crew members including length of employment with the Contractor, work experience, work resume, and specialized education and training history. The grouting superintendent/engineer shall have 3 years or more experience in compaction grouting in areas of carbonate rock (karst terrain). Each crew shall have no more than one trainee.

CONSTRUCTION

The work shall include the following:

(a) Submittal of a detailed description of the grouting procedure prior to equipment mobilization.

(b) Installation of steel casing to approximately 1 ft above the rock surface at each grout injection location.

(c) Injection of grout with supervision by experienced personnel.

(d) Provide a movement monitoring system of the roadway and nearby existing structures.

The Contractor shall, throughout the duration of the grouting, coordinate his work and cooperate with the Engineer. Specifically, the Contractor shall work closely with those concerned with any underground construction elements, existing or planned, which may require adjustment to the grout hole locations. The Contractor shall also provide at least one person who shall be present at the all times during casing installation and grouting who is familiar with the operations involved and will direct the work. The Contractor shall submit a schedule of all construction events and planning for review by the Engineer prior to mobilization.

MATERIALS

Cement shall be Portland cement conforming to all requirements of **Section 901.01** of the Standard Specifications.

The fine aggregate shall conform to all requirements of **Section 903.01** of the Standard Specifications. Additives to enhance flow or other performance criteria shall be permitted on approval of the Engineer.

Water shall be fresh, clean, and reasonably free of sewage, acid, alkali, salts, and organic matter.

Materials shall be properly delivered and handled to prevent the damage, contamination, and/or segregation of aggregates by proper arrangement and use of stockpiles. Cement stored on-site shall be covered to prevent dampness and contamination.

The cost of quality assurance testing of cement and aggregates shall be borne by the Contractor. Certified test reports and certificates, when required, shall be submitted to the Engineer and all other agencies and persons as he may designate.

All grout material, proportioning, mixing, transporting, and testing shall be in accordance with TDOT Standard Specifications for Road and Bridge Construction and TDOT Procedures for the Sampling, Testing, and Acceptance of Materials and Products (SOP 1-1) portland cement concrete non-structural concrete for small quantities.

EQUIPMENT

The on-site grout plant, if used, shall be designed to handle the specified materials for this type of work. The mixer shall be of the plaster and mortar type to ensure complete and uniform mixing of the materials used and shall be of sufficient capacity to continuously provide the pumping unit with mixed grout at its required pumping rate.

The grout pump shall be capable of continuously delivering the specified grout materials at a pressure of at least 600 psi. Pressure gauges shall be supplied at the pump and at the grout lead pipe. An adequate communications system shall be maintained between the grout plant, pump, and injection location so as to allow strict control of the pumping operations. A total grout pumping capacity of at least 30 cubic yards per 8 hour shift shall be provided.

Grout casing shall be steel casing of adequate strength to withstand the required pumping, drilling and/or jacking pressures. The casing shall have an inside diameter of at least 2 inches in order to handle the specified low slump material without plugging. The casing shall be installed by augering, drilling, and/or jacking in a manner that ensures that the grout pipes are free of soil and debris, and that a tight seal is made around the casing sufficient to withstand the grouting pressures. The installation of the grout casing shall be performed in such a manner as to extend the casing to the interpreted top of the bedrock at anticipated depths as shown in the Plan of Primary Grout Hole Locations in the Plans.

Grout casing pulling jacks shall be provided capable of withdrawing the steel. The Contractor shall adequately protect grout pipes from foreseeable hazards. After grouting at each grout hole location, the Contractor shall plug each hole and return the area to its original conditions.

GROUTING

The work consists of injecting 0-inch to 3-inch slump grout under pressure into the grout holes. The slump will be measured with a standard slump cone. Grouting mixes, pressures, and pumping rate shall be determined in the field by the Contractor based on existing soil conditions and reaction and approved by the Engineer.

Grout holes shall be drilled and continuously cased to the top of the rock as indicated by refusal of the drilling tools or other method acceptable to the Engineer. Adjustments to the grout hole locations may be required, upon approval by the Engineer, to avoid existing and future underground elements. Primary grout holes shall be located in a pattern as shown on the Plan of Primary Grout Hole Locations included in the Plans. Depending on field observation of the drilling and grouting operations, the Engineer may add additional intermediate secondary grout holes to the Contractor’s scope of work at the contract unit rates. A field layout of the primary

grout holes and any required secondary grout holes shall be made by the Contractor during the grouting operations and provided to the Engineer on a daily basis.

The grout mix shall be approximately 3-6 sacks of Portland cement per cubic yard of grout. The grout mix design including all proposed additives and consideration of water to be added at the site (if grout is delivered from off-site) shall be submitted to the Engineer for approval prior to mobilization. Water will be added as required to achieve a pumpable mix of not more than a 3-inch slump. Injected grout shall have an average unconfined compressive strength of not less than 1,500 psi at 28 days. If agitated continuously, the grout may be held in the grout plant for not more than 2 hours. All concrete material, proportioning, mixing, transporting, and testing shall be in accordance with *TDOT Standard Specifications for Road and Bridge Construction* and *TDOT "Procedures for the Sampling, Testing, and Acceptance of Materials and Products (SOP 1-1)"*.

GROUT INJECTION PROCEDURES

At each grout hole location, the grout casing shall be installed to refusal of the drilling equipment (as interpreted top of bedrock), then the grout casing shall be lifted approximately 1 foot. Grout shall then be pumped into the subsurface using the following limiting criteria:

- When the injection pressure at the grout casing header exceeds 400 psi, while injecting at a rate of approximately 0.25 cubic feet/minute.
- When the roadway surface elevation exceeds the design grade elevation as determined by the monitoring system.
- When the maximum quantity of grout has been injected. The maximum quantity of grout to be injected at any location shall be 8 cubic yards (not including the grout required to fill the grout hole itself) unless otherwise directed by the Engineer.
- When upward movement of nearby adjacent structures occurs as determined by the monitoring system.

The arrangement of the grouting equipment shall be so as to provide a continuous flow of grout to the injection point and to permit accurate pressure and flow rate control regardless of the magnitude of the grout take. During grouting operations, the Contractor shall take such precautions as may be necessary to prevent drill cuttings, equipment exhaust, oil, wash water, and grout from defacing or damaging adjacent structures. The Contractor shall furnish such pumps as may be necessary to handle wastewater and grout from his operations, and will clean up all waste resulting from his operations.

The Contractor shall keep records of all grouting operations, such as logs of each grout hole, time and nature and each change in grouting conditions, pressures, rates of pumping, composition of grout mix and any other data which the Engineer deems as necessary. Such records will be made available to the Engineer. Upon completion of the grouting procedures, the

Contractor will be responsible for confirming that the roadway has been restored to the degree acceptable to the Engineer.

MONITORING

A ground heave monitoring system will be provided and maintained by the Contractor. It shall be adequate to monitor key movement in the area influenced by the grouting. After the completion of the grouting program, the monitoring system shall be removed; all grout holes patched, and the surface restored as indicated in this Special Provision.

Any roadway heave in excess of 0.75 inch will require corrective action. The Tennessee Department of Transportation will determine the required repair and procure the corrective action. The cost of the corrective action will be born by the Contractor and will be deducted from any money due to the Contractor, not as a penalty, but as liquidated damages.

BASIS OF PAYMENT

The grouting work including all additions and subtractions to the scope of the pre-treatment grouting program shall be conducted on the basis of lump sum and unit rates as follows:

ITEM	UNIT
(204-05.20) Grout casing installation	(L.F.)
(604-15.20) Compaction Grout	(C.F.)

PAYMENT

The contract prices for the various specified items of work and material shall constitute full compensation for mobilizing, demobilizing, and furnishing all equipment, materials, and labor necessary to perform the advancing and casing of holes and for grouting in accordance with this Specification.

S T A T E **O F** **T E N N E S S E E**
(Rev. 2-1-02) January 1, 2021

SPECIAL PROVISION

REGARDING

EMBANKMENT (COMPACTED IN PLACE)

Description: This work shall consist of constructing roadway embankments in accordance with the Standard Specifications except as modified herein. All work shall be performed in reasonably close conformity with the lines and grades shown on the plans or as directed by the Engineer and shall include roadway excavation, the furnishing of borrow material, the preparation of the area upon which embankments are to be placed, the placing and compacting of approved material within roadway areas, removal and replacement of unsuitable material, clearing and grubbing of borrow sites, and transporting borrow material.

Materials. Materials used in the construction of embankments shall meet the requirements of Section 205 of the Standard Specifications unless otherwise specified on the plans.

Construction Requirements. Roadway excavation and embankment construction shall be performed in accordance with Section 203 and Section 205 respectively of the Standard Specifications except as modified herein.

The Contractor shall perform all excavation indicated or described in the plans or directed by the Engineer. All suitable material obtained from the roadway excavation, bridge excavation, channel excavation or other excavation may be used in the formation of embankments. All additional material required for completion of the embankments shall be furnished by the Contractor from locations approved by the Engineer.

Unsuitable material encountered in the roadway excavation will be removed and disposed of in accordance with the Standard Specifications except that the unsuitable material will be measured and paid for under Item No. 203-10, Embankment (Compacted in Place). No other material shall be removed from the project without the written consent of the Engineer except as provided for in the Plans and Specifications.

Topsoil shall be stripped and stockpiled in accordance with Subsection 203.06 of the Standard Specifications. The Engineer may at his discretion measure and pay for topsoil prior to placing and spreading, however, such payment shall not exceed 50% of the estimated volume of the stockpile.

Method of Measurement. Embankment (Compacted in Place) will be measured by the cubic yard complete in place. Final volume of Embankment (Compacted in Place) will be computed

using the average end area method and shall be based on original cross-sections taken after removal of topsoil and unsuitable material from the embankment areas and after placement of rock or other select material paid for under other items. Final cross sections will be taken on the completed embankment prior to placement of topsoil, mineral aggregate or other material which is paid separately. Boundaries of the embankment shall be the neat lines established by the slope stakes and the elevations shown on the plans or established by the Engineer. No measurement for payment will be made beyond these boundaries except as specified herein.

The centerlines, baselines or other lines shown on the Plans or established by the Engineer shall be used as reference lines for measurement of embankments. Cross-sections shall be taken from these reference lines at intervals not to exceed 50 feet.

The volume of embankment displaced by box culverts, box bridges, span bridges, pipe(s) with cumulative diameter(s) of 60" or greater and retaining walls including all structural backfill required for the structures will be deducted from the embankment quantity. Materials placed in the embankment area including but not limited to rock pads, sinkhole treatment and rock caps on subgrade which are paid for under other items will not be measured as part of the embankment.

Roadway excavation will not be measured on this project, but shall be a responsibility to be assumed by the Contractor in connection with the pay item(s) specified herein.

Basis of Payment. The amount of completed and accepted work, measured as provided for above, shall be paid for at the contract unit price bid for Embankment (Compacted in Place), which price shall be full compensation for furnishing all materials, placing and forming of embankments, all roadway excavation shown on the plans, clearing and grubbing of borrow pits, and all equipment, tools, labor, and incidentals necessary to complete the work.

Roadway excavation will not be paid for directly. The contract unit price for Embankment (Compacted in Place) shall be full compensation for all roadway excavation performed in accordance with the Plans and Specifications.

No additional payment will be made for undercutting at locations where the plans indicate undercutting is required. However, if the Engineer directs undercutting at locations not indicated on the plans, the unsuitable material removed will be measured by the cubic yard in its original location and paid for at 1.5 times the contract unit price bid for Embankment (Compacted in Place). Material used to replace unsuitable material will be measured and paid for under the appropriate contract item.

S T A T E **O F** **T E N N E S S E E**

(Rev. 5-15-17) January 1, 2021
(Rev. 4-15-19)
(Rev. 11-9-20)

SPECIAL PROVISION

REGARDING

BITUMINOUS PLANT MIX PAVEMENTS (HOT MIX)

ROADWAY DENSITY

Description

This work consists of the requirements for acceptance of asphalt roadway density by use of core samples, and for testing and acceptance of asphalt longitudinal joint density.

Meet all requirements of **407** of the Standard Specifications except as modified.

407.03.D.2.h - Contractor Quality Control System. Add the following between the second and third paragraphs:

Conduct quality control testing of surface and binder mixes for roadway density throughout placement to verify that the mixture being placed meets specified density requirements. A Quality Control Plan (QCP) for this density testing is required. Acceptable methods of quality control testing include coring, nuclear gauge testing, and non-nuclear gauge testing. Document all tests and records from the control strip (if any). Make quality control records available upon request to the Department.

407.07 - Rollers. Replace the entire subsection with the following:

Provide a sufficient number and type of self-propelled rollers to achieve proper compaction and obtain the specified densities.

407.15 - Compaction. Replace the entire subsection with the following:

A. General

After the bituminous mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly compacted. Use a method that shall be capable of compacting the mixture to the specified density while it is in a workable condition. Rollers shall not park or be refueled on the bituminous pavements.

B. Density Requirements

Meet the applicable density requirements for travel lanes and joints as specified in Table 407DEN-1 and Table 407DEN-2.

1. Mix Types: All Travel Lanes for A, B, BM, BM-2, C, CW, D, E
2. All levels of ADT
3. %Gmm values specified are for lot averages.

Table 407DEN-1

Travel Lane Density		
% Gmm		% Pay
Min	Max	
99.0	100	90
98.0	<99	94
97.0	<98	98
96.0	<97	100
95.0	<96	101
94.0	<95	102
93.0	<94	101
92.0	<93	100
91.0	<92	98
90.0	<91	94
89.0	<90	90
88.0	<89	86
	<88	*

Table 407DEN-2

Joint Density Incentive/Disincentive		
%Gmm		$/L.F./Lot
Min	Max	
98.0	100	*
97.0	<98	-0.70
96.0	<97	-0.42
95.0	<96	0.00
94.0	<95	0.00
93.0	<94	0.07
92.0	<93	0.14
91.0	<92	0.07
90.0	<91	0.00
89.0	<90	-0.14
88.0	<89	-0.42
87.0	<88	-0.70
86.0	<87	-0.98
	<86	*

*Shall be removed and replaced at no cost to the Department or as directed by the engineer.

% Pay for travel lanes shall be applied to the theoretical quantity of the mix on the travel lanes only, even when the shoulder and travel lane are placed concurrently. No incentive shall be paid for the second travel lane unless the joint for that lot is a minimum of 90.0%.

Any lot of joint density tests averaging below 87% shall be sealed at no cost to the Department. Approved sealers are listed on the Department's Qualified Products List (QPL), Listing #40 for Pavement Sealers. Sealing of deficient longitudinal joint lots will only be required for surface mixes. No incentive/disincentive shall be applied to a longitudinal joint between a travel lane and a shoulder.

Meet the applicable density requirements for shoulders as specified in Table 407DEN-3.

1. Mix Types: All shoulder mixes
2. All levels of ADT
3. %Gmm values specified are for lot averages.

Table 407DEN-3

Shoulder Density		
% Gmm		% Pay
Min	Max	
98.0	100	*
97.0	<98	96
96.0	<97	98
95.0	<96	100
94.0	<95	100
93.0	<94	100
92.0	<93	100
91.0	<92	100
90.0	<91	100
89.0	<90	100
88.0	<89	100
87.0	<88	98
86.0	<87	94
85.0	<86	90
	<85	*

* Shall be removed and replaced at no cost to the Department or as directed by the engineer.

% Pay for shoulders shall be applied to the theoretical quantity of mix on the shoulder even when the travel lane and shoulder are placed concurrently.

407.20.B.5 - Acceptance of the Mixture. Replace the entire subsection with the following:

5. Acceptance for Mix Density on the Roadway

a. General. The Department will apply a deduction in payment, not as a penalty but as liquidated damages, for failure to meet the density requirements as specified in **407.15.B**. As soon as practical after the final rolling is completed on each lot, 5 density tests (1 per sublot) shall be performed by the Department at random locations determined by the Engineer, and an average of all such tests shall be computed. Any deduction for failure to meet density requirements or incentive for exceeding density requirements shall be

computed to the nearest 0.1% as a percentage of the total payment otherwise due for each lot.

Consecutive lots with density deductions is cause to stop production as directed by the Engineer. Adjust the rolling operation and Quality Control Plan to achieve the required density. Construct a test strip of not more than 250 tons to demonstrate to the Engineer that the changes made produce densities meeting the requirement without deductions. Only resume full production after the Engineer has accepted the test strip.

b. Travel Lane, Turning Lane, Ramp or Shoulder Density. For density acceptance purposes, the pavement shall be divided into lots of 1,000 tons for surface mixes (D, E, C, and CW), 2,000 tons for intermediate mixes (B, BM, and BM2), and 3,000 tons for base mixes (A). Lots shall be divided into 5 even sublots. One core will be tested in each sublot and the average for the entire lot shall be compared with the requirements in Table 407DEN-1 for travel lanes or Table 407DEN-3 for shoulders. When possible, attention should be provided to avoid cutting cores in areas where signal/loop wire may be affected. If test location selections indicate testing locations in these areas, a new random number should be selected. At the beginning of a project or at any time advisable, the Department may consider smaller lots to evaluate compaction methods or for other reasons as approved or directed by the Engineer.

c. Joint Density. For density acceptance purposes, joints shall use the same length lot and longitudinal coring location as the last adjoining lane to be paved. The average of the 5 cores for the entire lot shall be compared with the requirements in Table 407DEN-2. At the beginning of a project or at any time advisable, the Department may consider smaller lots to evaluate compaction methods or for other reasons as approved or directed by the Engineer.

d. Test Method. Five randomly selected cores (4" min./ 6" max. diameter), from each lot, will be tested to determine density compliance and acceptance. The density (bulk specific gravity) determination for a compacted asphalt mixture shall be performed in accordance with AASHTO T-166, Method A only.

All core samples shall be COMPLETELY DRY before testing. Air drying is permitted provided core samples are weighed at 2-hour intervals until dry in accordance with AASHTO T166, Section 6.1. Cores may also be dried in accordance with ASTM D 7227.

The Bulk Specific Gravity (G_{mb}) of the cores shall be averaged for each lot.

For **lanes and shoulders** the maximum theoretical gravity (G_{mm}) from acceptance testing for that shift's production will be averaged and the percent density will be determined for compliance by dividing the G_{mb} average for each lot by the G_{mm} daily average.

For **joints** the maximum theoretical gravity (G_{mm}) from acceptance testing for both adjoining lanes shall be averaged, and the percent density will be determined for compliance by dividing the G_{mb} average for each lot by the G_{mm} daily average.

Obtain the cores at the locations randomly selected by the Engineer. The Department will test the cores by a certified plant technician.

If a lot is split between two days, determine the percent density of each individual core using the daily G_{mm} average from the day the sublot (represented by the core being tested) was paved.

After obtaining the cores, all core holes shall be properly filled and compacted in kind with hot mix asphalt at no additional cost to the Department.

Cores shall be clearly labeled in a discrete, sequential manner (i.e. – M1, M2,...,M30; J1, J2,...,J15) throughout the course of the project. After testing, cores shall be retained along with copies of test results and will be periodically obtained by regional materials and tests for spot-check verification testing. The cores may be discarded, if regional materials and tests determines that they are no longer needed for payment or dispute resolution.

e. Incentive/Disincentive Payment. The Department shall apply the incentive disincentive payment in accordance with the tables in **407.15.B**.

Any deduction in monies due the Contractor for failure to meet the density requirements shall be made under the item for Density Deduction.

Any incentive payment due the Contractor shall be under the item for Density Incentive.

STATE OF TENNESSEE

August 14, 2017
(Rev. 10-17-19)
(Rev. 11-5-21)

January 1, 2021

SPECIAL PROVISION

REGARDING

INTELLIGENT COMPACTION (IC) FOR HOT MIX ASPHALT (HMA)

Description

This work consists of the requirements for modification of standard HMA compaction equipment for the purpose of tracking and documenting location, and temperature. Compaction equipment and procedures shall meet all requirements listed in **407.07** and **407.15** except as modified herein.

Equipment

A. Rollers

Install Intelligent Compaction equipment meeting the requirements listed herein on the first (breakdown) and second (intermediate) roller in the roller train. Roller type(s) are to be as required in **Table 407.15 – Roller Requirements by Mix Type**. The IC systems may be either an integrated system or an added-on/retrofit systems.

B. Global Navigational Satellite System (GNSS)

Rollers shall be equipped with a GNSS units to monitor the equipment locations and track the number of roller passes utilizing the same reference system. GNSS system shall have a survey tolerance of not greater than 2.0 in in both the horizontal (x and y) directions.

GNSS receivers shall utilize the Universal Transverse Mercator (UTM) or Tennessee State Plane coordinate system. Once declared, the coordinate system utilized shall be the same for both rollers for the entire project.

GNSS data shall be in the following format:

1. Time: Military, local time zone, hhmmss.ss
2. GNSS: Latitude/Longitude, degrees/minutes; ddmm.mmmmmmmm or decimal degrees; dd.dddddddd
3. Grid: Meters, 0.001 m

C. Temperature Measurement

Rollers shall be equipped with non-contact temperature sensors for both the forward and reverse directions for measuring pavement surface temperatures. Temperature sensor shall be accurate to ±3°F.

D. Integrated On-Board Documentation System

An on-board documentation system that is capable of displaying real-time color-coded maps of IC data as defined under Project IC Data.

The Intelligent Compaction System shall be capable of transferring the Project IC Data by means of cellular data upload to cloud storage during the day's production.

E. Cloud Storage and Cloud Computing

Provide a system of cloud storage and cloud computing. The cloud storage shall be sufficient to contain all Project IC Data associated with the contract and accessible to the Department. The cloud computing system shall support real-time visualization/mapping of the Project IC Data. Paving operations shall not begin until real-time access is granted to the Department.

Project IC Data is to be uploaded throughout the project in real-time if data cellular coverage allows, but not less than once per day otherwise. If cellular data coverage for uploading the data at the project site is unavailable, upload the data prior to the next day's production by other means.

Provide the Department with unlimited review access to the intelligent compaction records through cloud storage and cloud computing starting from the beginning of the project paving until project finalization.

Construction Requirements

A. Project IC Data

Track and record the Project IC Data for the contract. Project IC data shall consist of:

1. Location of the roller in real time,
2. Number of roller passes at a given gridded location,
3. Pavement surface temperatures associated with each roller pass, and
4. The roller speed associated with each roller pass.

All data is to be gridded in one foot by one foot grid.

At the end of the project, provide a copy of the final Project IC Data for each pavement layer in a separate digital file to the Department formatted in the most current version of Veta. Veta is available at www.intelligentcompaction.com.

Export the raw or gridded data:

1. Directly into Veta if a file format compatible with Veta is available, or
2. Through a direct transfer of data from cloud storage to Veta.

Ensure that the date/time stamp is reflective of the local time zone for both mapped and exported data.

B. System Failure

In the event that the intelligent compaction system does not work due to failure of the system, work may continue for the day's production. The Intelligent Compaction system must be operational prior to starting the next day's production.

Notify the Engineer if real time data cannot be uploaded to cloud storage due to lack of cellular data or satellite coverage. Notification must be made each day if real time uploading of data is unavailable. In instances where the file is not uploaded in real time to the cloud storage, it must be uploaded by other means prior to the next day's paving.

File Name

Name Veta project files (*.VETAPROJ) using filenames CNXXXX_ROUTE_HMA_YYY standardized format where XXXX is replaced by the contract number (e.g. Z999), YYY is replaced with the mix type (e.g. D, BM2, TLD, etc) and ROUTE is replaced with the five character State Route or Interstate designation (e.g. SR001 or I0040).

Method of Measurement & Basis of Payment

The Department will not measure and pay for Intelligent Compaction directly, and will consider such work incidental to other items of work relating to the placement of Asphalt.

S T A T E **O F** **T E N N E S S E E**

April 4, 2011 January 1, 2021

SPECIAL PROVISION

REGARDING

ASPHALT PAVEMENT SAFETY EDGE

Description

The contractor shall attach a device to the screed of the paver such that material is confined at the end gate and extrudes the asphalt material in such a way that results in a consolidated wedge-shape pavement edge of approximately 25 to 30 degrees as it leaves the paver (measured from a line parallel to the pavement surface). The device shall maintain contact to the graded material adjacent to the pavement and must be adjustable to allow for transition to cross roads, driveways and obstructions without requiring the paver to be stopped routinely. The device shall constrain the asphalt head and increase the density of the extruded profile. To achieve desired results, rolling is not required on the wedge. The desired pavement edge angle is 30 degrees but angles as steep as 38 degrees are acceptable after the mat has been rolled for compaction.

The contractor shall use the TransTech Shoulder Wedge Maker, the Advant-Edge Edger or Ramp Champ, Carlson's Safety Edge Endgate or an equivalent device that produces the same wedge consolidation results. If the contractor uses a similar device, he must provide proof that his device has been used on previous projects with acceptable results (proof shall consist of, at a minimum, approval and endorsement of another State D.O.T. or FHWA Division). Short sections of handwork will be allowed when necessary for transitions and turnouts or otherwise authorized by the engineer. Conventional single plate strike off devices will not be allowed.

No direct payment will be made for the Safety Edge and all cost of furnishing and/or operation of this device will be included in other items.

Contact information for these wedge shape compaction devices is as follows:

1. **TransTech Systems, Inc.**
   1594 State Street
   Schenectady, NY 12304
   1-800-724-6306
   http:/www.transtechsys.com

2. **Advant-Edge Paving Equipment LLC**
   33 Old Niskayuna Road
   Loudonville, NY 12211
   Ph. 814-422-3343
   http://www.advantedgepaving.com

3. **Carlson Paving Products, Inc.**
   18425 50th Ave E, Tacoma WA 98446
   Phone (253) 875-8000 | Toll Free 1-800-216-2108 | General Fax# (253) 846-2703
   http://www.carlsonpavingproducts.com

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-01-02)
(Rev. 02-01-07)
(Rev. 10-20-07)
(Rev. 05-11-10)
(Rev. 10-8-18)

January 1, 2021

SPECIAL PROVISION

REGARDING

SECTION 411 – ASPHALTIC CONCRETE SURFACE (HOT MIX)

This provision sets up pavement smoothness requirements and how testing procedures, acceptance, and payment practices, will be handled by the Department.

Completed pavement surfaces of traffic lanes, including those on bridge deck surfaces on both the mainline and ramps between freeways that do not have stop or yield conditions shall be tested for smoothness with the Road Profiler in accordance with Department procedures.

For projects on all interstates and controlled access freeways that require the placement of BM or BM2 as a binder layer, the binder layer shall be tested for smoothness as soon as practicable after placement of the binder layer but prior to the placement of the final wearing surface. The binder layer shall have a maximum International Roughness Index (IRI) of 70 in./mi. Any lot, or fraction thereof, of the binder layer that is greater than 70 in./mi. shall be corrected prior to placement of the final surface mix. Ramps with posted speeds less than 45 MPH shall be excluded. All corrective action shall be approved by the Engineer and shall be completed at the Contractors expense including, but not limited to, grinding and asphalt leveling.

The Contractor shall be paid monies due for items in the surface mix based on the payment table below. Any lot (one mile or fraction thereof) of pavement where the Road Profiler's IRI value exceeds 80 inches per mile, as shown in the payment table below, will require corrective action. Any unacceptable lot(s) will be divided into 0.1-mile sub-lots for closer evaluation. The Contractor, at his discretion, shall choose those sub-lots, within the unacceptable lot, to correct in order to bring the overall lot into the acceptable smoothness range. However, the Contractor may not choose more than 3 sub-lots for repair, unless they are adjacent to each other and there are no more than 6 transverse joints. Otherwise, the entire lot will require corrective action. The minimum corrective action shall be the length of the entire sub-lot of 0.1 mile. The only acceptable corrective action is mill and inlay. Payment for the corrected one mile lot(s) will be based on the Road Profiler's International Roughness Index after corrective action has been taken.

Each lot of pavement will be tested by one pass of the Road Profiler. If corrective action is required, a second pass will then be made to determine the payment for the corrected lot(s).

Payment table for smoothness based on Road Profiler International Roughness Index values

SPECIFICATION			
411B			
Road Profiler Value IRI (IN/MI)	Percentage paid on bid price of surface items	Road Profiler Value IRI (IN/MI)	Percentage paid on bid price of surface items
Less than 35	110%	58	97%
35	110%	59	96%
36	109%	60	95%
37	108%	61	94%
38	107%	62	93%
39	106%	63	92%
40	105%	64	91%
41	104%	65	90%
42	103%	66	88%
43	102%	67	86%
44	101%	68	84%
45	100%	69	82%
46	100%	70	80%
47	100%	71	77%
48	100%	72	74%
49	100%	73	71%
50	100%	74	68%
51	100%	75	65%
52	100%	76	61%
53	100%	77	57%
54	100%	78	53%
55	100%	79	49%
56	99%	80	45%
57	98%	Greater than 80	Mill and Inlay*

* The mill and inlay shall be the thickness as specified on the plans for the surface layer.

S T A T E **O F** **T E N N E S S EE**

(Rev. 10-10-16) January 1, 2021
(Rev. 2-13-17)
(Rev. 10-8-18)
(Rev. 2-11-19)
(Rev. 10-12-20)
(Rev. 12-21-21)

SPECIAL PROVISION

REGARDING

ASPHALTIC CONCRETE SURFACE (HOT MIX)

This provision sets up pavement smoothness requirements and how testing procedures, acceptance, and payment practices will be handled by the Department.

Completed pavement surfaces of traffic lanes, including those on bridge deck surfaces on both the mainline and ramps with stop or yield conditions shall be tested for smoothness with the Road Profiler in accordance with Department procedures.

The Contractor shall be paid monies due for items in the surface mix based on the applicable payment table. Any lot (1 mile or fraction thereof) of pavement where the Road Profiler's International Roughness Index (IRI) value exceeds the maximum limit or does not provide at least the minimum percent improvement, as shown in the applicable payment tables, will require corrective action. Any unacceptable lot(s) will be divided into 0.1-mile sub-lots for closer evaluation. Choose those sub-lots, within the unacceptable lot, to correct in order to bring the overall lot into the acceptable smoothness range. However, do not choose more than 3 sub-lots for repair, unless they are adjacent to each other and there are no more than 6 transverse joints. Otherwise, the entire lot will require corrective action. The minimum corrective action shall be the length of the entire sub-lot of 0.1 mile. The only acceptable corrective action is mill and inlay. Payment for the corrected 1 mile lot(s) will be based on the Road Profiler's International Roughness Index after corrective action has been taken.

Each lot of pavement will be tested by one pass of the Road Profiler. If corrective action is required, a second pass will then be made to determine the pay adjustments for the corrected lot(s).

Roadway sections excluded from this provision will be identified in the project documents. Any excluded sections of roadway must comply with the straightedge requirements specified in **411.08** of the Standard Specifications.

Any deduction in monies due the Contractor for ride quality shall be made in accordance with this provision under the item for Rideability Deduction.

Payment tables for smoothness based on Road Profiler IRI values are as follows:

Table 411C-1 will apply to lots of surface mixtures that are greater than or equal to 1 inch in thickness that either receive more than one lift of surface mixture and/or lots of single lifts with an initial IRI less than 90 in/mi. Table 411C-1 will also apply to all lots of any thickness that are milled prior to overlay with an initial IRI less than 110 in/mi.

Table 411C-2 will apply to lots of surface mixtures that are greater than or equal to 1 inch in thickness that are single lift with an initial IRI greater than or equal to 90 in/mi. Table 2 will also apply to all lots of any thickness that are milled prior to overlay with an initial IRI greater than or equal to 110 in/mi.

Table 411C-3 will apply to lots of surface mixtures that are less than 1 inch in thickness that are a single lift with an initial IRI less than 90 in/mi and have not been milled prior to placement.

Table 411C-4 will apply to lots of surface mixtures that are less than 1 inch in thickness that are a single lift with an initial IRI greater than or equal to 90 in/mi and have not been milled prior to placement.

Cape Seal projects (i.e. chip seal/scrub seals, microsurface, that are covered by less than 1 inch of surface mixture) will follow Table 411C-3 or Table 411C-4 based on the initial IRI.

Thin lift surface mixtures placed on top of new construction, full depth recycled pavement, hot in-place or cold recycled pavement shall meet the requirements of Table 411C-1 and Table 411C-2.

For the purpose of this provision, placement of any mixture for spot leveling, cape seals, or microsurface will not be considered a lift of mixture to improve smoothness.

Table 411C-1

Road Profiler Value IRI (IN/MI)	Percentage paid on bid price of surface items
65 or less	100%
66	99%
67	98%
68	97%
69	96%
70	95%
71	94%
72	93%
73	92%
74	91%
75	90%
76	88%
77	86%
78	84%
79	82%
80	80%
81	77%
82	74%
83	71%
84	68%
85	65%
86	61%
87	57%
88	53%
89	49%
90	45%
Greater than 90	Mill & Inlay*

Table 411C-2

Percent Improvement % **	Percentage paid on bid price of surface items
30 or more	100%
29	99%
28	98%
27	97%
26	96%
25	95%
24	94%
23	93%
22	92%
21	91%
20	90%
19	88%
18	86%
17	84%
16	82%
15	80%
Less than 15	Mill and Inlay*

Table 411C-3

Road Profiler Value IRI (IN/MI)	Percentage paid on bid price of surface items
75 or less	100%
76	99%
77	98%
78	97%
79	96%
80	95%
81	94%
82	93%
83	92%
84	91%
85	90%
86	88%
87	86%
88	84%
89	82%
90	80%
Greater than 90	Mill & Inlay*

Table 411C-4

Percent Improvement % **	Percentage paid on bid price of surface items
15 or more	100%
14	99%
13	98%
12	97%
11	96%
10	95%
9	94%
8	93%
7	92%
6	91%
5	90%
4	88%
3	86%
2	84%
1	82%
0	80%
Less than 0	Mill & Inlay*

*The mill and inlay shall be the thickness as specified on the plans for the surface layer

**% Improvement $= \frac{(\text{Initial IRI - Final IRI})}{\text{Initial IRI}} \times 100$

S T A T E **O F** **T E N N E S S E E**

(Rev. 02-03-15) January 1, 2021
(Rev. 10-19-15)
(Rev. 6-21-21)

SPECIAL PROVISION

REGARDING

FULL DEPTH AND PARTIAL DEPTH CONCRETE PAVEMENT REPAIR

Description

This work shall consist of performing full depth or partial depth concrete pavement repair in reasonably close conformity with the design set out on the plans or established by the Engineer. The standard specification **501** shall apply except as revised.

Materials

Coarse aggregate shall be crushed stone, crushed slag, or washed gravel meeting the requirements of **903.03** and the grading requirements of **903.22** for size #57 aggregate; all other materials shall conform to **501.02**.

Chemical admixtures shall meet the requirements of **921.06** and be approved by the Department.

Partial Depth patching material shall be a concrete mixture meeting the requirements below or an approved non-shrink grout or epoxy concrete from the Department's Qualified Products List (QPL).

Dowel bars and tie bars shall be epoxy coated in accordance with ASTM D 3963, **907.02**, and listed on the Department's QPL. The bar sizes shall be determined from the Standard Drawings. Epoxy used to adhere dowel and tie bars shall be approved by the Department.

A. Proportioning

A workable concrete mix utilizing size Type I cement, #57 aggregate and natural sand conforming to **501.02**, and having a slump not greater than 2 1/2 inches shall be required. The slump may be increased to a maximum of 6 inches when using an approved high range admixture. The mixture shall have a maximum water to cement ratio of 0.40 including admixtures. The percentage of air entrained in the mix shall be five percent, with a tolerance of plus three or minus two percentage points.

The mixture shall have a minimum compressive strength of 2000 psi within 8 hours. Obtain the minimum compressive strength prior to opening the pavement to traffic.

B. Sampling and Testing

The concrete shall be tested in accordance with **501**. Prior to the start of the project and before any concrete is placed, batch, and mix a one-cubic yard trial batch of mix. The trial batch shall be made using the same equipment and procedures as is to be used on the project. The Department will test the trial batch for slump and air content and test cylinders shall be made. A minimum strength of 2000 psi in 8 hours shall be required on the test cylinders. If the trial batch does not produce the required results, adjustments shall be made by the Engineer and a new trial batch shall be required. During the progress of the work, if the Engineer deems necessary, additional trial batches may be required. No direct payment will be made for the trial batching.

The Engineer will perform tests for slump and air content as often as deemed necessary to maintain uniform, quality concrete.

C. Acceptance

The concrete shall be tested and accepted in accordance with **501** and Standard Operating Procedure 1-1. Perform quality control tests for slump and air content as often as deemed necessary to maintain uniform, quality concrete.

Equipment

Equipment and tools necessary for handling materials and performing all parts of the work shall conform to **501.04**.

Construction Requirements

The construction shall conform to the requirements of **501** in so far as the requirements do not conflict with the requirements herein specified or unless otherwise directed by the Engineer.

Full depth and partial depth concrete pavement repair shall be performed as shown on the plans. If the depth of the partial depth concrete pavement repair (Spall Repair) exceeds one third of the slab thickness, the pavement area to be repaired shall be removed and replaced full depth, to the dimensions shown on the plans for Concrete Pavement Replacement, or as directed by the Engineer.

A. Sawing

The perimeter of full depth concrete repairs shall be sawed full-depth prior to lifting. The non-joint perimeter of partial-depth concrete repairs shall be sawed at least 2 inches below the surface prior to removal.

B. Removal

Full depth repair slabs or portions of slabs shall be removed by lifting, unless the slab is deteriorated such that lifting is not possible. An adequate lifting machine will be required to minimize damage to the sub-base. Any soft base material shall be removed and replaced with specified materials and methods. All loose base material shall be compacted. The method of removal shall not spall or damage any existing concrete pavement.

For partial depth repairs, the area adjacent to the spall area shall be sounded to determine the limits of partial depth repair. The hammer for chipping shall be a maximum of 30 lbs. Lighter, 15 lb hammers are preferable for better depth control.

The exposed faces of concrete shall be sandblasted free of loose particles, oil, dust, traces of asphaltic concrete and other contaminants before placing patching materials.

The sandblasted faces shall be airblasted using clean dry, oil-free air at a minimum of 2.6 CY per minute and at least 90 PSI nozzle pressure.

Patching material for partial depth repairs may be mixed on site in small mobile drums or paddle mixers. Follow all manufacturer recommendations for proprietary materials.

C. Joints

For partial-depth repair, an approved compressible insert shall be placed in joints to ensure that concrete does not span the joint. The insert must extend at least 1 inch below the bottom of the patch and at least 3 inches beyond the patch limits. Sawing the joint shall be completed, as needed, to allow installation.

Joints shall be constructed for full depth repair and shall conform to **501.15**. Dowel and tie bar holes shall be drilled in the locations shown on the Plans or reference drawings. After drilling, the hole shall be cleaned either pneumatically or with a wire brush. A sufficient amount of epoxy shall be inserted at the back of the drill hole and the bar inserted with a twisting motion to assure uniform distribution of epoxy. Excess epoxy shall be removed.

D. Finishing and Curing

After vibrating the concrete in place, the full depth patch shall be finished using a vibratory screed parallel to the centerline such that it meets the existing grade and profile.

Final surface texture shall match the surrounding pavement unless grinding is planned.

Curing shall be completed in accordance with **501.18.C**.

Partial depth repairs shall be vibrated, without dragging the vibrator, to eliminate voids. Finishing shall progress from the center outwards to the edges.

E. Opening to Traffic

Traffic shall not be allowed on the newly placed concrete until a test cylinder break of at least 2000 psi is attained.

F. Sealing Joints

After the patch has gained sufficient strength, clean, saw, and seal the joints according **501.20** and manufacturer's recommendations.

Unsatisfactory Work

Repaired areas which do not produce a relatively smooth riding surface, show excessive shrinkage, cracking, do not produce an adequate bond to the adjacent slab or is lower than existing grade and profile shall be removed and replaced at no additional cost to the Department.

Repaired areas which do not produce a relatively smooth riding surface and are higher than existing grade and profile may have corrective grinding performed with equipment meeting **604.27.C** at no additional cost to the Department.

Method of Measurement

The Department will measure Full Depth Portland Cement Concrete Pavement Repair by the cubic yard in accordance with **109**.

The Department will measure Partial Depth Portland Cement Concrete Pavement Repair (Spall Repair) by the square yard in accordance with Section **109**.

Spall Repair areas that the depth of the repair exceeds one third of the slab thickness will become a full depth repair area and shall only be measured by the cubic yard as Full Depth Portland Cement Concrete Pavement Repair.

The Department will measure Sawing Concrete Pavement (Full Depth) by the linear foot.

The Department will measure Load Transfer Dowels and the Transverse Dowel Bars by each installed.

No measurement for payment will be made for removing and disposing of the existing Portland cement concrete pavement, for removing and disposing of soft base material, drilling holes, grouting, joint materials, etc., required in conjunction with the specified concrete pavement repair; and the cost for this work shall be included in the price bid for other items.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

502-03.20	FULL DEPTH PCC PAVEMENT REPAIR	C.Y.
502-03.21	PARTIAL DEPTH PCC PAVEMENT REPAIR	S.Y.
502-04.01	SAWING CONCRETE PAVEMENT (FULL DEPTH)	L.F.
502-04.02	LOAD TRANSFER DOWELS	EACH
502-04.03	TRANSVERSE DOWEL BARS	EACH

Such payments will be full compensation for performing all operations, furnishing all materials, equipment, tools, labor, and incidentals necessary to complete the work.

S T A T E **O F** **T E N N E S S E E**

(Rev. 09-30-2015) January 1, 2021
(Rev. 10-19-2015)
(Rev. 6-21-21)

SPECIAL PROVISION

REGARDING

FULL DEPTH AND PARTIAL DEPTH CONCRETE PAVEMENT REPAIR

(CLASS X-HIGH EARLY STRENGTH)

Description

This work shall consist of performing full depth or partial depth concrete pavement repair in reasonably close conformity with the design set out on the plans or established by the Engineer. The standard specification **501** shall apply except as revised.

Materials

Coarse aggregate shall be crushed stone, crushed slag, or crushed gravel meeting the requirements of **903.03** and the grading requirements of **903.22** for size #57 aggregate; all other materials shall conform to **501.02**.

The cement used in this construction shall be a Type I, Type III, or a rapid setting cement listed on the Department's Producer List.

Chemical admixtures shall meet the requirements of **921.06** and be approved by the Department.

Partial Depth patching material shall be a concrete mixture meeting the requirements below or an approved non-shrink grout or epoxy concrete from the Department's Qualified Products List (QPL).

Dowel bars and tie bars shall be epoxy coated in accordance with ASTM D 3963, **907.02**, and listed on the Department's QPL. The bar sizes shall be determined from the Standard Drawings. Epoxy used to adhere dowel and tie bars shall be approved by the Department.

A. Proportioning

A workable concrete mix with a minimum 28 day compressive strength of 3000 psi. The concrete mix will utilize an approved cement, #57 aggregate and natural sand conforming to **501.02**, and having a slump not greater than 2 inches shall be required. The slump may be increased to a maximum of 6 inches when using an approved high range admixture. The mixture shall have a maximum water to cement ratio of 0.40 including admixtures. The

percentage of air entrained in the mix shall be five percent, with a tolerance of plus three or minus two percentage points.

The mixture shall have a minimum compressive strength of 2500 psi within 6 hours. However, the time frame of 6 hours may be reduced depending on the mode of operation. Submit to the Engineer in writing the time frame in which the minimum compressive strength will be attained. Obtain the minimum compressive strength prior to opening the pavement to traffic.

B. Sampling and Testing

The concrete shall be tested in accordance with **501**. Prior to the start of the project and before any concrete is placed, batch, and mix a one-cubic yard trial batch of mix. The trial batch shall be made using the same equipment and procedures as is to be used on the project. The Department will test the trial batch for slump and air content and test cylinders shall be made. A minimum strength of 2500 psi within the designated time frame shall be required on the test cylinders. If the trial batch does not produce the required results, adjustments shall be made by the Engineer and a new trial batch shall be required. During the progress of the work, if the Engineer deems necessary, additional trial batches may be required. No direct payment will be made for the trial batching.

The Engineer will perform tests for slump and air content as often as deemed necessary to maintain uniform, quality concrete.

C. Acceptance

The concrete shall be tested and accepted in accordance with **501** and Standard Operating Procedure 1-1. Perform quality control tests for slump and air content as often as deemed necessary to maintain uniform, quality concrete.

Equipment

Equipment and tools necessary for handling materials and performing all parts of the work shall conform to **501.04.**

Construction Requirements

The construction shall conform to the requirements of **501** in so far as the requirements do not conflict with the requirements herein specified unless otherwise directed by the Engineer.

Full depth and partial depth concrete pavement repair shall be performed as shown on the plans. If the depth of partial depth concrete pavement repair (Spall Repair) exceeds one third of the slab thickness, the pavement area to be repaired shall be removed and replaced full depth, to the dimensions shown on the plans for Concrete Pavement Replacement, or as directed by the Engineer.

A. Sawing

The perimeter of full depth concrete repairs shall be sawed full-depth prior to lifting. The non-joint perimeter of partial-depth concrete repairs shall be sawed at least 2 inches below the surface prior to removal.

B. Removal

Full depth repair slabs or portions of slabs shall be removed by lifting, unless the slab is deteriorated such that lifting is not possible. An adequate lifting machine will be required to minimize damage to the sub-base. Any soft base material shall be removed and replaced with specified materials and methods. All loose base material shall be compacted. The method of removal shall not spall or damage any existing concrete pavement.

For partial depth repairs, the area adjacent to the spall area shall be sounded to determine the limits of partial depth repair. The hammer for chipping shall be a maximum of 30 lbs. Lighter, 15 lb hammers are preferable for better depth control.

The exposed faces of concrete shall be sandblasted free of loose particles, oil, dust, traces of asphaltic concrete and other contaminants before placing patching materials.

The sandblasted faces shall be airblasted using clean dry, oil-free air at a minimum of 2.6 CY per minute and at least 90 PSI nozzle pressure.

Patching material for partial depth repairs may be mixed on site in small mobile drums or paddle mixers. Follow all manufacturer recommendations for proprietary materials.

C. Joints

For partial-depth repair, an approved compressible insert shall be placed in joints to ensure that concrete does not span the joint. The insert must extend at least 1 inch below the bottom of the patch and at least 3 inches beyond the patch limits. Sawing the joint shall be completed, as needed, to allow installation.

Joints shall be constructed for full depth repair and shall conform to **501.15**. Dowel and tie bar holes shall be drilled in the locations shown on the Plans or reference drawings. After drilling, the hole shall be cleaned either pneumatically or with a wire brush. A sufficient amount of epoxy shall be inserted at the back of the drill hole and the bar inserted with a twisting motion to assure uniform distribution of epoxy. Excess epoxy shall be removed.

D. Finishing and Curing

After vibrating the concrete in place, the full depth patch shall be finished using a vibratory screed parallel to the centerline such that it meets the existing grade and profile.

Final surface texture shall match the surrounding pavement unless grinding is planned.

Curing shall be completed in accordance with **501.18.C.**

Partial depth repairs shall be vibrated, without dragging the vibrator, to eliminate voids. Finishing shall progress from the center outwards to the edges.

E. Opening to Traffic

Traffic shall not be allowed on the newly placed concrete until a test cylinder break of at least 2500 psi is attained.

F. Sealing Joints

After the patch has gained sufficient strength, clean, saw, and seal the joints according **501.20** and manufacturer's recommendations.

Unsatisfactory Work

Repaired areas which do not produce a relatively smooth riding surface, show excessive shrinkage, cracking, do not produce an adequate bond to the adjacent slab or is lower than existing grade and profile shall be removed and replaced at no additional cost to the Department.

Repaired areas which do not produce a relatively smooth riding surface and are higher than existing grade and profile may have corrective grinding performed with equipment meeting **604.27.C** at no additional cost to the Department.

Method of Measurement

The Department will measure Full Depth Portland Cement Concrete Pavement Repair by the cubic yard in accordance with **109**.

The Department will measure Partial Depth Portland Cement Concrete Pavement Repair (Spall Repair) by the square yard in accordance with Section **109**.

Spall Repair areas that the depth of repair exceeds one third of the slab thickness will be become a full depth repair area and shall only be measured by the cubic yard as Full Depth Portland Cement Concrete Pavement Repair

The Department will measure Sawing Concrete Pavement (Full Depth) by the linear foot.

The Department will measure Load Transfer Dowels and the Transverse Dowel Bars by each installed.

No measurement for payment will be made for removing and disposing of the existing Portland cement concrete pavement, for removing and disposing of soft base material, drilling holes, grouting, joint materials, etc., required in conjunction with the specified concrete pavement repair; and the cost for this work shall be included in the price bid for other items.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
502-03.25	FULL DEPTH PCC PAVEMENT REPAIR HIGH EARLY	C.Y.
502-03.26	PARTIAL DEPTH PCC PAVEMENT REPAIR HIGH EARLY	S.Y.
502-04.01	SAWING CONCRETE PAVEMENT (FULL DEPTH)	L.F.
502-04.02	LOAD TRANSFER DOWELS	EACH
502-04.03	TRANSVERSE DOWEL BARS	EACH

Such payments will be full compensation for performing all operations, furnishing all materials, equipment, tools, labor, and incidentals necessary to complete the work.

STATE **OF** **TENNESSEE**

(Rev. 12-13-16)
(Rev. 12-16-19)
(Rev. 3-4-22)

January 1, 2021

SPECIAL PROVISION

REGARDING

HOT APPLIED FIBER REINFORCED POLYMER PATCHING MATERIAL

Description

This work consists of furnishing, installing, all labor, material, and equipment necessary to repair spalled areas, potholes, joints, and large cracks (> 1 inch wide) on concrete pavements using a Hot Applied Fiber Reinforced Polymer Patching Material, bulking aggregates, and surface coarse aggregates as specified below.

Definitions

For the purposes of this specification, the following definitions apply:

- Binder - the thermal setting material that is the basis of the patching material, and to which any fillers, fibers, or other components are added.
- Patching material - the binder and other additives, mixed together, and in the form that will be applied to the patch, and shall not include bulking aggregate or final surface aggregate.
- Bulking aggregate - additional aggregate applied to the patch after the patching material has been applied for patches greater than 1 inch deep, and shall not include final surface aggregate.
- Final Surface Aggregate - aggregate applied to the surface of the patch to provide friction and protection

Material

Provide a hot applied patching material consisting of a combination of resin binder, polymers, graded fillers, aggregates, fibers, and rubber that once heated provides an impermeable, void less solid mass at ambient temperatures. Formulate the patching material according to climatic conditions to provide a durable pavement repair with good fluidity at process temperature, low temperature flexibility, and ambient temperature flow resistance.

The patching material shall be a product on the Department's Qualified Products List 13, Section B: QPL.13.010 - Elastomeric Patching Material Hot Applied. The material used shall be gray in color.

Bulking Aggregate

Provide **single sized** bulking aggregate consisting of a crushed, double washed, and dried granite. The size shall be from 5/8 to 7/8 inches determined through sieve analysis and shall not include any final surface aggregate.

Final Surface Aggregate

Final surface aggregate shall be crushed; double washed, and dried granite or Bauxite. The size shall meet the following gradation:

No. 4 Sieve Size	100% Passing
No. 16 Sieve Size	5% max Passing

Equipment

Provide all necessary equipment for satisfactory completion of the work including restoration of the site. Application equipment shall be certified by the material manufacturer.

Construction Requirements

1. Place the patching material installation to encompass the damaged or spalled areas as shown on the plans, or as directed by the engineer, with adjustments to the depth and width of the repairs as directed.
2. Saw cut around or mill the repair area and remove all loose and damaged pavements.
3. Remove material from the repair area to a depth and width which will allow proper seating of the patching material. (Minimum ¾ inch depth)
4. Remove all loose and damaged material from the repair area, either by saw cutting around the area and using a jackhammer to remove material, or by using a milling machine, as directed.
5. Remove material from the repair area to a depth and width necessary to provide sound pavement that will allow proper seating of the patching material.
6. If using a jackhammer, use an approved jackhammer capable of performing the required removal of the existing material without further damaging the surrounding pavement. Use a jackhammer no larger than 30 pounds unless approved by the Engineer.
7. Thoroughly clean and dry substrate faces using a hot-compressed air lance.
8. Prime the area using a primer determined by the manufacturer.
9. Allow the primer to completely dry before applying patching materials.
10. Mix and heat the patching material to 300°F – 360°F on site in a mixing unit equipped with electronically controlled thermostats in accordance with the manufacture's requirements.
11. Heat the bulking and final surface aggregates to ensure no moisture is present using a wheelbarrow or other approved container that will withstand the heat applied.
12. Apply the patching material to the repair area. If the repair area is deeper than 1 in., add bulking aggregate at a rate of 20%–40% by volume after placing the patching material.
13. Install additional patching material and bulking aggregate in 1 – 2 1/2 inch lifts until the repair is 1/2 inch or less below the existing pavement
14. The final lift shall be ¾ to 1 inch depending on the manufacture's requirements. Apply a final coat of the heated patching material to level the repair area.

15. Dress the surface of the patch with heated final surface aggregate. Perform this operation while the patch is still hot.
16. Sweep the area and remove all debris from the site.
17. Do not allow traffic over the material until after it has cooled to the point that it does not permanently deform under pressure, as recommended by the manufacturer, or as directed.

Traffic Control

Traffic control shall be completed in accordance with the plans and/or contract documents. All traffic control operations shall apply with the MUTCD at a minimum. Any changes must be approved by the engineer.

Method of Measurement

The Department will measure hot applied fiber reinforced polymer patching material by the pound of resin binder used, including primer, resin binder, bulking aggregate, and final surface aggregate.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract price as follows:

Item No.	Description	Unit
502-03.05	HOT APPLIED FIBER-POLYMER PATCHING MATERIAL	POUND

Such payment for the pound measurement of resin binder used shall be full compensation for primer, resin binder, bulking aggregate, final surface aggregate, labor, equipment, saw cutting, milling, removal and disposal of existing pavement material, and all incidental work and material.

S T A T E **O F** **T E N N E S S E E**

(Rev. 12-1-01) January 1, 2021

SPECIAL PROVISION

REGARDING

CLEANING AND RESEALING TRANSVERSE AND

LONGITUDINAL JOINTS AND RANDOM CRACKS

Description. This work shall consist of cleaning and resealing existing transverse and longitudinal joints and random cracks in portland cement concrete pavement, and joints between portland cement concrete pavement and asphaltic concrete pavement.

Materials. Material used to seal joints shall conform to the requirements of Subsection 905.05.

Equipment. All equipment necessary for the satisfactory performance of this construction shall be on the job and approved by the Engineer before work will be permitted to begin.

Joint Sealants shall be placed with equipment recommended by the sealant manufacturer. The equipment shall be capable of maintaining a uniform, homogeneous, mixture throughout the sealing operation.

Construction Requirements. Unless otherwise specified on the Plans, the longitudinal joints between Portland cement pavement and asphaltic pavement shall be prepared by sawing, or other approved method, so that an opening one inch wide by one inch deep measured from the lowest elevation is formed. Shoulder joints shall be filled full depth.

Pavement joints shall be re-sawed to the dimensions shown on the plans or as directed by the Engineer. Both sides of the joint shall be sawed in order to be thoroughly cleaned of all oil, grease, old sealant and all other foreign material. The faces of all sawed joints shall be sandblasted so that the sealant will adhere to the side of the joint. The sand shall be clean, sharp and have 100 percent passing the 2.0 millimeter (No. 10) sieve. The nozzle pressure shall be such that the joints will be cleaned out and the edges will have etched surfaces. Sandblasting and cleaning shall be done immediately prior to sealing, to assure proper preparation. Joints shall be dry before sealing.

Random Cracks shall be routed or chipped to the dimensions shown on the plans or as directed by the Engineer and shall be cleaned of all foreign material as specified above for joints.

The sealant shall be applied so that it flows into the joint without overlapping onto the concrete pavement. All sealant which overlaps onto the concrete pavement shall be removed by the contractor at his expense.

Hot poured sealant applied at other than the shoulder joint shall be placed to a depth as shown on plans after the bond breaker media has been placed to provide the proper shape factor. The sealant shall be applied in accordance with the manufacturer's recommendations and a primer shall be furnished and applied prior to sealing if so indicated in the recommendation. Any sealant spilled on the concrete shall be promptly removed.

The silicone sealant and backer rod shall be applied as shown on the plans and in accordance with the manufacturer's recommendations except as modified hereafter. The thickness of the silicone material measured from the highest point of the backer rod to the lowest point in the trough formed by the silicone material shall be as dimensioned on the plans within a tolerance of plus or minus 2 millimeters (1/16 inch). The application of primer shall be required if it is included in the manufacturer's recommendations.

Method of Measurement. Resealing Joints and Resealing Random Cracks will be measured by the meter (linear foot) along the surface of the joint or crack. No measurement of width or depth will be made.

Basis of Payment. Payment for Resealing Joints and Resealing Cracks shall be full compensation for the item complete in place, including sawing, cleaning, furnishing and installing all materials and all incidentals of the work. No additional payment will be made for irregular joint and crack widths or depths.

S T A T E **O F** **T E N N E S S E E**

(Rev 10-11-21) January 1, 2021

SPECIAL PROVISION

REGARDING

GRINDING CONCRETE PAVEMENT

Description

The work consists of grinding Portland Cement Concrete Pavement to eliminate joint faulting and/or to restore proper drainage, riding characteristics and skid resistance to the pavement surface. The work shall be accomplished in accordance with these Specifications and in reasonably close conformity to the details on the Plans.

Equipment

The grinding equipment shall be a power driven, self-propelled machine that is specifically designed to smooth and texture Portland Cement Concrete Pavement with diamond blades. The effective wheelbase of the machine shall not be less than 12.0 feet. The equipment shall be of a size that will cut or plane at least 3.0 feet wide. It shall also be of a shape and dimension that does not encroach on traffic movement outside of the Work area. The equipment shall be capable of grinding the surface without causing spalls at cracks, joints, or other locations.

Alternate equipment use may be requested in writing in accordance with **105.17**.

Construction Requirements

The Plans will designate the areas of concrete pavement surfaces to be ground. Grinding of bridge decks and roadway shoulders will not be required unless indicated on the Plans or required to improve drainage.

The work shall be scheduled and proceed in a manner that produces a uniform finished surface. Grinding will be accomplished in a manner that eliminates joint or crack faults while providing positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane. Auxiliary or ramp lane grinding shall transition as required from the mainline edge to provide positive drainage and acceptable riding surface. The entire area designated on the Plans shall be ground until the pavement surfaces of adjacent sides of transverse joints and cracks are in the same plane. The work shall result in pavement that conforms to the typical cross-section requirements, the faulting at joints and cracks should be eliminated, the rideability shall be within the limits specified, and the pavement surface shall be textured except that extra depth grinding to eliminate minor depressions in order to provide texturing for 100 percent of the pavement surface will not be required.

Establish a positive means for removing grinding and grooving residue. Remove solid residue from pavement surface during the grinding or grooving operations. Do not allow residue to flow across lanes used by public traffic, into gutters or drainage facilities. Dispose of residue in a manner that will prevent residue, whether in solid or slurry form, from reaching any waterway in a concentrated state.

Final Surface Finish

The grinding process shall produce a pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. The line type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy type appearance. The peaks of the ridges shall be approximately 1/16 inch higher than the bottoms of the grooves with approximately 50 to 52 evenly spaced grooves per foot for pavements constructed with limestone coarse aggregate and 53 to 57 evenly spaced grooves for pavements constructed with aggregate other than limestone. Grinding chip thickness shall be a minimum of 0.100 inches thick for pavements constructed with limestone coarse aggregate and a minimum of 0.080 inches thick for pavements constructed with coarse aggregate other than limestone.

The Department will conduct rideability testing using a roadway profiler to provide an International Roughness Index (IRI). Testing will be performed on each lane for mainline, auxiliary lanes, and all ramps.

To determine pavement rideability, the Department will evaluate the pavement using 0.1-mile Mean IRI (MRI) sections for overall roughness and IRI for individual continuous 25-foot sections for localized roughness in each wheel path. Mean IRI (MRI) shall be the average of each wheel path. Each 0.1-mile section will be considered a lot. IRI data will be calculated per ASTM E 1926. Each lot shall have a maximum Mean IRI value of 100 inches per mile. No individual continuous 25-foot section shall exceed an IRI of 220 inches per mile in either wheel path.

Perform corrective action to reduce the Mean IRI for each lot or IRI for any individual continuous 25-foot section that fails to meet the requirements specified. No more than 0.25 inches (two grinding passes) of material shall be removed by corrective diamond grinding without approval of the Engineer.

A grinding strategy plan is required before any corrective action begins. Submit a copy of the grinding plan to the Engineer at least 5 days prior to starting any work. After Corrective action is complete, the Department will retest and evaluate the pavement.

Grinding along the inside edge of the existing pavement shall conform to the straightedge requirements.

Transverse joints and random cracks shall be visually inspected to ensure that adjacent surfaces are in the same plane. Misalignment of the planes of the surfaces on adjacent sides of the joints or cracks which is in excess of 1/16 shall be ground until the surfaces are flush.

The transverse slope of the pavement shall be uniform to a degree that no depressions or misalignment of slope greater than 1/4 inch in 12 feet are present when tested with a straightedge placed perpendicular to the centerline. Straightedge requirements do not apply across longitudinal joints or outside of areas ground.

Measurement

The Department will measure Grinding Concrete Pavement by the square yard. Only the ground portion will be measured for payment.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
503-01	Grinding Concrete Pavement	Square Yard

Such payment shall be full compensation for furnishing all labor, materials, tools, equipment, and incidentals to complete the work

S T A T E **O F** **T E N N E S S E E**

January 1, 2021

SPECIAL PROVISION

REGARDING

DOWEL BAR RETROFITTING

DESCRIPTION

The work consists of installing epoxy coated 1-1/2 inch diameter by 18 inch long plain round dowel bars into existing concrete pavement. The existing Portland Cement Concrete pavement shall be slotted and the dowel bars shall be retrofit across pavement cracks and/or joints.

MATERIALS (See Standard Specifications for other details)

Dowel bars, including the ends, shall be epoxy coated. The dowel bars shall also be further coated prior to installation with a bond breaking compound. The bond breaking coating shall be one of the approved products appearing on the Department's Qualified Products List.

The dowel bars shall have tight fitting end caps made of nonmetallic material that allows for 1/4 inch bar movement at each end of the bar. The Contractor shall submit an end cap sample to the Engineer for approval prior to installation.

Chair devices for supporting and holding the dowel bar in place during placement of the patching material shall be completely epoxy coated and made of nonmetallic material. The Contractor shall submit a chair sample to the Engineer for approval prior to installation.

The foam core board filler material shall be 1/4 inch thick, constructed of closed cell foam and faced with poster board material on each side. The foam core board is to be used when existing transverse joints are being retrofitted.

The caulk for sealing the existing crack/joint at the bottom and sides of the slot shall be a commercial grade of silicone caulk containing a minimum of 50 percent silicone.

The Portland cement concrete pavement that is removed to install the dowel bars shall be replaced with one of the following approved patching products: Patchroc 1060, Five Star Highway Patch, Burke 928 Fast Patch, or an approved equal. The use of Set 45 will not be allowed.

The patching material may be extended with aggregate meeting the manufacturer's recommendations. The Contractor shall provide a concrete mix design, including all additives, to meet a minimum compressive strength of 4,000 psi in 6 hours.

The Contractor shall verify the results of the mix design prior to beginning work. If the mix design is not satisfactory, the Contractor shall provide the Department with a mix design that meets the requirement

prior to the beginning of work.

CONSTRUCTION REQUIREMENTS

The Contractor shall install the dowel bars in the existing Portland cement concrete pavement as shown in the plans and according to the following requirements:

1. Diamond saw cut the pavement to place the center of the dowel bar at mid-depth in the pavement. Multiple saw cuts parallel to the center line may be required to properly remove the waste material from the slot. The saw cuts for the six slots at each transverse crack/joint shall be made such that the dowel bars are placed within the following tolerances:

   Centerline of individual dowel bars shall be parallel to the top of pavement, parallel to the ether dowel bars, and parallel to the roadway centerline within + or - 1/4 inch in 18 inches.

2. Any jackhammers used to break loose the concrete shall net be larger than the 30 pound class. If the pavement is damaged by the 30 pound jackhammer, the engineer will require the Contractor to use a 15 pound hammer.

3. All surfaces exposed and cracks in the slot shall be sand blasted and cleaned prior to bar installation.

4. The crack/joint on the bottom and the sides of the slot shall be filled with silicone caulk.

5. The dowel bars shall be lightly coated with the bond breaking compound prior to placement. The bar chairs shall provide a minimum of 1/2 inch clearance between the bottom of the dowel bar and the bottom of the slot. The dowel bar shall be placed to the depth shown on the plans, parallel to centerline and the top of the roadway surface, and at the middle of the slot, all within the specified tolerances. The chairs shall hold the dowel bar securely in place during placement of the patching mix.

   Longitudinal dowel bar placement for skewed joints or cracks shall be within + or - 2 inches. Longitudinal dowel bar placement for perpendicular joints shall be within + or - 1 inch.

6. The 1/4 inch thick foam core board shall be placed at the middle of the dowel bar to maintain a transverse contraction joint. The existing joint sealant may need to be cut or removed to accommodate the 1/4 inch thick foam core board with 1/2 inch by 1 inch tabs. The tabs are required to stabilize the foam core board during patching material placement. The foam core board shall fit tightly around the dowel bar and to the bottom and edges of the slot. The top of the foam core board shall be flush with the top surface of the concrete pavement.

   The Contractor may need to increase the width of the foam core board for pavements with skewed joints. The skew angle may vary for different pavement sections.

   The Contractor shall caulk the transverse joint crack at the bottom and the sides of the slot on both sides of the 1/4 inch thick foam core board. The foam core board shall be capable of remaining in a vertical position and tight to all edges during the placement of the patching material.

If for any reason the foam core board shifts during the placement of the patching material, the work shall be rejected and replaced at the Contractor's expense.

7. The Contractor shall thoroughly moisten all surfaces on the sawed slot immediately prier to filling with patching compound. Care shall be taken to prevent standing water in the slot. All excess water shall be removed with compressed air.

   The Contractor shall fill the slot (with the installed dowel bar, chairs, foam core board where used, and silicone in place) with an approved patching material. The patching material shall be vibrated with a small hand held vibrator capable of thoroughly consolidating the patching material into the slot and around the dowel bar. The top surface of the filled slot shall be trowel finished and cured immediately after each group of three dowels are installed. The curing compound shall meet the requirements of the Standard Specifications.

   The patching material shall be mixed with a hand mixer. The Engineer will test the patching material once every four hours of production. The patching material shall have a minimum compressive strength of 4,000 psi in 6 hours. Department compression testing may be performed up to 24 hours after the cylinders are made. If the compressive strengths are not being met, production shall cease and the Contractor shall resubmit a concrete mix design correcting the strength problems.

8. The transverse contraction joints shall be sawed and sealed as required in the Standard Drawings within 24 hours after placement of the patching material.

9. Any damage to the pavement due to the Contractor's operation shall be repaired or replaced at the expense of the Contractor.

MEASUREMENT

Dowel bar retrofit will be measured by each dowel bar installed and accepted.

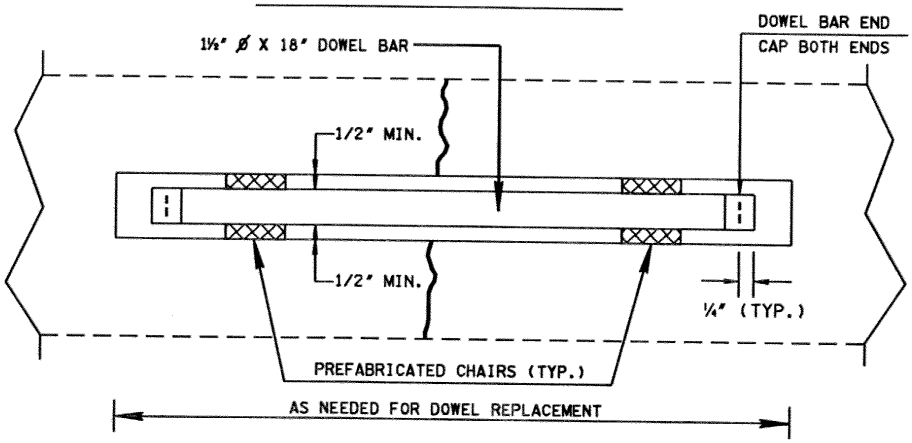
PAYMENT

Dowel bar retrofit will be paid at the contract unit price bid per each dowel bar. Payment shall be full compensation for equipment, materials, labor, and all incidentals required.

SP503DB

DOWEL BAR RETROFIT DETAILS

SP503DB



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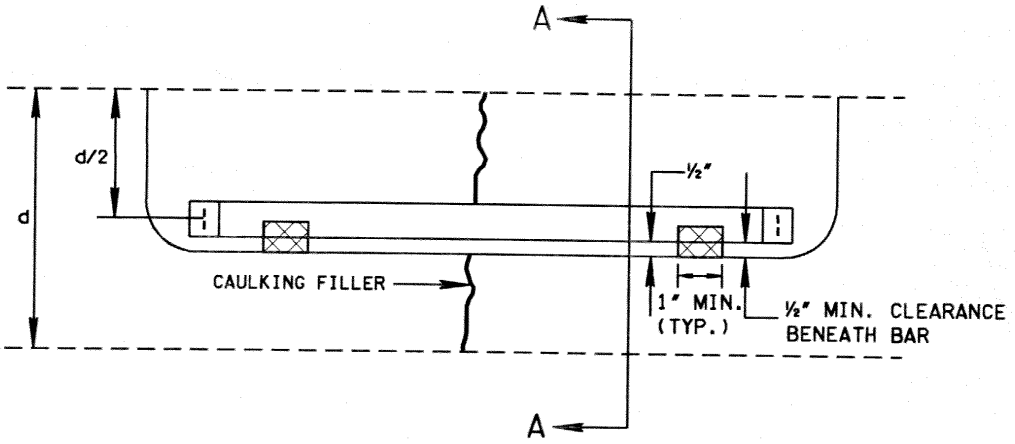

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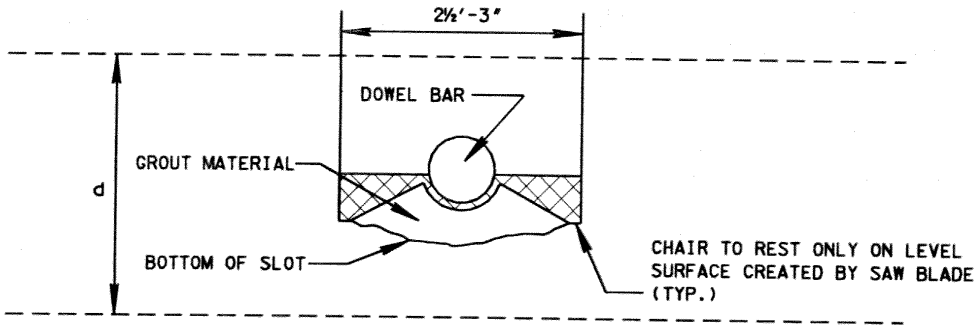
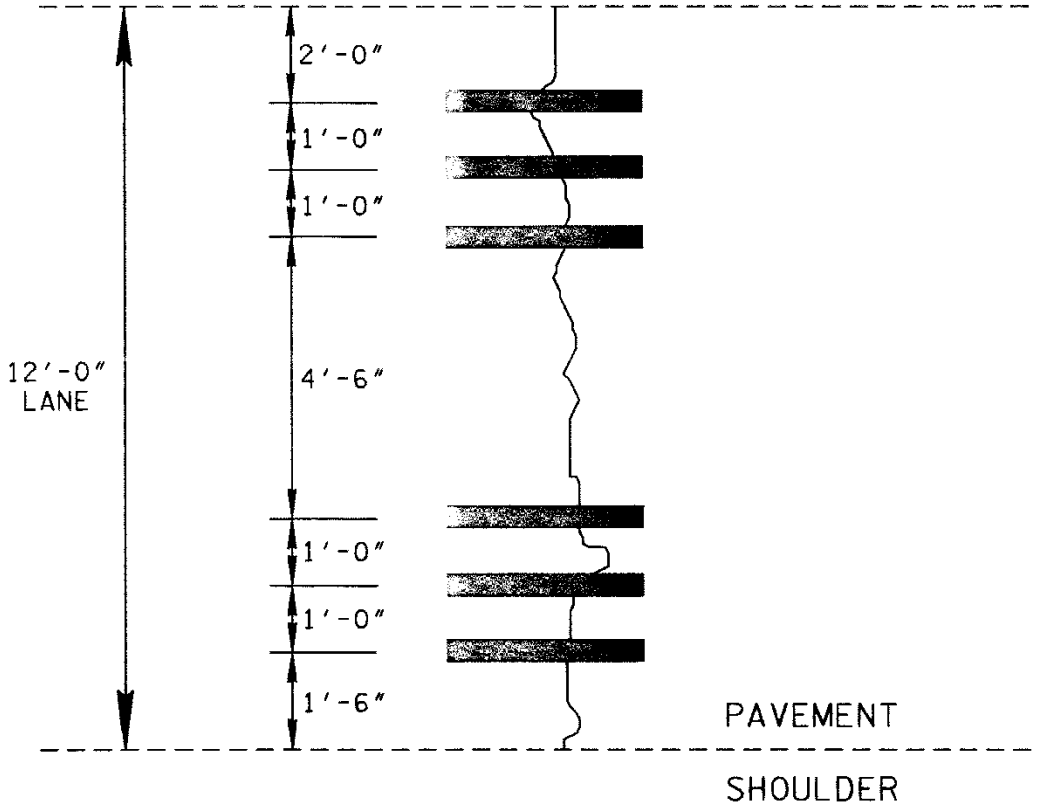


SECTION A-A

SP503DB SP503DB



DOWEL BAR PLACEMENT

S T A T E **O F** **T E N N E S S E E**

(Rev. 1-1-15) January 1, 2021
(Rev. 7-21-21)

SPECIAL PROVISION

REGARDING

RUBBLIZING CONCRETE PAVEMENT

Description

This work consists of rubblizing and compacting portland cement concrete pavement in accordance with these specifications, the lines and grades shown on the plans or as directed by the Engineer.

Materials

Filler aggregate shall meet the requirements of **903.03** for Size No. 57 or Size No. 67.

Equipment

The rubblizing operation shall be performed with a self-contained, self-propelled resonant frequency breaking unit or multi-head breaker capable of rubblizing the pavement to the sizes specified. The unit shall be equipped with a water system to suppress dust generated by the rubblizing process. A screen shall be provided to protect vehicles in the adjacent lane from flying chips during the fracturing process if the deemed necessary.

The compaction shall be performed with a vibratory steel wheel roller having a nominal gross weight of not less than 10 tons when operated in the vibration mode and a pneumatic tire roller having a nominal gross weight of not less than 25 tons.

Construction Requirements

Prior to rubblization remove all existing asphalt pavement surfaces. Patch materials do not need to be removed. Remove any snowplowable or raised pavement markers.

At least 2 weeks prior to rubbilization, the underdrain systems must be installed to allow the existing base to drain and dry out.

Full depth saw cut existing joints between the mainline pavement and ramp tapers, bridge approaches or other designated locations that are not to be disturbed to isolate the rubblized area.

The majority of the rubblized particles at the surface shall be 3 inches or less in greatest dimension. Any particles at the surface greater than 6 inches in greatest dimension shall be broken down further or removed and replaced with filler aggregate. The majority of rubblized particles shall be 9 inches or less in greatest dimension and all rubblized particles shall be 12 inches or less in greatest dimension. The Engineer may direct or allow larger maximum particle dimensions.

Before full production of rubblization, set up a test section to determine the proper speed and coverage required to rubblize the concrete pavement as specified and to demonstrate the equipment is capable of providing the specified particle size. The test section shall not exceed 500 feet in one travel lane. Excavate at least 2 full widths by 3 feet long, full depth sections at locations directed by the Engineer. At any time during rubblization, the Engineer may request verification sections be excavated to verify particle sizes are being met at no additional cost.

The test section shall also be used to determine the appropriate coverage of each roller in order to provide satisfactory seating and compaction of the rubblized materials. As a minimum, at least 2 passes with both the steel wheel and pneumatic tire roller shall be made. The roller speed shall not exceed 6 feet/sec (4 mph).

Once a sequence of operations has been established, this procedure shall be used for the remainder of the project unless field conditions reflect the need for modification.

The rubblizing pattern shall proceed in a longitudinal direction, beginning at a free edge (shoulder or previously rubblized edge) and progressing toward the opposite shoulder.

Any areas where the subgrade is found to be weak, or unsuitable, shall be repaired satisfactorily and all unsuitable materials shall be removed and replaced at no additional cost. Replace the rubblized concrete or place base materials meeting the requirements of **303**.

Any depressions, one inch or greater in depth from that of the immediate surrounding area, resulting from the rubblizing or compaction effort shall be filled with Size No. 57 or 67 aggregate and compacted as previously described.

Any reinforcement or dowels that are exposed as a result of the rubblization shall be cut off below the surface and removed.

Any damage to drainage structures, utilities, private property, or any existing structure due to rubbilization methods and practices shall be repaired or replaced at no additional costs.

Except at restricted cross-over and ramp intersections, traffic will not be allowed on the rubblized pavement before the initial asphalt overlay course is in place. Crossover and ramp intersections shall be maintained in the same compacted state as other areas until the initial asphalt concrete is placed.

Placing of the first course of the bituminous pavement shall follow the rubblization operations as closely as is practicable and, in no case shall the broken pavement remain exposed more than 24 hours. In the event that this 24 hour requirement is exceeded, rubblization operations shall be suspended until all existing broken pavement is covered by at least one bituminous paving course. No more than 5,000 linear feet of pavement shall be broken ahead of this paving operation.

In the event of rain, the placement of the asphalt overlay will be prohibited until the rubblized surface has sufficiently dried as determined by the Engineer.

Remove all loose materials, assure the surface is smooth and uniform, and apply a heavy application of tack coat (0.15 gal/sy) prior to paving.

Method of Measurement

The Department will measure Rubblization of Concrete Pavement, as accepted complete in place by the square yard in accordance with **109**.

Basis of Payment

Item No.	Description	Unit
505-01	RUBBILIZATION OF CONCRETE PAVEMENT	SQUARE YARD

Such payment shall be full compensation for furnishing all labor, equipment, materials, and all incidentals necessary, including leveling materials, base materials, saw cutting, preparing and testing of test sections and verification sections, etc.., to rubblize portland cement concrete pavement as specified.

S T A T E **O F** **T E N N E S S E E**

(Rev. 7-15-05) January 1, 2021

SPECIAL PROVISION

REGARDING

SECTION 602 STEEL STRUCTURES

The cost of structural steel inspection (QA), limited to the rates established below, will be paid by the Department:

Steel Structures (Weight Range)	**Inspection Cost**
Up to 833,000 pounds (First 377,850 Kgs.)	$25,000.00 L.S. ($25,000 L.S)
If Total Structural weight is between 833,000 and 2,500,000 pounds (Kgs. Between 377,850 and 1,134,000)	$0.03 per pound ($0.065 per Kg.)
If Total Structural weight is greater than 2,500,000 pound (Kgs. Over 1,134,000)*	$75,000 L.S. plus $0.01 per pound greater than 2,500,000 pounds ($0.022 per Kg.)

*For Complex Structures (Trusses, Box Member Bridges when box members are over fifty percent of the structure) and projects with more than five steel bridges:

If Total Structural weight is greater than 2,500,000 pound (Kgs. Over 1,134,000)	$75,000 L.S. plus $0.02 per pound greater than 2,500,000 pounds ($0.044 per Kg.)

The above rates shall be applied as specified in **Subsection 602.04** of the Standard Specifications.

S T A T E **O F** **T E N N E S S E E**

(Rev. 2-8-21) January 1, 2021

SPECIAL PROVISION

REGARDING

REPAIR OF BRIDGE DECK CRACKS

Description

This work consists of the cleaning and repairing of visible bridge deck cracks in accordance with the contract plans or as directed by the Engineer. Cracks shall be repaired using a High Molecular Weight Methacrylate (HMWM).

Materials

The material used for treating cracks shall be a low viscosity, non-fuming, high molecular weight methacrylate resin conforming to the following:

Physical Property	Requirement
Viscosity	25 cps, maximum (Brookfield RVT with UL adaptor, 50 RPM at 25°C (77°F))
Density	0.9 kg/L (7.5 lbs/gal), minimum, at 25°C (77°F)
Flash Point	82°C (180°F), minimum
Vapor Pressure	1.0 mm Hg, maximum at 25°C (77°F)
Gel Time	20 minutes minimum at application temperature
Tack Free Time	6 hours maximum
Bond Strength	10.3 MPa (1500 psi) minimum (ASTM C 882)

A qualified representative shall be on site to provide expert assistance on storage, mixing, application, clean-up and disposal of materials.

The promoter and initiator, if supplied separately, shall not contact each other directly. Containers of promoters and initiators shall not be stored together in a manner that will allow leakage or spillage from one to contact the containers or material of the other.

The quantity of resin mixed with promoter and initiator shall be limited to 5 gallons at a time for manual application. A significant increase in viscosity shall be cause for rejection. The mixed resin shall be applied within 10 minutes after complete mixing.

A Material Safety Data Sheet (MSDS) shall be furnished for the HMWM resin promoter and initiator to be used. A certification showing conformance to these specifications shall be provided with each batch of resin.

Aggregate materials shall consist of clean, dry, fine grained sand as per resin manufacturer specifications.

Surface Preparation

Preparation of the concrete bridge deck surface shall consist of air blasting all visible cracks with oil free compressed air using sufficient air pressure to remove all loose or objectionable material from the cracks and bridge deck surface as approved by the Engineer The surface cracks shall be visually dry before treatment with HMWM is allowed to begin.

Application of HMWM

Plan and prosecute the operations in such a manner as to protect persons and vehicles from injury or damage. If required, perform the Work prior to any mechanical grooving.

The concrete surface temperature shall not be less than 50° F and not more than 100° F at the time of resin application.

In applying to individual cracks on a linear foot basis the resin shall be applied at an average rate of 1 gallon per 200 linear feet or as directed by the Engineer. Large cracks (wider than 0.03 inches) should be pre-filled with sand before applying resin. Each crack shall be treated with resin by ponding the resin over the crack and allowing gravity to feed the material into the crack. The resin shall be ponded over each crack for 5-10 minutes. The ponding procedure shall be repeated until each crack is sealed. Excess resin shall be cleaned up.

Traffic shall not be permitted on the treated bridge deck until the treated cracks are tack free (non-oily).

Method of Measurement

The Department will measure, complete in place, Bridge Deck Crack Sealing by the linear foot

The Department will measure Sealant by the gallon of sealant material used for bridge deck crack sealing.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
617-02	BRIDGE DECK CRACK SEALING	LINEAR FEET
617-05	SEALANT (DESCRIPTION)	GALLON

Such payment will be full compensation for all work specified including labor, materials, equipment, tools, surface preparation and incidentals to complete the work.

STATE **OF** **TENNESSEE**

May 17, 2021 January 1, 2021

SPECIAL PROVISION

REGARDING

FOLDED PVC PIPE LINER

Description

This work consists of furnishing, installing, and providing all labor, materials, and equipment necessary to rehabilitate existing roadway pipe by the heating, insertion, and expansion of folded polyvinyl chloride (PVC) pipe liner.

The required hydraulic capacity of the host pipe shall be determined and then improved or maintained by this rehabilitation.

Material

A. Folded Polyvinyl Chloride (PVC) Pipe Liner

The folded PVC pipe liner shall be manufactured with virgin or reworked PVC compounds meeting the properties for classifications 12334, 13223, 32334, 32111, 12111, or 33223 in ASTM D1784.

The folded PVC pipe liner shall be fabricated to a size that will fit the internal circumference of the pipe as specified by the Engineer. Allowance for circumferential expansion during installation shall be made.

The folded PVC pipe liner material shall be made from a compound meeting the following requirements:

Table 607FP-1: PVC Physical Properties:

Impact Strength (Izod)	0.65 ft-lb/in. of notch
Tensile Strength	4,500 psi
Tensile Modulus	360,000 psi
Flexural Strength	7,500 psi
Flexural Modulus	360,000 psi

The recommended nominal folded PVC pipe liner sizes are applicable for a range of host pipe inside diameters as indicted in **Table 607FP-2.**

Table 607FP-2: Recommended Range of Use

Folded PVC Liner Pipe O.D. (nominal), inches	Recommended Host Pipe I.D., inches	Folded PVC Liner Pipe wall thickness (nominal), inches	Dimension Ratio
18	17.6 - 18.2	0.300 – 0.500	60 - 35
24	23.5 - 24.3	0.300 – 0.500	80 - 48
30	29.5 - 30.3	0.300 – 0.500	100 - 60
36	35.5 - 36	0.300 – 0.500	120 - 72

B. Grouts

Grouts used for the reestablishment of pipe inverts shall meet the requirements of **921.09** – Type 1. Alternate grouts recommended by the manufacturer may be used upon approval of the Engineer.

Certification

When requested by the Engineer, furnish a manufacturer's signed certification that the folded PVC pipe liner material was manufactured, sampled, tested, and inspected, and meets requirements. If requested, submit a report of the test results certification signed by an authorized agent of the manufacturer.

Installation of folded PVC pipe liner shall be performed by personnel who are recognized by the manufacturer as an authorized installer.

Product Marking

The folded PVC pipe liner shall be clearly marked at intervals of 5 feet or less as follows:

1. Manufacturer's name or trademark and code,
2. Nominal outside diameter,
3. The legend "DR XX Folded PVC Pipe,"
4. Production date code

Packaging

The full length and wall thickness of the folded PVC pipe liner is heated and coiled onto a reel in a continuous length in a reduced cross section of either a "C" or an "H" at the time of manufacture for storage and shipping in accordance with the manufacturer's recommendations.

Equipment

Provide all necessary equipment for satisfactory completion of the work including restoration of the site.

Construction Requirements

A. Inspection of Existing Pipelines

Inspection of existing pipelines shall be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit television.
The interior of the pipeline shall be inspected carefully to determine the location of any conditions that may prevent proper installation of the folded PVC pipe liner, such as protruding service taps, collapsed or crushed pipe, out-of-roundness, significant line sags, and deflected joints. These conditions should be noted and corrected prior to installation.

The existing pipeline shall be clear of obstructions that will prevent the proper insertion and full expansion of the folded PVC pipe liner such as offset joints of more than 12.5 % of inside pipe diameter service connections that protrude into the pipe more than 12.5 % of the inside pipe diameter or 1 inch, whichever is less; and, other reductions in cross-sectional area of more than 10 % based on the inside diameter of the existing pipe.

If inspection reveals an obstruction that cannot be removed by conventional equipment, then a point repair excavation shall be made to uncover and remove or repair the obstruction. Typically, bends along the pipe length in excess of 30° and changes in pipe size cannot be accommodated along an insertion length of the folded pipe.

Such conditions require access at these points for termination and start of a new insertion.

B. Installation

1. Insertion

The method of installation shall be compatible with the manufacturer's recommended practices. Verify the lengths in the field before insertion of the folded PVC pipe liner. The minimum folded PVC pipe liner length shall span the distance from the inlet to the outlet of the existing pipe.

The folded PVC pipe liner shall be brought to the work site in an apparatus suitable for applying heat to the PVC pipe. To make the folded PVC pipe liner pliable enough to be easily removed from the coil and to remove any “reel set”, the coil shall be heated to a temperature as determined by the manufacturer. The temperature shall be maintained in the heating chamber for a minimum of 1 hour to fully heat the length of folded PVC pipe liner to be inserted. Shorter insertion lengths may be fully heated over a shorter time period.

The folded PVC pipe liner shall be inserted into the pipe through existing structures, if needed, without modification of the structures.

A cable shall be strung through the existing pipe and attached to the folded PVC pipe. The folded PVC pipe liner shall be heated along the entire length and fed through the insertion point. The heated folded PVC pipe liner shall be pulled into the existing pipe using a cable from a winch connected through the lumen of the existing pipe and attached to the end of the folded PVC pipe.

Maintain the feed with the folded PVC pipe reel to avoid stretching the material with the winch cable. Pulling forces shall be monitored so as not to exceed the axial strain limits of the folded PVC pipe material. Pull enough material to allow for insertion of a flow-through plugs at the termination points.

After insertion is complete, cycle down the steam temperature to allow the folded PVC pipe liner to relax and reduce tensile stress on the material. During the relaxation cycle, the ends of the will tend to contract. It may take several heating/cooling cycles until the folded PVC pipe material liner has relaxed and is no longer contracting.

2. Expansion

Steam monitoring methods and forming period shall be recommended by the manufacturer.

The equipment shall be capable of delivering steam through the folded PVC pipe liner to uniformly raise the temperature and pressure to effect forming of the PVC pipe. This temperature and pressure shall be determined by the system employed. The heat source shall be fitted with suitable monitors to gauge the steam temperature and pressure at the input and exhaust ends of the folded PVC pipe.

Insert flow-through plugs into ends of folded PVC pipe liner. Ensure plugs are adequately restrained. Through the use of heat and pressure, the folded PVC pipe liner shall be expanded fully.

Expansion pressures shall be sufficient to unfold the PVC pipe liner, press it against the wall of the existing pipe, and form dimples at service connections. Folded PVC pipe expansion pressures typically are in the range of 0.25 to 3 psi, but not to exceed 5 psi (safety measure), depending on liner size, or other site conditions.

3. Cool Down

The formed PVC pipe liner shall be cooled to a temperature below 100°F before relieving the pressure required to hold the PVC pipe against the existing pipe wall. After the formed PVC pipe liner has cooled down, where applicable the terminating ends shall be trimmed to at least 2 inches beyond the existing pipe.

4. Connections

After the formed PVC pipe liner has been installed, the existing connections shall be reconnected. This should be done without excavation from the interior of the pipeline by means of a television camera and a remote-control cutting device unless otherwise specified by the Engineer.

5. Inspection and Acceptance

The installation may be inspected by closed-circuit television. The formed PVC pipe liner shall be continuous over the entire length of the insertion and conform to the walls of the existing pipe by visible joint definition and mirroring of existing pipe irregularities. The formed PVC pipe liner shall be as free as practical from visual defects such as foreign inclusions and pin holes.

Variations from true line and grade may be inherent because of the conditions of the existing pipeline. No infiltration of groundwater through the formed pipe wall should be observed. All service entrances should be accounted for and be unobstructed.

If the PVC pipe liner fails to install properly, as determined by the Engineer, remove the failed liner, if not able to be reprocessed, and replace it with a new PVC pipe liner at no additional cost to the Department.

6. **Sealing at Structures:**

If, due to broken or offset pipe at the structure wall, the PVC pipe liner fails to make a tight seal, apply a seal at that point. The seal shall be of a material compatible with the PVC pipe liner material.

7. Clean-up:

Restore or replace removed or damaged structures disturbed by the work. Restore the project area to a condition equal to that before the work began, to the satisfaction of the Engineer, and shall furnish all labor and material incidental.

Surplus PVC pipe material, tools and temporary structures shall be removed after completion of the work. All dirt and trash from the operation shall be legally disposed of , and the work site shall be left clean to the satisfaction of the Engineer.

Method of Measurement

The Department will measure the Folded PVC Pipe Liner by the linear feet complete in place and accepted.

Basis of payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
607-67.10	18” FOLDED PVC PIPE LINER	LINEAR FEET
607-67.11	24” FOLDED PVC PIPE LINER	LINEAR FEET
607-67.12	30” FOLDED PVC PIPE LINER	LINEAR FEET
607-67.13	36” FOLDED PVC PIPE LINER	LINEAR FEET

Such payment will be full compensation for all work specified including labor, materials, equipment, tools, and incidentals to complete the work.

STATE **OF** **TENNESSEE**

(Rev. 10-7-19) January 1, 2021

SPECIAL PROVISION

REGARDING

SLIP LINING OF ROADWAY CULVERTS

Description

This work consists of furnishing, installing, grouting and providing all labor, material and equipment necessary to rehabilitate existing roadway culvert pipe by the slip lining method.

The required hydraulic capacity of the host pipe shall be determined and then improved or maintained by the use of slip lining products. The slip lining process will require the complete grouting of the annular void between the hosts and insert pipe unless approved otherwise. If the Engineer's hydraulic and geometric evaluation indicates that downsizing of the existing line is acceptable, a variety of materials listed below may be used for insertion.

When necessary, hydraulic advantages may be gained by improvements to inlet details on inlet controlled culverts. (See TDOT Drainage Manual 6.04.3.2 I Improved Inlets). Where improved inlets create low pressure on the culvert pipes, pipe liner joints shall be watertight, and testable to the limits of the required pressure.

See Table 607G-1 for Slip lining Pipe Dimension.

Materials

Provide materials for pipe liner that are acceptable for slip lining pipe and include one of the following;

a. Corrugated High Density Polyethylene Pipe (HDPE),
b. Profile Walled PVC,
c. Corrugated Polypropylene Pipe (PP),
d. Solid Wall High Density Polyethylene Pipe (SWHDPE),
e. Steel Reinforced Polyethylene Pipe (SRPE),
f. Machine Spiral Wound PVC or HDPE Pipe,
g. Glass Fiber Reinforced Plastic Pipe, or
h. Smooth Wall Carbon Steel Plate Pipe.

Submit manufacturer's detailed product data with complete information on pipe liner materials (pipes, joints, gaskets, fittings, entrance bells), physical properties, dimensions, installation minimum/maximum allowable parameters such as maximum recommended external grout

pressure, axial compressive stress, minimum bending radius or maximum joint angular deflection.

Pipe liner materials other than those stated above may be submitted for consideration and approval by the Engineer based on meeting the design requirements as stated.
Secure written product approval from the Manufacturer before commencing any work.

A. Corrugated High Density Polyethylene Pipe (HDPE)

1. Pipe

The pipe liner shall consist of a HDPE profile wall pipe that conforms to the requirements of AASHTO M 294 for Corrugated Polyethylene Pipe Type "S" or "D".

2. Joints

Join HDPE profile wall pipe liner by thermal fusion (extrusion welding) per manufacturer specifications, or provide a positive mechanical joint that meets the requirements of ASTM D 3212, consist of an integrally formed bell and spigot connection with a rubber gasket meeting ASTM F477, or a connection meeting equivalent performance standards such that joints shall meet the requirements of ASTM D3212.

If mechanically restrained joints are required to line the host pipe, the pipe joints shall be restrained to allow the pipe to be pulled or pushed into the host pipe without joint separation.

B. Profile Wall Poly Vinyl Chloride (PVC)

1. Pipe

Pipe liner shall consist of PVC corrugated pipe with a smooth interior that conforms to the requirements of AASHTO M304, Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter or ASTM F 949.

Use pipe made of PVC compound with a cell classification of 1245B per ASTM D 1784.

2. Joints

Join the PVC pipe liner with a PVC coupling that uses elastomeric sealing gaskets. The assembled joint shall meet the performance requirements of ASTM D 3212.

The joint shall be able to be pulled or pushed into the host pipe without joint separation. Ensure that elastomeric seals meet the requirements of ASTM F 477.

C. Corrugated Polypropylene Pipe (PP)

1. Pipe

Polypropylene pipe and fittings shall meet the requirements contained in AASHTO M330 type "S" or "D" wall, and or ASTM F2736/ASTM F2764.

Extruded Pipe and Fittings shall be made of virgin polypropylene compounds as described in AASHTO M330 and or ASTM F2736/ASTM F2764.

Polypropylene compounds shall be comprised of the base polypropylene resin and all additives, colorants, UV inhibitors, and stabilizers.

The pipe and fittings shall be free of foreign inclusions and visible defects such as cracks, holes, foreign inclusions or other injurious defects.

2. Joints

Joints shall be water-tight over the range of head pressure expected for the pipe. Joints shall consist of an integrally formed bell and spigot connection with a rubber gasket meeting ASTM F477 or a connection meeting equivalent performance standards such that joints shall meet the requirements of ASTM D3212.

The ends of the pipe shall be square and clean so as not to adversely affect joining or connecting.

D. Solid Wall High Density Polyethylene Pipe (HDPE)

1. Pipe

High density polyethylene pipe and fittings shall meet the requirements in the AASHTO LRFD Bridge Design Specifications, Section 12, as a solid wall HDPE pipe meeting the requirements of Specification AASHTO M 326.

The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties. Pipe shall be solid wall with a smooth interior and exterior with no corrugations or ferrous elements.

Pipe and pipe fittings shall be manufactured from high density compounds in accordance with ASTM D3350, cell classification 345464C or (345474C) with a designation of PE 3408or (PE 4710) and a minimum Standard Dimension Ratio (SDR) of 32.5.

Each pipe segment shall be marked on the outside with a coded number which identifies the manufacturer, SDR, size, materials, machine, date and shift on which the pipe was extruded.

Pipe[s] shall be specifically applicable for installation and use in the project environment.

2. Joints

Joints shall be water-tight and soil tight meeting AASHTO M 326 over the range of head pressure expected for the pipe.

Joints shall be butt-fused in accordance with ASTM F2620 and the manufacturer's recommendations or shall be capable of being joined into a continuous length by an

interlocking method such that joints meet the requirements of ASTM D3212. Screw-type or threaded joints will not be allowed unless a positive lock is included in the joint system or the perimeter of the joint is extrusion welded at the bearing assembly prior to insertion. Internal beads resulting from butt fusion shall be limited to a 0.25 inch (6 mm) projection perpendicular to the inside wall of the pipe. Trim beads larger than a 0.25 inch (6 mm) 360 degrees around the interior of the pipe. External beads resulting from butt fusion need not be trimmed unless the bead projection will negatively impact pipe installation or migration of annulus grout.

E. Steel Reinforced Polyethylene Pipe (SRPE)

1. Pipe

The pipe profile is manufactured using a high quality stress-rated thermoplastic meeting the requirements of ASTM F2562 "Standard Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage" or AASHTO Designation MP-20, Bridge Construction Section 26 & Design Section 12.

Virgin high density polyethylene stress-rated resins are used to manufacture the pipe and complimentary fabricated fittings. Resins shall conform to the minimum requirements of cell classification 345464C as defined and described in the latest version of ASTM D3350 "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials".

2. Joints

Low Head (LH) Joints (30" – 72") shall be gasketed, stress-rated high density polyethylene bell and spigot joints (meeting the requirements set forth in the above Material Properties paragraph) that have been laboratory tested to 3 psi when tested in accordance with ASTM D3212 "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

High Performance (HP) Joints (30" – 72") shall be gasketed, bell and spigot joints where both the bell and spigot are reinforced with steel that is fully encased in stress-rated high density polyethylene (meeting the requirements set forth in the above Material Properties paragraph) and that have been laboratory tested to 15 psi when tested in accordance with ASTM D3212 "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals".

Welded Coupler (WC) Joints (36" – 120") shall utilize plain ended pipe welded together with a polyethylene coupler by way of electro fusion welding or extrusion welding technology. The welded connections provide a true, infield watertight system. The field installed welded coupler joints shall remain watertight and can achieve zero leakage rates on appropriate applications. The welded coupler joints have been laboratory tested to 30 psi in accordance with ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals".

F. Machine Spiral Wound PVC or HDPE Pipe

1. Profile Strip

Provide extruded PVC profile strip in accordance with the requirements of ASTM F1697 except as noted below.

Provide extruded HDPE profile strip in accordance with the requirements of ASTM F1741 "standard Practice for Installation "OD" Machine Spiral wound PVC Pipe Liner for Rehabilitation of Existing Sewers and conduit" modified for SPR PE (HDPE) pipe liner.

Pipe made from similar grade HDPE as new sewer and drainage pipe, meeting cell classification of 335420C (or E) in accordance with ASTM D 3350.

Continuous welding process seals subsequent strip of profile creating a seamless pipe line of high stiffness, consistent material properties.

Structural stand-alone liner – does not rely upon the grout for strength but only to transfer the load.

All profile strips shall be specifically applicable for installation and use in the project.

2. Joints

Joints shall meet the requirements of ASTM D3212, and gaskets meeting the requirements of ASTM F477. The joint shall consist of a single, mechanical interlock between profile strips supplemented with sealant and is created continuously as the profile is wound into the pipe. Once wound into place within the host pipe, joints shall be considered completed and the pipe shall not be intentionally or otherwise expanded or permitted to translate in any direction at the joint. Joints shall be water-tight over the range of head pressure expected for the pipe.

The completed pipe liner shall be provided such that the outside diameter of the pipe is not increased, nor the internal diameter of the pipe is decreased at the joint.

G. Glass Fiber-Reinforced Plastic Pipe

1. Pipe

Provide centrifugally cast fiberglass reinforcement plastic mortar pipe (CCFRMP) in accordance with ASTM D3262, cell classification Type 1, Liner 2, Grade 3. All pipes shall be specifically applicable for installation and use in the project environment.
Minimum pipe stiffness shall be 36 psi (248) kPa when tested in accordance with ASTM D2412.

The glass fibers shall be a commercial grade of E-type glass fibers with the amount, location and orientation of the chopped glass-fiber reinforcement specifically designed for each application.

Sand shall be minimum 98 percent silica kiln-dried and graded.

The polyester wall resin shall be an isophthalic, orthophthalic or other approved resin with a minimum tensile elongation of 2 percent.

Fiberglass liner shall be shown by tests to be resistant to long-term corrosion. Testing shall be performed in accordance with ASTM D3681 using 1.0N sulfuric acid for sanitary sewage.

Each pipe segment shall be marked on the inside and outside to identify the manufacturer's number, diameter, stiffness, ASTM designation and lot number.

2. Joints

Provide pipe with joints designed so that neither the outside diameter of the pipe is increased, nor the internal diameter of the pipe is decreased at the joint. Joints shall be water-tight over the range of head pressure expected for the pipe. Joints shall meet the performance requirements of ASTM D4161. Field connect pipe[s] with low-profile, fiberglass bell-spigot joints or flush fiberglass bell-spigot joints, when the fit requires. Utilize elastomeric sealing gaskets as the sole means to maintain joint water-tightness. Gaskets shall meet the requirements of ASTM F477. Joints at tie-ins, when needed, may utilize gasket-sealed closure couplings.

H. Smooth Wall Carbon Steel Plate Pipe

1. Pipe

The pipe liner shall consist of arc welded straight seam pipe with .20 minimum copper content for improved corrosion resistance, for use in culvert rehabilitation and pipe linings. The pipe liner may be round, elliptical, arch shaped, or other special sections as specified. All round and non-round pipe liner sections of a smooth wall carbon steel plate pipe must conform to the following requirements:

a. All pipe must be domestic with melted and manufactured in USA (MMU), made from new unused steel plates, and shall be straight seam pipe. Longitudinal seams welded after rolling must be welded by the automatic double submerged arc weld (DSAW) method. Joints or midwelds welded after rolling must be welded by automatic or semiautomatic DSAW, flux cored arc weld (FCAW) or gas metal arc weld (GMAW) methods, and splices and repair welds done before rolling must be welded by automatic, semiautomatic or manual DSAW, FCAW, GMAW methods.

b. Each heat number of steel used for the pipe liner must be tested for chemical composition and tensile requirements that meet the following:

Carbon:	0.26 max
Manganese:	1.65 max, *See Note
Phosphorous:	0.035 max

Sulfur:	0.035 max
Copper:	0.20 max
Tensile Strength:	60,000 PSI min
Yield Strength:	36,000 PSI min

*For each 0.01 percent reduction of carbon below the maximum concentration shown above, a 0.05 percent increase of manganese is allowed up to a maximum concentration of 2 percent manganese.

c. Pipe liner wall thicknesses should be no less than .500 (½") wall, or as determined by ASHTO HL-93 load bearing analysis. The minimum specified wall thickness to be used for round pipe liner made to this specification shall be .500 nominal wall, and the wall thickness at any point shall not be more than 12.5% under the specified nominal wall thickness.

d. The minimum specified wall thickness to be used for elliptical, arch, and other non-round pipe liner sections shall be .500, and the wall thickness at any point shall not be thinner than .015 under the specified wall thickness.

2. Joints

Welded steel pipe liner joints must be full penetration welds in accordance with AWS D1.1, allowing for Bevel X Plain End joint configuration.

Table 607G-1: SLIPLINING PIPE DIMENSION

	Nominal Pipe Size (in.)		
Pipe Materials (Size Dimension)	**12 - 36**	**42 - 60**	**66 - 120**
Corrugated HDPE (Inner)	X		
Profile Wall PVC (Inner)	X		
Corrugated PP (Inner)	X	X	
Solid Wall HDPE (Outer)	X	X	
SRPE (Inner)	X	X	X
Spiral Wound PVC	X	X	X
Spiral Wound HDPE		X	X
Glass Fiber Reinforced (Inner)		X	X
Smooth Wall Carbon Steel Plate Pipe	X	X	X

I. Grout for Annular Space

Provide grout for the annular space in accordance with this Specification and with the manufacturer's published recommendations.

The grout shall be nonstructural or structural based upon the type of slip liner system provided. If the pipe liner provided cannot meet the stated requirements for factor of safety against buckling or crushing, then a structural grout must be used regardless of the pipe lining system used in order to fulfill the factor of safety requirements as stated herein.

Utilize material specifications for solidification of the annular void between host and the inserted liner with low density flowable fill or cellular grout. The cellular grout with a density between 40 and 80 lbs. per cubic foot may be used. Reduced density flowable fill grout with a density between 80 and 120 lbs. per cubic foot may be used.

Grout shall be mixed in small quantities as needed, and shall not be re-tempered or used after it has begun to set, unless otherwise specified or directed. The grout shall consist of one part portland cement and two parts sand by volume mixed with sufficient water to form a grout of proper consistency. When non-shrinking or non-shrinking fast-setting grout is specified, it shall be formulated by the incorporation of an admixture, or a pre-mixed grout may be used. The formulation and the admixture or the premixed grout used will be subject to the approval of the Engineer, and shall be mixed and used in accordance with the recommendations of the manufacturer.

For pipe 12”-36” when justified by structural design factors the use of grout is not required.

Equipment

Provide all necessary equipment for satisfactory completion of the work including restoration of the site.

Pipe Stockpiling and Handling

Pipe and fittings shall be stockpiled in a safe manner at each contractor staging area or pit location. The stockpiling shall be arranged to cause a minimum of interference to pedestrian and stored outside the safety clear zone of vehicular traffic.

When handling slip lining pipe, take all precautions necessary to avoid damaging the pipe. Pipe with cuts greater than 10% of the wall thickness shall be rejected or replaced at no cost to the Department.

Pipe storage areas shall be approved by the Engineer.

Construction Requirements

The existing culvert pipe shall be cleaned by whatever means necessary to remove all obstructions which may be encountered that would prevent insertion of the slip liner into the host pipe as approved by the Engineer. All drainage structures and ditches shall remain open at all times.

As Directed by the Engineer, reestablish the flow-line of eroded inverts with grout meeting the requirements of Subsection 918.21 of the specifications. Premixed grout may be used subject to approval of the Engineer.

A detailed plan on holding the liner pipe on the invert of the host pipe shall be submitted to the Engineer for approval.

Where required, a bullnose device shall be pulled through the existing culvert to facilitate the slip lining installation. The bullnose device shall be of appropriate diameter to return the culvert to its approximate shape.

The annular void shall be completely grout filled without deflecting the insertion pipe greater than 1.5 percent.

Provide end seals at the open points of each run of pipe to be grouted

.

Penetration of the host pipe shall be permitted for host pipe constructed with Corrugated Metal Pipe (CMP) to facilitate grouting of the annular void. Multiple fill pipes will be required.

The annular void shall be grouted solid by injecting grout from one end of the pipe run and allowing it to flow toward the other end. Venting of the annular void shall be performed to assure uniform filling of the void space during the grouting process. An open ended, high point tap or equivalent vent must be provided and monitored at the bulkhead opposite to the point of grouting.

After installation of the pipe liner is complete, seal the inlet end of the pipe with a water tight seal between the pipe liner and the existing pipe. The seal shall be one recommended by the pipe manufacturer and approved by the Engineer.

All incidental work, such as brush removal, flow-line adjustments, etc., shall be accomplished by the contractor.

Upon acceptance of the installation work and testing, clean-up and restore the project area affected by operations as approved by the Engineer.

Method of Measurement

The Department will measure the pipe liner to Slip Line the existing pipe by the linear feet installed and accepted.

The Department will measure the Cement by each per 94 lb bag. If pre-mixed grout is used, the amount of cement in each bag, or other units of pre-mixed grout, must be determined and expressed in equivalent 94 pound bag units for payment purposes.

Basis of Payment

The Department will pay for accepted quantities at the contract prices as follows:

Item		Pay Unit
607-65.20	Site Preparation	Each
607-65.XX	(Desc) Pipe To Slip Line (Desc)	Linear Feet
719-03	Cement	Bag

Such payment is full compensation for furnishing and installing pipe liner, clearing, reestablishing pipe flow lines, site restoration, and all other labor, materials and any incidentals necessary to complete the work.

All cost incurred in grouting eroded inverts of existing culvert pipes shall be included in the contract bid price for cement (per 94 pound bag).

STATE **OF** **TENNESSEE**

January 1, 2021

SPECIAL PROVISION

REGARDING

SPRAY APPLIED PIPE LINERS (SAPL)

Description:

This specification shall govern all work, materials, and equipment required for pipe and culvert rehabilitation using a "spray applied method" for the purpose of eliminating infiltration and exfiltration, repair of voids, and restoration of the structural integrity of the pipe or culvert.

Material:

Products meeting this provision shall have been submitted and evaluated through AASHTO' s National Transportation Product Evaluation Program (NTPEP) or AASHTO Product Evaluation List (APEL). Only products that are on the TDOT Qualified Products List (QPL) 42, SPRAY APPLIED PIPE LINERS (SAPL), may be used.

Grouts for the reestablishment of pipe inverts and for filling voids shall meet the requirements of section 921.09- Type 1 of the Standard Specifications. Alternate grouts recommended by the SAPL manufacturer may be used upon approval of the Engineer.

Spray Applied Pipe Lining Method

The spray applied lining material shall be used to form structurally enhanced monolithic liner covering all interior surfaces of the structure, including benches and inverts of manholes.

The spray applied slip lining shall conform to the minimum physical requirements as tested an approved during the initial NTPEP Evaluation. The physical requirements must be verified by an independent, certified, third party testing laboratory within the last five years.

Submit to the project engineer manufacturer's detailed product data with complete information on liner pipe materials (pipes, joints, gaskets, fittings, entrance bells), physical properties, dimensions, installation minimum / maximum allowable parameters such as maximum recommended external grout pressure, axial compressive stress, minimum bending radius or maximum joint angular deflection.

The SAPL will include applying a self-leveling grout to repair eroded inverts followed by the application of a TDOT approved spray applied liner process.

Equipment

Applicator must use approved equipment designed and manufactured by the material supplier specifically for the application of the spray applied liners. Other models may be approved after review by the manufacturer.

The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.

Existing Pipe Inspection

Applicator shall inspect all surfaces specified to receive a protective coating prior to the existing pipe preparation.

The interior of the host pipe shall be thoroughly inspected to determine the location of any conditions which may prevent proper installation, and it shall be recorded so that these conditions can be corrected.

Applicator shall notify Owner of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair mortar and protective coating.

Existing Pipe Prep

All aspects of the existing pipe prep shall be in accordance with the manufacturer's recommendation.

Any and all obstructions shall be removed using a high pressure water jet or other means necessary to the satisfaction of the project engineer. The pipe preparation will also include the following:

- removal of any loose and unsound material
- cleaning and preparing the area to be sprayed
- elimination of active infiltration prior to liner application
- repair and filling of voids
- repair and sealing of the invert and benches
- repair of collapsed pipe sections by jacking or other approved methods

Application of Repair Material

Grout all voids beneath and around the pipe where infiltration, erosion, or scour have occurred and reestablish the invert of the pipe.

Repair materials shall be used to; fill voids, bug holes, structurally reinforce and/or rebuild surfaces, etc. as determined necessary by the protective coating applicator.

Repair materials must be compatible with the specified coating and shall be applied in accordance with the manufacturer's recommendations.

The repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds should not be used unless approved for compatibility with the specified protective coating.

Areas where structural steel has been exposed or removed shall be repaired with a non-shrink grout or approved alternate per the Project Engineer's recommendations.

Application of the repair materials, if not performed by the coating certified applicator, should be inspected by the protective coating certified applicator to ensure proper finishing for suitability to receive the specified coating.

Application of Spray Applied Liner (SAPL)

The applicator shall be approved and trained by the manufacturer using the specially designed equipment for the application.

Application procedures shall conform to the requirements and recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.

Apply the SAPL to a minimum thickness of 1.0 inch for Geopolymer and Cementious based material: and a minimum thickness of 0.5 inch for resin based material, unless otherwise specified.

Ground water shall not be permitted to infiltrate into the host pipe during the liner process.

Method of Measurement

Grouts for the reestablishment of pipe inverts and for filling voids will be measured by the cubic foot (CF).

The spray applied pipe liner (SAPL) shall be measured by the linear foot (CF) of pipe repaired and accepted. The Department will measure, in place, end to end along the centerline of the pipe section repaired.

Basis of Payment

607-25.02	SPRAY APPLIED PIPE LINER (SAPL)	Cubic Foot (CF)
607-25.01	SAPL TYPE 1 GROUT (REPAIR)	Cubic foot (CF)

Payment for grout is full compensation for all labor, materials, and equipment used for the batching, mixing, pumping placing, and finishing of grout, and all other incidentals necessary to complete the work.

Such payment for the spray applied pipe liner is full compensation for all labor, materials, and equipment used for the proper repair of the pipe including inspection, cleaning, drying, removing obstructions, preparation of pipe, repairing voids, jacking collapsed areas of pipe, diversion of existing water sources, application of materials, and all other incidentals necessary to complete the work.

S T A T E **O F** **T E N N E S S E E**

Rev. 03-17-15
Rev. 08-27-15
Rev. 12-7-15
Rev. 5-16-16
Rev. 5-14-18

January 1, 2021

SPECIAL PROVISION

REGARDING

RETAINING WALLS

General Description

This Special Provision covers the design requirements, submittal of wall design drawings and supporting calculations, materials, construction, measurement, and payment for earth retaining walls. The scope of work for retaining wall construction includes, but is not limited to, the following as required:

1. All grading necessary for wall construction,
2. Undercutting and backfilling of weak surficial zones, and or ground improvement as required by plans
3. Temporary Shoring/Wall
4. Compaction of wall foundations
5. General and local dewatering as required for proper execution of the work
6. Construction of leveling pads
7. Formwork, placement of reinforcing steel, placement and curing of concrete
8. Texture coating or architectural treatment
9. Placement of drainage materials
10. Installation of piling
11. Placement of soil reinforcing devices
12. Placement and compaction of backfill
13. Preparation and erection of wall units
14. Construction of any required caps, copings, or end sections

All items included in the construction of the retaining wall shall conform to this Special Provision, the *Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction*, henceforth referred to as the Standard Specifications, American Society for Testing Materials Standards (ASTM), Federal Highway Administration (FHWA) Technical Publications, the current edition of the *AASHTO LRFD Bridge Construction Specifications*, and the current *AASHTO LRFD Bridge Design Specifications* with interims, henceforth referred to as the AASHTO LRFD. The architectural treatment and/or texture finish of the walls shall be in accordance with the contract plans.

Design Criteria

The design of all types of earth retaining walls shall be in accordance with this Special Provision and the following Specifications as required:

1. AASHTO *LRFD Bridge Design Specifications* with interims
2. Publication no. FHWA-NHI-10-024, *Mechanically Stabilized Earth Walls and Reinforced Soil Slopes*
3. (FHWA Report No. FHWA-SA-99-018, 1999)*Geotechnical Engineering Circular No. 4, Ground Anchors and Anchored Systems*

The soil and/or rock properties and specific design values required for wall design are provided in the contract plans.

Submittal Requirements for Contractor/Supplier Prepared Design Plans

The Contractor shall utilize the information contained on the Retaining Wall Conceptual drawing as well as information shown elsewhere in the plans (i.e. utility sheets or traffic control/phasing sheets) to prepare his bid for the wall during the project bidding process and to prepare wall design plans during the construction of the project. The final design shall be submitted subsequent to contract award and a minimum of sixty (60) days prior to start of wall construction and shall include detailed design computations and all details, dimensions, quantities and cross sections necessary to construct the wall. Acceptable wall types will be identified on the concept drawing. Specific wall systems for the Acceptable Wall Types shall be selected from the Department's Qualified Products List (QPL 38) in effect at time of bid letting. In certain circumstances for a particular project, TDOT may elect to provide a complete, detailed wall design in the contract plans. The Contractor shall not bid for nor shall the Contractor submit plans for wall types and/or specific wall systems not listed as an Acceptable Wall Type on the Retaining Wall Conceptual Drawing and related drawings. If a specific wall design is provided for in the contract plans, the Contractor shall not bid for or submit plans for other wall types or design. (See Section 8 for the limited conditions under which other wall types or designs may be considered).

The plans shall be prepared to include but not be limited to the following items:

1. A plan and elevation sheet or sheets for each wall containing the following:

    a. An elevation view of the wall showing grades at the top of the wall, every 50 feet along the wall and at all horizontal and vertical break points. Elevations at the top of leveling pads and footings, the distance along the face of the wall to all steps in the footings, and leveling pads, the designation as to the type of panel or module, the length, size and number of tiebacks, nails, mesh or strips and all the distances along the face of the wall to where changes in length of the reinforcing elements occur and the location of the original and final ground line should be shown. The Contractor shall be responsible for field verifying original ground elevations.

    b. A plan view of the wall shall indicate the offset from the construction

centerline to the face of the wall at all changes in horizontal alignment, the limit of the widest module, tiebacks, nails, mesh or strip and the centerline of any drainage pipe which is behind, under, in front of or passes through the wall.

c. Any general or special notes, standard or special drawings, or other unique provisions required for construction of the wall.
d. All horizontal and vertical curve data affecting wall construction.
e. Cross sections showing limits of construction and in fill sections, limits and extent of select granular backfill material placed above original ground.
f. Limits and extent of reinforced soil volume
g. Limits and extent of any ground improvements as required by the contract plans.
h. Limits and extent of temporary shoring/retaining walls.

2. Details

   a. All structural details including reinforcing bar bending details. Bar bending details shall be in accordance with CRSI standards.
   b. All details for foundations and leveling pads, including details for steps in the footings or leveling pads.
   c. Wall Elevation drawings shall delineate the changes in wall design height with corresponding changes in reinforcement type and/or lengths for the design section.
   d. For each delineated wall design segment the Applied Factored Bearing Load at both the Service and Strength Limit States shall be shown.
   e. All modules and facing elements shall be detailed. The details shall show all dimensions necessary to construct the elements, all reinforcing steel in the element, and the location of reinforcement element attachment devices embedded in the facing.
   f. All details for construction of the wall around drainage facilities, overhead sign footings, abutment piles or other obstructions shall be clearly shown.
   g. All details for connections to traffic barriers, coping, parapets, noise walls and attached lighting shall be shown.
   h. All details for drainage behind wall or reinforced soil volume.
   i. If vehicular impact protection is required due to the wall system not satisfying the minimal design requirements of Section 5.0, details of the barrier wall and end terminals shall be shown on the Contractor/Supplier Design plans for the proposed wall.

3. Detailed design computations which clearly demonstrate compliance with design requirements provided in this specification.

4. Limits of design responsibility, if any.

5. Each design submittal shall include a detailed list of quantities for each wall unit. The quantities shall include but not be limited to: concrete cast in-place, pre-cast concrete, select backfill material, backfill material, reinforcing steel,

geomembrane/geogrid reinforcement, modular blocks, structural steel, pre-stressing steel, etc. If known, all materials sources shall be identified so acceptance and verification sampling and testing can be conducted. All quantities listed are for informational purposes only and do not necessarily constitute a pay item or quantity . All retaining walls shall only be paid for under the respective retaining wall bid item measured and described herein.

6. The Contractor's wall plans shall be signed, stamped and dated by a qualified registered Professional Engineer licensed in the State of Tennessee.

7. Submittals and Approval

   Four sets of design drawings and detail design computations shall be submitted to the Structures Division. The computations shall include a detailed explanation of any symbols and computer programs used in the design of walls. Structures Division will submit two of their four copies to the Division of Materials and Tests.

   Each design drawing shall contain in the title block the project number, county, structure name, structure number, station and contract number. Design drawings shall be submitted in sets with the drawing numbers running consecutively in each set, and if more than five (5) sheets in a set, shall be appropriately bound.

   All designs and construction details will be checked by the Structures Division and the Materials and Tests Division against the pre- approved design drawings and procedures for that particular system. Review of the wall submittal will occur within 30 days of receipt. If there are design or plans issues requiring revisions then the Structures Division will inform the appropriate TDOT Construction Office and provide a listing of the required revisions. Depending on the required revisions the 30 day review timeframe may be extended. Approval of the detailed design and plans shall be made by the Structures Division and Materials and Tests Division. Notification to proceed shall be made by the Structures Division.

   After approval, the Contractor shall submit additional sets of the design drawings (full size and half size) as determined by the Structures Division for Departmental distribution. Also, an electronic copy of the design drawings and detail design computations shall be submitted to the Structures Division and the Materials and Tests Division upon completion of the project.

8. Other Submission Requirements

   As discussed in the previous sections, the Contractor shall bid for and, subsequently, (for the Contractor for which the project was awarded) prepare plans for and be prepared to construct the wall type(s) given on the Retaining Wall Conceptual Drawing or, under special circumstances, the specific wall type and design as provided by in the Contract Plans. The Contractor awarded the project may only under the circumstances discussed below request that a

wall type, wall system, or associated construction for a wall (i.e., foundation improvement requirements, construction sequence requirements, etc.) be changed, altered, or eliminated from those requirements set forth in the plans.

The Contractor may request the Department consider a change in the wall type, specific system, and associated construction through the submission of a Value Engineering Change Proposal (VECP) unless the contract prohibits submission of a VECP. Furthermore, any conditions of a VECP, such as a minimum cost savings required by the contract must be followed. The Department's agreement to review a VECP for a retaining wall shall in no way imply subsequent acceptance of the VECP or any part thereof. Any costs associated with preparation and submittal of a VECP shall be borne by the Contractor and no construction scheduling changes or time delays shall be caused by the Contractor's submission of the VECP and the Department's review of the VECP. If the proposed change involves a wall system not on the Approved Wall System list, then the contractor must coordinate with the system supplier to gain approval of the system and shall be aware of the approval requirements and time considerations for this approval process.

The Contractor may request the Department consider a change in the wall type, specific system, and/or associated construction if the Contractor determines that project conditions exist that substantially differ from those conditions upon which the decision to specify in the plans a particular wall type(s), wall system, or associated construction was made. An example of this would be where a soldier pile-lagging wall is specified as the only wall type due to right-of-way constraints not allowing for a typical wall type to be built, then subsequently it is determined TDOT can acquire or has sufficient right- of-way available to make another wall type feasible.

The request for consideration of changing of a wall type, system, or associated construction shall be made in writing and be submitted to the Construction Engineer. The Construction Engineer will distribute the request to the Regional Construction Engineer, Structures Division, Geotechnical Engineering Section, Design Division, and Right-of-Way Division, if applicable. The parties will review the request and provide recommended action (approval, rejection, alterations) to the Construction Engineer. If necessary, a plans revision will be made. Note that the Contractor's submission of a request does not imply acceptance by the Department and that the request process shall not be justification for a project schedule change or time extension. The Department reserves the right to require the Contractor to construct the wall as shown in the plans if there are no conditions that exist which render the contract plan wall requirement not constructible.

The Contractor must provide documentation in the request to demonstrate that the proposed change does not in any way cause additional cost to the wall and associated construction or to other aspects of the project. If the Contractor judges that a change involving wall construction must be made due to differing site conditions, the Contractor must follow procedures given in Sections 104.02 and 104.03 of TDOT Standard Specifications for Road and

Bridge Construction.

Requirements for retaining wall protection provided by the retaining wall system

When noted on the plans that a retaining wall is located in a hazard zone subject to vehicular impact, the Contractor shall be aware that retaining wall protection against vehicular collision for the wall may be required. If the retaining wall facing meets any one of the following criteria, an independent barrier wall shall be provided in front of the wall and included in the square foot cost of the wall:

1. Any retaining wall facing that is constructed of non-reinforced concrete (cast-in-place concrete gravity walls are exempt from this requirement and do not require protection.
2. Any dimension of a retaining wall facial panel that is less than 5'0" x 5'0" x 6" thick reinforced panel.
3. Any type of crib retaining walls.
4. A cast in place reinforced facing that has a thickness less than 6 inches.

Materials Approval

The materials used in the construction of the earth retaining walls shall conform to this Special Provision and/or the Standard Specifications. Prior to delivery of any material used in the retaining wall construction, the materials must be accepted in conformance with the specifications associated with the wall type being constructed.

Materials

Unless other otherwise stated in specific retaining wall specifications, the materials used in the construction of earth retaining walls shall conform to the following specifications:

1. Concrete Class "A" shall be in accordance with Section 604 of the Standard Specifications.
2. Concrete Class "D" Shall be in accordance with Section 604 of the Standard Specifications.
3. Reinforcing steel shall conform to ASTM A 615, Grade 60.
4. The sources for all backfill material shall be approved in conformance with the Standard Specifications before the material is delivered to the job site. Any select backfill material must be approved or tested for compliance prior to construction.
5. Lifting hooks and threaded inserts shall be of the size indicated on the working drawings.
6. When required, imbedded items must be galvanized in accordance with AASHTO M 232 or ASTM A 153.
7. Acceptance of materials furnished for work will be in accordance with the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1) and certified test reports as specified in Section 106 – Control of Materials supplemented by routine tests run by the Department as defined in the various applicable sections of the Standard

Specifications.

8. Clearing and grubbing, removal of structures and obstructions, and excavation and undercutting shall be performed in accordance with the provisions of Sections 201, 202, and 203, respectively, of the Standard Specifications. Cost of these items, however, shall be included in the square foot price bid for retaining walls as shown in contract plans.
9. Reinforced Concrete Facing Panels - The panels shall be fabricated in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels."
10. Stone masonry shall be in accordance with Section 612 of the Standard Specifications.
11. All fabricated or precast retaining wall assemblies shall be selected from the TDOT's Qualified Products List.

All concrete, reinforcing steel, and backfill materials shall be tested at the specified frequencies in accordance with the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

Method of Measurement

The method of measurement shall be square foot area of the wall face, measured from the top of footing (or bottom of wall for walls without footings) to the top of the wall excluding any appurtenances in accordance with drawing number W-MSE-1 (in this document). Appurtenances are defined herein as barriers, fences, sign supports, noise wall support posts, and other fixtures. Coping, caps, end sections and moment slabs will **not** be considered appurtenances and are to be considered as part of the wall face.

Basis of Payment

The earth retaining wall, complete in place and accepted, shall be paid for at the contract square foot bid price. The bid price for walls shall include as required: grading and compaction of the wall foundation, undercutting and backfilling of weak surficial zones, installation of ground improvement, footing excavation, presplitting, sheeting, shoring, drilling, piles, lagging, grouting, concrete, reinforcing steel, reinforcement strips or mesh, tie strips or rods, fasteners, connectors, wire mesh baskets, prefabricated modular components, post tensioning, performance testing and evaluation, architectural treatment and/or texture finish, drainage system, water-stops and joint sealing material, coping, caps, end sections, moment slabs, and all miscellaneous material and labor for the complete installation of the wall. If the contractor's design requires the use of select granular backfill, the unit price bid for the wall shall be full compensation for any additional backfill costs due to the use of select backfill material.

If required for retaining wall protection against vehicle impact, the cost of the barrier wall and end terminals shall be included in the square foot cost of the wall.

Additional area of wall required due to unforeseen foundation conditions or other reasons and approved by the Engineer will be paid for on the basis of the unit price bid except as noted below.

The mechanically stabilized earth wall, complete in place and accepted as noted above, shall be paid for at the contract square foot bid price. No increase in unit price will be

paid for increases in wall height less than or equal to 10 feet as compared to the contract plans and wall heights. Wall height increases greater than 10 feet will be paid for by supplemental agreement.

The cast-in-place concrete cantilever or counterfort retaining wall, complete in place and accepted shall be paid for at the contract square foot bid price except as noted below.

If the actual driven quantity of concrete piles driven varies more than 10% from the estimated quantity based on the estimated lengths, an increase or decrease based on the contract bid price, or in the absence of a bid item, a unit price of twenty eight (28) dollars, per linear foot of additional or reduced pile length will be added or deducted accordingly from the price paid for the retaining wall. If the Engineer orders additional test piles, they will be paid for at the contract bid price, or in the absence of a bid item, a unit price of forty (40) dollars per linear foot. If the contractor changes friction pile types or sizes, additional load test(s) may be required at the Engineer's discretion and at the contractor's expense.

If the contractor uses a different type of pile than those that have estimated lengths shown on the contract plans, the price of the wall shall include all costs associated with piles and pile installation with no additional payment for any variation in pile lengths. All pile types and pile driving procedures, lengths, and bearings shall be in accordance with the Standard Specifications and shall be approved by the Engineer

The contractor shall show the estimated quantity of point bearing steel piles on the design drawings submitted for approval. If the actual quantity of steel piles driven differs more than 10% from this approved quantity because of variation in the rock line, the cost of the retaining wall will be increased or decreased accordingly based on the contract bid price, or in the absence of a bid item, a unit price of thirty five (35) dollars per linear foot, for the adjusted piling quantity.

If the Engineer orders changes in the work which alters the surface area of the wall without increasing the height of the wall, payment will be increased or decreased accordingly based on the square foot bid price. If the Engineer orders changes in the work which increases the height of the wall, the unit price bid for the wall sections that were increased up to a maximum of 10 feet will be adjusted according the following tables. Adjustments exceeding 10 feet will be made by supplemental agreement.

RETAINING WALL COST ADJUSTMENT FACTORS
Level Backfill with Slope <= 3 : 1 (Run : Rise)

Original Height (ft.)	Height Increase (ft.)									
	1	2	3	4	5	6	7	8	9	10
1 - 10	1.01	1.02	1.04	1.06	1.08	1.10	1.13	1.16	1.20	1.24
11	1.01	1.03	1.05	1.07	1.09	1.12	1.15	1.19	1.22	1.26
12	1.02	1.03	1.06	1.08	1.11	1.14	1.17	1.21	1.25	1.29
13	1.02	1.04	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.31
14	1.02	1.04	1.07	1.10	1.13	1.17	1.21	1.25	1.29	1.34
15	1.02	1.05	1.08	1.11	1.14	1.18	1.22	1.26	1.31	1.36
16	1.03	1.05	1.08	1.12	1.15	1.19	1.24	1.28	1.33	1.38
17	1.03	1.06	1.09	1.13	1.16	1.21	1.25	1.29	1.34	1.40
18	1.03	1.06	1.10	1.13	1.17	1.22	1.26	1.31	1.36	1.41
19	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.37	1.42
20	1.03	1.07	1.11	1.15	1.19	1.23	1.28	1.33	1.38	1.44
21	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.34	1.39	1.45
22	1.04	1.07	1.11	1.15	1.20	1.25	1.29	1.35	1.40	1.45
23	1.04	1.07	1.12	1.16	1.20	1.25	1.30	1.35	1.41	1.46
24	1.04	1.08	1.12	1.16	1.21	1.25	1.30	1.36	1.41	1.47
25	1.04	1.08	1.12	1.16	1.21	1.26	1.31	1.36	1.41	1.47
26	1.04	1.08	1.12	1.17	1.21	1.26	1.31	1.36	1.42	1.47
27	1.04	1.08	1.12	1.17	1.21	1.26	1.31	1.37	1.42	1.48
28	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	1.48
29	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	1.48
30	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	1.48
31	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.37	1.42	
32	1.04	1.08	1.12	1.17	1.22	1.26	1.31	1.36		
33	1.04	1.08	1.12	1.17	1.22	1.26	1.31			
34	1.04	1.08	1.12	1.17	1.21	1.26				
35	1.04	1.08	1.12	1.17	1.21					
36	1.04	1.08	1.12	1.17						
37	1.04	1.08	1.12							
38	1.04	1.08								
39	1.04									

RETAINING WALL COST ADJUSTMENT FACTORS
Level Backfill with Slope > 3 : 1 (Run : Rise)

Original Height (ft.)	Height Increase (ft.)									
	1	2	3	4	5	6	7	8	9	10
1 - 10	1.03	1.07	1.11	1.16	1.22	1.28	1.35	1.43	1.51	1.60
11	1.04	1.08	1.13	1.18	1.25	1.31	1.39	1.47	1.56	1.65
12	1.04	1.09	1.14	1.20	1.27	1.34	1.42	1.50	1.59	1.69
13	1.05	1.10	1.15	1.22	1.29	1.36	1.44	1.53	1.62	1.72
14	1.05	1.10	1.16	1.23	1.30	1.38	1.46	1.55	1.65	1.75
15	1.05	1.11	1.17	1.24	1.32	1.40	1.48	1.57	1.67	1.77
16	1.05	1.12	1.18	1.25	1.33	1.41	1.49	1.59	1.68	1.78
17	1.06	1.12	1.19	1.26	1.33	1.42	1.50	1.59	1.69	1.79
18	1.06	1.12	1.19	1.26	1.34	1.42	1.51	1.60	1.70	1.80
19	1.06	1.12	1.19	1.27	1.34	1.42	1.51	1.60	1.70	1.80
20	1.06	1.13	1.19	1.27	1.34	1.43	1.51	1.60	1.69	1.79
21	1.06	1.13	1.19	1.27	1.34	1.42	1.51	1.60	1.69	1.79
22	1.06	1.13	1.19	1.27	1.34	1.42	1.51	1.59	1.68	1.78
23	1.06	1.13	1.19	1.27	1.34	1.42	1.50	1.59	1.68	1.77
24	1.06	1.13	1.19	1.26	1.34	1.41	1.50	1.58	1.67	1.76
25	1.06	1.12	1.19	1.26	1.33	1.41	1.49	1.57	1.66	1.74
26	1.06	1.12	1.19	1.26	1.33	1.40	1.48	1.56	1.64	1.73
27	1.06	1.12	1.19	1.25	1.32	1.40	1.47	1.55	1.63	1.72
28	1.06	1.12	1.18	1.25	1.32	1.39	1.46	1.54	1.62	1.70
29	1.06	1.12	1.18	1.25	1.31	1.38	1.46	1.53	1.61	1.69
30	1.06	1.12	1.18	1.24	1.31	1.38	1.45	1.52	1.60	1.67
31	1.06	1.11	1.17	1.24	1.30	1.37	1.44	1.51	1.58	
32	1.06	1.11	1.17	1.23	1.30	1.36	1.43	1.50		
33	1.05	1.11	1.17	1.23	1.29	1.36	1.42			
34	1.05	1.11	1.17	1.22	1.29	1.35				
35	1.05	1.11	1.16	1.22	1.28					
36	1.05	1.10	1.16	1.22						
37	1.05	1.10	1.16							
38	1.05	1.10								
39	1.05									

Specific Wall Construction and Materials Requirements

A. Cast-in-Place (CIP) Concrete Gravity Retaining Walls

1. Construction

The construction of the wall shall be in accordance with this Special Provision and the Standard Specifications.

B. Cast-In-Place (CIP) Concrete Cantilever And Counterfort Retaining Walls

1. Construction

The construction of the wall shall be in accordance with this Special Provision and the Standard Specifications. If the use of piles is anticipated, the foundation information shown on the contract plans shall include the skin friction (Fs) and end bearing (Qb) values, or the location of the rock line. Based on this information, estimated pile lengths shall be shown on the contract plans for fifty (50) and one hundred (100) tons ultimate bearing capacity for Size 1 concrete friction piles. The contractor shall estimate point bearing steel pile refusal lengths based on the given rock line information.

Concrete friction piles shall be installed to provide a minimum factor of safety of 2.0 if a load test is used and a minimum factor of safety of 3.0 if a load test is not used. Pile types, load test procedures, and driving equipment shall be in accordance with the Standard Specifications and shall be approved by the Engineer. The number and location of test piles and load tests shall be approved by the Engineer. Test pile lengths shall be ten (10) feet longer than the estimated pile lengths. Test piles shall be driven in accordance with the Standard Specifications, and shall be required at least every fifty (50) feet along the wall, unless otherwise approved by the Engineer. No pile shall be any farther than five hundred (500) feet from a load test, if a load test is used, unless otherwise approved by the Engineer. The length of production piles to be driven and the required bearing based on the driving equation shall be determined by the Engineer based on the required design bearing, the results of the test piles and load tests (if used), and applicable safety factors. Driven pile lengths and final bearings shall be approved by the Engineer.

Point Bearing Steel Piles shall be driven to refusal. Pile tips shall be used when indicated on the contract plans.

All reinforcing steel projecting from footing into the wall in the back face (fill side) shall be epoxy coated.

C. Concrete Crib Walls (See QPL 38 for Approved Manufacturer/Supplier)

1. Materials

The following items are the construction materials requirements necessary for crib wall design fabrication. All materials shall be approved prior to use.

- Pre-Cast Concrete Crib Units

  The pre-cast crib units are to be made of Class D Portland cement concrete conforming to Section 604 of the Standard Specifications.

- Crib Backfill

  All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

  - The crib backfill material shall consist of an AASHTO classified A-1-a, A-1-b, or A-3 soil with the additional requirement no more than ten percent by weight pass the #200 sieve.
  - The unit weight of the crib fill should be a minimum 115 lb. per cubic foot.
  - Filter protection (geotextile) may be required.

- Backfill Behind the Crib Type Structure

  All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

  - If a filter blanket is placed behind the wall, native soil may be used as backfill behind the structure.
  - Select fill, as defined in 4.2.1 of this document, can be used as backfill behind the structure. The backfill unit weight must be a minimum of 115 pcf. An internal angle of friction can be assumed equal to 35 degrees.

2. Fabrication of Precast Concrete Crib Units

- All pre-cast concrete shall be produced in an approved plant in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

  Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e. aggregate quality reports, cement/steel mill test reports, etc.)

  The fabricator shall provide two precast modular units to the Engineer for approval.

  - These approved precast modular units will serve as standard models. The finished exposed faces of the production precast modular units should be similar to the exposed faces of the model precast modular units.
  - One of the model precast modular units should be kept at the production plant for relative comparison to future modular units. The other model should be kept on the construction site for comparison to the other delivered units.

- To assure uniform unit production steel forms must be used.
- The placement of reinforcing steel within the precast units should conform to the design placement shown in the shop drawings.

- Final acceptability of the precast units shall be determined on the basis of compression tests, production defects and tolerances, and visual inspection. The manufacturer shall furnish all sampling and testing facilities.
- Section 604 of the Standard Specifications states the units shall be steam or moist cured until developing the specified compressive strength set forth in the shop drawings. Any unit not developing the specified compressive strength shall be rejected.
- The precast units should not be delivered before samples have attained the required compressive strength of 4,000 psi (f'_c).
- Prior to shipment, the finished units are subject to visual inspection by the Engineer. Individual crib units may be rejected for any of the reasons listed below.
    i. Variations in the exposed face texture relative to the approved model face texture.
    ii. The length or height of the unit not satisfying the unit allowable tolerance limit of 3/16".
    iii. Honeycombed or open texture units which are notp roperly repaired.
    iv. Individual defects which could affect the structural integrity of the unit Variations in the exposed face texture relative to the approved model face texture.
- TDOT will verify products before shipment in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels". If products are manufactured out of state, TDOT may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests Division that products need to be verified.
- Upon delivery, the exposed surface of the precast units shall be examined. If the exposed faces of any of the units are below the standards of the approved model on site, the units shall be replaced or properly repaired until conforming to the appearance, strength, and durability of the approved model.
- The date of manufacture shall be clearly and permanently marked on one of the inside surfaces of each unit. Each shipment must be accompanied with a certification letter as stated in the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels.

3. Construction

- The Contractor should perform any soil improvement, such as undercutting and backfilling before foundation preparation.

- Compact the top 12" of soil on which the structure will rest to at least 95% of the maximum laboratory dry density as specified in AASHTO T-99.
- No Crib-type wall should be built upon frozen ground.
- Following excavation for the crib wall system, the Contractor shall notify the Engineer for approval of the footing depth and character of the foundation material. No crib wall system work shall proceed until approval has been granted.
- The correct batter of the wall shall not exceed ½" per 10 ft. of wall height.
- The crib backfill should be placed and compacted to at least 95% of the maximum laboratory dry density (AASHTO T-99) in layers no thicker than 12".
- Backfilling behind the crib system shall follow erection as closely as possible. The wall height should never be greater than three feet above the backfill.
- Any underdrain shall be placed in accordance with the details of the working plans.
- The Contractor shall furnish, install, operate, and maintain satisfactory dewatering systems as required to maintain the site in a dry and workable condition. These systems shall be continued as long as necessary. No separate measurement or payment will be made for dewatering.

D. Bin Wall (See QPL 38 for Approved Manufacturer/Supplier)

1. Materials

- Filler for horizontal joints between modular units shall be resin-bonded cork filler or closed cell foam, cross linked polyethylene polymer, conforming to test requirements of AASHTO M 153 or ASTM D 1752 (Type II) or equal. Filter fabric placed behind front vertical joints shall be at least 6" wide and conform to section 918.27 of the TDOT Standard Specifications).
- Backfill: All select granular material shall be free from shale and organic or otherwise deleterious material and conform to the following gradation limits:

Sieve Size	Percent Passing
6 inch	100
3 inch	75-100
No. 200	0-15

The Contractor, at his option, may produce the select granular material by processing the excavation from the project or from approved material from other sources. No direct payment will be made for producing the select granular material.

All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

- Bearing pads shall be rubber of size, and manufacture shown on shop drawings, with the following properties perpendicular to the pad thickness:
    i. Compression- minimum ultimate strength 8000 psi
    ii. Initial Cracking Strain- 40% of thickness
    iii. Hardness (Shore A) – 75 +/- 5
    iv. Tensile Strength- ASTM D 412, die "C", 1000 psi +/- 100 psi
    v. Tear Strength- ASTM D 624, die "B" – 360 psi minimum
- Acceptance of materials furnished for work will be in accordance with the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1) and certified test reports as specified in Section 106 – Control of Materials supplemented by routine tests run by the Department as defined in the various applicable sections of the Standard Specifications.

2. Construction

- Bin Fabrication
    - All pre-cast concrete shall be produced in an approved plant in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

      Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e. aggregate quality reports, cement/steel mill test reports, etc.)

      Before proceeding with production, a model precast modular unit shall be provided by the fabricator for the Engineer's approval to establish a guide and standard for the type of finish to be furnished on the exposed face. This model shall be kept at the fabricator's plant to be used for comparison purposes during production. Formed surfaces other than the exposed face shall not require a special finish
    - Forms: Forms for the units shall be constructed of steel with dimensional tolerances that will assure the production of uniform units. Finish for the front face of the wall shall be in accordance with the finish specified on the contract plans.

    i. Mixing and Placing Concrete: The concrete mix as designed shall be proportioned and mixed in a batch mixer to produce a homogeneous concrete. The transporting, placement, and compaction of concrete shall be by methods that will prevent segregation of the concrete materials and the displacement of the reinforcement steel from its proper position in the form. Concrete shall be carefully placed in the forms and vibrated sufficiently to produce a surface free from imperfections such as honeycomb, segregation or cracking. Clear form oil of the same manufacture shall be used throughout the casting operation.

    ii. Reinforcing Steel: All reinforcing steel for the precast modules and other components shall be fabricated and placed in accordance with plans and Standard Specifications.

- Testing and Inspection: Acceptability of the precast units at the casting yard shall be determined on the basis of compression tests and visual inspection during casting. The manufacturer shall furnish such facilities and assistance as is required to carry on the sampling and testing in an expeditious and satisfactory manner. The manufacturer shall document and provide all test data and certify in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

iii. Curing: The units shall be steam or moist cured as specified in Section 604 of the Standard Specifications for a sufficient length of time so that the concrete will develop the specified compressive strength. Any panel which does not reach specified strength within 28 days shall be rejected.

- Compressive Strength: Compressive tests to determine the minimum strength requirements shall be made on cylinders. A minimum of six cylinders for determining when the units may be put into service will be made from each day's production and cured in accordance with AASHTO T 23 or ASTM C 31. The 28 day compressive strength shall be at least 5000 psi. Compressive strength tests shall be in accordance with AASHTO T 22 or ASTM C 39.

- Rejection: The quality of materials, the process of manufacture, and the finished units shall be subject to inspection by the Engineer prior to shipment. Precast units may be subject to rejection on account of failure to conform to the requirements set forth herein. Individual units may be rejected because of any of the following:

  - Variations in the exposed face that substantially deviate from the approved model as to texture in accordance with precast concrete industry standards.
  - Dimensions not conforming to the following tolerances:
    - Face of panel, length or height: plus/minus 3/16"
    - Deviation from square when measured on diagonal: 5/16" for modules up to 10' wide, 3/4" for larger units.
  - Honeycombed or open texture not properly repaired.
  - Defects which would affect the structural integrity of the unit.

- Shipment: The precast units shall not be shipped until they have achieved the required concrete strength (f'c) of 5000 psi. TDOT will verify products before shipment in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels". If products are manufactured out of state, TDOT may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests Division that products need to be verified

- Repairs at Plant: Before shipment, surfaces of all precast units shall be examined. If the exposed face of a unit is below the standard of the approved model then it shall be properly repaired to conform to the balance of the work with respect to appearance, strength and durability.
- Handling and Storage: Handling devices, as required, shall be provided in each precast modular unit for the purpose of handling and placing. Care shall be taken during storage, transporting, hoisting and handling of all units to prevent cracking or damage. Units damaged by improper storing, transporting or handling shall be replaced or repaired to the satisfaction of the Engineer.
- Marking: The date of manufacture and production lot number shall be clearly and permanently marked on the rear face of each unit.

- Erection:

i. Foundation Preparation: The foundation for the bin wall shall be graded to the elevations and dimensions shown on the contract plans. Prior to wall construction, the top 12 inches of the foundation shall be compacted to at least 95% of the maximum laboratory dry density as determined by AASHTO T 99. Any foundation soils found to be unsuitable or incapable of sustaining the required compaction shall be removed and replaced. After the excavation for each location of the bin wall has been performed, the Contractor shall notify the Engineer. No concrete leveling footing shall be placed until the depth of excavation and the character of the foundation material has been approved by the Geotechnical Engineering Section of the Division of Materials and Tests and permission has been given to proceed by the Engineer.

ii. At each unit foundation level, either a precast or cast-in-place footing and/or leveling pad shall be provided as shown on the shop drawings. The footings shall be given a wood float finish and shall reach the required compressive strength of 3000 psi, before placement of wall modules. The completed footing surface shall be constructed in accordance with grades and cross slopes shown on the shop drawings. When tested with a 10’ straight edge, the surface shall not vary more than 1/8” in 10’. Any additional depth of footing required to level the top surface and bear on approved foundations shall be at the Contractor’s expense.

iii. The modular units shall be installed in accordance with the manufacturer’s recommendations. Special care shall be taken in setting the bottom course of units to true line and grade. Joint filler and neoprene pads, when required, shall be installed in the horizontal joints. Joints at corners or angle points shall be closed as shown on the plans or in accordance with recommendation of the manufacturer.

iv. All units above the first course shall interlock with the lower courses.

Vertical joints shall be staggered with each successive course, or as shown on shop drawings. The vertical joint opening on the front face of the wall shall not exceed 3/4".

v. The interior of each successive course of precast modular units shall be filled with select granular backfill. The maximum lift thickness shall be 2 feet, and shall then be thoroughly consolidated with a vibratory tamping device.

vi. Backfill behind the wall shall be compacted to at least 95 percent of the maximum laboratory dry density as defined in AASHTO T 99 to within one foot of the top of the wall. The top 12 inches shall be compacted to at least 100 percent of the maximum laboratory dry density.

vii. When erecting a battered wall, placement of backfill behind the wall shall closely follow erection of successive courses of units. At no time shall the difference in elevation between the backfill and the top of the last erected course exceed seven feet.

viii. The overall vertical tolerance of the wall shall not exceed 1/2 inch per 10 feet of wall as shown per plans.

ix. Underdrain, if required, shall be placed in accordance with the details shown on the plans or shop drawings.

x. Storm Drains: Where required, precast concrete wall units shall be provided with the appropriate storm drain openings cast into units at the appropriate elevation and locations indicated on drainage profiles. Catch basins shall be located so pipes will enter perpendicular (plan view) to the precast wall units or below the leveling footing as shown on the plans. Construction of catch basins and placement of storm drains must be coordinated with the bin wall construction.

xi. Cooperation between contractors: Contractors must coordinate all phases of the work to prevent delays and expedite construction.

xii. Dewatering: The Contractor shall furnish, install, operate, and maintain satisfactory dewatering systems as required to maintain the site in a dry and workable condition so as to permit grading and compaction of the wall foundation and proper erection and backfill of the wall. These systems shall include all equipment and materials, and shall be continued as long as necessary. No separate measurement or payment will be made for dewatering.

xiii. Technical Consultations: The fabricator will be required as a part of the contract to provide onsite technical expertise to the Contractor and/or the State upon request. Response to requests shall be required within five (5) days of the request. The cost of

furnishing such technical consultations shall be at no cost to the State.

- On Site Inspection
  The quality of materials, the process of manufacture, and the finished member shall be subject to inspection and approval by the Engineer. Any bin wall units damaged prior to acceptance shall be repaired or reconstructed as directed by the Engineer. All costs of repairs or reconstruction shall be at the Contractor's expense.

E. Gabion Wall (See QPL 38 for Approved Manufacturer/Supplier)

1. General:

This section covers the furnishing, assembling, filling with stone and tying open wire mesh rectangular compartmented gabions placed on filter cloth or filter stone as specified herein, and in reasonably close conformity with the lines, grades, dimensions, and cross-sections shown on the plans or as directed by the Engineer, and the design, working drawings, materials, construction, measurement and payment for gabions.

Included in the scope of this section are: grading and compaction of the wall foundation, general and local dewatering as required for proper execution of the work, installation of wall drainage systems as specified on the plans, erection of units, the placement of stone within the units and compaction of the soils behind the units as well as the construction of any required reinforced concrete appurtenances such as caps, copings, or end sections as specified on the plans. For the purposes of this section, the gabions foundation shall include all areas underlying the gabion wall. All other items included in the construction of the retaining wall not specifically mentioned herein this manual shall conform to the applicable sections of the *Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction, January 1, 2015* and the current *AASHTO LRFD Bridge Design Specifications* with interims. Future reference to the *Tennessee Department of Transportation Standard Specification For Road And Bridge Construction- January 1, 2015* will be made as Standard Specifications.

2. Design Criteria

The current AASHTO LRFD Bridge Design Specifications with interims shall be used as the basis for design for the Gabion Wall utilized as a gravity type retaining wall.

3. Submittals

Working drawings and design calculations shall be submitted to the Engineer for review and approval at least 60 days before wall construction is to begin. See Chapter I, Section 4.0 for contractor/supplier submittal responsibilities. The Contractor shall not start work on the bin wall until the working drawings have been approved by the Engineer. Approval of the Contractor's working drawings shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work.

4. Materials

- Gabion Wire Mesh

Gabion basket units shall be fabricated from either a double twisted hexagonal wire mesh (metallic or PVC coated as required in contract plans) or welded wire mesh (metallic or PVC coated as required in contract plans) that meets property requirements described in:

ASTM Designation: A974 − 97 (Reapproved 2011)
Standard Specification for
Welded Wire Fabric Gabions and Gabion Mattresses
(Metallic-Coated or Polyvinyl Chloride (PVC) Coated)

ASTM Designation: A975 − 11
Standard Specification for
Double–Twisted Hexagonal Mesh Gabions and Revet
Mattresses (Metallic-Coated Steel Wire or Metallic-Coated
Steel Wire With Poly(Vinyl Chloride) (PVC) Coating

All other components of the gabion construction such as selvedge wire, lacing wire, spiral connectors, clips, galvanization, PVC coating shall be in accordance with the above specifications.

- Stone Fill

  All stone fill shall be approved by the Engineer and shall be of suitable quality to ensure durability. When the stone is subjected to five alterations of sodium sulfate soundness testing, in accordance with AASHTO T-104, the weighted percentage of loss shall not be more than twelve percent. The inclusion of objectionable quantities of shale, dirt, sand, clay, rock fines, and other deleterious material will not be permitted. Stone fill shall be of well-graded mixture with sizes ranging between 4 inches and 10 inches in diameter, based on U.S. Standard square mesh sieves. No stone shall have minimum dimension less than 4 inches. Stone fill material selected for use in the gabions shall meet the minimum in-place density specified on the plans.

- Filter Cloth

  All filter cloth shall meet the applicable requirements of Section 918.27, Sub-Section 27, of the Standard Specifications.

- Filter Stone

  All filter stone shall meet the applicable requirements of Grading Size 68 or 57. See the Standard Specifications section 903.22.

5. Construction

- Clearing and Grubbing

  Clearing and grubbing, removal of structures and obstructions, and excavation and undercutting shall be performed in accordance with the provisions of Sections 201, 202, and 203, respectively, of the Standard Specifications. Cost of these items, however, shall be included in the square foot price bid retaining walls as shown in contract plans.

- Foundation Preparation

  Foundation preparation for the gabions shall be made to the required depth below the finished surface and to such a width as to permit the proper installation of the gabions. Prior to wall construction, the top 12 inches of the foundation shall be compacted to at least 95% of maximum laboratory dry density as specified in AASHTO T 99. All soft and unsuitable material shall be removed and replaced with suitable material, which shall then be compacted. The finished subgrade shall be smooth and uniform, with no protruding debris or rock formations. A Size 57 stone may be required to obtain the smooth uniform surface and shall be in reasonably close conformity with the dimensions and designs shown on the plans or established by the Engineer. No gabions shall be constructed upon frozen foundation material.

- Filter Cloth or Filter Stone

  Upon final foundation preparation and acceptance by the Engineer, the filter cloth or filter stone shall be placed directly on the foundation at those locations shown on the plans or as directed by the Engineer. All end and side laps shall be a minimum of 18 inches for the filter cloth.

- Assembly (Fabrication)

  Gabions shall be fabricated in such a manner that the sides, ends, lid, and diaphragms can be assembled at the construction site into rectangular baskets. Gabions shall be of single unit construction, i.e., the base, lid, ends, and sides shall be either woven into a single unit or one edge of these members connected to the base section of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh. Gabion units shall be equally divided, by diaphragms of the same mesh and gauge as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary. All perimeter edges of the mesh forming the gabion shall be securely joined so that the joints formed by tying the selvedges or installation of spiral ties have at least the same strength as the body of the mesh. Lacing wire or connecting wire shall be supplied in sufficient quantity for securely fastening all diaphragms and edges of the gabion.

- Assembly (Field)

  i. Empty gabion units shall be placed on the filter blanket when required on contract drawings and shall be assembled individually to the lines and grades indicated on the Plans. Or as directed by the Engineer, with the sides, ends, and diaphragms erected in such a manner to ensure the correct position. All adjoining empty gabion units must be connected by tie wire lacing along the perimeter of their contact surfaces in order to obtain a monolithic structure. Lacing of adjoining basket units shall be accomplished by continuous stitching with alternating single and double loops at

intervals of not more than 5 inches. All lacing wire terminals shall be securely fastened. The use of expedient clip connections for this purpose or as final lid closing will not be permitted. After adjoining empty basket units are set to line and grade and common sides with adjacent units thoroughly laced, they shall be placed in tension and stretched to remove any kinks from the mesh and to a uniform alignment. The stretching of empty basket units shall be accomplished in such a manner as to prevent any possible unraveling and distortion.

ii. Stone filling operations shall carefully proceed with placement by hand or machine so as not to damage galvanized wire coating, to assure a minimum of voids between the stones, to prevent damage to the underlying filter blanket, and to ensure the maintenance of alignment throughout the filling process. The maximum height from which the stone may be dropped into the basket units shall be 36 inches. Along all exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat and compact appearance. The last layer of stone shall be leveled with the top of the gabions to allow for the proper closing of the lid and to provide an even surface that is uniform in appearance.

iii. Lids shall be stretched tight over the stone fill using crowbars or lid closing tools until the lid meets the perimeter edges of the front and end panels. The lid shall then be tightly laced with tie wire along all edges, ends and internal cell diaphragms by continuous stitching with alternating single and double loops at intervals of not more than 5 inches. Special attention shall be given to see that all projections or wire ends are turned into the baskets. Where shown on the drawings or as directed by the Engineer, or where a complete gabion unit cannot be installed because of space limitations, the basket unit shall be cut, folded and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely or folded back and neatly wired to an adjacent gabion face. The assembling, installation, filling, lid closing, and lacing of the reshaped gabion units shall be carried out as specified above.

- Backfill

  Backfilling of the gabion wall shall follow erection as closely as possible and in no case should the height of the wall be greater than seven feet above the backfill. Underdrains, if required, shall be placed in accordance with the details shown on plans. Gabion walls backfill shall have a density of 100 pounds per cubic foot or as specified on contract plans and shall be compacted to at least 95 percent of the maximum laboratory dry density as defined in AASHTO T 99 to within one foot of the top of the wall. The top 12 inches shall be compacted to at least 100 percent of the maximum laboratory dry density. The backfill material shall consist of broken or crushed stone, gravel, sand, slag or other suitable coarse granular material to insure proper drainage. Shale, clay or cinders shall not be permitted as

backfill material. Prior to placement, the backfill material must be approved by the Engineer. The Contractor shall furnish, install, operate, and maintain satisfactory dewatering system as required to maintain the site in a dry and workable condition so as to permit grading and compaction of the wall foundation and proper erection and backfill of the wall. These systems shall include all equipment and materials, and shall be continued as long as necessary. No separate measurement or payment will be made for dewatering or dewatering systems.

All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

- Vertical Wall Tolerance

  The overall vertical tolerance of the wall (plumbness from top to bottom) shall not deviate more than ½ inch per 10 feet of wall height from the contract drawings batter of the wall.

- On Site Inspection

  The quality of materials, the process of manufacture, and the finished members shall be subject to inspection and approval by the Engineer. Any gabions damaged prior to acceptance shall be repaired or reconstructed as directed by the Engineer. All costs of repairs or reconstruction shall be at the Contractor's expense.

F. Segmental, Precast Facing Mechanically Stabilized Earth (MSE) Wall (See QPL 38 for Approved Manufacturer/Supplier)

1. Materials

General - The Contractor shall make arrangements to purchase or manufacture the facing elements, reinforcing mesh or strips, attachment devices, joint filler, and all other necessary components. Materials not conforming to this section or the Standard Specifications or from sources not listed in the contract document shall not be used without written consent from the Engineer.
Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e. aggregate quality reports, cement/steel mill test reports, etc

- Reinforced Concrete Facing Panels - The panels shall be fabricated in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels."

  i. Acceptability of the precast units will be determined on the basis of compressive strength tests, production tolerances, and visual inspection. The Contractor, or the supplier, shall furnish facilities and perform all necessary sampling and testing in an expeditious and satisfactory manner as directed by the Engineer.

  ii. The Portland cement shall be types 1, 2, or 3 and shall conform to the requirements of AASHTO M 85 (ASTM C 150). Concrete for precast panels shall be Class D (4000 psi) as specified in Section

604 of the TDOT Standard Specifications. Admixtures containing chlorides shall not be used.

iii. The panels shall be cast using steel forms. The front face of the panel (face exposed to view when installed in the wall) shall be cast against a steel form or architectural form liner. The back face is to be float finished. The concrete in each panel shall be placed without interruption and shall be consolidated by the use of an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corners of the forms and prevent the formation of stone pocket or cleavage planes. Clear form oil of the same type shall be used throughout the casting operation.

iv. Unless otherwise indicated on the plans or elsewhere in the Standard Specifications, the concrete surface for the front face shall have a Class 1 finish as defined by Section 8.12 of AASHTO, Division II, and for the rear face a uniform surface finish. The rear face of the panel shall be float finished sufficiently to eliminate open aggregate pockets and surface distortions in excess of 1/4 inch. The panels shall be cast on a flat area. The strips or other galvanized attachment devices shall not contact or be attached to the face panel reinforcement steel.

v. Curing and forms removal shall be in accordance with the requirements of Section 604.20 and 604.24 of the Standard Specifications, unless otherwise approved by the Engineer. The forms shall remain in place until they can be removed without damage to the panel.

vi. The units shall be fully supported until the concrete reaches a minimum compressive strength of 1000 psi. The units may be shipped after reaching a minimum specified compressive strength of 4000 psi. TDOT will verify products before shipment in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels and Retaining wall panels". If products are manufactured out of state, TDOT may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests Division that products need to be verified.

vii. Marking - The date of manufacture, the production lot number, and the piece mark shall be clearly scribed on an unexposed face of each panel.

viii. Handling, Storage, and Shipping - All units shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels damaged during handling or storage at the casting plant shall be repaired at the plant as directed by the Engineer. Any panels damaged during handling, storing, or shipping may be rejected upon delivery at the option of the Engineer. Panels in storage shall be supported in firm blocking located immediately

adjacent to embedded connection devices to avoid bending the connection devices.

ix. Tolerances - All units shall be manufactured within the following tolerances:

- Panel Dimensions - Position panel connection devices within 1 inch, except for all other dimensions within 3/16 inch.
- Panel Squareness - Squareness as determined by the difference between the two diagonals shall not exceed 1/2 inch.
- Angular distortion with regard to the height of the panel shall not exceed 3/16 inch in 5 feet.
- Panel Surface Finish - Surface defects on smooth formed surfaces measured over a length of 5 feet shall not exceed 1/8 inch. Surface defects on the textured-finish surfaces measured over a length of 5 feet shall not exceed 5/16 inch.

x. Steel - In accordance with the Standard Specifications.

xi. Compressive Strength - Acceptance of the concrete panels, with respect to compressive strength, will be determined on the basis of production lots. A production lot is defined as a group of panels that will be represented by a single compressive strength sample and will consist of a single day's production as defined in the certify in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

xii. During the production of the concrete panels, the Engineer will sample the concrete in accordance with AASHTO T 141 (ASTM C 172). A single compressive strength sample, consisting of a minimum of six (6)cylinders, will be randomly selected for every production lot.

xiii. Cylinders for compressive strength tests shall be prepared in accordance with AASHTO T 23 (ASTM C 31) on 6" x 12" or 4" x 8" specimens. For every compressive strength sample, a minimum of two (2) cylinders will be cured in the same manner as the panels and tested for acceptance no later than twenty-eight (28) days. The average compressive strength of these two cylinders, when tested according with AASHTO T 22 (ASTM C 39), will determine the compressive strength of the production lot.

xiv. If the Contractor wishes to remove forms or ship the panels prior to 28 days, a minimum of two (2) additional cylinders will be cured in the same manner as the panels. The average compressive strength of these cylinders when tested in accordance with AASHTO T 22, will determine whether the forms can be removed and the panels are acceptable.

xv. Acceptance of a production lot will be made if the compressive strength test result is greater than or equal to 4,000 psi when tested for acceptance no later than 28 days.

xvi. In the event that a production lot fails to meet the specified compressive strength requirements, the production lot shall be rejected. Such rejection shall prevail unless the manufacturer, at their own expense, obtains and submits cores for testing and the results show that the strength and quality of the concrete placed within the panels of the production lot is acceptable. The cores shall be taken from the panels within the production lot and tested in accordance with the specifications of AASHTO T 24 (ASTM C 42). Two cores per each cylinder that failed will be required. In addition, any or all of the following defects shall be sufficient cause for rejection:

- Defects that indicate imperfect molding.
- Defects indicating honeycombing or open texture concrete.
- Defects in the physical characteristics of the concrete such as cracked or severely chipped panels.
- Color variation on front face of panel due to excess form oil or other reasons.
- Damage due to handling, storing or shipping.

xvii. The Engineer shall determine whether spalled, honeycombed, chipped or otherwise defective concrete shall be repaired or rejected. Repair of concrete, if allowed, shall be done with a TDOT approved cementitious polymer patching mortar in a manner satisfactory to the Engineer. Repair to concrete surface which will be exposed to view after completion of construction must be approved by the Engineer.

- Soil Reinforcing and Attachment Devices - All reinforcing and attachment devices shall be shop fabricated and carefully inspected to ensure they are true to size and free from defects that may impair their strength and durability.

i. Reinforcing Strips - Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to either AASHTO M 183 (ASTM A 36) or AASHTO M 223 (ASTM A 572) grade 65 or equal. Galvanization shall conform to the minimum requirements or AASHTO M 111 (ASTM A 123).

ii. Tie Strips - The tie strips shall be shop- fabricated of hot rolled steel conforming to the minimum requirements of ASTM 570, Grade 50 or equivalent. Galvanization shall conform to AASHTO M 111 (ASTM A 123). Tie straps may be partially bent before shipment to the precast yard. Minimum bending radius shall be one inch. Final bending may be accomplished at the precast yard.

iii. Reinforcing Mesh - Reinforcing mesh shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M 32 (ASTM A 82) and shall be welded into the finished mesh fabric in accordance with AASHTO M 55 (ASTM A 185). Galvanization shall be applied after the mesh is fabricated

and conform to the minimum requirements of AASHTO M 111 (ASTM A 123).

iv. Fasteners - Fasteners shall be high strength hexagonal cap screw bolts and nuts conforming to AASHTO M 164 (ASTM A 325). Galvanizing fastener elements, including washers, shall be in accordance with AASHTO M 232 (ASTM A 153). Bolts and nuts nominal diameter will be shown in the plans and supplied in accordance with the fasteners as specified previously.

v. Steel Strap Connections - The steel strap connection bar and plate shall meet the same requirements as the reinforcing and tie strips specified above. Bolts, nuts, and washers shall conform to the requirements for the fasteners specified above. Coatings for connecting devices shall be as specified below.

vi. Clevis Loop and Mesh Loop - Clevis loops and mesh loops shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32 (ASTM A 82) and welded in accordance with AASHTO M 55 (ASTM A 185) and shall develop a minimum stress of 0.9 F_y.

vii. Connector Bar - Connector bar shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32 (ASTM A 82).

viii. Holes for bolts shall be punched in the location shown. Surfaces resulting from punching holes for bolts shall be galvanized in accordance with AASHTO M 111 (ASTM A 123). Those parts of the connecting devices which are threaded shall be galvanized in accordance with AASHTO M 232 (ASTM A 153). Alignment pins are to be hot dip galvanized.

ix. All connecting devices shall be to the dimensions shown on the plans. Connecting members and soil reinforcement devices shall be assembled prior to galvanization. All connecting devices shall be true to size and free from defects that may impair their strength or durability.

x. Any damage sustained to any part of the connecting devices, bolts or reinforcing devices during any phase of fabrication, storage or erection shall be repaired to the satisfaction of the Engineer at no increase in contract cost.

- Geosynthetic Reinforcement Material- Where geosynthetic reinforcements are used for the construction of MSE walls the following requirements shall apply:

i. Geotextiles and Thread for Sewing - Woven or nonwoven geotextiles shall consist only of long chain polymeric filaments or yarns formed into a stable network such that the filaments or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the long chain polymer shall be polyolefin or polyester. The material shall be free of defects and tears. The geotextile shall

conform as a minimum to the properties indicated for Separation, Medium Survivability indicated under AASHTO T 288. The geotextile shall be free from any treatment or coating that might adversely alter its physical properties after installation.

ii. Geogrids - The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport and installation.

iii. Required Properties - The specific geosynthetic material(s) shall be preapproved by the Department and shall have certified long-term strength (T_{al}) as determined by:

- Long-Term strength (T_{al}) based on $T_{al}= T_{ULT}/(RF_D)*(RF_{ID})*(RF_{CR})$ where RF_{CR} is developed from creep tests performed in accordance with ASTM D 5262, RF_{ID} obtained from site installation damage testing and RF_{ID} from hydrolysis or oxidative degradation testing extrapolated to 75 or 100 year design life.
- Ultimate Strength (TULT) based upon minimum average roll values (MARV) (lb/ft), ASTM D4595.
- Pullout Resistance Factor developed in accordance with Chapter 3 of chapter 3 of FHWA-SA-96-071.

iv. Certification - The Contractor shall submit a manufacturer's certification that the geosynthetics supplied meet the respective index criteria set when the geosynthetic was approved by the Department, measured in full accordance with all test methods and standards specified and as set forth in this document.

The manufacturer's certificate shall state that the furnished geosynthetic meets the requirements of this document as evaluated by the manufacturer's quality control program. The certificates shall be attested to by a person having legal authority to bond the manufacturer. In case of dispute over validity of value, the Engineer can require the Contractor to supply test data from a Department approved laboratory to support the certified values submitted.

v. Manufacturing Quality Control: The geosynthetic reinforcement shall be manufactured with a high degree of quality control. The manufacturer is responsible for establishing and maintaining a quality control program to ensure compliance with the requirements of this document. The purpose of the QC testing program is to verify that the reinforcement geosynthetic being

supplied to the project is representative of the material used for performance testing and approval by the Department.

Conformance testing shall be performed as part of the manufacturing process and may vary for each type of product. As a minimum, the following index tests shall be considered as applicable for an acceptable QA/QC program:

Property	**Test Procedure**
Specific Gravity (HDPE only)	ASTM D 1505
Wide Width Tensile	ASTM D 4595; GRI:GG1
Melt Flow (HDPE and PP only)	ASTM D 1238
Intrinsic Viscosity (PET only)	ASTM D 4603
Carboxyl End Group (PET only)	ASTM D 2455

vi. Sampling, Testing, and Acceptance - Sampling and conformance testing shall be in accordance with ASTM D 4354. Conformance testing procedures shall be as established under 4.3.5. Geosynthetic product acceptance shall be based on ASTM D 4759.

The quality control certificate shall include:

- Roll numbers and identification
- Sampling procedures
- Result of quality control tests, including a description of test methods used

vii. Select Granular Backfill Material for use with Geosynthetic Reinforcement – The backfill material shall conform to the requirements as stated below in Select Granular Backfill Material. except that the maximum size of the backfill shall be 3/4 inch, unless full scale installation damage tests are conducted in accordance with ASTM D 5818.

- Joint Materials - Installed to the dimensions and thicknesses in accordance with the plans or approved shop drawings.

i. If required, provide flexible foam strips for filler for vertical joints between panels, and in horizontal joints where pads are used, where indicated on the plans.

ii. Provide in horizontal joints between panels preformed EPDM rubber pads conforming to ASTM D 2000 for 4AA, 812 rubbers, neoprene elastomeric pads having a Durometer Hardness of 55 ± 5, or high density polyethylene pads with a minimum density of 59 lb/ft^3 in accordance with ASTM D 1505.

iii. Cover all joints between panels on the back side of the wall with a geotextile meeting the minimum requirements for filtration applications as specified by AASHTO M 288. The minimum width and lap shall be 12 inches. Adhesive used to attach the filter fabric to the back of the panels shall be approved by the wall supplier.

- Select Granular Backfill Material - All backfill material used in the Mechanically Stabilized Earth structure volume, as shown on the plans, shall be reasonably free (maximum of 0.1%) from organic and otherwise deleterious materials, and it shall be approved by the Engineer prior to use. The material shall conform to the following gradation limits and be tested at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)". The Contractor shall also provide test data from an approved laboratory certifying that the material meets the following:

i. Gradation as determined by AASHTO T 27.

Sieve Size	Percent Passing
4 inches	100
3/8 inch	0-75
No. 4	0-25
No. 8	0-10
No. 16	0-5

Note: Size Nos. 1 through 78 as listed in order of Table 1 Standard Sizes of Processed Aggregate in Section 903.22 of Standard Specifications meet the above gradation requirements.

ii. In addition, the backfill must conform to all of the following requirements:

- Soundness - The material shall be substantially free from shale or other soft, poor durability particles. The material shall have a sodium sulfate loss of less than 12 percent after five (5) cycles determined in accordance with AASHTO T 104.

- The material shall exhibit an angle of internal friction of not less than 34 degrees as determined by the standard direct shear test AASHTO T 236 on the portion finer than the No. 4 sieve, using a sample of the material compacted to 95 percent of AASHTO T 99. No testing is required for backfills where 80 percent of sizes are greater than 3/8 inch.

- Electrochemical requirements - The backfill shall meet the following criteria:

REQUIREMENTS	**TEST METHOD**
ph = 5-10	AASHTO T 289 – 91
Resistivity > 3000 ohm centimeters[1]	AASHTO T 288 – 91
Chlorides < 100 parts per million	AASHTO T 291 – 91
Sulfates < 200 parts per million	AASHTO T 290 – 91
Organic Content < 1 %	AASHTO T 267 – 86

1. If the resistivity is greater or equal to 5000 ohm centimeters the chloride and sulfates requirements may be waived.

- Unit weight- The unit weight of the backfill material (at optimum condition) shall meet the requirements of the approved shop drawings or plans.

- Concrete Leveling Pad, Traffic Barrier and Coping - The concrete shall conform to the requirements of the Standard Specifications for Class A concrete.
- Acceptance of Material - The Contractor shall furnish the Engineer a Certificate of Compliance certifying the above materials comply with the applicable contract specifications. A copy of all test results performed by the Contractor necessary to assure contract compliance shall be furnished to the Engineer.

  Acceptance will be based on the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

2. Construction

a. Foundation Preparation - The foundation for the MSE wall shall be graded level for a minimum width equal to the width of the reinforced volume and leveling pad plus one (1) foot, or as shown on the plans, using the top of the leveling pad as the grade elevation. Prior to wall construction, the foundation shall be compacted to 95 percent of optimum density, as directed by the Engineer. Any foundation soils found to be unsuitable shall be removed as directed by the Engineer and replaced with select granular backfill material compacted to 95 percent of AASHTO T 99. The contractor shall conduct any ground improvements required by the contract plans as part of foundation preparation.

At each panel foundation level, a precast reinforced or a cast-in-place unreinforced concrete leveling pad of the type shown on the plans shall be provided. The concrete shall be Class "A" concrete with compressive strength of 3000 psi (28 day strength). The leveling pad shall be cured a minimum of 12 hours before placement of wall panels.

b. Wall Erection - Where a proprietary wall system is used, a field representative shall be available during the erection of the wall to assist the fabricator, Contractor, and Engineer. If there is more than one wall of the same type on the project, this requirement will apply to construction of the initial wall only. After construction of the initial wall, the representative will be available on an as-needed basis, as requested by the Engineer, during construction of the remainder of the walls. Wall erection shall be in conformance with the latest edition of the MSE wall construction manual as published by the wall supplier. For erection, panels are handled by means of a lifting device set into the upper edge of the panel. Precast concrete panels shall be placed such that a final vertical face will be obtained.

It shall be the responsibility of the Contractor to consult with the designer/supplier and to utilize the proper methods necessary to achieve a vertical face for the final wall. Panels should be placed in successive horizontal lifts as backfill placement proceeds. As backfill material is placed behind the panels, the panels shall be maintained in position by means of temporary wedges or bracing according to the wall supplier's recommendations. External bracing shall also be required for this initial lift. The wedges shall remain in place until the fourth layer of panels is placed, at which time the bottom layer of wedges shall be removed. Each succeeding layer of wedges shall be removed as the succeeding panel layers are placed. When the wall is completed, all wedges shall be removed. No wedges shall be used as a means of leveling panels on leveling pads. Wedges placed below the ground line on the front face of the wall shall be removed before this area is backfilled.

Tolerances and alignment shall be as follows:

i. Horizontal and vertical joint openings between panels shall be uniform. The maximum allowable offset in any panel joint shall be 3/4 inch.

ii. Vertical tolerance (plumbness) and horizontal alignment tolerances as the wall is constructed shall not exceed 3/4 inch when measured along a 10 foot straightedge.

The overall vertical tolerance of the wall (plumbness from top to bottom) in its final position shall not exceed 3/4 inch per 10 feet of wall height.

Cast-in-place concrete shall be placed on top of wall panels to allow precast coping elements on top of the wall to be brought to proper grade.

Prior to placing any select backfill material on any soil reinforcement device, all connections to the panels shall be completed.

c. Backfill Placement - Backfill placement shall closely follow the erection of each lift of panels. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials including panels, soil reinforcements, and connections, or misalignment of the facing panels or reinforcing elements. Any wall materials which may become damaged or disturbed during backfill placement, or due to wall settlement prior to completion of the project shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Engineer. Any misalignment or distortion of the wall facing panels due to placement of backfill outside the limits of this section shall be corrected, as directed by the Engineer at the Contractor's expense. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T 99. When the backfill supports a spread footing of a bridge or other structural load, the top 5 feet shall be compacted to 100 percent of the maximum density. For backfills containing more than 30 percent retained on the ¾ inch sieve, a method compaction consisting of a minimum of 2 passes of a steel drum roller or truck equipment equivalent or larger than a Caterpillar D-6 Bulldozer shall be used.

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall be placed at a moisture content not more than 2 percentage points less than or equal to the optimum moisture content. Backfill material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The optimum moisture content shall be determined in accordance with AASHTO T 99.

At each soil reinforcement device level, backfill shall be compacted to the full length of reinforcement devices and be sloped to drain away from the wall before placing and attaching the next layer of reinforcement devices. The compacted backfill shall be level with the connecting device before the reinforcement device can be connected. Compaction within three feet of the back face of the wall facing panel shall be achieved with at least three (3) passes of a light weight mechanical tamper, roller, or vibratory system.

Unless otherwise indicated on the plans or directed by the Engineer, soil reinforcement devices shall be placed at 90 degrees to the face of the wall. The maximum lift thickness before compaction shall be ten (10) inches and shall closely follow panel erection. The Contractor shall decrease this

lift thickness, if required, to obtain the specified density.

At the end of each day's operation, the Contractor shall slope the last level of backfill away from the wall facing to rapidly direct runoff or rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

G. Prefabricated Modular Block Facing Mechanically Stabilized Earth (MSE) Wall (See QPL 38 for Approved Manufacturer/Supplier)

1. Materials

General - The contractor shall make arrangements to purchase or manufacture the facing elements, reinforcing mesh or strips, attachment devices, joint filler, and all other necessary components. Materials not conforming to this section or from sources not listed in the contract document shall not be used without written consent from the Engineer.

- Concrete Modular Block Facing - The concrete modular blocks shall be either hollow or solid concrete structural retaining wall units, machine made from Portland cement, water, and mineral aggregates with or without the inclusion of other materials. The units are intended for use in the construction of mortarless, modular block retaining (MBW) walls.

  i. Cementious Materials - Materials shall conform to the following:

  - Portland Cement - AASHTO M 85 (ASTM C 150).
  - Blended Cements – Type IP -AASHTO M 240 (ASTM C 595).
  - Pozzolans – Class C or Class F fly ash -AASHTO M 295 Blast Furnace Slag Cement – grade 100 or 120- AASHTO M 302 (ASTM C 989).

  ii. Aggregates - Aggregates shall conform to the following specifications, except that grading requirements shall not necessarily apply:

  - Normal Weight Aggregates – TDOT Standard Specification sections 903.01 and 903.03.
  - Lightweight Aggregates - TDOT Standard Specification section 903.19.

  iii. Other Constituents - Air-entraining agents, coloring pigments, integral water repellants, finely ground silica, and other constituents shall be previously established as suitable for use in concrete MBW units and shall conform to applicable AASHTO Standards or, shall be shown by test or experience to be not detrimental to the durability of MBW units or any material customarily used in masonry construction.

  iv. Physical Requirements. Prior to delivery to the work site, the units shall conform to the following physical requirements:

  1. Minimum required compressive strength = 4,000 psi (Average 3 coupons)
  2. Minimum required compressive strength = 3,500 psi

(Individual coupon)

3. Maximum water absorption = 5%
4. Maximum number of blocks per lot = 2,000

Also, prior to delivery, TDOT will conduct verification testing on the modular blocks in accordance with the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)

If products are manufactured out of state, TDOT may verify at the project site PRIOR to the placement of the units. The Contractor, or producer, shall notify the Regional Materials and Tests Division that products need to be verified.

v. Tolerances. Blocks shall be manufactured within the following tolerances:

- The length and width of each individual block shall be within 1/8 inch of the specified dimension. Hollow units shall have a minimum wall thickness of 1-1/4 inch.
- The height of each individual block shall be within 1/16 inch of the specified dimension.
- When a broken face finish is required, the dimension of the front face shall be within 1 inch of the theoretical dimension of the unit.
- Finish and Appearance. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Minor cracks (e.g. no greater than 1/32 inch in width and no longer than 25 % of the unit height) incidental to the usual method of manufacture or minor chipping resulting from shipment and delivery, are not grounds for rejection.

  The face or faces of units that are to be exposed shall be free of chips, cracks or other imperfections when viewed from a distance of 30 feet under diffused lighting. Up to five (5) percent of a shipment may contain slight cracks or small chips not larger than 1 inch.

  Color and finish shall be as shown on the plans and shall be erected with a running bond configuration.

- If pins are required to align MBW units, they shall consist of a non-degrading, polymer or galvanized steel and be made for the express use with the MBW units supplied.
- Cap units shall be cast to or attached to the top MBW units in strict accordance with the manufacturer's requirements and the adhesive manufacturer's recommended procedures. The Contractor shall provide a written 10 year warranty acceptable to the Department that the integrity of the materials used to

attach the cap blocks will preclude separation and displacement of the cap blocks for the warranty period.

vi. Sampling and Testing. Acceptance of the concrete block with respect to compressive strength and absorption will be determined on a lot basis. The lot will be randomly sampled in accordance with ASTM C 140. Compressive strength and absorption tests shall be performed by the manufacturer and submitted to the Department. Compressive strength test specimens shall be cored or shall conform to the saw-cut coupon provisions of section 6.2.4 of ASTM C 140. Blocks represented by test coupons that do not reach an average compressive strength of 4,000 psi or an individual strength of 3500 psi, or have less than 5 % absorption will be rejected.

vii. Rejection. Blocks shall be rejected because of failure to meet any of the requirements specified above. In addition, any or all of the following defects shall be sufficient cause for rejection.

- Defects that indicate imperfect molding.
- Defects indicating honeycomb or open texture concrete.
- Cracked or severely chipped blocks.
- Color variation on front face of block due to excess form oil or other reasons.

Blocks may also be rejected if TDOT verification test results do not comply with the requirements specified above.

- Unit Fill - The unit fill and drainage aggregate shall be a well graded crushed stone or granular fill meeting the following gradation:

U.S. Sieve Size	**Percent Passing**
1 inch	100-75
3/4 inch	50-75
No. 4	0-60
No. 40	0-50
No. 200	0-5

- Geosynthetic Reinforcement Material - The following requirements shall apply for geosynthetic reinforcement material:

i. Geotextiles and Thread for Sewing - Woven or nonwoven geotextiles shall consist only of long chain polymeric filaments or yarns formed into a stable network such that the filaments or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the long chain polymer shall be polyolefin or polyester. The material shall be free of defects and tears. The geotextile shall

conform as a minimum to the properties indicated for Separation, Medium Survivability indicated under AASHTO T 288. The geotextile shall be free from any treatment or coating that might adversely alter its physical properties after installation.

ii. Geogrids - The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid structure shall be dimensionally stable and able to retain its geometry under manufacture, transport and installation.

iii. Required Properties - The specific geosynthetic material(s) shall be pre-approved by the Department and shall have certified long-term strength (T_{al}) as determined by:

- Long-Term strength (T_{al}) based on $T_{al} = T_{ult}/(RF_D)*(RF_{ID})*(RF_{CR})$ where RF_{CR} is developed from creep tests performed in accordance with ASTM D 5262, RF_{ID} obtained from site installation damage testing and RF_{ID} from hydrolysis or oxidative degradation testing extrapolated to 75 or 100 year design life.
- Ultimate Strength (T_{ULT}) based upon minimum average roll values (MARV) (lb/ft), ASTM D4595.
- Pullout Resistance Factor developed in accordance with chapter 3 of FHWA-SA-96-071.

iv. Certification - The Contractor shall submit a manufacturer's certification that the geosynthetics supplied meet the respective index criteria set when the geosynthetic was approved by the Department, measured in full accordance with all test methods and standards specified and as set forth in this section of the TDOT Earth Retaining Structures Manual. The manufacturer's certificate shall state that the furnished geosynthetic meets the requirements of this document as evaluated by the manufacturer's quality control program. The certificates shall be attested to by a person having legal authority to bond the manufacturer. In case of dispute over validity of values, the Engineer can require the Contractor to supply test data from a Department approved laboratory to support the certified values submitted.

v. Manufacturing Quality Control: The geosynthetic reinforcement shall be manufactured with a high degree of quality control. The manufacturer is responsible for establishing and maintaining a quality control program to ensure compliance with the requirements of the TDOT Earth Retaining Structures Manual. The purpose of the QC testing program is to verify that the geosynthetic being supplied to the project is representative of the material used for performance testing and approval by the

Department.

Conformance testing shall be performed as part of the manufacturing process and may vary for each type of product. As a minimum the following index tests shall be considered as applicable for an acceptable QA/QC program:

Property	**Test Procedure**
Specific Gravity (HDPE only)	ASTM D 1505
Wide Width Tensile	ASTM D 4595; GRI:GG1
Melt Flow (HDPE and PP only)	ASTM D 1238
Intrinsic Viscosity (PET only)	ASTM D 4603
Carboxyl End Group (PET only)	ASTM D 2455

vi. Sampling, Testing, and Acceptance - Sampling and conformance testing shall be in accordance with ASTM D 4354. Conformance testing procedures shall be as established under section 4.3.5. Geosynthetic product acceptance shall be based on ASTM D 4759.

The quality control certificate shall include:

- Roll numbers and identification
- Sampling procedures
- Result of quality control tests, including a description of test methods used.

vii. Select Granular Backfill Material for use with Geosynthetic Reinforcement - The backfill material shall conform to the requirements as stated below in Select Granular Backfill Material except that the maximum size of the backfill shall be 3/4 inch, unless full scale installation damage tests are conducted in accordance with ASTM D 5818.

All backfill material shall be tested prior to use and at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

- Soil Reinforcing and Attachment Devices - Where steel reinforcing and attachment devices are used in the construction of the MSE wall the following requirements shall apply.

i. Reinforcing Strips - Reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to either AASHTO M 183 (ASTM A 36) or AASHTO M 223 (ASTM A 572) grade 65 or equal. Galvanization shall conform to the minimum requirements or AASHTO M 111 (ASTM A 123).

ii. Tie Strips - The tie strips shall be shop-fabricated of hot rolled steel conforming to the minimum requirements of ASTM A 570,

Grade 50 or equivalent. Galvanization shall conform to AASHTO M111. Tie straps may be partially bent before shipment to the precast yard. Minimum bending radius shall be one inch. Final bending may be accomplished at the precast yard.

iii. Reinforcing Mesh - Reinforcing mesh shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M 32 (ASTM A 82) and shall be welded into the finished mesh fabric in accordance with AASHTO M 55 (ASTM A 185). Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of AASHTO M 111

iv. Fasteners - Fasteners shall be high strength hexagonal cap screw bolts and nuts conforming to AASHTO M 164 (ASTM A 325).Galvanizing fastener elements, including washers, shall be in accordance with AASHTO M 232 (ASTM A 153). Bolts and nuts nominal diameter will be shown in the plans and supplied in accordance with the fasteners as specified previously.

v. Steel Strap Connections - The steel strap connection bar and plate shall meet the same requirements as the reinforcing and tie strips specified above. Bolts, nuts, and washers shall conform to the requirements for the fasteners specified above. Coatings for connecting devices shall be as specified below.

vi. Clevis Loop and Mesh Loop - Clevis loops and mesh loops shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32 and welded in accordance with AASHTO M 55 and shall develop a minimum stress of 0.9 F_y.

vii. Connector Bar - Connector bar shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32.

Holes for bolts shall be punched in the location shown. Surfaces resulting from punching holes for bolts shall be galvanized in accordance with AASHTO M 111. Those parts of the connecting devices which are threaded shall be galvanized in accordance with AASHTO M 232. Alignment pins are to be hot dip galvanized.

All connecting devices shall be to the dimensions shown on the plans. Connecting members and soil reinforcement devices shall be assembled prior to galvanization. All connecting devices shall be true to size and free from defects that may impair their strength or durability.

Any damage sustained by any part of the connecting devices, bolts or reinforcing devices during any phase of fabrication, storage or erection shall be repaired to the satisfaction of the Engineer at no increase in contract cost.

Select Granular Backfill Material - All backfill material used in the Mechanically Stabilized Earth structure volume, as shown on the plans, shall be reasonably free (maximum of 0.1%) from organic and otherwise deleterious materials, and it shall be approved by the Engineer prior to use. The material shall conform to the following gradation limits and be tested

at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)". The Contractor shall also provide test data from an approved laboratory certifying that the material meets the following:

i. Gradation as determined by AASHTO T 27.

Sieve Size	Percent Passing
4 inches	100
3/8 inch	0-75
No. 4	0-25
No. 8	0-10
No. 16	0-5

Note: Size Nos. 1 through 78 as listed in order of Table 1 Standard Sizes of Processed Aggregate in Section 903.22 of Standard Specifications meet the above gradation requirements.

ii. In addition, the backfill must conform to all of the following requirements:

- Soundness - The material shall be substantially free from shale or other soft, poor durability particles. The material shall have a sodium sulfate loss of less than 12 percent after five (5) cycles determined in accordance with AASHTO T 104.
- The Plasticity Index (P.I.), as determined by AASHTO T 90, shall not exceed 6.
- The material shall exhibit an angle of internal friction of not less than 34 degrees as determined by the standard direct shear test AASHTO T 236 on the portion finer than the No. 4 sieve, using a sample of the material compacted to 95 percent of AASHTO T 99. No testing is required for backfills where 80 percent of sizes are greater than 3/8 inch.
- Electrochemical requirements - The backfill shall meet the following criteria:

REQUIREMENTS	**TEST METHOD**
ph= 5-10	AASHTO T 289 – 91
Resistivity > 3000 ohm centimeters[1]	AASHTO T 288 – 91
Chlorides < 100 parts per million	AASHTO T 291 – 91
Sulfates < 200 parts per million	AASHTO T 290 – 91
Organic Content < 1%	AASHTO T 267 – 86

1. If the resistivity is greater or equal to 5000 ohm centimeters the chloride and sulfates requirements may be waived.

- Unit weight- The unit weight of the backfill material (at optimum condition) shall meet the requirements of the approved shop drawings or plans.

- Concrete Leveling Pad, Traffic Barrier and Coping - The concrete shall conform to the requirements of the Standard Specifications for Class A concrete.

- Acceptance of Material - The contractor shall furnish the Engineer a Certificate of Compliance certifying the above materials comply with the applicable contract specifications. A copy of all test results performed by the Contractor necessary to assure contract compliance shall be furnished to the Engineer.

2. Construction

a. Wall Excavation - Unclassified excavation shall be in accordance with the requirements of the Standard Specifications and in reasonably close conformity with the limits and construction lines shown on the plans. Temporary excavation support as required shall be the responsibility of the Contractor.

b. Foundation Preparation - The foundation for the MSE wall shall be graded level for a minimum width equal to the width of the reinforced volume and leveling pad plus one (1) foot, or as shown on the plans, using the top of the leveling pad as the grade elevation. Prior to wall construction, the foundation shall be compacted to 95 percent of optimum density, as directed by the Engineer. Any foundation soils found to be unsuitable shall be removed as directed by the Engineer and replaced with select granular backfill material compacted to 95 percent of AASHTO T 99 methods. The contractor shall conduct any ground improvement required by the contract plans as part of foundation preparation.

At each block foundation level, a precast reinforced or a cast-in-place unreinforced concrete leveling pad of the type shown on the plans shall be provided. The concrete shall be Class A concrete with compressive strength of 3000 psi (28 day strength). The leveling pad shall be cured a minimum of 12 hours before placement of wall panels.

c. Wall Erection - Where a proprietary wall system is used, a field representative shall be available during the erection of the wall to assist the fabricator, Contractor, and Engineer. If there is more than one wall of the same type on the project, this requirement will apply to construction of the initial wall only. After the initial wall, the representative will be available on an as-needed basis, as requested by the Engineer, during construction of the remainder of the walls. Wall erection shall be in conformance with the latest edition of the MSE wall construction manual as published by the wall supplier.

It shall be the responsibility of the Contractor to consult with the designer/supplier and to utilize the proper methods necessary to achieve a vertical face for the final wall. Blocks should be placed in successive horizontal lifts as backfill placement proceeds per the manufacturer's recommendations.

Cast-in-place concrete shall be placed on top of wall panels to allow precast coping elements on top of the wall to be brought to proper grade.

Prior to placing any select backfill material on any soil reinforcement device, all connections to the blocks shall be completed.

d. Backfill Placement - Backfill placement shall closely follow the erection of each lift of blocks. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials including blocks, soil reinforcements, and connections, or misalignment of the facing blocks or reinforcing elements. Any wall materials which may become damaged or disturbed during backfill placement, or due to wall settlement prior to completion of the project shall be either removed and replaced at the Contractor's expense or corrected, as directed by the Engineer. Any misalignment or distortion of the wall facing blocks due to placement of backfill outside the limits of this section shall be corrected, as directed by the Engineer. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T 99. When the backfill supports a spread footing of a bridge or other structural load, the top 5 feet shall be compacted to 100 percent of the maximum density. For backfills containing more than 30 percent retained on the ¾ inch sieve, a method compaction consisting of a minimum of 2 passes of a steel drum roller or tracked equipment equivalent or larger than a Caterpillar D-6 Dozer shall be used.

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall have a placement moisture content less than or equal to the optimum moisture content. Backfill material with placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift. The optimum moisture content shall be determined in accordance with AASHTO T 99.

At each soil reinforcement device level, backfill shall be compacted to the full length of reinforcement devices and be sloped to drain away from the wall before placing and attaching the next layer of reinforcement devices. The compacted backfill shall be level with the connecting device before the reinforcement device can be connected. Compaction within three feet of the back of the wall facing shall be achieved with at least three (3) passes of a light weight mechanical tamper, roller, or vibratory system.

Unless otherwise indicated on the plans or directed by the Engineer, soil reinforcement devices shall be placed at 90 degrees to the face of the wall. The maximum lift thickness before compaction shall be ten (10) inches and shall closely follow modular block erection. The Contractor shall decrease this lift thickness, if required, to obtain the specified density.

At the end of each day's operation, the Contractor shall slope the last level

of backfill away from the wall facing to rapidly direct runoff or rainwater away from the wall face. In addition, the contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

H. Anchored Wall (See QPL 38 for Approved Manufacturer/Supplier)

Part A - Part A covers specifications for permanent ground anchor walls exclusive of the ground anchors.

1. Design Criteria

Unless otherwise directed the Contractor shall select the type of wall element to be used. The wall shall be designed for shear, moment, and lateral and axial capacity in accordance with AASHTO LRFD procedures. The Contractor shall be responsible for determining the length of the wall element and required section necessary to resist loadings due to earth, and water forces while controlling ground movements. Structure design life and corrosion protection requirements for sheet-piles and soldier beams will be provided on the contract drawings. Soil properties, safety factors, anchor tendon corrosion protection requirements, wall finish and color requirements, and appurtenance locations are given in the contract plans or specifications.

The Contractor shall be familiar with the requirements for ground anchors described in Part B, "Ground Anchors". The contractor shall incorporate all dimensional and location restrictions on ground anchor locations, spacing, and length of anchor bond length and unbonded length that may affect the design of the wall system covered by this section.

- The wall system shall be designed to resist maximum anticipated loadings calculated for the effects of any special loadings shown on the contract plans.
- The wall shall be designed to ensure stability against passive failure of the embedded portion of the vertical wall elements (below the base of excavation).
- The axial load carrying capacity of the embedded portion of the vertical wall elements (below the base of the excavation) shall be evaluated.. The wall shall be designed to resist vertical loads including vertical anchor forces and the weight of the lagging and the vertical wall elements. Relying on transfer of vertical load into the soil behind the wall by friction shall not be permitted, unless approved by the Engineer.
- Permanent facing shall be precast or cast-in-place reinforced concrete. Architectural facing treatments, if required, shall be as indicated on the contract drawings. The facing shall extend a minimum of 2.0ft below the gutter line or, if applicable, the ground line adjacent to the wall unless otherwise indicated on the contract drawings.
- The Contract Plans will provide minimum requirements of design elements in order to provide global stability requirement such as minimum embedment of vertical pile elements or minimum lengths of unbonded (free-length) zone for anchors. The wall design shall provide these minimum requirements.
- Wall Drainage. The wall drainage system shall operate by gravity and

shall be capable of relieving water pressures on the back face of the wall under anticipated worst case water pressure conditions. When drainage systems are incorporated into the specific design, hydrostatic head on the back of the wall shall not exceed 6 inches above the elevation of the drainage collection pipe.

2. Materials

The Contractor shall not deliver materials to the site until the Engineer has approved the submittals outlined in section 3.0. The Contractor shall protect the materials from the elements by appropriate means. Prestressing steel strands and bars shall be stored and handled in accordance with the manufacturer's recommendations and in such a manner that no damage to the component parts occurs. All steel components shall be stored under cover and protected against moisture.

- Soldier Beam and Structural Steels

  i. Steel Soldier Beams - Steel soldier beams shall be of the type and weight indicated on the approved working drawings. Steel soldier beams shall conform to the requirements of AASHTO M 183 (ASTM A 36) or AASHTO M 223 (ASTM A 572) unless otherwise specified.

  ii. Steel Sheet Piles - Steel sheet piles shall be of the type and weight indicated on the approved working drawings. Steel sheet piles shall conform to the requirements of AASHTO M 202 (ASTM A 328) or AASHTO M 270 (ASTM A 709) Grade 50.

  iii. Steel Plate - Steel used to fabricate steel studs and other devices shall conform to the requirements of AASHTO M 169 (ASTM A 108)

  iv. Steel Tube - Steel tube shall conform to the requirements of ASTM A 500.

  v. Reinforcing Steel - Reinforcing steel shall conform to ASTM A 615. The required Grade of all reinforcing shall be shown on the plans.

- Concrete

  i. Cement - Portland cement shall be Type I or II and shall conform to AASHTO M 85.

  ii. Structural Concrete - Structural concrete shall conform to the requirements of Section 604 of the TDOT Standard Specifications Structural concrete shall be Class A with a minimum 28-day compressive strength of 3000 psi, unless otherwise noted on the contract drawings.

  iii. Lean-Mix Concrete Backfill - Lean-mix concrete backfill shall consist of Type I or Type II Portland cement, fine aggregate and water. Each cubic yard of lean-mix concrete backfill shall consist of a minimum of one sack (94lbs) of Portland cement.

iv. Precast Concrete - Precast concrete elements such as panels shall be made by an approved plant in accordance with the TDOT Procedure for the "Manufacture and Acceptance of Pre-cast Concrete Drainage Structures, Noise Wall panels, and Retaining wall panels".

Out-of-state producers shall provide documentation of material quality before the manufacture of any pre-cast products (i.e. aggregate quality reports, cement/steel mill test reports, etc.)

Unless otherwise shown on the contract drawings, Portland cement concrete used in precast elements shall conform to Class D with a minimum 28-day compressive strength of 4000 psi

- Drainage Materials

i. Drainage Aggregate - Drainage aggregate to be used as a drainage medium shall conform to section 903.17 of the Standard Specifications.

ii. Preformed Permeable Geocomposite Drains – The preformed permeable geocomposite drains shall be continuous and a minimum of one (1) foot wide. The drains shall be placed in sections with a minimum overlap of one (1) foot and be spliced to assure continuous drainage.

iii. Pipe and Perforated Pipe - Pipe and perforated pipe shall conform to section 610 of the Standard Specifications.

- Lagging

i. Temporary Timber Lagging - Temporary timber lagging shall be construction grade rough cut and shall be a minimum of 3 inches thick. Where necessary, the Contractor shall provide certification that the timber conforms to the grade, species, and other specified requirements. If the timber is to be treated with a preservative, a certificate of compliance shall be furnished.

ii. Permanent Timber Lagging – Permanent timber lagging shall conform to all requirements of section 2.d.i. and shall be constructed from structural stress-graded lumber.

3. Construction

- General Considerations

i. Wall elements for anchored walls designed and constructed in accordance with this manual shall be either continuous interlocking sheet-piles or steel soldier beams that are either driven or placed in pre-drilled holes that are subsequently backfilled with lean mix or structural concrete.

- Excavation

i. Excavation below a level of anchors shall be limited to 2 feet below the anchor level and shall not commence below this level until anchors at that level have been installed, load tested, locked

off and accepted by the Department. Placement of timber lagging shall immediately follow excavation in the front of the wall.

- Driven Sheet Pile and Soldier Beam Installation.

  i. Driven sheet piles and soldier beams shall be driven to the specified minimum tip elevation shown on the approved working drawings. The Contractor shall select a sheet pile or soldier beam section that satisfies all design criteria. The Contractor shall select a driving method and pile driving and ancillary equipment consistent with the expected ground conditions at the site. The sheet-pile or soldier beam shall be driven to the specified minimum tip elevation or to the approved elevation based on bearing capacity without damaging the sheet pile or soldier beam. The interlocks between adjacent sheet piles shall not be damaged. Equipment shall be used to permit the impact energy to be distributed over the tops of the sheet pile or soldier beam.

- Soldier Beam Installation in Pre-drilled Holes

  i. Excavations required for soldier beam placement shall be performed to the dimensions and elevations on the approved working drawings. The methods and equipment used shall be selected by the Contractor.

  ii. The Contractor shall ensure that the sidewalls of the pre-drilled holes (i.e. shafts) do not collapse during drilling. Uncased shafts may be used where the sides and the bottom of the shaft are stable and may be visually inspected prior to placing the soldier beam and concrete. Casing or drilling muds shall be used where the sides of the shaft require additional support.

  iii. The Contractor shall provide equipment for checking the dimensions and alignment of each shaft excavation. The dimensions and alignment shall be determined by the Contractor but shall be observed by the Inspector. The Inspector will check the alignment of the drilling equipment at the beginning of shaft construction and periodically thereafter. Final shaft depth shall be measured after final cleaning by the Contractor.

  iv. Loose material shall be removed from the bottom of the shaft. No more than 2 feet of standing water shall be left in the bottom of the shaft prior to beginning soldier beam installation.

  v. The soldier beam shall be placed in the shaft without difficulty and aligned prior to general placement of concrete. The Contractor may place up to 2 feet of concrete at the bottom of the shaft to assist in aligning the soldier beam. The soldier beam shall be blocked or clamped in place at the ground surface, prior to placement of concrete.

  vi. For shafts constructed without casing or drilling muds, concrete (either structural or lean-mix backfill) may be placed by free-falling the concrete from the ground surface down the shaft and

around the soldier beam. If casing is used, the placement of concrete shall begin prior to casing removal. Remove the casing while the concrete remains workable. For shafts constructed using slurry, concrete shall be placed using the tremie method from the bottom of the shaft. The tremie pipe shall be withdrawn slowly as the level of the concrete rises in the shaft and the level of the tremie pipe outlet shall never exceed the height of the slurry.

- Wall Tolerances

  i. Soldier beams shall be placed at the locations shown on the approved working drawings and shall not deviate by more than 1 foot along the horizontal alignment of the wall. The wall shall not deviate from the vertical alignment shown of the contract drawings by more than 4 inches in each plane.

  ii. The soldier beam or sheet pile tip shall be installed to within 1 foot of the specified tip elevation shown on the approved working drawings.

  iii. Whenever a soldier beam deviates in location or plumbness by more than the tolerance given in these guidelines, the Contractor, at his option, may provide corrective measures such as 1) rebuilding soldier beams; 2) redesigning soldier beam; 3) adjust soldier beam spacing by adding additional soldier beams; 4) redesigning concrete facing; 5) building up the soldier beam section, or 6) other methods.

- Welding and Splicing

  i. Splicing of sheet piles or soldier beams shall not be permitted, unless approved by the Department. All structural welding of steel and steel reinforcement shall be performed by certified welders qualified to perform the type of welding shown on the shop drawings. All sheet piles or soldier beams shall be cutoff to a true plane at the elevations shown on the approved working drawings. All cutoff lengths shall remain the property of the Contractor and shall be properly disposed.

- Timber Lagging Installation

  i. Timber lagging shall be placed from the top-down in sufficiently small lifts immediately after excavation to prevent erosion of materials into the excavation. Prior to lagging placement, the soil face shall be smoothed to create a contact surface for the lagging. Large gaps behind the lagging shall be backfilled and compacted prior to applying any loads to the ground anchors.

  ii. A gap shall be maintained between each vertically adjacent lagging board for drainage between adjacent lagging sections. In no case shall lagging be placed in tight contact to adjacent lagging.

- Drainage System Installation

  i. The Contractor shall handle preformed permeable geocomposite drains in such a manner as to ensure the geocomposite drain is not

damaged in any way. Care shall be taken during placement of the geocomposite drain not to entrap dirt or excessive dust in the geocomposite drain that could cause clogging of the drainage system. Delivery, storage, and handling of the geocomposite drains shall be as provided in the plans or based on manufacturer's recommendations.

ii. Drainage geocomposite strips shall be placed and secured tightly against the timber lagging with the fabric facing the lagging. A continuous sheet of drainage geocomposite that spans between adjacent soldier beams shall not be allowed. Seams and overlaps between adjacent composites shall be made according to the special provisions or manufacturer's recommendations and specifications. Repairs shall be performed at no additional cost to the Department and shall conform to the plans or manufacturer's recommendation.

iii. Where drainage aggregate is used to construct a vertical drain behind the permanent wall and in front of the lagging, the drainage aggregate shall be placed in horizontal lifts. The construction of the vertical drain should closely follow the construction of the precast facing elements. Care should be exercised to ensure that connection devices between wall elements and facing elements are not damaged during the placement of the drainage aggregate.

iv. Perforated collector pipe shall be placed within the permeable material to the flow line elevations and at the location shown on the approved working drawings. Outlet pipes shall be placed at the low end of the collector pipe and at other locations shown or specified in the approved working drawings.

- Concrete Facing Installation

  For permanent cast-in-place and precast concrete facings, concrete manufacture, handling, placement, and finishing shall conform to the requirements in Section 8 "Concrete Structures" of the AASHTO - *LRFD Bridge Construction Specifications with interims*. Connections used to secure the facing to wall elements shall conform to the details shown on the approved working drawings. The exposed surface of the concrete facing shall receive a Class I finish as specified in Section 8 "Concrete Structures," unless a special architectural treatment is specified.

Part B, Anchored Wall (See QPL 38 for Approved Manufacturer/Supplier) – Part B covers specifications for the design, construction and testing of Permanent Ground Anchors.

1. Description

The work covered under this section includes the furnishing of all materials, labor, tools, equipment, and other incidental items for the designing, detailing, and construction of permanent ground anchors. All other items included in the construction of the permanent ground anchors not specifically mentioned herein shall

conform to all applicable sections of the *Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction*, henceforth referred to as the Standard Specifications, the current *AASHTO LRFD Bridge Design Specifications* with latest revisions, the current *AASHTO LRFD Bridge Construction Specifications* with interims, and the latest version of Post Tensioning Institute (PTI) Standards, including: 1. *PTI, "Post Tensioning Manual"*, 2. *PTI "Specification for Unbonded Single Strand Tendons"*, 3. *PTI "Recommendations for Prestressed Rock and Soil Anchors."*

Unless otherwise noted the Contractor shall select the ground anchor type, drilling method, grouting method, and grout pressures, determine the ground anchor capacity, bond length, free stressing (unbonded) length, and anchor diameter. The Contractor shall be responsible for installing ground anchors that will develop the load-carrying capacity indicated on the approved working drawings in accordance with the testing subsection of this section. The anchor tendon shall be protected from corrosion as shown on the approved working drawings and in accordance with the requirements of this specification.

2. Design Criteria

- Unless otherwise directed the Contractor shall select the type of tendon to be used. The tendon shall be sized so the design load does not exceed 60 percent of the specified minimum tensile strength of the prestressing steel. The lock-off load for the tendon shall be chosen based on anticipated time or activity dependent load changes, but shall not exceed 70 percent of the specified minimum tensile stress of the prestressing steel. The prestressing steel shall be sized so the maximum test load does not exceed 80 percent of the specified minimum tensile strength of the prestressing steel.

- The Contractor shall be responsible for determining the bond length necessary to develop the design load indicated on the approved working drawings. The minimum bond length shall be 15 feet for strand tendons in rock and 10 feet for bar tendons in rock. The minimum bond length shall be 15 feet for strand and bar tendons in soil. The minimum tendon bond length shall be 10 feet.

- The free stressing length (unbonded length) for rock and soil anchors shall not be less than 10 feet for bar tendons and 15 feet for strand tendons. The free stressing length shall extend at least 5 feet or 20 percent of the height of the wall, whichever is greater, behind the critical failure surface. The critical failure surface shall be evaluated using slope stability or similar procedures.

3. Submittals

Requirements for submittals are as outlined above and also include the following:

- Contractor qualifications as outlined in Part A, of these anchored wall design and construction requirements.
    - The working drawings and design submission shall include the following:
        a) A ground anchor schedule giving:
        - Ground anchor number

- Ground anchor design load
- Type and size of tendon
- Minimum total anchor length
- Minimum bond length
- Minimum tendon bond length
- Minimum unbonded length

b) A drawing of the ground anchor tendon and the corrosion protection system including details for the following:

- Spacers and their location
- Centralizers and their location
- Unbonded length corrosion protection system
- Bond length corrosion protection system
- Anchorage and trumpet
- Anchorage corrosion protection system

- Certificates of Compliance for the following materials , if used. The certificate shall state that the materials or assemblies to be provided will fully comply with the requirements of the contract.

a) Prestressing steel, strand or bar
b) Portland cement
c) Prestressing hardware
d) Bearing plates
e) Corrosion protection system

- The Contractor shall submit to the Engineer for review and approval or rejection mill test reports for the prestressing steel and the bearing plate steel. The Engineer may require the Contractor to provide samples of any ground anchor material intended for use on the project. The prestressing steel and bearing plates shall not be incorporated in the work without the Engineer's approval.

- The Contractor shall submit to the Engineer for review and approval or rejection calibration data for each test jack, load cell, primary pressure gauge and reference pressure gauge to be used. Testing cannot commence until the Engineer has approved these calibrations.

- The Contractor shall submit to the Engineer within twenty calendar days after the completion of the ground anchor work a report containing the following:

a) Prestressing steel manufacturer's mill test reports for the tendons incorporated in the installation
b) Grouting records indicating the cement type, quantity injected and the grout pressures
c) Ground anchor test results
d) As-built drawings showing the location and orientation of each ground anchor, anchor capacity, tendon type, total anchor length, bond length, unbonded length, and tendon bond length as installed

and locations of all instruments installed by the Department.

- Existing Conditions – Prior to beginning work, the Department shall provide utility location plans to the Contractor. The Contractor is responsible for contacting a utility location service to verify the location of underground utilities before starting work. The Contractor shall survey the condition of adjoining properties and make records and photographs of any evidence of settlement or cracking of any adjacent structures. The Contractor's report of this survey shall be delivered to the Department before work begins.

4. Materials

- General

  a) The Contractor shall not deliver materials to the site until the Engineer has approved the submittals outlined in Section 3.0.

  b) The Contractor shall protect all materials from theft, vandalism, and the elements by appropriate means. Prestressing steel strands and bars shall be stored and handled in accordance with the manufacturer's recommendations and in such a manner that no damage to the component parts occurs. All steel components shall be protected from the elements at all times. Cement and additives for grout shall be stored under cover and protected against moisture.

- Anchorage Devices

  a) Stressing anchorages shall be a combination of either steel bearing plate with wedge plate and wedges, or a steel bearing plate with a threaded anchor nut. The steel bearing and wedge plate may also be combined into a single element. Anchorage devices shall be capable of developing 95 percent of the specified minimum ultimate tensile strength of the prestressing steel tendon. The anchorage devices shall conform to the static strength requirements of Section 3.1.6 (1) and Section 3.1.8 (1) and (2) of the latest edition of the PTI *"Guide Specifications for Post-Tensioning Materials."*

  b) The bearing plate shall be fabricated from steel conforming to AASHTO M 183 or M 222 specifications, or equivalent, or may be

a ductile iron casting conforming to ASTM A 536.

c) The trumpet shall be fabricated from a steel pipe or tube or from PVC pipe. Steel pipe or tube shall conform to the requirements of ASTM A 53 for pipe or ASTM A 500 for tubing. Steel trumpets shall have a minimum wall thickness of 0.1 inch for diameters up to 4 inches and 0.2 inch for larger diameters. PVC pipe shall conform to ASTM A 1785, Schedule 40 minimum. PVC trumpets shall be positively sealed against the bearing plate and aligned with the tendon to prevent cracking during stressing.

d) Anchorage covers shall be fabricated from steel or plastic with a minimum thickness of 0.1 inch. The joint between the cover and the bearing plate shall be watertight.

e) Wedges shall be designed to preclude premature failure of the prestressing steel due to notch or pinching effects under static and dynamic strength requirements of Section 3.1.8 (1) and 3.1.8 (2) of the PTI *"Post Tensioning Manual."* Wedges shall not be reused.

f) Wedges for epoxy coated strand shall be designed to be capable of biting through the epoxy coating and into the strand. Removal of the epoxy coating from the strand to allow the use of standard wedges shall not be permitted. Anchor nuts and other threadable hardware for epoxy coated bars shall be designed to thread over the epoxy coated bar and still comply with the requirements for carrying capacity.

- Prestressing Steel

a) Ground anchor tendons shall be fabricated from single or multiple elements of one of the following prestressing steels:

- Steel bars conforming to AASHTO M 275
- Seven-wire, low relaxation strands conforming to AASHTO M 203
- Compact, seven-wire, low-relaxation strands conforming to ASTM A 779
- Epoxy coated strand conforming to ASTM A 882
- Epoxy coated reinforcing steel bars conforming to ASTM A 775

b) Centralizers shall be provided at maximum intervals of 10 feet with the deepest centralizer located 1 foot from the end of the anchor and the upper centralizer for the bond zone located no more than 5 feet from the top of the tendon bond length. Spacers shall be used to separate the steel strands of strand tendons. Spacers shall be provided at maximum intervals of 10 feet and may be combined with centralizers.

- Prestressing Steel Couplers

  Prestressing steel bar couplers shall be capable of developing 100 percent of the minimum specified ultimate tensile strength of the prestressing steel bar. Steel strands used for a soil or rock anchor shall be continuous with no splices, unless approved by the Engineer.

- Centralizers

  a) Centralizers shall be fabricated from plastic, steel or material, which is non-detrimental to the prestressing steel. Wood shall not be used. The centralizer shall be able to support the tendon in the drill hole and position the tendon so a minimum of 2 inches of grout cover is provided and shall permit grout to freely flow around the tendon and up the drill hole.

  b) Centralizers are not required on pressure injected anchors installed in coarse grained soils when the grouting pressure exceeds 145 psi or on hollow stem-augured anchors when they are grouted through the auger with grout having a slump of 9 inches or less.

- Spacers

  Spacers shall be used to separate elements of a multi-element tendon and shall permit grout to freely flow around the tendon and up the drill hole. Spacers shall be fabricated from plastic, steel or material, which is non-detrimental to the prestressing steel. Wood shall not be used. A combination centralizer-spacer may be used.

- Tendon Bond Length Encapsulations

  When the contract plans require the tendon bond length to be encapsulated to provide additional corrosion protection, the encapsulation shall be fabricated from one of the following:

  a) High density corrugated polyethylene tubing conforming to the requirements of AASHTO M 252 and having a minimum wall thickness of 0.06 inch except pre-grouted tendons, which may have a minimum wall thickness of 0.04 inch.
  b) Deformed steel tubing or pipes conforming to ASTM A 52 or A 500 with a minimum wall thickness of 0.2 inch.
  c) Corrugated, polyvinyl chloride tubes manufactured from rigid PVC compounds conforming to ASTM D 1784, Class 13464- B.
  d) Fusion-bonded epoxy conforming to the requirements of AASHTO M 284.

- Heat Shrinkable Sleeves

Heat shrinkable sleeves shall be fabricated from a radiation cross-linked polyolefin tube internally coated with an adhesive sealant. Prior to shrinking, the tube shall have a nominal wall thickness of 0.025 inch. The adhesive sealant inside the heat shrinkable tube shall have a nominal thickness of 0.02 inch.

- Sheath

  A sheath shall be used as part of the corrosion protection system for the unbonded length portion of the tendon. The sheath shall be fabricated from one of the following:

  a) A polyethylene tube pulled or pushed over the prestressing steel. The polyethylene shall be Type II, III or IV as defined by ASTM D 1248 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.

  b) A hot-melt extruded polypropylene tube. The polypropylene shall be cell classification B55542-11 as defined by ASTM D 4101 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.

  c) A hot-melt extruded polyethylene tube. The polyethylene shall be high density Type III as defined by ASTM D 1248 (or approved equal). The tubing shall have a minimum wall thickness of 0.06 inch.

  d) Steel tubing conforming to ASTM A 500. The tubing shall have a minimum wall thickness of 0.2 inch.

  e) Steel pipe conforming to ASTM A 53. The pipe shall have a minimum wall thickness of 0.2 inch.

  f) Plastic pipe or tube of PVC conforming to ASTM D 1784 Class 13464-B. The pipe or tube shall be Schedule 40 at a minimum.

  g) A corrugated tube conforming to the requirement of the tendon bond length encapsulation Subsection 4.g. above.

- Bondbreaker

  The bondbreaker shall be fabricated from a smooth plastic tube or pipe having the following properties: (1) resistant to chemical attack from aggressive environments, grout, or corrosion inhibiting compound; (2) resistant to aging by ultraviolet light; (3) fabricated from material non-detrimental to the tendon; (4) capable of withstanding abrasion, impact, and bending during handling and installation; (5) enable the tendon to elongate during testing and stressing; and (6) allow the tendon to remain unbonded after lockoff.

- Cement Grout

  Type I, II, III or V Portland cement conforming to AASHTO M 85 shall be used for grout. The grout shall be a pumpable neat mixture of cement and water and shall be stable (bleed less than 2 percent), fluid, and provide a minimum 28-day compressive strength of at least 3000 psi measured in accordance with ASTM C 109 at the time of stressing.

- Admixtures

  Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to the approval of the Engineer. Admixtures, if used, shall be compatible with the prestressing steels and mixed in accordance with the manufacturer's recommendation. Expansive admixtures may only be added to the grout used for filling sealed encapsulations, trumpets, and anchorage covers. Accelerators shall not be permitted.

- Water

  Water for mixing grout shall be potable, clean, and free of injurious quantities of substances known to be harmful to Portland cement or prestressing steel.

- Corrosion Inhibiting Compound

  The corrosion inhibiting compound placed in either the free length or the trumpet areas shall be an organic compound (i.e. grease or wax) with appropriate polar moisture displacing, corrosion inhibiting additives and self-healing properties. The compound shall permanently stay viscous and be chemically stable and nonreactive with the prestressing steel, the sheathing material, and anchor grout.

- Grout Tubes

  Grout tubes shall have an adequate inside diameter to enable the grout to be pumped to the bottom of the drill hole. Grout tubes shall be strong enough to withstand a minimum grouting pressure of 145 psi. Post-grout tubes shall be strong enough to withstand post-grouting pressures.

5. Construction

1. Tendon Storage and Handling

   - Tendons shall be handled and stored in such a manner as to avoid damage or corrosion. Damage to the prestressing steel, the corrosion protection, and/or the epoxy coating as a result of abrasions, cuts, nicks, welds or weld splatter will be cause for rejection by the Engineer. The prestressing steel shall be protected if welding is to be performed in the vicinity.

Grounding of welding leads to the prestressing steel is forbidden. Prestressing steel shall be protected from dirt, rust, or other deleterious substances. A light coating of rust on the steel is acceptable. If heavy corrosion or pitting is noted, the Engineer shall reject the affected tendons.

- The Contractor shall use care in handling and storing the tendons at the site. Prior to inserting a tendon in the drill hole, the Contractor and the Inspector shall examine the tendon for damage to the encapsulation and the sheathing. If, in the opinion of the Inspector, the encapsulation is damaged, the Contractor shall repair the encapsulation in accordance with the tendon supplier's recommendations. If, in the opinion of the inspector, the smooth sheathing has been damaged, the Contractor shall repair it with ultra-high molecular weight polyethylene tape. The tape should be spiral wound around the tendon to completely seal the damaged area. The pitch of the spiral shall ensure a double thickness at all points.

- Banding for fabricated tendons shall be padded to avoid damage to the tendon corrosion protection. Upon delivery, the fabricated anchors or the prestressing steel for fabrication of the tendons on site and all hardware shall be stored and handled in such a manner to avoid mechanical damage, corrosion, and contamination with dirt or deleterious substances.

- Lifting of the pre-grouted tendons shall not cause excessive bending, which can debond the prestressing steel from the surrounding grout.

- Prestressing steel shall not be exposed to excessive heat (i.e. more than 446° F).

b. Anchor Fabrication

- Anchors shall be either shop or field fabricated from material conforming to part 4 of this section and as shown in the approved working drawings and schedules.
- Prestressing steel shall be cut with an abrasive saw or, with the written approval of the prestressing steel supplier, an oxyacetylene torch.
- All of the tendon bond length, especially for strand, must be free of dirt, manufacturer's lubricants, corrosion-inhibitive coatings, or other deleterious substances that may significantly affect the grout- to-tendon bond or the service life of the tendon.
- Pre-grouting of encapsulated tendons shall be done on an

inclined, rigid frame or bed by injecting the grout from the low end of the tendon.

c. Drilling

- Drilling methods shall be left to the discretion of the Contractor, whenever possible. The Contractor shall be responsible for using a drilling method to establish a stable hole of adequate dimensions, within the tolerances specified. Drilling methods may involve, amongst others, rotary, percussion, rotary/percussive or auger drilling; or percussive or vibratory driven casing.

- Holes for anchors shall be drilled at the locations and to the length, inclination and diameter shown on the approved working drawings. The drill bit or casing crown shall not be more than 0.12 inch smaller than the specified hole diameter. At the ground surface the drill hole shall be located within 1 foot of the location shown on the approved working drawings. The drill hole shall be located so the longitudinal axis of the drill hole and the longitudinal axis of the tendon are parallel. In particular, the ground anchor hole shall not be drilled in a location that requires the tendon to be bent in order to enable the bearing plate to be connected to the supported structure. At the point of entry the ground anchor shall be installed within plus/minus three (3) degrees of the inclination from horizontal shown on the approved working drawings. At the point of entry the horizontal angle made by the ground anchor and the structure shall be within plus/minus three (3) degrees of a line drawn perpendicular to the plane of the structure unless otherwise shown on the approved working drawings. The ground anchors shall not extend beyond the right of- way or easement limits shown on the contract drawings.

d. Tendon Insertion

- Tendons shall be placed in accordance with the approved working drawings and details and the recommendations of the tendon manufacturer or specialist anchor contractor. The tendon shall be inserted into the drill hole to the desired depth without difficulty.

Each anchor tendon shall be inspected by Department field personnel during installation into the drill hole or casing. Damage to the corrosion protection system shall be repaired, or the tendon replaced if not repairable. Loose spacers or centralizers shall be reconnected to prevent shifting during insertion. Damaged fusion bonded epoxy coatings shall be repaired in accordance with the manufacturer's recommendations. If the patch is not allowed to

cure prior to inserting the tendon in the drill hole, the patched area shall be protected by tape or other suitable means.

e) The rate of placement of the tendon into the hole shall be controlled such that the sheathing, coating, and grout tubes are not damaged during installation of the tendon. Anchor tendons shall not be subjected to sharp bends. The bottom end of the tendon may be fitted with a cap or bullnose to aid its insertion into the hole, casing or sheathing.

- Grouting

    - The Contractor shall use a neat cement grout or a sand- cement grout. The cement shall not contain lumps or other indications of hydration. Admixtures, if used, shall be mixed in accordance with the manufacturer's recommendation.

    - The grouting equipment shall produce a grout free of lumps and undispersed cement. A positive displacement grout pump shall be used. The pump shall be equipped with a pressure gauge to monitor pressures. The pressure gauge shall be capable of measuring pressures of at least 145 psi or twice the actual grout pressure used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The mixer should be capable of continuously agitating the grout.

    - The grout shall be injected from the lowest point of the drill hole. The grout may be pumped through grout tubes, casings, hollowstem-augers, or drill rods. The grout can be placed before or after insertion of the tendon. The quantity of the grout and the grout pressures shall be recorded. The grout pressures and grout takes shall be controlled to prevent excessive heave or

- After the tendon is installed, the drill hole may be filled in one continuous grouting operation except that pressure grouting shall not be used in the free length zone. The grout at the top of the drill hole shall not contact the back of the structure or the bottom of the trumpet.

- If the ground anchor is installed in a fine-grained soil using drill holes larger than 6 inches in diameter, then the grout above the top of the bond length shall be placed after the ground anchor has been tested and stressed. The Engineer will allow the Contractor to grout the entire drill hole at the same time if the Contractor can demonstrate that their particular ground anchor system does not derive a significant portion of its load-carrying capacity from the soil above the bond length portion of the ground anchor.

- If grout protected tendons are used for ground anchors anchored in rock, then pressure grouting techniques shall be utilized. Pressure grouting requires that the drill hole be sealed and that the grout be injected until a minimum 50 psi grout pressure (measured at the top of the drill hole) can be maintained on the grout for at least five (5) minutes.

- The grout tube may remain in the hole on completion of grouting if the tube is filled with grout.

- After grouting, the tendon shall not be loaded for a minimum of three (3) days.

f. Anchorage Installation

- The anchor bearing plate and the anchor head or nut shall be installed perpendicular to the tendon, within plus/minus three (3) degrees and centered on the bearing plate, without bending or kinking of the prestressing steel elements. Wedge holes and wedges shall be free of rust, grout and dirt.

- The stressing tail shall be cleaned and protected from damage until final testing and lock-off. After the anchor has been accepted by the Engineer, the stress tail shall be cut to its final length according to the tendon manufacturer's recommendations.

- The corrosion protection surrounding the unbonded length of the tendon shall extend up beyond the bottom seal of the trumpet or 4 inches into the trumpet if no trumpet seal is provided. If the protection does not extend beyond the seal or sufficiently far

enough into the trumpet, the Contractor shall extend the corrosion protection or lengthen the trumpet.

- The corrosion protection surrounding the unbonded length of the tendon shall not contact the bearing plate or the anchor head during testing and stressing. If the protection is too long, the Contractor shall trim the corrosion protection to prevent contact.

g. Corrosion Protection

- Protection Requirements

  Corrosion protection requirements shall be determined by the Department and shall be shown on the contract plans. The corrosion protection systems shall be designed and constructed to provide reliable ground anchors for temporary and permanent structures.

- Anchorage Protection

  - All stressing anchorages permanently exposed to the atmosphere shall receive a grout-filled cover, except, for restressable anchorages where a corrosion inhibiting compound must be used. Stressing anchorages encased in concrete at least 2 inches thick do not require a cover.

  - The trumpet shall be sealed to the bearing plate and shall overlap the unbonded length corrosion protection by at least 4 inches. The trumpet shall be long enough to accommodate movements of the structure and the tendon during testing and stressing. On strand tendons, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon along the unbonded length to the diameter of the tendon at the wedge plate without damaging the encapsulation.

  - The trumpet shall be completely filled with grout, except re-stressable anchorages must use corrosion inhibiting compounds. Compounds may be placed any time during construction. Compound filled trumpets shall have a permanent seal between the trumpet and the unbonded length corrosion protection. Grout must be placed after the ground anchor has been tested and stressed to the lock-off load. Trumpets filled with grout shall have either a temporary seal between the trumpet and the unbonded length corrosion protection or the trumpet shall fit tightly over the unbonded length corrosion protection for a minimum of 4 inches.

- Unbonded Length Protection

  a) Corrosion protection of the unbonded length shall be provided by a combination of sheaths, sheath filled with a corrosion inhibiting compound or grout, or a heat shrinkable tube internally coated with a mastic compound, depending on the tendon class. The corrosion inhibiting compound shall completely coat the tendon elements, fill the void between them and the sheath, and fill the interstices between the wires of 7-wire strands. Provisions shall be made to retain the compound within the sheath.

  b) The corrosion protective sheath surrounding the unbonded length of the tendon shall be long enough to extend into the trumpet, but shall not come into contact with the stressing anchorage during testing. Any excessive protection length shall be trimmed off.

  c) For pre-grouted encapsulations and all Class I tendons, a separate bond breaker or common sheath shall be provided for supplemental corrosion protection or to prevent the tendon from bonding to the grout surrounding the unbonded length.

- Unbonded Length/Bond Length Transition

  The transition between the corrosion protection for the bonded and unbonded lengths shall be designed and fabricated to ensure continuous protection from corrosive attack.

- Tendon Bond Length Protection for Grout Protected Tendons (Class II)

  a) Cement grout can be used to protect the tendon bond length in non-aggressive ground when the installation methods ensure that the grout will remain fully around the tendon. The grout shall overlap the sheathing of the unbonded length by at least 1 inch.

  b) Centralizers or grouting techniques shall ensure a minimum of 0.5 inch of grout cover over the tendon bond length.

- Tendon Bond Length Protection for Encapsulated Tendons (Class I)

  a) A grout-filled, corrugated plastic encapsulation or a grout-filled, deformed steel tube shall be used. The prestressing steel can be grouted inside the encapsulation prior to being placed.

  b) Centralizers or grouting techniques shall ensure a minimum of 0.5 inch of grout cover over the encapsulation.

- Epoxy

  A fusion-bonded epoxy may be used to provide a layer of protection for the steel tendon in addition to the cement grout.

- Coupler Protection

  a) On encapsulated bar tendons (Class I), the coupler and any adjacent exposed bar sections shall be covered with a corrosion-proof compound or wax-impregnated cloth tape. The coupler area shall be covered by a smooth plastic tube, complying with the requirements set forth in 4.9, overlapping the adjacent sheathed tendon by at least 1 inch. The two joints shall be sealed each by a coated heat shrink sleeve of at least 6 inches in length, or approved equal. The corrosion-proof compound shall completely fill the space inside the cover tube.

  b) Corrosion protection details for strand couplers, if specifically permitted, shall be submitted for approval of the Engineer.

h. Stressing, Load Testing, and Acceptance

- General

  Each ground anchor shall be tested. No load greater than ten (10) percent of the design load can be applied to the ground anchor prior to testing. The maximum test load shall be no less than 1.33 times the design load and shall not exceed 80 percent of the specified minimum ultimate tensile strength of the prestressing steel of the tendon. The test load shall be simultaneously applied to the entire tendon. Stressing of single-element tendons shall not be permitted.

- Stressing Equipment

  a) The testing equipment shall consist of:

  a) A dial or vernier scale capable of measuring to the nearest .001 inch shall be used to measure the ground anchor movement. The movement measuring device shall have a minimum travel equal to the theoretical elastic elongation of the total anchor length at the maximum test load and it shall have adequate travel so the ground anchor movement can be measured without resetting the device at an interim point.

  b) A hydraulic jack and pump shall be used to apply the test load. The jack and a calibrated primary pressure gauge shall be used to measure the applied load. The jack and primary pressure gauge shall be calibrated by an independent firm as a unit. The calibration shall have been performed within forty-five (45) working days of

the date when the calibration submittals are provided to the Engineer. Testing cannot commence until the Engineer has approved the calibration. The primary pressure gauge shall be graduated in 100 psi increments or less. The ram travel shall be at least 6 inches and preferably not be less than the theoretical elongation of the tendon at the maximum test load. If elongations greater than 6 inches are required, re-stroking can be allowed.

c) A calibrated reference pressure gauge shall also be kept at the site to periodically check the production (i.e. primary pressure) gauge. The reference gauge shall be calibrated with the test jack and primary pressure gauge. The reference pressure gauge shall be stored indoors and not subjected to rough treatment.

d) The Contractor shall provide an electrical resistance load cell and readout to be used when performing an extended creep test.

e) The stressing equipment shall be placed over the ground anchor tendon in such a manner that the jack, bearing plates, load cells and stressing anchorage are axially aligned with the tendon and the tendon is centered within the equipment.

f) The stressing equipment, the sequence of stressing and the procedure to be used for each stressing operation shall be determined at the planning stage of the project. The equipment shall be used strictly in accordance with the manufacturer's operating instructions.

g) Stressing equipment shall preferably be capable of stressing the whole tendon in one stroke to the specified test load and the equipment shall be capable of stressing the tendon to the maximum specified test load within 75 percent of the rated capacity. The pump shall be capable of applying each load increment in less than 60 seconds.

h) The equipment shall permit the tendon to be stressed in increments so that the load in the tendon can be raised or lowered in accordance with the test specifications, and allow the anchor to be lift-off tested to confirm the lock off load.

i) Stressing equipment shall have been calibrated, within an accuracy of plus or minus two (2) percent, a maximum of 45 days prior to use. The calibration certificate and graph shall be available on site at all times. The calibration shall be traceable to the National Institute of Standards and Technology (NIST).

- Load Test Setup

a) Dial gauges shall bear on the pulling head of the jack and their stems shall be coaxial with the tendon direction. The gauges shall be supported on an independent, fixed frame, such as a tripod, which will not move as a result of stressing or other construction activities during the operation.

b) Prior to setting the dial gauges, the Alignment Load (AL) shall be accurately placed on the tendon. The magnitude of the AL depends on the type and length of the tendon.

c) Re-gripping of strands, which would cause overlap wedge bites, or wedge bites on the tendon below the anchor head, shall be avoided.

d) Stressing and testing of multiple element tendons with single element jacks is not permitted.

e) Stressing shall not begin until the grout has reached adequate strength.

- Performance Tests

a) Five (5) percent of the ground anchors or a minimum of three (3) ground anchors, whichever is greater, shall be performance tested in accordance with the procedures described in this section. The Engineer shall select the ground anchors to be performance tested. The remaining ground anchors shall be tested in accordance with the proof test procedures as outlined in 5.h. below.

- The performance test shall be made by incrementally loading and unloading the ground anchor in accordance with the schedule provided in section 5.h. The load shall be raised from one increment to another immediately after recording the ground anchor movement. The ground anchor movement shall be measured and recorded to the nearest

0.001 inch with respect to an independent fixed reference point at the alignment load and at each increment of load. The load shall be monitored with the primary pressure gauge. The reference pressure gauge shall be placed in series with the primary pressure gauge during each performance test. If the load determined by the reference pressure gauge and the load determined by the primary pressure gauge differ by more than ten (10) percent, the jack, primary pressure gauge and reference pressure gauge shall be recalibrated at no expense to the Department. At load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

- The maximum test load in a performance test shall be held for ten (10) minutes. A load cell shall be used to monitor small changes in load during constant load-hold periods.
- The jack shall be adjusted as necessary in order to maintain a constant load. The load-hold period shall start as soon as the maximum test load is applied and the ground anchor movement, with respect to a fixed reference, shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If the ground anchor movement between one (1) minute and ten (10) minutes exceeds .04 inch, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the ground anchor movement shall be recorded at 15, 20, 30, 40, 50 and 60 minutes.

- Steps for the Performance Test – The steps for the performance test are detailed in the table on the following page:

Step	Loading	Applied Load	Record and Plot Total Movement (d_{ti})	Record and Plot Residual Movement (d_{ri})	Calculate Elastic Movement (d_{ei})
1	Apply alightment load (AL)				
2	Cycle 1	0.25DL	$\mathbf{d_{t1}}$		$\mathbf{d_{t1} - d_{r1} = d_{e1}}$
		AL		$\mathbf{d_r}$	
3	Cycle 2	0.25AL	$\mathbf{d_2}$		$\mathbf{d_{t2} - d_{r2} = d_{e2}}$
		0.50DL	$\mathbf{d_{t2}}$		
		AL		$\mathbf{d_{r2}}$	
4	Cycle 3	0.25DL	$\mathbf{d_3}$		$\mathbf{d_{t3} - d_{r3} = d_{e3}}$
		0.50DL	$\mathbf{d_3}$		
		0.75FL	$\mathbf{d_3}$		
		AL		$\mathbf{d_{r3}}$	
5	Cycle 4	0.25DL	$\mathbf{d_4}$		$\mathbf{d_{t4} - d_{r4} = d_{e4}}$
		0.50DL	$\mathbf{d_4}$		
		0.75DL	$\mathbf{d_4}$		
		1.00DL	$\mathbf{d_{t4}}$		
		AL		$\mathbf{d_{r4}}$	
6	Cycle 5	0.25DL	$\mathbf{d_5}$		$\mathbf{d_{t5} - d_{r5} = d_{e5}}$
		0.50DL	$\mathbf{d_5}$		
		0.75DL	$\mathbf{d_5}$		
		1.00DL	$\mathbf{d_5}$		
		1.2DL	$\mathbf{d_5}$		
		AL		$\mathbf{d_{r5}}$	
7	Cycle 6	0.25DL	$\mathbf{d_6}$		
		0.50DL	$\mathbf{d_6}$		
		0.75DL	$\mathbf{d_6}$		
		1.00DL	$\mathbf{d_6}$		
		1.2DL	$\mathbf{d_6}$		
		1.33DL	$\mathbf{d_{t6}}$ **, zero reading for creep test**		
8	Hold load for 10 minutes while recording movement at specified times. If the total movement measured during the load hold exceeds the specified maximum value then the load hold should be extended to a total of 60 minutes.				
9	Cycle 6 cont=d	AL		$\mathbf{d_{r6}}$	Cycle 6: $\mathbf{d_m - d_{r6} = d_{e6}}$

Notes: AL = Alignment Load, DL = Design Load, d_i = total movement at a load other than maximum for cycle, i = number identifying a specific load cycle.

- Proof Tests

  The proof test shall be performed by incrementally loading the ground anchor in accordance with the following schedule. The load shall be raised from one increment to another immediately after recording the ground anchor movement. The ground anchor movement shall be measured and recorded to the nearest 0.001 inch with respect to an independent fixed reference point at the alignment load and at each increment load. The load shall be monitored with the primary pressure gauge. At load increment other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

Proof Test Schedule

Step	**Load**
1	AL
2	0.25DL
3	0.50DL
4	0.75DL
5	1.00DL
6	1.20DL
7	1.33DL
8	Reduce to lock-off load
9	AL (optional)
10	Adjust to lock-off load

- The maximum test load in a proof test shall be held for (10) minutes. The jack shall be adjusted as necessary in order to maintain a constant load. The load-hold period shall start as soon as the maximum test load is applied and the ground anchor movement with respect to a fixed reference shall be measured and recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. If the ground anchor movement between one (1) minute and ten (10) minutes exceeds 0.04 inch, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the ground anchor movements shall be recorded at 15, 20, 30, 40, 50, and 60 minutes.

- Extended Creep Tests

  a) The Department shall determine if extended creep testing is required and select those ground anchors that are to be creep tested. If creep tests are required, at least two (2) ground anchors shall be tested. The stressing equipment shall be capable of measuring and maintaining the hydraulic pressure within 50 psi.

  b) The extended creep test shall be made by incrementally loading and unloading the ground anchor in accordance with the performance test schedule provided in 5.8.5. At the end of each

loading cycle, the load shall be held constant for the observation period indicated in the creep test schedule below. The times for reading and recording the ground anchor movement during each observation period shall be 1, 2, 3, 4, 5, 6, 10, 15, 20, 25, 30, 45, 60, 75, 90, 100, 120, 150, 180, 210,

240, 270 and 300 minutes as appropriate for the load increment. Each load-hold period shall start as soon as the test load is applied. In a creep test, the primary pressure gauge and reference pressure gauge will be used to measure the applied load and the load cell will be used to monitor small changes in load during constant load-hold periods. The jack shall be adjusted as necessary in order to maintain a constant load.

c) The Contractor shall plot the ground anchor movement and the residual movement measured in an extended creep test. The Contractor shall also plot the creep movement for each load hold as a function of the logarithm of time.

Extended Creep Test Schedule

Load	**Observation period (min)**
AL	
0.25DL	10
0.50DL	30
0.75DL	30
1.00DL	45
1.20DL	60
1.33DL	300

- Ground Anchor Acceptance Criteria

A performance-tested or proof-tested ground anchor with a 10 minute load hold shall be acceptable if the: (1) ground anchor resists the maximum test load with less than 0.04 inch of movement between 1 minute and 10 minutes; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

a) A performance-tested or proof-tested ground anchor with a 60 minute load hold shall be acceptable if the: (1) ground anchor resists the maximum test load with a creep rate that does not exceed 0.08 inch in the last log cycle of time; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

b) A ground anchor subjected to extended creep testing is acceptable if the: (1) ground anchor resists the maximum test load with a creep rate that does not exceed 0.08 inch in the last log cycle of time; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

c) The initial lift-off reading shall be within plus or minus five (5) percent of the designated lock-off load. If this criterion is not met, then the tendon load shall be adjusted accordingly and the initial lift-off reading repeated.

- Procedures for Anchors Failing Acceptance Criteria

a) Anchors that do not satisfy the minimum apparent free length criteria shall be either rejected and replaced at no additional cost to the Department or locked off at no more than 50 percent of the maximum acceptable load attained. In this event, no further acceptance criteria are applied.

b) Re-groutable anchors which satisfy the minimum apparent free length criteria but which fail the extended creep test at the test load may be post grouted and subjected to an enhanced creep criterion. This enhance criterion requires a creep movement of not more than 0.04 inch between 1 and 60 minutes at test load. Anchors which satisfy the enhanced creep criterion shall be locked off at the design lock-off load. Anchors which cannot be post grouted or regroutable anchors that do not satisfy the enhanced creep criterion shall be either rejected or locked off at 50 % of the maximum acceptable test load attained. In this event, no further acceptance criteria are applied. The maximum acceptable test load with respect to creep shall correspond to that where acceptable creep movements are measured over the final log cycle of time.

c) In the event that the anchor fails, the Contractor shall modify the design and/or construction procedures. These modifications may include, but are not limited to, installing additional anchors, modifying the installation methods, reducing the anchor design load by increasing the number of anchors, increasing the anchor length, or changing the anchor type. Any modification of design or construction procedures shall be at no change in the contract price. A description of any proposed modifications must be submitted to the Engineer in writing. Proposed modifications shall not be implemented until the Contractor receives written approval from the Engineer.

- Anchor Lock-Off

a) After testing has been completed, the load in the tendon shall be such that after seating losses (i.e. wedge seating); the specified lock-off load has been applied to the anchor tendon.

b) The magnitude of the lock-off load shall be specified in the approved working drawings, or as determined by the designer.

c) The wedges shall be seated at a minimum load of 50% F_{pu}. If the lock-off load is less than 50% F_{pu}, shims shall be used under the wedge plate and the wedges seated at 50% F_{pu}. The shims shall then be removed to reduce the load in the tendon to

the desired lock-off load. Bar tendons may be locked off at any load less than 70% F_{pu}.

- Anchor Lift-Off Test

  After transferring the load to the anchorage, and prior to removing the jack, a lift-off test shall be conducted to confirm the magnitude of the load in the anchor tendon. This load is determined by reapplying load to the tendon to lift off the wedge plate (or anchor nut) without unseating the wedges (or turning the anchor nut). This moment represents zero time for any long time monitoring.

S T A T E **O F** **T E N N E S S EE**

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SPECIAL PROVISION

REGARDING

DRILLED SHAFT SPECIFICATIONS

625.01 Description

This work consists of constructing cast-in-place reinforced concrete drilled shafts and rock sockets, as required, to serve as a structural foundation. This work shall provide reinforced concrete shafts cast in cylindrically excavated holes extending sufficiently into soil or sound rock to adequately support the structure and all externally applied loads for which the shaft was designed. The drilled shaft foundation, including the rock socket, where required, shall be constructed in accordance with these Specifications, as shown on the Plans and in accordance with other Specifications included in the contract documents.

625.02 Qualifications of Drilled Shaft Contractor

The driller and/or foreman or superintendent on the project site shall be experienced in the drilled shaft specialty and have installed drilled shafts of both diameter and length similar to those shown on the Plans. The driller and/or foreman or superintendent on site shall have a minimum of three years of experience in the geologic conditions associated with the project site prior to the bid date for this project. This work shall be performed under the direct supervision of driller, foreman or superintendent knowledgeable and experienced in the method of constructing drilled shafts as required by the project. Supply all equipment required to complete the work within the specified contract time. Furnish evidence of experience and expertise that meets the following requirements:

A list containing a description of at least five projects either on-going or completed in the last three years on which the driller, foreman or superintendent responsible for the drilled shaft construction, have installed drilled shafts of similar size as shown in the Plans and with similar excavation techniques anticipated for this project. This list of projects shall contain a brief description of the project as well as names and phone numbers of the project owner's representatives who can verify the participation on the project.

625.03 Drilled Shaft Work Plan

Develop a work plan for all the drilled shafts and submit the plan for review and acceptance by the Engineer 30 days prior to beginning construction of the drilled shafts. The Drilled Shaft Work Plan shall provide detailed project specific information, including the following:

1. Work experience in accordance with required qualifications in **625.02.**

2. List and size of proposed equipment; including cranes, kelly bars, drill rigs, vibratory hammers, augers, core barrels, cleanout buckets, airlifts and/or submersible pumps, tremies and/or concrete pumps, casing (diameters, thicknesses, and lengths), etc.

3. Details of the sequence and proposed schedule of drilled shaft construction, including the anticipated order in which shafts will be constructed.

4. Details of excavation methods.

5. Details of proposed methods to clean the excavation bottom.

6. Details of the method(s) to be used to ensure shaft stability (i.e., prevention of caving, bottom heave, etc. using temporary casing, slurry, or other means) during excavation and concrete placement. If appropriate, this shall include a review of method suitability to the anticipated site and subsurface geotechnical conditions.

7. Details of reinforcement placement including support and method to center in the excavation.

8. Details of concrete placement including proposed operational procedures for the concrete tremie or pump (if applicable); including initial placement, how the tremie or pump will be raised during concrete placement and what type of discharge control will be used to prevent concrete contamination when the tremie or pump is initially placed in the excavation.

9. If applicable, details of casing installation and temporary casing removal including order of telescoped casing removal and minimum concrete head in each casing during removal.

10. Required submittals for concrete mix designs.

11. Details on how drilling spoils will be handled including environmental control procedures used to prevent the loss of concrete and spoils.

12. Detailed procedures for mixing, using, maintaining, and disposing of the slurry shall be provided. A detailed mix design (including all additives and their specific purpose in the slurry mix), and a discussion of its suitability to the anticipated subsurface geotechnical conditions, shall also be provided for the proposed slurry.

13. Other information shown in the Plans or requested by the Engineer.

The Engineer will review the Drilled Shaft Work Plan for conformance with the Plans and Specifications. Within 15 days of receiving the plan, the Engineer will notify the Contractor of any additional information required and/or changes that may be necessary to satisfy the Plans, Specifications, and special provisions. If any part of the plan that is unsatisfactory and rejected by the Engineer, submit proposed changes for re-evaluation. The Engineer will respond to the Contractor within 7 days after receiving the proposed changes.

Review of the Drilled Shaft Work Plan by the Engineer does not relieve the Contractor of the responsibility to perform the work in accordance with Plans and Specifications. The Drilled Shaft Work Plan is intended to provide an opportunity to explain the approach to the work and to allow the Engineer to comment on equipment and procedures before Work begins.

625.04 Preconstruction Conference

After the Drilled Shaft Work Plan has been reviewed by the Engineer, a drilled shaft preconstruction conference shall be scheduled with the Contractor/Drilling Subcontractor to discuss construction and inspection of the drilled shafts. At a minimum, the attendees should include the General Contractor's Superintendent, the Drilling Subcontractor's Superintendent, the State's representatives, the Geotechnical Engineer, the Structural Engineer, and members of the Inspection Team. This conference shall be completed prior to beginning any drilled shaft work.

Construction Requirements

625.05 Materials

All materials shall be in accordance with the Plans and in accordance with other Specifications included in the contract document.

625.06 Self-Consolidating Concrete (SCC)

Drilled shafts shall be constructed of the class concrete and concrete strength specified on Plans, and all material, proportioning, mixing, and transporting of concrete shall be in accordance with Standard Specifications for Road and Bridge Construction. The concrete mix for drilled shafts shall be dense, homogeneous, fluid, and resistant to segregation, and shall consolidate under self-weight such that vibrating, or rodding will not be required as specified in **604.03.A.1.b** Self-Consolidating Concrete (SCC) Design and Production Parameters. The concrete mix shall have a set time that ensures that fluidity is maintained throughout the shaft concrete placement and removal of temporary casing, if used.

625.07 Casing

When applicable, select the rigid casing used to stabilize shaft during construction unless casing is specified on Plans. A casing with sufficient strength to safely resist all imposed loads, including those from the soil and ground water, shall be used. Insure the stability of casing during all drilled shaft operations.

Shop drawings for permanent steel casings shall be submitted to and approved by the Engineer prior to installation of the casings.

Casings shall be smooth, clean, and watertight. Out-of-round tolerance shall not exceed one inch at any portion of the casing. Demonstrate the casing is within tolerance after installation. Telescoping casing shall not be allowed in bridges located in Seismic Zones 3 or 4.

Permanent casings, if required, shall be continuous wherever possible or practical. The permanent casing shall terminate at the specified elevation. Where drilled shafts are located in open water areas, casings shall be extended at least 18 inches above the datum defined water elevation as shown on the plans. Adjustment casing at the time of installation due to water fluctuations, if needed.

The casing may be fabricated with teeth or a cutting edge to facilitate insertion into the rock.

Splicing of permanent casings is not desirable and will only be permitted when approved by the Engineer. If splices are required, the welding process shall be in accordance with the requirements specified in **602.19**. Ensure the adequacy of welds during driving.

Welding of casings shall be in accordance with the current edition of *AASHTO/AWS Bridge Welding Code* and Standard Specification for Road and Bridge Construction and as specified in Plans, except that shop welding of casings will not require radiographic inspection. Inspection of welds will be of a visual nature. If evidence indicating poor welding is found, the Engineer may require ultrasonic testing at no additional cost to the Department.

625.08 Slurry

Drilling slurry will be defined as mineral slurry, polymer slurry, natural slurry formed during the drilling process, water or other fluids used to maintain stability of the drilled shaft excavation to aid in the drilling process or to maintain the quality of the rock socket. In addition, the terms

mineral slurry and polymer slurry, as used herein, will be defined as the final mixed composite of all additives, including manufactured mineral or polymer slurry additives required to produce the acceptable drilling slurry.

Drilling slurry shall be used if detailed in the approved installation plan, if in accordance with the contract documents or if approved in writing by the Engineer. Drilling slurry may be used at the Contractor's option if the slurry is not in accordance with the contract documents; however, any slurry shall be approved by the Engineer prior to use. Drilling slurry, when used, will be non-compensable and effect on time of performance due to the use of the slurry will be non-excusable.

The material used to make the slurry shall not be detrimental to the concrete or surrounding ground strata. Mineral slurries shall have both a mineral grain size that remains in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Polymer slurries shall have sufficient viscosity and gel characteristics to transport excavated material to suitable screening systems or settling tanks. The percentage and specific gravity of the material used to make the slurry shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. If approved by the Engineer, water and on-site soils as drilling slurry may be used. In that case, the range of acceptable values for density, viscosity, and pH, as shown in the following table for bentonite slurry, shall be met, except that maximum density (unit weight) shall not exceed 70 pounds/cubic foot. When water is used as the drilling fluid to construct rock sockets in limestone, dolomite, sandstone, or other formations that are not erodible, the requirements for slurry testing will not apply.

Prior to introduction into the shaft excavation, the manufactured mineral or polymer slurry admixture shall be pre-mixed thoroughly with clean, fresh water and for adequate time in accordance with the slurry admixture manufacturer's recommendations allotted for hydration. Potable water can be used for mixing although stream or river water may be used when approved by the engineer. Slurry tanks of adequate capacity will be required for slurry mixing, circulation, storage, and treatment. No excavated slurry pits will be allowed in lieu of slurry tanks without written approval from the Engineer. Adequate de-sanding equipment will be required as necessary to control slurry properties during the drilled shaft excavation in accordance with the values provided in the table below.

Perform the Control tests using suitable apparatus on the slurry to determine density, viscosity, sand content and pH of freshly mixed slurry, recycled slurry, and slurry in the excavation. Tests of slurry samples from within one foot of the bottom and at mid-height of the shaft shall be conducted in each shaft excavation during the excavation process to establish a consistent working pattern. A minimum of four sets of tests shall be conducted during the first eight hours of slurry use on the project. When the results show consistent behavior, the testing frequency may be decreased to one set every four hours of slurry use, or as otherwise approved by the Engineer. Reports of all tests, signed by an authorized representative, shall be furnished to the Engineer on completion of each drilled shaft. An acceptance range of values for the physical properties will be as shown in the table 625.08-01.

When slurry samples are found to be unacceptable, bring the slurry in the shaft excavation to within specification requirements. Concrete shall not be poured until re-sampling and testing results produce acceptable values. Prior to placing shaft concrete, take slurry samples from within one foot of the bottom and at mid-height of the shaft. Any heavily contaminated slurry that has accumulated at the bottom of the shaft shall be removed. Disposal of all slurry shall be done in areas approved by the Engineer. Perform final shaft bottom cleaning after suspended solids have settled from the slurry mix.

Table 625.08-01: Slurry Control Test Physical Properties

Range of Acceptable Values for Mineral and Polymer Slurries in Fresh Water Without Additives					
Property	**Bentonite**	**Emulsified Polymer**	**Dry Polymer**	**Units**	**Test Method**
Density (Unit Weight)					
At Introduction	63.5- 66.8	< 63	< 63	lb/ft3	Density Balance
Prior to Concreting	63.5- 70.5	< 63	< 63		
Marsh Funnel Viscosity					
At Introduction	32 – 60	33 – 43 **b**	50 – 80 **b**	sec/qt	Marsh Funnel
Prior to Concreting	32 – 60	33 – 43 **b**	50 – 80 **b**		
pH					pH
At Introduction	8 – 10	8 – 11	7 – 11	--	Paper or pH
Prior to Concreting	8 – 10	8 – 11	7 – 11	--	Meter
Sand Content					
At Introduction	< 4	< 1	< 1	Percent by Volume	API Sand Content Kit
Prior to Concreting	< 2	< 1	< 1		
Maximum Contact Time **a**	4	72	72	Hours	

a. Without agitation and sidewall cleaning.

b. Higher viscosities may be required to maintain excavation stability in loose or gravelly sand deposits.

625.09 Protection of Existing Structures

All precautions shall be taken to prevent damage to existing structures and utilities as stated in Standard Specifications for Road and Bridge Construction or noted in plans. These measures shall include, but are not limited to, monitoring and controlling the vibrations from the driving of casing or drilling of the shaft, and selecting construction methods and procedures that shall prevent excessive caving of the shaft excavation.

625.10 Technique Shafts

When required by the contract documents, demonstrate the adequacy of methods and equipment used during construction of the first drilled shaft, which shall be an out of position technique shaft, constructed with reinforcement as identified for production shafts on the Plans. This technique shaft shall be drilled in the position as directed by the Engineer and drilled to the maximum depth for any production shaft shown on the Plans. If at any time the demonstration of the adequacy of methods or equipment and alterations required, at the Engineers discretion, an additional technique shaft(s) may be required. Technique shafts shall be cut off three feet below ground line, buried, or otherwise disposed of as specified in the contract documents or as directed by the Engineer. Once approval has been given to construct production shafts, no changes will be permitted in the methods of equipment used to construct the shaft without approval from the Engineer. When a technique shaft is not required, construction of the first production shaft will be used to determine if the methods and equipment used are acceptable. Failure at any time to demonstrate to the Engineer the adequacy of methods or equipment will be cause for the Engineer to require appropriate alterations in equipment or methods to eliminate unsatisfactory results.

625.11 Construction Sequence

Where construction of a footing is applicable, excavation to footing elevation shall be completed before shaft construction begins, unless otherwise authorized by the Engineer. Any disturbance to the footing area caused by shaft installation shall be repaired prior to pouring the footing. When drilled shafts are to be installed in conjunction with embankment placement, the construct drilled shafts after placement of fills. Drilled shafts constructed prior to the completion of fills shall not be capped until the fills have been placed as near to final grade as possible, leaving only the necessary work room for construction of the caps.

625.12 General Equipment and Methods

Perform excavations through whatever material is encountered to the dimensions and elevations shown on the Plans. The methods and equipment shall be suitable for the intended purpose and for whatever material is encountered.

Provide equipment capable of constructing the shafts to a depth equal to the deepest shaft tip elevation shown on the Plans plus a minimum of 15 feet. When a rock socket is identified on the Plans at a shaft location, the definition of “shaft tip elevation”, for the purposes of this subsection, shall be taken to refer to the bottom of the rock socket.

Excavations required for shafts and rock sockets shall be completed in a continuous operation. ensure the stability of the shaft excavation and the surrounding soil. When obstructions, either expected or unexpected, are encountered, notify the Engineer promptly. The dry method, wet method, temporary casing method, permanent casing method if specified, or combinations, as necessary, shall be used to produce sound, durable concrete drilled shafts free of defects and or anomalies. The permanent casing method shall be used only when required by the contract documents or approved by the Engineer. Blasting excavation methods will not be permitted. When a rock socket is required, the Engineer will be the sole judge as to what constitutes the top of sound rock. The Engineer may order in writing additional depths of rock socket below the top of sound rock as considered necessary to improve the foundation. If the top surface of the sound rock is found to be inclined across the width of the shaft, immediately notify the Engineer. Use an airlift, or other method approved by the Engineer, to clean the bottom of the shaft excavation.

625.13 Dry Construction Method

The dry construction method shall be used only at sites where the groundwater table and site conditions, generally stiff to hard clays or rock above the water table, are suitable to permit construction of the shaft in a relatively dry excavation and where the sides and bottom of the shaft remain stable without any caving, sloughing, or swelling and allow visual inspection prior to concrete placement. The dry method shall consist of drilling the shaft excavation, removing accumulated seepage water and loose material from the excavation, and placing the shaft reinforcing and concrete in a relatively dry excavation. Dry construction will be allowed only if less than 3 inches of standing water is found at the bottom of the shaft and the seepage rate is less than 12 inches of water per hour. Loose material and water shall be satisfactorily removed from the shaft before inspection and placement of rebar and concrete.

625.14 Wet Construction Method

The wet construction method shall be used at sites where a dry excavation cannot be maintained for placement of the shaft concrete. This method shall consist of drilling the shaft excavation below the water table, keeping the shaft filled with water, natural slurry formed during the drilling process, mineral slurry, or polymer slurry to control seepage, groundwater movement and stability of the hole perimeter until excavation to the final depth and placement of the reinforcing cage and concrete has been completed. This procedure will require placing the shaft concrete with either a tremie or concrete pump beginning at the shaft bottom, and displacing the water or slurry as concrete is placed. Temporary partial depth casings near the ground surface shall be provided to aid shaft alignment and position and to prevent sloughing of the top of the shaft excavation. Where drilled shafts are located in open water areas, shafts shall be constructed by the wet method using casings extending from above the water elevation to the Plans casing tip elevation or top of rock socket to protect the shaft concrete from water action during placement and curing. The casing shall be installed in a manner that produces a positive seal at the bottom of the casing.

625.15 Temporary Casing Construction Method

The temporary casing construction method shall be used at all sites where the stability of the excavated hole, the effects of groundwater cannot be controlled by other means, or other conditions exist in which the Engineer deems it necessary. In this method, the hole shall be advanced through caving material by the wet method in accordance with **625.14**. When a formation is reached that is nearly impervious, a casing shall be placed in the hole and sealed. Drilling may proceed by the dry method to the projected depth. The placement of concrete shall proceed by the dry or wet method, except that the casing shall be withdrawn after the concrete is placed. In the event seepage conditions prevent use of the dry method, excavation shall be completed by the wet method. Before and during casing withdrawal, a 5-foot minimum head of fresh concrete above the bottom of the casing shall be maintained at such a level that fluid trapped behind the casing is displaced upward out of the shaft excavation without mixing with or displacing the shaft concrete. Casing extraction shall be at a slow, uniform rate with the pull in line with the axis of the shaft. Temporary casings shall be removed while the concrete is still workable, and the slump of the concrete is between four and eight inches. Vibratory hammers shall not be used for casing installation or removal with a clear spacing between the edge of the shafts less than three shaft diameters 3 shaft diameters of other shafts that have been completed less than 24 hours earlier. The reinforcing cage shall not be damaged or displaced when withdrawing the temporary casing.

625.16 Permanent Casing Construction Method

The permanent casing construction method shall be used only when required by the contract documents or authorized by the Engineer. The casing shall be continuous between top and bottom elevations shown on the Plans. Vibratory hammers shall not be used for casing installation within

a clear spacing between the edge of the shafts less than 3 shaft diameters of shafts which have had concrete poured within the past 24 hours

625.17 Time Limitations

When bentonite slurry is used, adjust operations such that the maximum time that slurry is in contact with the bottom five feet of the shaft, the time from the end of drilling to the beginning of concrete placement, does not exceed four hours without agitation. If the four-hour limit is exceeded, the bottom five feet of the shaft shall be over reamed prior to performing other operations in the shaft. For rock sockets constructed in shale using polymer slurry, concrete placement shall begin within 72 hours of starting the rock socket excavation to avoid degradation of the shaft sidewall. Before concrete placement begins, foundation inspection, when required, cleaning operations, and reinforcing steel placement shall be completed and approved by the Engineer. These operations will be included in the 72 hour time limit. If concrete placement is not begun within the time limit, take corrective measures to the satisfaction of the Engineer.

625.18 Level of Slurry

During construction, the level of slurry is not less than five feet above the water table and shall be maintained at a height sufficient to prevent caving of the excavation. If the Engineer determines that the slurry construction method is failing to produce the desired final results, discontinue operations and propose an alternate method for approval from the Engineer. Correction for a failed slurry construction method will be non- compensable and any effect on time of performance non-excusable.

625.19 Slurry Manufacturer's Representative

When manufactured mineral or polymer slurry additives are to be incorporated into the drilling slurry mix, provide the technical assistance of a representative of the mineral or polymer slurry additive manufacturer at the site prior to introduction of the slurry into the first shaft where slurry use will be required, and during drilling and completion of a minimum of one shaft to adjust the slurry mix to the specific site conditions.

625.20 Cleaning of Shaft or Casing Sidewalls

Cleaning of the shaft or casing sidewalls shall occur by a method approved by the Engineer as necessary to remove the depth of softening or to remove excessive slurry cake buildup.

625.21 General Excavation Considerations

The Plans will indicate the top of shaft elevations and the estimated bottom of shaft elevations between which the drilled shaft shall be constructed. Drilled shafts may be extended or shortened as approved by TDOT Geotechnical Engineering Section and TDOT Structures if the foundation material encountered is unsuitable or better than anticipated, or based on the results of load tests.

625.22 Time Restrictions

Drilled shaft excavation shall begin only if, the excavation, perform foundation inspection and testing, and place the reinforcement and concrete as a complete continuous daily operation. No shaft with a clear spacing between the edge of the shafts less than 3 shaft diameters of another shaft shall be excavated at the same time. Shafts shall not be constructed within 24 hours of the completion of an adjacent shaft if the clear spacing between the edge of the shafts is less than 3 shaft diameters.

625.23 Disposal of Excavated Material

Excavated material removed from the shaft and any drilling fluids used shall be disposed of in accordance with the contract documents, as directed by the Engineer, and in compliance with federal and state regulatory requirements.

625.24 Worker Entry Into Shaft Excavation

Do not allow workers to enter the shaft excavation for any reason, unless both a suitable casing has been installed and adequate safety equipment and procedures have been provided to workers entering the excavation.

625.25 Rock and Obstructions

Subsurface obstructions at drilled shaft locations shall be removed. Employ special procedures or tools when the hole cannot be advanced using conventional equipment. Blasting will not be permitted. Any man-made material that significantly limits excavation advancement such as concrete, steel, timber, etc. will be classified as an "obstruction". Drilling tools lost in the excavation will not be considered obstructions and shall be promptly removed. The presence of an obstruction for pay purposes must be verified by the Engineer. Boulders or rock layers of such size that do not allow the use of soil excavation tools as described will not be considered an obstruction but will be considered Drilled Caisson Rock as described.

625.26 Inspection Equipment

Maintain at the job at all times, all equipment suitable for use in the shaft inspection.

625.27 Removal of Excess Sediment

Final shaft depth shall be measured with approved methods after final cleaning by airlift, or other method approved by the Engineer. Unless otherwise stated in the contract documents, a minimum of 50 percent of the base of each shaft shall have less than ½ inch of sediment at the time of concrete placement. The maximum depth of sediment or any debris at any place on the base of the shaft shall not exceed 1 ½ inches. Shaft cleanliness will be verified by the Engineer for wet or dry shafts.

625.28 Inspection, Supervision, and Records

Provide aid to the Engineer in maintaining accurate records during all phases of the drilled shaft installation. Provide the Engineer with any information required for the drilled shaft inspection reports. Provide bosun chairs, gas meters, safety equipment, lights, mirrors, weighted tape measures, steel probes, cameras, personnel, etc. and all assistance that may be required for the Engineer to inspect the drilled shaft excavations. Perform any corrective work found necessary as a result of inspections. Necessary time shall be allowed for performance of these inspections.

625.29 Inspection for Side Walls

At the Engineer's request, lower the Inspector to the level of the bottom of the casing and allow visual examination of the side walls of the rock socket to confirm the top of rock socket has been reached once the casing has been extended to the top of rock. Preferably, the sidewall inspection should not be performed until the drilled shaft excavation has extended to the anticipated base of rock socket and before any inner casing is set below the top of rock. Should the observed rock excavation reveal soil inclusions or voids, the drilled shaft excavation shall be extended as directed

by the Engineer. Where groundwater cannot be controlled or other conditions prevent safe down-hole entry, side wall inspection will be performed using a camera. The camera should include any light source needed to allow for clear imaging. Provide sufficient proof that casing has been properly seated into rock and that side walls are free from soil inclusions or voids.

625.30 Inspection of Bottom of Shaft

Where groundwater can be effectively controlled (that is, less than one foot of standing water is maintained in excavation bottom) after reaching the anticipated base of rock socket, lower the Inspector to the level of the bottom of the socket and allow visual examination of the bottom of the shaft. Temporary casing should extend to the base of the rock socket to allow the Inspector to safely enter the excavation. Where groundwater cannot be controlled or other conditions prevent safe down-hole entry, bottom of shaft inspection will be performed using a camera. The camera should include any light source needed to allow for clear imaging. Provide sufficient proof that excess sediment has been removed in accordance with **625.27**. The determination of the shaft's tip elevation after excavation to the anticipated base of rock socket will either be made by the Engineer's judgment of conditions found in previously performed test borings drilled within the dimensions of the rock socket, examination of rock socket shaft excavation results (recovered cores or observation of shaft drilling response) or by examination of rock cores taken at least 8 feet below the shaft bottom as required in **625.31**.

625.31 Core Drilling

When required by contract documents, core drilling shall be performed as described in the Plans and paid for under Core Drilling and Sampling at the contract unit price. The Engineer may require rock core samples to be taken a minimum depth of 8 feet and up to a maximum depth of 20 feet below the bottom of the drilled shaft excavation to either aid in predetermining acceptable rock socket elevations prior to beginning of shaft excavation or to provide information to determine the acceptability of a completed rock socket. Core sampling should be performed in accordance with ASTM D 2113 using a double or triple wall core barrel of NX (54.7 mm / 2.16 in.) or NQ (47.5 mm / 1.87 in.) size. Perform this core sampling or schedule a qualified representative to do the Work.

625.32 Log of Confirmation Drilling. Maintain a log of core drilling and sampling (confirmation drilling) for each foundation inspection hole, and such logs shall be delivered to the Engineer within 24 hours of completion of the boring. The log shall include the following:

(a) The amount of NX or NQ cored per run and the amount recovered. All core loss shall be noted and explained. Clay layers shall be noted and located on the log by depth.

(b) The Rock Quality Designation (RQD) for the NX or NQ core. The bedding thickness and degree of weathering shall also be noted.

(c) Location and elevation of holes.

625.33 Storage and Labeling of Rock Cores

Rock cores shall be stored in structurally sound core boxes and shall be protected from the elements. The core boxes shall be properly labeled to indicate location, depth, beginning elevation, Contract Number, and date, and shall be delivered to the Engineer.

625.34 Reinforcing Steel Cage Fabrication and Placement

The reinforcing steel cage, consisting of the longitudinal bars, ties, spirals, cage stiffener bars, spacers, centering devices, and other necessary appurtenances, shall be completely assembled as a unit, and shall be placed immediately after the shaft excavation is inspected and accepted, and just prior to shaft concrete placement. Temporary internal cage stiffeners shall be removed as the cage is placed in the shaft such that interference with the placement of concrete does not occur. The Contractor shall verify the stability of the reinforcing steel cage. Submit verification calculations to the Engineer for review and approval. Calculations shall be sealed by a Professional Engineer licensed in the State of Tennessee.

625.35 Reinforcing Ties, Splices and Clearances

All reinforcing steel in the shaft shall be tied at every intersection and supported such that the steel remains within the allowable tolerances specified in Table 625.35-01 during placement of concrete or casing removal. The reinforcing steel cage shall have sufficient rigidity to prevent racking or permanent deformations during delivery or installation.

Table 625.35-01: Concrete Cover

Concrete Cover			
Shaft Diameter	**Uncased**	**Casing Remains**	**Casing Withdrawn**
3'-0" or less	3"	3"	4"
>3'-0" & <5'-0"	4"	4"	4"
5'-0" or larger	6"	6"	6"

625.36 Spacers

Rolling spacers for reinforcing steel shall be used to minimize disturbance of the shaft sidewalls and to facilitate removal of the casing during concrete placement. Sets of concrete spacers or other approved non-corrosive spacing devices shall be used at sufficient vertical intervals, near the bottom and along the shaft at intervals not exceeding five feet, to ensure concentric location of the cage within the shaft excavation. When the vertical steel is greater than one inch in diameter, the maximum spacing may be increased to 10 feet. As a minimum, a set of spacers shall be provided within two feet of both the top and bottom of the shaft. In addition, one set of spacers shall be provided at both two feet above and below each change in shaft diameter. Non-corrosive spacers shall be provided at a minimum of one spacer per 30 inches of circumference of cage with a minimum of three at each vertical level to maintain the required reinforcement clearances. The spacers shall be of adequate dimension to maintain the specified clearance between the outside of the reinforcing cage and the side of the excavated hole or casing.

625.37 General Considerations

Accumulations of water in casings and excess sediment at the base shall be removed as described herein before the concrete is placed. No concrete shall be placed until all casings, if used, within a 15 foot radius has been installed. Within the 15 foot radius, all driving or vibratory installation methods shall be discontinued until the concrete in the last shaft has set at least five days. Concrete placement shall begin as soon as possible after completion of the excavation, inspection and setting of the reinforcing cage, and shall proceed in a continuous operation from the bottom of the shaft to the Plans construction joint or above as specified herein. An unplanned stoppage of work may require an emergency construction joint during the shaft construction.

625.38 Placement of Concrete in the Shaft

Concrete shall be placed for each shaft with the flow of concrete directed down the center of the shaft. Concrete shall be placed by free fall or through a tremie or concrete pump. The free fall placement method will only be permitted in dry holes. Concrete placed by free fall shall fall directly to the base without contacting either the reinforcing cage or hole sidewall. Drop chutes may be used to direct concrete to the base during free fall placement.

625.39 Time Limitations

Maintain a continuous pour until the shaft is complete. All admixtures shall be adjusted for the conditions encountered on the job, so that the concrete remains in a workable plastic state throughout the two-hour placement limit. Prior to concrete placement, provide test results of a trial mix that demonstrates the concrete meets the two-hour placement limit. When the estimated placement time exceeds the two-hour limit, provide a concrete mix design that will maintain a slump of 4 inches or greater throughout the estimated placement time, as demonstrated by the slump loss test. The trial mix and slump loss tests shall be conducted using concrete and ambient temperatures approved for site conditions and recorded on form MT-0334.

625.40 Concrete Placement by Tremie

Tremies used to place concrete shall consist of a tube of sufficient length to discharge concrete at the shaft base elevation. The tremie shall have sufficient weight to rest on the shaft bottom before the start of concrete placement and to prevent curling of the tremie line during placement of the concrete. The tremie shall not contain aluminum parts that may come in contact with the concrete. A tremie shall consist of a watertight tube having an inside diameter of no less than 10 inches and fitted with a hopper at the top. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concrete placement. The tremie wall thickness shall be adequate to prevent crimping or sharp bends that restrict concrete placement.

625.41 Tremie Operation

Underwater placement of concrete shall not begin until the tremie is at the shaft base elevation. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete during placement operations. The tremie discharge end shall remain immersed as deep as practical in the concrete, but shall be no less than five feet at all times. The tremie shall be supported such as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be sealed closed at the start of work to prevent water from entering the tube before the tube is filled with concrete. After placement has started, the level of the concrete in the tremie shall be maintained above the level of slurry or water in the shaft at all times to prevent water or slurry intrusion into the shaft concrete. If water enters the tube after placement is started, the tremie shall be withdrawn, the discharge end resealed, and the placement restarted. The flow of concrete shall be continuous until the work is completed.

625.42 Removal of Tremie Orifice from Concrete

If at any time during the concrete pour, when using the wet construction method, the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete surface, the entire drilled shaft may be considered defective. Corrections made will be non-compensable and any effect on time of performance non-excusable.

625.43 Concrete Placement by Pump

Concrete pumps and lines may be used for concrete placement by either the wet or dry construction method. All pump lines shall have a minimum diameter of 5 inches and shall be constructed with watertight joints. Concrete placement shall not begin until the pump line discharge orifice is at the shaft base elevation. For the wet construction method, a plug or similar device shall be used to separate the concrete from the fluid in the hole until pumping begins. The plug shall either be removed from the excavation or shall be of a material that does not cause a defect in the shaft if the plug is not removed. The discharge orifice shall remain at least 5 feet below the surface of the fluid concrete. If at any time during the concrete pour the pump line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete level, the shaft may be considered defective. Corrections made will be non-compensable and any effect on time of performance non-excusable.

625.44 Adjustment of Concrete Free Fall or Rate of Concrete Flow

If the free fall concrete causes the shaft excavation to cave, control the movement of concrete by reducing the free fall of the concrete or the rate of flow of concrete into the excavation and follow the details of the method(s) to be used to ensure shaft stability as required by **625.03.6.**

625.45 Drop Chutes

Drop chutes may be used to direct placement of free fall concrete down the center of the shaft excavations. Drop chutes shall be a smooth tube constructed either as a continuous one-piece unit or as removable sections. Aluminum drop chutes will not be permitted. Concrete may be placed through either a hopper at the top of the tube or side openings as the drop chute is retrieved during concrete placement.

625.46 Construction Joints

Construction joints shall not be utilized unless otherwise approved by the Structural Engineer. All planned reinforcing steel shall extend uninterrupted through joints. Surfaces of fresh concrete at horizontal construction joints shall be rough floated sufficiently to thoroughly consolidate the surface and to intentionally leave the surface in a roughened condition.

625.47 Concrete Curing

Portions of drilled shafts exposed to a body of water shall be protected from the action of water by leaving the temporary casing in place for at least seven days after concrete placement or until the shaft concrete reaches a minimum strength of 3,375 psi. After placement, the temporarily exposed surfaces of the shaft concrete shall be cured to prevent loss of water.

625.48 Construction Tolerances

During excavation of the shaft, monitor the plumbness, alignment and dimensions of the shaft. Any deviation exceeding the allowable construction tolerances specified herein shall be corrected with a procedure approved by the Engineer. Drilled shaft excavations constructed in such a manner that the concrete shaft cannot be completed within the required tolerances will not be accepted. Correction methods shall be submitted for the Engineer's approval. Drilled shaft construction shall not begin until final approval has been obtained. When a shaft excavation is completed with unacceptable tolerances, propose, develop and, after approval from the Engineer, implement corrective work. Redesign drawings and computations originally submitted and have signed by a

Professional Engineer licensed in the State of Tennessee. The following construction tolerances will apply to drilled shafts unless stated otherwise in the contract documents:

(a) Temporary casing diameters shall provide a final shaft diameter as shown on the Plans. When approved by the Engineer, the Contractor may provide a larger casing at the Contractor's expense.

(b) Shafts shall be constructed such that the center of the top of the shaft is within 3 inches of Plans position in the horizontal plane at the plan elevation for the top of the shaft.

(c) For shafts in rock, the vertical alignment of a vertical shaft excavation shall not vary from the Plans alignment by more than ¼ inch per foot of depth. For shafts in soil, the vertical alignment of a vertical shaft excavation shall not vary from the Plans alignment by more than 3/16 inch per foot of depth.

(d) The bottom of the shaft excavation shall be normal to the axis of the shaft within a tolerance of 3/8 inch per foot of shaft diameter.

(e) Shaft steel reinforcing bar shall be no higher than six inches above or three inches below Plans elevation.

625.49 Integrity Testing

The completed shaft shall be subjected to the testing methods specified by Plans such as concrete coring, cross-hole sonic logging (CSL) , and/or thermal integrity profiling (TIP), to determine the extent of any defects that may be present. If CSL or TIP testing are indicated in the plans, the Department will supply a consultant to perform the testing. If CSL testing reveals voids or discontinuities in the concrete which indicate that the shaft is not structurally adequate, the shaft will be retested within 3 to 7 days of receiving the report or 10 days from test, whichever is sooner. In the event retesting confirms the results of the initial test, further measures as specified in **625.50** shall be conducted at the no additional cost to the Department. The Department may also conduct TIP testing to further evaluate the extent of the integrity of the shaft.

Concrete shall not be placed in additional drilled shafts until the Contractor demonstrates the adequacy of the shaft construction method to the satisfaction of the Engineer. Any additional work required as a result of shaft defects will be non- compensable and any effect on time of performance non-excusable.

625.50 Concrete Coring

Upon completion of placing concrete and after waiting a minimum of 48 hours, the top surface of concrete shall be cleaned of laitance and any unsound concrete. One or more core holes, at the location and number indicated in the contract documents or as directed by the Engineer, shall be drilled completely through the shaft concrete and the rock socket to approximately one foot below the bottom of the rock socket of the shaft. Provisions for the inspection of the concrete surface shall be in accordance with the applicable requirements described herein. Core holes shall be drilled at locations specified by the Engineer. The holes shall be drilled to recover 4 inch diameter cores. The core samples recovered shall be labeled as to the location from which the samples were taken. The samples shall be delivered to the Engineer for examination. If the cores indicate defective concrete in the shaft, which in the judgment of the Engineer impairs the strength of the completed shaft, drill additional cores as directed by the Engineer. If the concrete is found to be defective, submit to the Engineer in writing a proposal for correction, and those corrective procedures shall be approved by the Engineer before such corrective work is undertaken. The

cored holes in non-defective concrete shall be filled with grout such that all voids are filled. Grout shall be non-shrink and obtain a compressive strength equal to or in excess of that specified for the drilled shaft concrete. Grout shall be selected from Qualified Products List or alternate submitted for to the Engineer for approval. No direct payment will be made for grout and grouting.

625.51 Non-Destructive Testing

A. Cross-Hole Sonic Logging (CSL)

If CSL testing is indicated on a project with CEI oversight, the CEI firm shall supply a subconsultant that is qualified to perform the testing. If the project does not have CEI oversight, then the Department will supply a consultant to perform the testing. Shafts six feet in diameter and larger require the addition of 3D tomography. Testing will be performed after the shaft concrete has cured as specified in Table 625.51-1. Provide reasonable access to the shaft top for performance of CSL testing.

Table 625.51-1 Sonic Logging Time Requirements

Shaft Diameter	Minimum Cure Time (prior to testing)
4 to 6 ft.	72 hours
6 to 8 ft.	96 hours
>8 ft.	120 hours

Furnish and install ≥1 ½" nominal inside diameter steel pipes with 0.145" minimum wall thickness, ASTM A 53, Standard Weight, for use in sonic testing of each drilled shaft. Pipes shall be installed in each drilled shaft at the locations shown on the Plans, as required by the testing agency, or as directed by the Engineer. The pipes shall be sufficiently regular and free from defects to permit the free and unobstructed passage of the probes. The pipe shall be installed such that all internal joints are flush. Stiffening devices such as mandrels, tape, or similar material to seal the joints shall not be used. Pipe shall be watertight with clean internal and external faces, the latter to ensure a good bond between the concrete and the pipes. The pipes shall be fitted with a screw-on watertight shoe and cap and shall be securely fixed to the interior of the reinforcement cage with a minimum cover of three inches from the shaft periphery. The pipes shall be as near too parallel as possible, equally spaced, and vertical. Where several sections of pipe are required to reach the full length, joints shall be made watertight. The pipes shall be filled with water and plugged or capped before shaft concrete is poured. The upper end of the pipe shall not be left open after the pour. The pipes shall extend at least three feet above the top of the concrete in the shaft to compensate for water displaced by insertion and removal of the transmitter, receiver, and cable. For shafts with a rock socket, the lower end of the pipes shall extend to the bottom of the rock socket. Care shall be taken during the drilled shaft concrete pour to not damage the pipes. If a tremie is used, the tremie shall not be permitted to rest on top of the pipes during the pour. After completion of the sonic logging and final acceptance of the drilled shaft, fill the access pipes with grout.

The sonic logging equipment furnished by the CSL consultant/subconsultant shall consist of all necessary supplies, support equipment and power to perform the sonic logging testing requirements as described herein.

The drilled shaft shall be tested between three and 7 days after concrete placement. The following procedures shall apply:

(a) Pipes shall be checked to ensure the pipes are free from blockages and are filled with water.

(b) Levels shall be taken on top of each pipe; each pipe shall be plumbed, and the length shall be recorded.

(c) Testing shall be performed between each pair of adjacent pipes around the shaft perimeter and also in pairing combinations between each pipe with all other pipes in the shaft.

(d) All tests shall be carried out with the probes in the same horizontal plane unless the Engineer directs that defects be further evaluated with the probes on different horizontal planes.

(e) The probes shall be raised simultaneously from the bottom of the pipes ensuring that all slack is taken out of the cables before the analyzer is switched on, and that the distance between transducers remains constant during the course of the test. The speed of ascent shall be less than 12 inches per second. Measurements shall be taken at three inch intervals or less. Anomalies indicated by longer pulse first- arrival times (FAT) and significantly lower amplitude per energy signals shall be reported. If anomalies are detected, additional tests with two or more sources per receiver vertical offsets of greater than or equal to 20 inches shall be conducted between the same tubes unless the anomaly is within 20 inches of the bottom of the shaft.

(f) The CSL consultant/subconsultant shall provide accurate measurements of probe depths on the logs.

Preliminary results of the testing shall be provided on site prior to the CSL consultant/subconsultant leaving the site. A detailed CSL report and test data shall be submitted to the Engineer within seven days. The CSL report shall be signed and sealed by a Professional Engineer licensed in the State of Tennessee. The CSL report shall include, but is not limited to, the following: project identification and dates of testing, a table and schematic showing shafts tested with accurate identification of tube coordinates and collar elevation, name of personnel that performed the tests and interpretation and those personnel's affiliation, equipment used, data logs, interpretation, analysis, and results. The data logs shall include XY plots of FAT, amplitude, and velocity versus depth. CSL data shall be processed to provide easy to understand 2D cross-sections between tubes for all tube pair combinations. These plots shall be annotated by the CSL consultant/subconsultant as appropriate to delineate anomalous results. For shafts six feet in diameter and larger, 3D tomography will be required along with CSL testing. If 3D tomography is requested, the data shall be submitted to the Engineer within ten days. If offset surveys are performed as part of 3D tomography , data plots shall include 3D volumetric images for the entire shaft, color-coded, to indicate velocity variations along the shaft. Locations and geometry of anomalies or unconsolidated zones shall be identified in 3D color images with detailed discussion. The results for CSL and 3D surveys shall be based on the percentage decrease in velocity as correlated to the Table 625.51-02 Concrete Condition Rating Criteria (CCRC). The velocity datum of good concrete shall be established by averaging the velocities in the good concrete along the drilled shaft. Deviations from the velocity datum shall be used for determining the Concrete Condition Rating.

Table 625.51-2: Concrete Condition Rating Criteria

		Overall Rating shall be the lower of the two criteria		
Concrete Condition Rating	**Rating Symbol**	**Velocity Reduction**	**Signal Distortion/Strength**	**Indicative Results**
Good	G	0 to 10%	None / normal Energy Reduction ≤ 6 dB	Acceptable concrete
Questionable	Q	10% to 20%	Minor / lower Energy reduction = 6.1 to 9 dB	Minor concrete contamination or intrusion. Questionable quality concrete.
Poor	P/D	> 20%	Severe / much lower Energy reduction > 9 dB	Defects exist, possible water slurry contamination, soil intrusion, and or poor quality concrete.
Water	W	V= 4760 to 5005 ft/sec (≈60% reduction)	Severe / much lower Energy reduction > 12 dB	Water intrusion, or water filled gravel intrusion with few or no fines present.
No Signal	NS	No signal received	None	Soil intrusion or other severe defect absorbed the signal, tube debonding if near top.

a The baseline velocity shall be 13,000 feet per second for normal weight concrete.

The CSL consultant/subconsultant shall immediately inform the Engineer of any suspected anomalies, honeycombing or poor concrete quality detected by testing. The Contractor and CSL consultant/subconsultant shall duly perform further tests as directed by the Engineer to evaluate the extent of any detected anomalies. Core drilling, or other investigative methods as approved by the Engineer, shall be performed to further investigate the anomaly. If a defect is confirmed, the Contractor shall bear all costs involved with the shaft coring, grouting and remediation. Within 14 days of the completion of testing, provide a report signed and sealed by a Professional Engineer licensed in the State of Tennessee providing the results of the additional investigations and recommendations to accept or repair the shaft. The report shall also contain recommendations for modification of construction procedures to prevent defects for subsequent shaft installations. The dates of the completion of drilling, cleaning, steel placement and concrete pour shall also be provided. Work above the top of shaft shall not be performed until the shaft has been accepted by the Engineer.

B. Thermal Integrity Profiling (TIP)

TIP testing data, which will monitor the temperature of the shaft concrete while it is curing, will be collected based on the ASTM D7949. The testing period differs based on diameter and testing method. If TIP testing is indicated on a project with CEI oversight, the CEI shall supply a subconsultant that is qualified to perform the testing. If the project does not have CEI oversight, then the Department will supply a consultant to perform the testing.

The installation of Access Ducts method A could allow the use of the CSL tubes to be utilized for the temperature probe to be lowered into the shaft. The depth the probe should be lowered following ASTM D7949 7.2.3.

The installation of Thermal Wire method B will allow for continuous monitoring during the concrete curing cycle. The thermal wire cable with the thermal sensors for the TIP should be attached to the reinforcing cage before placement in the shaft. One cable per foot of diameter of the shaft is expected. All cables should be connected to Thermal Acquisition Port (TAP) that will collect data on site at any given time.

After data collection, the TIP consultant/subconsultant shall provide a written report along with analysis of data within 7 days of the final readings. The TIP report shall include all ASTM D7949 TIP report elements. Analysis should include the Effective Average Radius of the shaft based on the collected data and the location of any anomalies detected in the shaft.

625.52 Drilled Shaft Load Tests

All load tests, when required by the contract documents, shall be completed, and submitted to the Engineer for review and approval before construction of any production drilled shafts. The locations of load test shafts, the maximum loads to be applied, the test equipment to be furnished by the Contractor, and the actual sequence of the load testing shall be as shown on the Plans or as specified in the contract documents. After completion of testing, test shafts not used as production shafts shall be cut off at an elevation three feet below the finished ground line. The portion of shafts cut off shall be disposed of, at no additional cost to the department, in a manner approved by the Engineer.

Compensation

625.53 Method of Measurement

A. The Department will measure the accepted drilled shafts Drilled Shaft Excavation (Soil) to the nearest 0.10 vertical foot of length along the axis of each shaft. For shafts without a rock socket, measurement will be from the Plans elevation for the top of shaft to the bottom of the shaft. For shafts with a rock socket, measurement will be from the Plans elevation for the top of shaft to the top of the rock socket as defined in section "Drilled Shaft Excavation (Rock)".

B. The Department will measure the accepted rock sockets and drilling through rock as Drilled Shaft Excavation (Rock) to the nearest 0.10 vertical foot of length along the axis of the shaft for the cumulative length of rock, as determined by the Engineer. The "top of rock" is defined as the elevation at which natural material cannot be drilled by conventional drilling tools and requires the use of special rock augers, core barrels, air tools, or specialized removal methods.

C. The Department will measure Drilled Shaft Concrete by the cubic yard and computed from the dimensions indicated on the Plans or directed in writing by the Engineer.

D. The Department will measure Drilled Shaft Reinforcing Steel for payment by the pound, unless otherwise stipulated in the Plans, in accordance with **604.30**.

E. The Department will measure Permanent Drilled Shaft Casing by the vertical foot of permanent casing installed. Additional permanent drilled shaft casing installed for the convenience of the Contractor will not be measured for payment.

F. The Department will not measure Temporary Drilled Shaft Casing for payment and shall be incidental to the work.

G. The Department will measure Foundation probe holes will be measured for payment to the nearest 0.10 linear foot of length along the axis of each hole and paid for as Item Rock Drilling Bridges.

H. The Department will measurement Core Drilling And Sampling for foundation core holes to the nearest 0.10 linear foot of length along the axis of each hole.

I. The Department will measurement Concrete Coring to the nearest 0.10 vertical foot of length along the axis of the shaft from the top of concrete to a point determined by the Engineer, and may extend the entire length of the shaft plus one foot below the bottom of the rock socket.

J. When testing is not performed by the CEI, The Department will measure Sonic Logging Testing per each drilled shaft as required.

K. The Department will measure Load tests for each load test performed.

625.54 Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
625-01.07	PIEZOMETER	L.F.
625-01.08	INCLINOMETER	L.F.
625-01.10	CAMERA INSPECTION - DRILLED SHAFT (DRY)	EACH
625-01.11	CAMERA INSPECTION-DRILLED SHAFT (UNDERWATER)	EACH
625-02.XX	DRILLED SHAFT-SOIL (DIA.)	V.F.
625-02.XX	DRILLED SHAFT-ROCK (DIA.)	V.F.
625-02.XX	DRILLED SHAFT CASING-PERMANENT (DIA.)	V.F.
625-02.40	DRILLED SHAFT (SH-SCC) CONCRETE	C.Y.
625-02.43	CONCRETE CORING	V.F.
625-02.44	DRILLED SHAFT REINFORCING STEEL	LB.
625-02.45	DRILLED SHAFT REINFORCING STEEL (GRADE 75)	LB.
625-02.46	SONIC LOGGING TESTING	EACH
625-02.47	DRILLED SHAFT LOAD TEST	EACH
204-05.01	CORE DRILLING AND SAMPLING	L.F.
204-05	ROCK DRILLING (BRIDGES)	L.F.

A. Such payment for Drilled Shaft (Soil) will be considered full compensation for all temporary steel casing required, costs of drilling, excavation, slurry, dewatering, cleaning, and incidental work, and materials required to complete the excavation. Payment for any drilled shaft excavation will be at the contract unit price per vertical foot for the diameter of the drilled shafts specified. No additional compensation will be made for concrete required to fill an oversized casing or for oversized excavation.

B. Such payment for Drilled Shaft (Rock) will be considered full compensation for drilling, excavation, slurry, cleaning, dewatering, and incidental work, and material required to complete the excavation. For payment purposes the length of any rock socket installed and accepted shall be paid for at the contract unit price per vertical foot for the diameter of the rock socket specified. If the method of construction requires that drilled shaft casing be seated into the sound rock such that the bottom of the casing is below the determined top of sound rock elevation, payment for excavation below the top of the sound rock layer (top of the rock socket) will be included in the payment for the rock socket. In the event that the Engineer orders additional rock socket

construction, payment for the additional length will be at the contract unit price per vertical foot of rock socket. Payment will be considered full compensation for the additional excavation into rock including all incidentals necessary to complete the work down to the elevation designated by the Engineer. Additional reinforcing steel and concrete shall be paid for at the contract unit bid price.

C. Removal of obstruction(s) will be paid at two times the unit price bid for Item Drilled Shaft (Rock) V.F. for the shaft length from the first occurrence of the obstruction until such depth that the shaft is advanced to the point of removal of the obstruction and normal shaft excavation methods can resume.

D. Such payment for Drilled Shaft Concrete will be considered full compensation for all costs associated with furnishing and placing concrete in the drilled shaft in the unit price bid per cubic yard for Drilled Shaft Concrete in accordance with the Contract Plans. Include all costs associated with furnishing and installing Sonic logging access tubes and any required extensions in the unit price bid per cubic yard for Item Drilled Shaft Concrete. No payment will be made for construction delays resulting from the initial sonic logging testing of the drilled shaft. The Department will pay the costs for the initial sonic logging testing. The Contractor shall pay for all costs associated with coring, engineering design, cost required to correct defects and any construction delay costs, if a defect is found based on the sonic logging. The Contractor shall pay the costs of sonic logging testing to re-test the repaired drilled shafts.

E. Such payment for Drilled Shaft Reinforcing Steel will be considered full compensation for all costs associated with furnishing and placing reinforcing steel, including but not limited to spacers, ties, and splices, in the drilled shaft at the unit price bid per pound for Reinforcing Steel in accordance with **604.31**

F. Such payment for Drilled Shaft Reinforcing Steel will be considered full compensation for all costs associated with furnishing and installing permanent casing in the drilled shaft in the unit price bid per vertical foot of Drilled Shaft Casing. Temporary Casing, including all costs associated with installation and removal, shall be included in the bid price for item Drilled Shaft Excavation.

G. Such payment for Core Drilling and Sampling will be considered full compensation for drilling or coring the holes, extracting, and packaging the samples or cores, laboratory testing, delivering the samples or cores to the specified TDOT location and for all other expenses necessary to complete the work. Payment shall be full compensation for completing the core drilling as specified.

H. Such payment for concrete coring will be considered full compensation for all material, labor, tools, equipment, grouting and incidentals necessary to complete the work.

I. When testing is not performed by the CEI, but required by contract documents, or directed by the Engineer, such payment for sonic logging testing will be considered full compensation for providing all equipment, conducting the actual probing measurements as specified, furnishing reports, removing equipment, and all tools, labor, and any incidentals necessary to complete the work. The number of sonic logging inspections may vary from the estimated quantities, but the contract unit price shall prevail regardless of the variation. No payment will be made for supplementary sonic logging testing to evaluate defects.

J. When required by contract documents, such payment for drilled shaft load test will be considered full compensation for all work related to performing and reporting load tests as specified.

S T A T E **O F** **T E N N E S S E E**

Rev. 8-21-17 January 1, 2021

SPECIAL PROVISION
REGARDING
AGGREGATE FOUNDATION SYSTEMS

626.01 Description – This work shall consist of the design, furnishing of materials and the construction/installation and testing of aggregate foundations, consisting of either stone columns or aggregate piers. The intent of the aggregate foundations specified herein is to provide sufficient soil reinforcement and/or soil densification (i.e. global slope stability, bearing capacity, settlement) within the limits indicated on the contract documents to achieve the degree of improvements required to meet the performance criteria stated in the contract documents.

626.02 Method – Stone columns or aggregate piers shall be designed and constructed for the aggregate foundations based upon the soil information provided in the contract documents, the Contractors expertise, and other factors. The Contractor shall be responsible for all aspects of the design of the aggregate foundation system selected and meeting the performance requirements specified in the contract documents, including any grading deemed necessary by the contractor to prepare the project site for the aggregate foundations.

If the Prime Contractor does not possess the capability or expertise to design and/or install the aggregate foundations, as stated herein, or they select a system that is considered proprietary, they shall make arrangements to contract the services of a licensed Contractor or other qualified personnel, who meet the requirements stated herein, to perform the design and/or installation. All aggregate foundation improvement documents shall be signed and sealed by a Professional Engineer licensed in the State of Tennessee. The procurement of any permits required for the installation of the aggregate foundations, including the disposal of any water or spoils, shall be the sole responsibility of the Contractor.

626.03 Qualifications of Designer/Installer – The Contractor performing the work described herein shall have personnel on-site (engineer, operator, and/or foreman or superintendent) experienced in the aggregate foundations being installed. This work shall be performed under the supervision of the Contractors superintendent, who is knowledgeable and experienced in the method of constructing

aggregate foundations as required by the project. The Contractors equipment shall have the capacity to undertake the work and shall be sufficient to complete the work within the specified contract time.

The Contractor selected for this project shall meet the following criteria:

1. A minimum of five (5) years of experience in the selected aggregate foundation system design and installations.
2. At least one (1) registered Professional Engineer licensed to perform work in the State of Tennessee. The Contractor shall assign an engineer to supervise the work with at least (3) years of experience in the design and installation of the selected aggregate foundations.
3. A superintendent or foreman with a minimum of two (2) years of experience in the supervision of the aggregate foundation. The contractor may not use consultants or manufacturers' representatives in order to meet the requirement of this section.
4. Evidence of successful design and installation of the selected aggregate foundation system, within the United States of America, under similar conditions on at least three (3) projects in the last three (3) years. This documentation shall contain at a minimum: name of client contact, address, and telephone number; location of project; contract value, description of aggregate foundations and use (i.e. slope stability, settlement, bearing capacity, etc.)

626.04 Design Requirements – The Contractor shall be responsible for ensuring that the size, pattern, depth and spacing of the aggregate foundations are adequate to provide the required global slope stability, bearing capacity and/or settlement. The contractor shall be fully responsible for all assumptions, made by the contractor in regard to the aggregate foundation system, the strength of the soil and rock, and all implications that the properties of the soil and rock have on the design, constructability and stability.

The design of the aggregate foundation system shall meet all requirements contained within the contract documents.

626.05 Submittal of Designs and Details– The Contractor shall submit the designs and details (Design Packet) for review and acceptance by the Engineer (Materials and Test Division) no less than sixty (60) calendar days prior to beginning construction of the aggregate foundations.

INITIAL SUBMITTAL

1. Work experience in accordance with required qualifications mentioned in Subsection 625.03 of this Special Provision.
2. The Contractor shall submit one (1) full size plan set and one (1) electronic copy (PDF) of the

design packet to the Engineer as an initial submittal. If clarifications are required, an email with an accompanying electronic file (PDF) will be sent to the Contractor for clarifications within 15 business days after the receipt of the initial submittal.

3. The Contractor will be allowed 5 business days for comments clarification after the initial comments have been received. The Engineer will be allowed 5 business days following the Contractors response to determine if further clarification is needed.
4. The Engineer will not approve the submittal of the design packet but will review the submittal for completeness.
5. The initial submittal shall be signed and sealed by a registered Professional Engineer licensed to perform work in the State of Tennessee.

FINAL SUBMITTAL

1. Once the Engineer informs the Contractor that the design packet is complete, the Contractor shall submit one (1) full size set and one (1) electronic copy (PDF) of the final approved set of plans.
2. The final submittal shall be signed and sealed by a registered Professional Engineer licensed to perform work in the State of Tennessee.

MINIMUM REQUIREMENTS OF THE SUBMITTAL OF DESIGN CALCULATIONS

1. Configuration of the Design Submittal
    a. The design packet shall contain in the title block the project number, county, foundation locations, initials of the preparer, contract number and page number. An index page shall be included to provide a list of the pages of the submitted design packet.
    b. The design packet shall include an explanation of the symbols on the calculations, a description of the computer program(s) used in the design, and at least one hand calculation documenting the computer program results. The design calculations shall indicate the target minimum replacement ratio and target minimum composite angle of internal friction at each section.
2. Diagrams of Critical Cross Sections
    a. The design packet shall include diagrams of the critical design cross section geometry including soils and rock strata, along with the locations, size and depths of the aggregate foundations.
    b. The design cross sections shall also include the critical slip surface shown where it will result with the minimum factor of safety.

3. Physical Properties of Rock and Soil

    a. The soil and rock properties, including shear strength, friction angle, cohesion and unit weights shall be shown for each soil and rock strata. Geotechnical information is provided in the contract documents.

4. Factor of Safety

    a. The comparison of the calculated factor of safety and the minimum required factor of safety shall be clearly shown in the design packet.

MINIMUM REQUIREMENTS OF THE SUBMITTAL OF AGGREGATE FOUNDATION DETAILS

1. Plan View of the Aggregate Foundations

    a. A plan view of the aggregate foundations shall be submitted. The following details shall be shown in the plan view:

        i. Identification numbers of the aggregate foundations;

        ii. A reference baseline;

        iii. Offset from the construction centerline or baseline to the aggregate foundations;

        iv. Size and alignment of aggregate foundations;

        v. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures and other potential interferences;

        vi. The centerline of any drainage structures or drainage pipes located behind, within, or under the foundations.

2. Elevation View of Aggregate Foundations

    a. A drawing of the elevation view of the aggregate foundations shall be submitted. The following details shall be shown in the elevation view:

        i. Identification numbers of the aggregate foundations;

        ii. The elevation at the top and bottom of the aggregate foundations;

        iii. Size and alignment of the aggregate foundations;

        iv. Schematic and elevations of the structure, slope, etc. being supported by the aggregate foundation.

        v. The centerline of any drainage structures or drainage pipes located behind, within, or under the foundations.

626.06 Work Plan – The Contractor shall develop a work plan and submit the plan for review and acceptance to the Engineer no less than sixty (60) days prior to beginning construction of the aggregate foundations. The Contractor shall submit one (1) paper copy set and one (1) electronic copy (PDF) of the Quality Control Plan to the Engineer as an initial submittal. If clarifications are required, an email with an accompanying electronic file (PDF) will be sent to the Contractor for clarifications. Submittal clarifications and responses will follow same process as outlined in Subsection "626.05 Submittal of Designs and Details" The Work Plan shall provide detailed project specific information, including the following:

1. Work experience in accordance with required qualifications mentioned in Subsection 625.03 of this Special Provision, SP626.
2. List and size of all equipment and construction procedures to be used during installation;
3. The source of the proposed aggregate foundation backfill material and the gradation with tolerances the Contractor proposes to use. Upon approval of the backfill source and gradation, the contractor shall maintain this gradation throughout the aggregate foundation installation;
4. Details of the sequence and proposed schedule of aggregate foundation installation, including the anticipated order in which aggregate foundations will be constructed;
5. Details of excavation methods;
6. Designs of temporary embankment slopes and/or shoring deemed necessary by the Contractor;
7. Details on how water and spoils will be handled;
8. Other information shown in the Plans or requested by the Engineer.

626.07 Quality Control Plan – The Contractor shall develop a Quality Control Plan and submit the plan for review and acceptance to the Engineer no less than sixty (60) days prior to beginning construction of the aggregate foundations. The Contractor shall submit one (1) set and one (1) electronic copy (PDF) of Quality Control Plan to the Engineer as an initial submittal. If clarifications are required, an email with an accompanying electronic file (PDF) will be sent to the Contractor for clarifications. Submittal clarifications and responses will follow the same process as outlined in Subsection "626.05 Submittal of Designs and Details" The quality control plan shall include the following:

1. A proposed plan for quality control throughout the installation process;
2. Controls and measurements of the aggregate foundations;
3. A proposed verification program, including proposed independent testing agency to be used;
4. Copies of forms to be used for daily reports, testing reports and other pertinent reports;

5. Copies of testing methods to be used;
6. Copy of written Verification Program.

626.08 Verification Program – A verification plan designed, accomplished and reported by the Contractor is required to measure the quality of the installed aggregate foundations. The proposed verification program is subject to approval by the Engineer. As a minimum, the verification program shall include the following:

1. Proposed means and methods for verification that design and performance criteria, as stated in contract documents, has been satisfied. This may include but shall not be limited to modulus testing on individual elements and/or groups, soil borings, and other methods as required by the aggregate foundation system designer and approved by the Engineer.
2. Quality control program to verify that aggregate foundation elements are installed in accordance with the specifications and requirements as outlined in this Special Provision. The quality control program shall include testing and/or observations by an independent testing agency.
3. Program to monitor performance of the aggregate foundation system during and after construction of the overlying embankment. This procedure may include the installation of instrumentation. Instrumentation installed to monitor performance may also be used to aid in the verification that design and performance criteria have been satisfied.

626.09 Daily Progress Reports and Final Reports – During construction the Contractor shall submit an electronic file (PDF) copy of daily progress reports to the Engineer. Daily reports shall contain (if applicable) but shall not be limited to, element identified by location number, date constructed, drilled diameter, elevation of top and bottom of element, average lift thickness, the type and size of equipment used, description of soil and ground water conditions, quantity of aggregate used per element, results of quality control testing, and other pertinent daily activity information. The Contractor shall immediately report any unusual conditions encountered during aggregate foundation installation to the Engineer.

At the completion of the installation of the aggregate foundations, the Contractor shall submit a final report to the Engineer detailing the equipment and methods used, production rates, the performance of the site during treatment, and that the site meets the established criteria set forth in the contract documents. This report shall include a summary of all verification testing performed.

626.10 Pre Construction Conference – A pre-construction conference shall be held a minimum of 14 calendar days prior to the Contractor beginning any aggregate foundation installation work at the site to

discuss construction procedures, personnel, verification program, quality control and equipment to be used. Those in attendance shall include:

1. The superintendent and/or foreman, on-site supervisors, and the independent testing agency representative.
2. The Engineer, key inspection personnel, and representatives of the Contracting Authority.

If significant changes are made to the Contractors personnel, or significant revisions are made to the Contractors Design Packet and Work Plan, an additional conference shall be held before any additional work is performed.

626.11 Materials – Aggregate foundation backfill materials shall be furnished by the Contractor. Aggregates used for the construction of aggregate foundations shall be relatively clean crushed stone, meeting the requirements of Section 903 of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction for abrasion loss and sodium soundness.

Gradations for aggregate foundations shall be Type I, Grade B in accordance with ASTM D1241, ASTM C33 sizes No. 57, No. 67, or shall be a graded aggregate selected by the installer and approved by the Designer and Engineer. For aggregate foundation elements that extend below the water table, the gradation shall be the same as ASTM D1241 Type I, Grade B, except that particles passing the number 40 sieve shall be eliminated. Alternatively, ASTM C33 size No. 57 stone or other stone selected by the installer and approved by the Designer and Engineer. The aggregate shall have been successfully used in the modulus test.

626.12 Installation – The excavation, installation and testing shall be performed in accordance with the requirements shown on the submittals outlined in Subsection “626.05 Submittal of Designs and Details” and “Subsection 626.06 Work Plan”.

1. Excavation and Shoring
    a. The site shall be graded and leveled as needed for proper installation of the aggregate foundation system selected by the Contractor. The Contractor is also responsible for determining the need for and consequently designing any temporary embankment slopes and/or types of temporary shoring used to ensure proper installation. Any designs of temporary embankment slopes and/or types of temporary shoring shall be signed and sealed by a registered Professional Engineer licensed to perform work in the State of Tennessee.

626.13 Tolerances – Aggregate foundations shall be installed so that each completed element will be

continuous throughout its length. Aggregate foundations shall be installed in a sequence that will minimize ground heave. Any heaving shall be re-compacted or excavated as directed by the Engineer, and be considered incidental to aggregate foundation installation.

1. The center of the completed element shall be within 6 inches of the required horizontal location as shown on the approved details.
2. The completed element shall be out of plumb no more than 2 inches horizontal for every 10 feet vertical of depth as shown on the approved details.
3. The diameter of the completed element shall not be less than 10% of the required diameter as shown on the approved details
4. The centerline of the top of the ground improvement provided by the completed element shall be within 6 inches of the required elevation.

If the aggregate foundation elements are determined to be out of one of more of these tolerances, installation of an additional element may be required at the Contractors expense. The Engineer may require additional aggregate foundation elements to be installed at the Contractors expense if the average effective diameter of any group of 40 consecutively installed elements is less than the plan diameter as shown on the approved design and details.

626.14 Modulus Testing – Testing to evaluate performance values selected for design will be provided by the Contractor. A telltale shall be installed at the bottom of the test foundation so that the deflection at the bottom of the element can be measured. The modulus test shall be conducted at a location where the bottom of the element terminates in soil. ASTM D1143 general test procedures shall be used to establish load increments, load increment duration, and load decrements. Performance will be deemed acceptable when the deflection at the bottom of the element does not exceed 20% of the deflection at the top of the element.

1. The minimum number of modulus tests required will be presented in the contract documents, if not specified in the contract documents a minimum of one modulus test shall be required.
2. The location(s) of the modulus test(s) shall be determined by the Engineer.
3. A seating load of approximately 5% to 9% of the design load shall be applied prior to application of load increments and prior to the measurement of deflection.
4. With the exception of the load increment representing approximately 115% of the design maximum foundation stress, all load increments shall be held for a minimum of 15 minutes and a maximum of 1 hour, and until the rate of deflection reduces to 0.01 inches per hour or less.
5. The load increment that represents approximately 115% of the design maximum on the foundation shall be held for a minimum of 15 minutes, a maximum of 4 hours and until the rate

of deflection reduces to 0.01 inches per hour or less.

6. The modulus testing shall be performed as described in the design packet.

626.15 SPT Verification Testing – Testing to evaluate performance values selected for design will be provided by the Contractor. SPT verification testing parameters will be given in the contract documents. The SPT verification testing shall be conducted in compliance with the following criteria;

1. Testing at each SPT location shall be performed at 2.5 ft. intervals through the entire depth of the improved soil zone.
2. The normalized SPT blow count shall be equal to the sum of the hammer blows required to drive the sample from 6 to 18 inches below the cleanout depth adjusted to an overburden pressure of 1 tsf and for a hammer efficiency of 60%.
3. SPT testing shall be conducted in accordance with ASTM D1586.
4. SPT testing shall be conducted at midpoint locations between the column patterns.
5. Failure to satisfy the minimum normalized SPT blow count criterion given in the contract documents shall require the installation of additional aggregate columns at the Contractors expense. The Engineer may elect to perform additional SPT verification testing.

626.16 Rejection of Aggregate Foundation Elements – If an aggregate foundation element is installed in an incorrect location or does not satisfy the specified tolerances, the Contractor shall install an additional element near the rejected element at a location approved and agreed upon by both the Designer and the Engineer. Alternate remedial procedures will be accepted only if they are approved by the Engineer. Unless the rejection is caused by an obstruction, refusal in rock, dense soil or errors in the project drawings, the cost of all labor and materials required for the additional element shall be the responsibility of the Contractor.

626.17 Method of Measurement – Aggregate Foundation Improvements will be measured as Lump Sum.

626.18 Basis of Payment – The Contractor will be paid the contract Lump Sum price for the aggregate foundation improvements. This payment shall be full compensation for all submittals, labor, equipment, tools, materials, material tests, field tests, verification program, and incidentals necessary to acceptably construct the foundations.

Payment will be made under Item Number:

- 626-01.01 Aggregate Foundation Improvements – Lump Sum

S T A T E **O F** **T E N N E S S E E**

Rev. 5-14-18 January 1, 2021

SPECIAL PROVISION

REGARDING

PREFABRICATED VERTICAL DRAINS

627.01 Description – The work shall consist of furnishing all necessary labor, equipment, materials, incidentals and transportation for the installation of Prefabricated Vertical Drains (PVDs) in accordance with the details shown on the Plans and the requirements of these Specifications.

627.02 Testing Standards – Use the latest edition of the testing standards indicated in this Special Provision. Substitution of standards will require the prior written approval of the Engineer. The Contractor or the PVD Installer is to provide copies of all substituted standards to the Engineer.

The most recent version of the following testing method(s) may be employed:

- Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method); ASTM D3884
- Grab Breaking Load and Elongation of Geotextiles; ASTM D4632
- Trapezoid Tearing Strength of Geotextiles; ASTM D4533
- Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products; ASTM D4833
- Mullen Burst Test; ASTM 3786
- Water Permeability of Geotextiles by Permittivity; ASTM D4491
- Apparent Opening Size of a Geotextile; ASTM D4751
- Tensile Properties of Geotextiles by the Wide-Width Strip Method; ASTM D4595
- (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head; ASTM D4716
- Particle-Size Analysis of Soils; ASTM D422

627.03 Materials - The PVDs shall consist of newly manufactured materials and shall consist of a continuous polymeric drainage core and nonwoven geotextile filter fabric (jacket). The jacket shall allow

free passage of pore water to the core without loss of soil material or piping. The core shall provide continuous vertical drainage. The core and jacket material may be either non-bonded or bonded. For non-bonded PVDs, the jacket material is wrapped around the core and seamed to itself. For bonded PVDs, the jacket material is fused to both faces of the core along the peaks of the corrugations.

JACKET MATERIALS – The jacket components shall conform to the following:

- The jacket material shall be a synthetic nonwoven polymeric geotextile meeting the criteria listed in Table 1.
- The jacket material shall not be subject to localized damage (e.g., punching through the filter fabric by sand/gravel particles).
- The jacket material shall be rigid enough to withstand lateral earth pressures due to embedment and surcharge so that the vertical flow capacity through the core will not be adversely affected.
- The jacket material shall be flexible enough to bend smoothly during installation and during any induced consolidation settlement without damage.
- The jacket material shall not undergo cracking and peeling during installation of the vertical drain.

Table 1 – Jacket Material Properties

PROPERTY[1]	TEST METHODS	UNITS	REQUIREMENTS
Mass	ASTM D5261	oz./yd^2	≥ 4.0
Grab Elongation	ASTM D4632	%	≥ 50
Grab Strength[2]	ASTM D4632	lbs.	≥ 130
Tear Strength[3]	ASTM D4533	lbs.	≥ 60
Permittivity	ASTM D4491	sec.$^{-1}$	≥ 0.5
AOS	ASTM D4751	Sieve Size (mm)	#100 (≤ 0.15)
Ultraviolet Stability (Retained Strength)	ASTM D4355	%	≥ 50 after 500 hrs. of exposure

Notes:

[1]All numeric values represent Minimum Average Roll Value (MARV) in the weaker principal direction. Provide geotextiles whose average test results from any roll sampled in a lot for conformance or quality assurance testing meets or exceeds minimum values provided in this Table.

[2]For bonded drains, grab tensile strength tests shall be conducted on the assembled drain using ASTM D4595.

[3]For bonded drains the trapezoidal tear strength test shall be waived.

CORE MATERIALS – The core materials shall conform to the following:

- The core material shall be continuous polymeric material fabricated with grooves to promote drainage along the axis of the vertical drain. Studded cores are not allowed.
- The core material shall meet the criteria listed in Table 2.

Table 2 – Core Material Properties

PROPERTY	TEST METHODS	UNITS	REQUIREMENTS
Thickness	ASTM D5199	in.	0.09375 (3/32)
Mass	ASTM D3776	oz./ft.	≥ 0.60
Tensile Strength	ASTM D638	lbs.	300
Crush Strength	ASTM D1621	psi	450
Ultraviolet Stability (Retained Strength)	ASTM D4355	%	≥ 50 after 500 hrs. of exposure

ASSEMBLED PVD – The assembled PVD shall conform to the following:

- The mechanical properties (strength and modulus) of the assembled drain shall equal those specified for the component jacket and core.
- The assembled PVDs shall be resistant against wet rot, mildew, bacterial action, insects, dissolved salts, acids, alkalis, solvents, and other components in the site ground water.
- Use only one single type of assembled PVD on the project.
- Provide an assembled PVD that meets the properties indicated in Table 3

Table 3 – Assembled PVD Properties

PROPERTY	TEST METHODS	UNITS	REQUIREMENTS
Perimeter	--	in.	≥ 7.75
Width	Measure with caliper	in.	≥ 3.75
Thickness	ASTM D5199	in.	≥ 0.1250 (1/8)
Discharge Capacity	ASTM D4716	gpm	1.5 (at 50 psi)
	ASTM D6918		1.5 (at 25% compression)

TRANSPORTATION AND STORAGE OF ASSEMBLED PVD – The transportation and storage of the assembled PVD shall conform to the following:

- Label or tag the assembled PVDs in such a manner that the information for sample identification and other quality control purposes can be read from the label. As a minimum, identify each roll of assembled PVD by the manufacturer as to lot or control numbers, individual roll number, date of manufacture, manufacturer and product identification of the jacket and core.
- During shipment and storage, wrap the PVDs in burlap or similar heavy duty protective covering. Protect the PVDs from sunlight, mud, dirt, dust, debris, and other detrimental substances during shipping and on-site storage. The PVDs shall be free of defects, rips, holes, and/or flaws. Material which is damaged during shipment, unloading, storage, or handling, or which does not meet the requirements of the drain material will be rejected by the Engineer.

SPLICING PVD

- Non-bonded PVDs may be field spliced. Remove approximately 6 inches of the jacket material from the current assembled PVD roll exposing the core. Insert the exposed core into the new roll of assembled PVD and secure using methods approved by the PVD supplier and accepted by the Engineer. The core material shall not be exposed after splicing. The core materials from each roll should be in firm contact with the corrugated peaks of one core overlapping the corrugated valleys of the other core.
- For bonded PVDs, provide to the Engineer the PVD Manufacturer's splicing procedure for review and acceptance by the Engineer prior to any PVD material being installed.

PVD DRAINAGE LAYER – Unless otherwise stated in the Plans, the PVD drainage layer shall conform to the following:

- Place a drainage layer consisting of at least 24 inches, unless otherwise specified in the plans, prior to PVD installation.
- Unless otherwise specified in the plans, the drainage layer material shall conform to the following gradation requirements (ASTM D422), as shown in Table 4:

Table 4 – Drainage Layer Gradation

SIEVE	PERCENT PASSING
2-inch	100
½-inch	65-100
¼-inch	50-100
No. 10	40-70
No. 40	10-40
No. 200	0-5

- Material not meeting the gradation defined above will be rejected. Acceptance of materials will be at the project site.

627.04 Submittals – At least 30 calendar days before the beginning of the PVD installation, the Contractor shall submit to the Engineer for review, full details of the materials, equipment, sequence and method of installation. Review by the Engineer of these items shall not relieve the Contractor of the responsibility to install PVDs in accordance with this Special Provision. As a minimum, the submittal shall contain the following:

PREFABRICATED VERTICAL DRAIN MATERIAL - Acceptance of the sample PVD material by the Engineer will be required prior to delivery of the PVD material to the Project. At least 30 calendar days before beginning PVD installation, the Contractor and PVD Installer shall:

- Identify the proposed source of the assembled PVDs prior to delivery to the site.
- Supply, to the Engineer, a manufacturer's material certification that the assembled PVD meets or exceeds the material requirements of this specification. The manufacturer's literature shall document the physical and mechanical properties of the PVD. The PVD Manufacturer shall be a specialist in the manufacture of PVDs and shall have produced a minimum of 5,000,000 linear feet of the PVD material similar to that proposed for the Project and that has been successfully used in similar applications within the past 5 years, including details on prior performance on these projects.
- Submit to the Engineer, for review and visual inspection, 3 samples of the un-spliced PVD to be used and 3 samples of proposed splices, if splices are allowed on the project. The samples of un-spliced PVD shall be at least 5 feet long. Samples of spliced PVD shall be long enough to include the splice plus 2 feet of un-spliced drain on both sides of the splice. The samples shall be stamped or labeled by the manufacturer as being representative of the PVD material having its specified trade name.
- Submit to the Engineer, for review and visual inspection, 3 samples of the proposed anchor plate to be used to anchor the PVDs at the design depth shown on the plans.

PREFABRICATED VERTICAL DRAIN INSTALLER - Provide proof to the Engineer of the experience of the PVD Installer for the work described at least 30 calendar days prior to PVD installation. The PVD Installer shall:

- Document successful installation of at least 5,000,000 linear feet of PVDs during the last 5 years and shall be a certified installer of the PVD Manufacturer.
- Document at least 5 successfully completed projects within the last 5 years of similar size and complexity to that of the Project. Document the PVD Installer's experience by providing a project summary that includes for each referenced project, the project start and completion dates, total quantity of PVDs installed, and a detailed description of the project, site conditions,

and subsurface conditions. Include in the project description details of the PVD materials, the equipment and technique used to install the PVDs, the average and maximum length of PVD installed, the client name and address, the name and telephone number of the representative of the consultant and owner for whom the work was performed and who can attest to the successful completion of the work, and any other information relevant to demonstrating the PVD Installer's qualifications.

- Identify a full-time supervisor who has been in responsible charge of supervising PVD installation operations for at least 5 projects in the last 5 years. The supervisor shall be present at the work site at all times during PVD installation operations. Provide a detailed resume of the supervisor's experience and qualifications. Provide a detailed resume for the replacement supervisor, if required.

PREFABRICATED VERTICAL DRAIN INSTALLATION PLAN - At least 30 calendar days prior to PVD installation, the Contractor shall submit to the Engineer, for review, a PVD Installation Plan that includes as a minimum the following information:

- The configuration of the installation equipment including size, type, weight, maximum pushing force, and vibratory hammer rated energy.
- Dimensions and length of the mandrel.
- Details of the PVD anchorage.
- Detailed description of proposed installation procedures.
- Proposed methods for securing splices in non-bonded PVDs or the manufacturers splicing procedure for bonded PVDs, if splicing is allowed.
- Proposed methods and equipment for pre-augering or spudding.
- Submit documentation of the successful application of the proposed PVD installation operations.
- Provide shop drawings showing the planned locations and bottom elevations of all PVDs, a unique identification number for each PVD, the proposed installation sequence, the location of all potential conflicts with the locations of the PVDs.

627.05 Submittal Reviews – Acceptance of the proposed materials, equipment, construction sequence, and installation method will be accepted by the Engineer. Acceptance of the PVD materials, equipment, construction sequence, or installation method does not relieve the Contractor and PVD Installer of its responsibility to install the PVDs in accordance with the plans and specifications. Acceptance by the Engineer of the method and equipment to be used to install the PVDs is contingent upon satisfactory demonstration of PVD installation at the project site. If, at any time, the Engineer

considers that the method of installation does not produce satisfactory PVDs, alter the method and/or equipment as necessary to comply with this Special Provision. The Engineer will determine the adequacy of the Contractor's methods and equipment.

627.06 Installation Requirements

- Install PVDs as indicated on the plans or as directed by the Engineer. Install the PVDs with equipment that will minimize the disturbance of the subsoil during the installation operation and maintain the mandrel in a vertical position. Size the equipment to minimize the disturbance of the subsoil during the installation operation. Provide equipment with sufficient push force to install the PVDs through all existing subsurface material to the depths shown on the plans. Size the equipment to have the capability of installing the PVDs to a depth of approximately 20 feet greater than the maximum PVD depth shown on the plans. Select equipment such that it will not force the fill soil into the existing soil, nor disturb the fill soil, nor cause any bearing capacity problems with the subgrade soils due to the weight of the equipment.
- Install the PVDs using a mandrel or sleeve that can be advanced through the soils to the required depth. The mandrel or sleeve shall protect the PVD material from tears, cuts, and abrasion during installation and shall be retracted after each PVD is installed. To minimize disturbance of the subsoil, the mandrel or sleeve shall have a maximum cross-sectional area of 10 square inches. The mandrel or sleeve shall be sufficiently stiff to prevent wobble or deflection during installation. In no case will alternative raising and lowering of the mandrel during advancement be permitted. Permit the raising of the mandrel only after completion of the PVD installation to the bottom PVD elevation shown on the plans or otherwise authorized by the Engineer.
- Install the PVDs using either a constant load or constant rate of advancement technique. Use a vibrator only when approved by the Engineer in areas where constant load or constant rate of advancement methods cannot install the PVDs to the design depths. Jetting or use of an impact hammer will not be allowed to install PVDs.
- Provide each PVD with an "anchor" plate or similar arrangement to anchor the bottom of the drain at the required depth during mandrel removal and to prevent soil from entering the bottom of the mandrel during PVD installation. The anchorage shall be adequate to keep the bottom of the PVD at the required depth subject to approval and field verification by the Engineer. The corresponding dimension of the anchor shall conform as closely as possible to the breadth dimensions of the mandrel to minimize soil disturbance. The projected cross-sectional area of the mandrel and anchor combination shall not be greater than 14 square inches.

- Notify the Engineer at least 3 working days prior to installation of the initial PVDs at the location(s) shown on the plans to allow the Engineer sufficient time to provide the necessary inspection for the initial PVD installation. Do not begin installation of the initial PVDs at the location(s) indicated without the presence of the Engineer or his/her representative. During the installation of the initial 10 PVDs at the indicated location(s), demonstrate that the equipment, method, and material produce a satisfactory installation, as determined by the Engineer. Following completion of the initial PVD installations at the indicated location(s), do not proceed with the installation of the remaining PVDs at the embankment location until authorized by the Engineer.
- If foundations have been previously installed, install the PVDs in a manner as to avoid these foundations. The location of the PVDs relative to the foundations shall be determined and staked out prior to the installation of the PVDs. In addition, take precautions to preserve the stake locations and re-stake PVD locations as necessary.
- Using a baseline and benchmark determined by the Contractor, locate, number, and stake out the PVDs. All other construction staking, for taking precautions to preserve the stake locations, and for re-staking, if necessary, is the responsibility of the Contractor. Do not vary the as-installed locations of the PVDs by more than 6 inches from the locations designated on the plans or approved shop drawings.
- PVDs that deviate from the plan locations by more than 6 inches, that are damaged, or improperly installed will be rejected. Abandon in place rejected PVDs. Replacement PVDs shall be placed as close as possible to the correct original locations.
- Provide the Engineer with a means of verifying the plumb-ness of the mandrel and determining the depth of the PVDs. Check the equipment for plumb-ness prior to installing each PVD. A deviation from the vertical of no more than 2 percent (2%) during installation is allowed.
- Splices, if allowed in the plans or by the Engineer, shall be done in accordance with approved PVD Installation plan.
- Cut off the PVDs neatly at least 6 inches above the working layer, unless otherwise shown on the plans.
- Provide the Engineer with a means of determining the depth of the advancing PVD at any given time and the length of the drain installed at each location. Submit a summary tabulation of the number and length (to nearest 1/2 foot) of acceptable PVD daily to the Engineer.
- Refusal is defined as the point where the soils resist a reasonable effort at further penetration of the PVDs. The Engineer will establish refusal criteria based on the existing soil borings and the initial PVD installations to be performed by the PVD Installer in the presence of the Engineer or his/her inspector, as specified herein. Terminate no PVDs above the design PVD bottom

elevations shown on the plans without the approval of the Engineer. The Engineer may vary the depths, spacing, and/or number of PVDs to be installed, and may revise the plan limits for this work based on the actual subsurface conditions encountered.

- Where obstructions are encountered below the working surface, install a new drain within a 1 foot radius of the original location of the obstructed PVD. As directed by the Engineer make a maximum of 2 additional installation attempts for each obstructed PVD. If the PVD still cannot be installed to the design bottom elevation, abandon the PVD location and install a new PVD at a location directed by the Engineer. Clearly mark in the field locations where PVDs do not meet the depth criteria due to obstructions. The Engineer will have the right to waive the replacement PVD requirement upon written notice to the Contactor and the PVD Installer.

- Pre-augering or spudding for the PVD installation shall be allowed to advance the PVDs through compacted fill material or other obstructions. Penetrate the overlying fill material or any dense layers or obstructions when encountered to satisfactorily install the PVDs. Obstructions are defined as any man-made or natural object or strata that prevents the proper insertion of the mandrel and installation of the PVD.

- The Contractor may use augering, spudding, or other approved methods to loosen the soil and obstructing material prior to the installation of the PVDs. The obstruction clearance procedure is subject to the approval of the Engineer; however, such approval shall not relieve the Contractor or PVD Installer of the responsibility to clear obstructions in accordance with the specifications.

- If augering is the selected method, the augers shall have a minimum outside diameter equal to the largest horizontal dimension of the mandrel, shoe, or anchor, whichever is greatest. The maximum outside diameter of the auger shall be no more than 3 inches greater than the maximum dimension of the mandrel.

- Limit the use of obstruction clearance procedures and use only when approved by the Engineer. Penetrate no more than 3 feet beneath the obstruction when using augering or other obstruction removal techniques.

- Provide the Engineer with “As-Built” plans of the PVD installation. Include in the plans the location, the date installed, and the length of each PVD below the fill soil surface elevation. In addition, include on the “As-Built” PVD plans the fill soil surface elevation at each location, the “As-Built” PVD bottom elevation, and identify any rejected or abandoned PVD installations. Submit “As-Built” plans at least weekly during PVD installation operations. Submit a final “As-Built” PVD plan within 7 calendar days of the completion of PVD installation in all embankment locations. The final “As-Built” plans will be subject to the approval of the Engineer.

627.07 Method of Measurement – Furnish all supervision, materials, equipment, mobilization, crews, tools, required permits, survey stake out of PVD locations, and other equipment and materials as necessary to properly execute the work. In addition, this item includes clearing of obstructions and the proper disposal of surplus materials brought to the ground surface by obstruction clearance, if required.

Mobilization will be paid for by lump sum.

PVDs will be measured and paid for as the number of linear feet satisfactorily installed, or abandoned as directed by the Engineer. Measure the length of acceptably installed PVDs to the nearest 1/2 foot. The length of the PVDs to be paid for shall be the distance the installation mandrel tip penetrates below the working grade plus the required cut-off length above the working surface. Payment will not be made for drains that are not anchored to the required depth, unless previously approved by the Engineer in writing.

The Engineer may vary the depths, spacing, or numbers of PVDs to be installed and may revise the PVD installation limits shown on the plans based on the actual subsurface conditions encountered. Such changes or revisions may increase or decrease the total quantity of the PVDs estimated based on the plans. In the event of such changes in required PVD quantity, the payment for PVDs shall be made on the basis of the contract unit price per linear foot.

Drainage Layer Material will be paid for in cubic yards of material, complete and in place.

627.08 Basis of Payment – Mobilization shall include the cost of furnishing of all equipment and materials necessary to properly execute the work.

PVD payment will be based on the sum total length of all acceptably installed. No payment will be made for PVDs, or for any delays or expenses incurred through changes necessitated by improper material, equipment, or installation. No payment will be made for PVDs placed deeper than the bottom elevation designated on the plans unless authorized in writing by the Engineer. The unit bid price for PVDs shall include the cost of survey and stakeout, installing PVDs, and furnishing all labor, tools, and incidentals necessary to complete the work.

Drainage layer material payment will be based on the sum total cubic yards of material in place. The unit bid price for the drainage layer material shall include the cost of furnishing all labor, tools, and incidentals necessary to complete the work.

Payment will be made under Item Number:

- 627-01.01 Mobilization Lump Sum
- 627-01.02 Prefabricated Vertical Drain Linear Feet
- 627-01.03 Drainage Layer Material Cubic Yard

S T A T E **O F** **T E N N E S S E E**

(Rev. 7-28-21) January 1, 2021

SPECIAL PROVISION

REGARDING

HIGHWAY SIGNS, LUMINAIRES, AND TRAFFIC SIGNALS

Scope

These design requirements shall apply to **713**-Highway Signing, **714**-Roadway and Structure Lighting, and **730**-Traffic Signals of the current Standard Specifications.

Description

The design of the supports for overhead sign bridges and butterfly configurations, high mast lighting, luminaires, CCTV camera poles, and traffic signal strain poles and mast arm structures shall be in accordance with the American Association of Highway and Transportation Officials (AASHTO) LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 1st edition, with addenda.

General Conditions

All overhead sign bridges and butterfly sign structures, traffic signal strain poles and mast arm structures and high mast light poles 90-feet or greater in height, shall be designed using the Fatigue Category 1 provisions found in the subject specifications except that, design for galloping-induced fatigue and truck-induced gust fatigue, are excluded. Fatigue designs are not required for luminaire poles less than 55-feet in height, span-wire poles, or roadside sign poles.

In lieu of designing for galloping-induced fatigue in mast arm pole assemblies, a 60-inch by 16-inch by 0.125 gauge aluminum or galvanized steel panel shall be installed horizontally near the end of the mast arm with the long axis of the panel collinear with the long axis of the mast. The panel shall be mounted at such a height as to provide a least a 6-inch clearance from the top of the signal assembly or sign blank located on the mast arm within the length of the anti-galloping panel. The panel and attachment hardware shall be shown on the shop drawings, and is considered an item included in the price bid for the mast arm assembly.

Additionally, all mast arm connections to the support pole shall be accomplished using a wrap-around ring stiffener assembly.

The design coordination instructions are as follows:

a. The Basic Wind Speed shall be 120 mph for Extreme 1 Limit State.
b. The Design Life shall be 50 years resulting in a 1,700 year Recurrence Interval.

STATE **OF** **TENNESSEE**
(Rev. 2/20/2020) January 1, 2021
(Rev. 2/8/2021)
(Rev. 3/14//2022)

SPECIAL PROVISION

REGARDING

GUARDRAIL REPAIR / REPLACEMENT

SCOPE OF WORK

The Contractor shall be responsible for repairing concrete barrier wall, bridge ends, pier protections, replacing damaged glare foils, removing and/or replacing metal beam guardrail, terminal anchors, post, and miscellaneous hardware in kind or to current standards at all designated sites within the Region specified in the Special Notes for this contract. In addition, entire guardrail sections may be removed and replaced to current standards, if the major portion of the section is damaged beyond repair and directed by the Engineer. Guardrail, concrete, and glare foil on bridges will be included within this contract. The previously specified work shall include all labor, equipment, materials and incidentals needed to perform the work successfully.

Estimated quantities are for bid purposes only and quantities shown may be increased, decreased or eliminated depending on actual need and/or as directed by the Engineer.

MATERIALS, SPECIFICATIONS, AND DESIGN REQUIREMENTS

The Contractor shall be responsible for providing updated and approved manufacturers' drawings, component shop drawings, specifications, and parts catalogues for each approved guardrail system found on the QPL as well as installation and training documentation for each system if offered by the manufacturer to the Engineer at the preconstruction conference. Product specifications and drawings may be obtained by contacting the manufacturer. A listing of the currently accepted guardrail systems by manufacturer may be obtained by referring to the Material & Tests Divisions, Qualified Products List (QPL). Only qualified manufacturer's products which appear on the QPL shall be installed under the terms of this contract.

All repair work shall be done in accordance with the currently adopted TDOT version of the MUTCD, the currently approved Standard Drawings for safety appurtenances, manufacturer's shop drawings, and the January 1st, 2021 edition of the Standard Specifications for Road and Bridge Construction with all its supplements and modifications within this Special Provision.

Materials used to construct earth pads for tangential energy absorbing guardrail terminals shall conform to the requirements of Sections 303 and 903.05 of the Standard Specifications.

Concrete and steel bar reinforcement used for the execution of work for this contract shall meet the requirements of Section 604 of the Standard Specifications. All concrete used shall meet "CLASS A" requirements for classification, proportioning, and quality assurance. The contractor shall provide the Concrete Design and Concrete Process Control Plan at the Preconstruction meeting. Should the Concrete Design and/or Concrete Process Control Plan expire within the timeframe of the contract, the contractor must resubmit the required documents before any concrete related work is performed.

However, pre-packaged concrete may be used at sites requiring ¼-cubic yard or less if approved by the Engineer.

Materials used in the replacement or repair of damaged guardrail shall conform to the requirements of Section 909 of the Standard Specifications.

Damaged Materials

Any and all damaged material produced as a result of the repair/replacement work shall become the property of the Contractor and shall be removed from the right-of-way and disposed of at the Contractors expense.

EQUIPMENT

All equipment necessary for the satisfactory performance of this work shall be on hand before construction will be permitted to begin.

PROGRESS OF WORK

Initial Callout

The Engineer will issue the Initial Callout on the effective start date of the Contract and provide a list of all known damaged guardrail sites. Work shall begin on the initial callout within fourteen (14) calendar days of the receipt date of the callout. See Special Provision 108B. The initial list of damaged guardrail sites shall be repaired or replaced within the following timeframe:

Table 1 (Initial Callout)

Number of Locations	Calendar Days
1-50	30
51-100	60
101-150	90

The Contractor shall provide a plan of operation for the Initial Callout according to subsection 108.03.A of the Standard Specifications within seven (7) days of the receipt of the Initial Callout. Should the progress of work not be maintained as described in the provided plan of operation and to the satisfaction of the Engineer by midway of the initial timeframe in Table 1, the Regional Director will initiate a letter to the contractor requesting progress schedule updates. Failure to maintain the approved progress schedule may result in the work being performed by others at the contractor's expense in accordance with Subsection 107.12 of the Standard Specifications.

Emergency Callout

In the event damaged guardrail creates a major hazard to the traveling public, the Engineer will issue an Emergency Callout. The Emergency Callout will consist of one (1) site. The work at the one site shall begin within two (2) calendar days. Identification of Emergency Callout sites will be at the discretion of the Engineer.

Routine Callout

Callouts will be issued at the discretion of the Engineer and may be issued concurrently with multiple active callouts. As additional damaged guardrail locations are identified by the Department, the locations will be provided to the contractor and shall be repaired or replaced within thirty (30) calendar days of contractor receipt.

Once work begins at a specific site, a continuous operation shall be maintained. A Continuous Operation is defined as the uninterrupted performance of work on successive calendar days until the completion of a specific site (see Section 101.03 of the January 1, 2021 Standard Specifications for the definition of Calendar Day). Each

damaged guardrail site repair shall be complete before moving to the next site unless approved by the Engineer. Failure to promptly perform the work may result in the work being performed by others at the contractor's expense in accordance with Subsection 107.12 of the Standard Specifications.

Damaged guardrail discovered when traveling from one designated site to another may be repaired if approved by the Engineer. Typically, these sites should only be repaired if severely damaged and non-functional at the Engineer's discretion.

A repair site will consist of work to be performed in a section of guardrail. A section of guardrail is defined as one continuous run of guardrail (regardless of length) between two end terminals on one side of the roadway or median. There may be more than one repair or replacement site in a single section of guardrail, e.g., posts, rail, and an end terminal not immediately adjacent to the posts and rail being repaired or replaced (resulting from two separate vehicular impacts).

The contractor shall provide their work schedule to the Engineer one week in advance to allow for inspection scheduling except on Emergency Callouts.

CONSTRUCTION REQUIREMENTS

All construction methods used to perform work under this contract shall conform to Sections 303, 705, and 706 of the Standard Specification for Road and Bridge Construction dated January 1, 2021 with addenda, and as modified in the Special Notes and this Special Provision.

In accordance with Section 705.06 of the Standard Specification the Contractor shall be responsible for notifying each utility owner of the plan of operation by calling 1-800-351-1111, and ensuring that utilities within the designated project limits have been properly located and marked prior to beginning work.

The Department reserves the right to perform any guardrail repair within the limits of this contract whenever the Department determines that such work is in the public's interest and safety. Sections of guardrail within construction or maintenance work zones may be temporarily suspended from the terms of this contract.

The Contractor will be relieved of maintenance for a site when the repair or replacement is completed, accepted, and serving its intended purpose. Repairs or replacements completed by the Contractor with defective materials or substandard workmanship, pending final acceptance of the site, shall be corrected by the Contractor without additional compensation.

Guardrail Adjustment, Removal, and Resetting

Substandard or impacted metal beam guardrail sections may require re-alignment, re-setting, removal, or some combination of the three in order to bring the section back into current specification. When required these items of work are paid according to the following definitions. **Re-align Guardrail** shall be defined as the length in feet of impacted or substandard undamaged guardrail which has been restored to its original functional position within ±6 inches horizontally and ±2 inches vertically without having to disassemble and/or replace any of the components over the impacted repair length. **Reset Guardrail** shall be defined as the undamaged length in feet of impacted or substandard guardrail which has been restored to its original functional position by removing the original components, repairing the impacted ground, and resetting them in place. **Remove Guardrail** shall be defined as the length in feet of guardrail which is removed and not replaced and includes removal of all components of the system and the repair of impacted ground from the removal process. Measurement for these items of work shall include the lengths of terminal and in-line type anchors where applicable.

Steel Beam Guardrail

Existing blockouts that are 7.5 inches deep may be replaced with any of the 7.5 inch blockouts on the TDOT Qualified Products List regardless of the type of blockout material and provided the blockout depths remain constant in any given run of guardrail (terminal to terminal).

Guardrail End Treatments

Damaged trailing end guardrail terminals on divided roadways shall be replaced with Guardrail Terminal Anchor (Type 13), if feasible.

All end treatment replacements on the National Highway System with a posted speed limit ator above 45 mph shall be replaced with MASH Test Level 3) approved terminals that meet the requirements of and is listed on the Department's QPL or Standard Drawings. The minimal end treatment replacement on the National Highway System below 45 mph, shall meet the requirements of and is listed on the Department's QPL or Standard Drawings.

The Contractor shall furnish the Department the manufacturer's crash tested drawings, component shop drawings, and Specifications. These must be available to the Engineer upon request. These units shall be installed as per the manufacturer's specifications. Installer shall be certified by manufacturer prior to installation.

All bid prices for the above terminals shall include an appropriate hazard marker for the nose piece if present and the labor, equipment, and materials required to install it.

Concrete Barrier

Concrete barrier wall shall be reconstructed in accordance with Section 711 of the Standard Specifications. Damaged sections of concrete barrier wall shall be smoothly sawed from top to bottom in a plane perpendicular to the length of the wall and removed. Sections removed for replacement shall have a minimum length of four (4) feet and shall be at least four (4) feet from the nearest joint. If the damaged section is located within a separately poured glare screen, only the glare screen shall be removed and replaced. In these areas, the glare screen shall be removed one foot wider than the damaged sections or to the construction joint of the barrier wall and saw cut for vertical sides.

Longitudinal reinforcement shall be replaced in kind. Longitudinal reinforcing bars shall be inserted into the undamaged concrete barrier by drilling holes a maximum of 1/4-inch larger than the bar diameter, cleaned properly, and secured with epoxy grout. Embedment length shall be not less than 20 bar diameters.

When sawing does not occur at a joint, tie bars shall be inserted along the centerline of the sawed face on six (6) inch centers beginning six (6) inches from the top of the wall. Tie bars shall be installed by the method described above and shall have a length of at least 40 bar diameters.

The exposed surface of concrete barrier repairs shall be given the same finish (texture coating) as the exposed surface of the wall being repaired in accordance with Subsection 604.21.

Failure to supply the required approved documents and promptly perform the concrete work may result in the work being performed by others at the contractor's expense in accordance with Subsection 107.12 of the Standard Specifications.

Guardrail at Bridge Ends or Pier Protection

The guardrail attachments of concrete bridge ends and pier protections shall be reconstructed in accordance with Section 604 of the Standard Specifications. The damaged concrete wall sections shall be removed a minimum of one (1) foot wider than the damaged area or to a construction joint. Damaged sections of the guardrail attachments shall be smoothly sawed a minimum depth of 1 ½ inches so as not to damage the reinforcing steel.

Damaged reinforcing steel requiring embedment shall be as detailed in Concrete Barrier above. In areas where the reinforcing steel may remain the concrete shall be removed 1 ½ inches beyond the reinforcing steel.

Replaced portions of concrete bridge ends, pier protections and barrier wall shall be finished in the same manner and color as the existing structure in accordance with Sections 604 or 711 of the Standard Specifications. The replacement in-kind includes texture coating surfaces.

Nothing in the general notes or special provisions shall relieve the contractor of his responsibilities toward the safety and convenience of the general public and the residents along the highway. In the event the guardrail operation causes an unsafe situation for the traveling public, the Engineer has the authority to stop work and set working times that must be followed by the contractor to rectify the safety concern.

Earth Pads

Earth pads installed in conjunction with tangential energy absorbing guardrail terminals shall be constructed per Standard Drawings S-GRT-2P and S-GRT-2R or as directed by the Engineer.

Environmental

The contractor shall take all appropriate steps to ensure that environmental features (streams, wetlands, or springs) are not impacted by the work conducted under the terms of this contract without the approval of the Engineer and the TDOT Environmental Permits Section.

Quality Assurance Testing

Random verification of post installations will be conducted under this contract for all guardrail posts installed region wide by all Contractors for the term of this contract. The Contractor will be required to remove posts as directed by Regional Materials & Tests staff for inspection. Costs for removing and reinstalling posts will be paid for under Item Number 706-10.72, Pull and Reinstall Guardrail Post for Verification, Each. If a new replacement post is required due to damage to the pulled post, it will be paid for under Item No. 706-03.01, Posts Furnished, Each. A mobilization payment will be made for each call-out performed exclusively for post verification.

TRAFFIC CONTROL

The Contractor shall establish and maintain traffic control work zones and all traffic control devices according to these notes, the State of Tennessee currently adopted edition of the Manual on Uniform Traffic Control Devices (MUTCD) defined under the Rules of Tennessee Department of Transportation Chapter 1680-3-1, and the Standard Specifications.

Arrow boards utilized for traffic control under this contract shall be “Type B” flashing boards as defined in the MUTCD or an approved equivalent (see Std. Dwg. T-WZ-FAB1).
All ramp and lane closures including traffic control for mobile operations must be requested by the Contractor and approved in advance by the Engineer. All requests shall be made a minimum of seven (7) days in advance of the anticipated work for callouts. Since lane closures are scheduled and approved in advance, if the Engineer determines that work cannot commence as scheduled, call-out time should be suspended until a future lane closure can be scheduled and approved.

All work including the set-up and removal of traffic control work zones shall only be allowed as scheduled and approved by the Engineer. The approved working schedule shall be determined using the table below based on the roadway classification and AADT for the work required in each roadway segment. No scheduled work or closures of any type shall be allowed during holidays or holiday weekends as specified in section 104.04 of the Standard and Supplemental Specifications.

Roadway Classification	Roadway AADT	Working Hours
Interstate and Access Controlled Highways*	AADT ≥ 25,000	8:00 PM – 6:00 AM
	AADT < 25,000	8:00 PM – 6:00 AM
		9:00 AM – 3:00 PM
Multi-lane Highways (# of lanes >2)*	AADT ≥ 25,000	8:00 PM – 6:00 AM
	10,000≤ AADT< 25,000	8:00 PM – 6:00 AM
		9:00 AM – 3:00 PM
	AADT < 10,000	No Working Restrictions
Two Lane Highways (One lane in each direction)*	AADT ≥ 25,000	8:00 PM – 6:00 AM
	5,000≤ AADT< 25,000	8:00 PM – 6:00 AM
		9:00 AM – 3:00 PM
	AADT < 5,000	No Working Restrictions
*Work requiring the use of shoulder closures(only) will be allowed between 9AM -3PM		

Signs and channelizing devices for lane closures shall be erected immediately before work begins each day and shall be removed at the end of work each day to permit traffic to have unrestricted use of all traffic lanes when work is not in progress.

Truck Mounted Attenuator with Mounted Message Board

The following truck shall be utilized on all Interstate and Access Controlled Highways with AADT ≥ 25,000 AADT.

1. A truck mounted attenuator that meets the requirements of and be listed on the Department's Qualified Products List. The attenuator truck cab & chassis must meet and/or exceed manufacturers recommended gross vehicle weight (GVW) requirements.
2. Four (4) strobe lights (with auto-dimmers) positioned rear facing
   a. Two (2) mounted under rear bumper
   b. Two (2) mounted at cab level
3. One (1) standard cab mounted light bar.
4. A truck mounted message board with a full matrix display and a minimum panel size of 72" W x 35" H mounted as per manufacturer specifications and in accordance with Sections 2L.04 and 6F.60 of the MUTCD for Portable Changeable Message signs
5. All Queue truck operators shall have the following mandatory training:
   a. Four Hour National Traffic Incident Management (TIM) Responder Training for Queue Truck Operators, or
   b. Approved equal training program developed by ATSSA, or
   c. The National Safety Council.

COMPENSATION

Method of Measurement

Re-Aligned, Reset, and Removal of guardrail will be measured by the Linear Foot. Each repaired section of guardrail will be measured separately. No measurement for payment will be made for excavation or backfilling performed in connection with removing or installing post or terminal anchors.

Glare Foils will be measured for payment by the unit per each.

Concrete Barrier Wall Repair, Bridge End Repair, or Pier Protection Repair will be paid for by the cubic yard of concrete measured in place.

Guardrail End Terminals will be paid per each for complete assemblies complete and in place.

W Beam guardrail will be paid per lineal foot complete and in place.

Truck Mounted Attenuator with Message Board will be paid per day and shall include providing the truck as defined above including driver. A day is defined as a work shift and includes all incidentals.

Basis of Payment

Guardrail elements which are to be installed on a curve with a radius of 150 feet or less shall be shop curved and will be paid for as Radius Rail Item No. 706-06.03.

Payment for reset guardrail, including but not limited to W-Beam, Thrie Rail, Box Beam, and Weak Post Systems, shall include the removal and resetting of the guardrail including the furnishing of all labor, tools, equipment and incidentals to satisfactorily complete the work.

Payment for the removal of guardrail and post(s) shall include the complete removal of all guardrail elements including rails, posts, anchors, footings, and miscellaneous hardware.

Damaged guardrail parts requiring removal prior to replacement with new guardrail components will be paid under the items for new guardrail items. No additional payment will be made under the removal item.

Payment for the replacement of damaged guardrail end terminals shall be for a complete new unit. This work shall include the complete removal of the damaged unit from the right-of-way, all required rails, posts, anchors, footings, miscellaneous hardware, and decals as directed by the Engineer. No additional payment will be made for the removal of the damaged end terminal.

All work necessary to construct Earth Pads, for guardrail end terminals, shall be paid for under item 705-04.11 per ton. This item shall include the delivery and placement of stone, grading of stone, erosion control, and final stabilization items necessary to complete the work as detailed in Standard Drawing S-GR-38A.

Payment for Concrete Barrier Wall Repair, Bridge End Repair, or Pier Protection Repair will be made at the contract unit price bid per cubic yard of concrete measured in place and shall include sawing, removal, and disposal of the damaged portion of the structure. These items of work shall also include furnishing and installation of guardrail attachments, steel bar reinforcement and tie bars as described above, finishing, texture coating if required, and all costs of forms, labor, materials, and incidentals necessary for the complete performance of the work. Payment for concrete repairs shall be a minimum of one half (0.5) cubic yard per site. No payment will be made for concrete repairs, until all formwork has been removed, the required finish has been applied, and all debris at the site has been removed. Prior to payment for the initial estimate, the contractor shall be required to provide the Engineer the Concrete Design and Concrete Process Control Plan.

Payment for the repair or replacement of Glare Foils will be made at the contract unit price per each and shall include full compensation for all labor and incidentals required to complete this item of work in accordance with these Specifications.

All cost for temporary traffic control, excluding lane closures, shall be included in unit prices bid on other items of work. Payment will be made for each lane closure at the contract unit price per each and shall include full compensation for all flagmen, traffic control devices, and other equipment and materials required to complete this item of work in conformance with the requirements described above and subject to the following:

a) Only one lane closure payment will be made for lane closures erected at a single work site for the duration of the callout.
b) Only one lane closure payment will be made for repair operations performed within a continuous highway section one quarter mile or less in length. On divided highways each directional roadway will be considered independently in establishing the length of the continuous highway section.
c) No lane closure payment will be made if the lane is not properly closed and deemed necessary by the Engineer. Lane closures will be identified by the Engineer per callout
d) A maximum of four (4) lane closures per site may be used for concrete work.

The Department will pay for Emergency Callouts per each site. The payment shall include one Mobilization for each Emergency Callout. Payment for Emergency Callout mobilization will be paid under Item Number 717-01.04, Mobilization (Emergency Call-Out) The Work for each Emergency Callout shall be paid for at the contract unit cost for the items associated with the work.

The accepted quantities of work will be paid for at the contract unit price for each item shown on the plans or as tabulated in the general notes. The price shall be full compensation for repairing concrete barrier wall, bridge ends, pier protections, glare foil, metal guardrail, terminal anchors, posts, and miscellaneous hardware in kind or to current standards in accordance with the plans, tabulated quantities in the general notes, or as directed by the Engineer, including the furnishing of all labor, tools, equipment, and incidentals to satisfactorily complete the work.

STATE **OF** **TENNESSEE**

(Rev. 1-30-10 VB) January 1, 2021

SPECIAL PROVISION

REGARDING

ROCKFALL BARRIER SYSTEMS

General Requirements

The work under this special provision shall consist of installing a Rockfall Barrier System (i.e. Rockfall Fence) including posts, cables, braking elements, and required anchors within the limits shown on the plans, to the manufacturer's specifications and as directed by the Engineer.

The system shall be designed to withstand dynamic forces generated from rocks impacting the installed system. The rock fall protection system shall be capable of absorbing, arresting and retaining Maximum Energy Level (MEL) design impact loads of specified kinetic energy. When maintained in its original condition, the system shall be capable of arresting and retaining at least two Service Energy Level (SEL equal to 1/3 MEL) design impacts, retaining at least 70% of its original height after the first impact. When maintained in its original condition, it shall have the structural capacity to absorb the specified impact design load without passage of particles larger than 4 inches through the barrier. The rockfall barrier shall consist of standard components that can be replaced easily when needed. The rockfall barrier shall be resistant to corrosion, UV degradation and thermal deterioration. The system design shall have been previously used and shall have demonstrated satisfactory performance in similar applications and capacities. The wire mesh and net portions of the rockfall barrier system shall be replaceable after initial installation. Maximum horizontal displacement of net under design load, but before failure of system, shall be as shown on the drawings and not protrude into the traffic lane. A rockfall net shall be allowed to displace into paved shoulder during a rockfall event.

The contractor shall submit in writing documentation that the supplied rockfall barrier kit has performed satisfactorily in similar applications including field-testing, performance history, and locations of similar installations.

The manufacturer shall provide certification test data for the rockfall barrier kit design demonstrating satisfactory performance under MEL and SEL impact loads in a similar application and capacity. The manufacturer shall be regularly engaged in designing and manufacturing rock fall protection systems and have documented experience with manufacturing such systems used in a similar application and capacity. The manufacturer shall supply written evidence demonstrating certification of a quality assurance program, as well as proof and validity of seller's liability insurance.

Additional wire mesh may be required to be attached to the rockfall barrier system in order to retain rocks smaller than the openings in the barrier mesh panels. For rockfall fence mesh that cannot retain rocks greater than four inches in size, the secondary mesh shall be installed to the manufacturer's specification, as shown on the shop drawings, and as directed by the Engineer.

Concrete foundations and wire mesh shall be provided as shown on the design drawings. They shall be supplied and installed by the contractor as outlined in the plans and specifications.

Field Installation Supervision

The manufacturer shall include a minimum of two days and up to one (1) week at 8 hours per day installation supervision by a qualified Field Engineer in order to ensure the system is properly installed. Travel and living expenses shall be borne by the barrier manufacturer or supplier. The cost for the installation supervision shall be included in the cost for the system.

All materials shall be labeled by the manufacturer in order for the Contractor to identify the materials on the manufacturer's working drawings. The cable anchor foundations and post foundations shall be installed in accordance with the requirements of the manufacturer, as shown on the working drawings, as specified in this special provision, and as approved by the Engineer.

The foundation work for post foundations and cable anchor foundations shall be performed in accordance with rockfall barrier manufacturer's requirements and working drawings. The distance from centerline to centerline of the post for rockfall barrier shall be within 3 inches of the distance indicated on the plans.

The rockfall barrier shall be installed in accordance with the requirements of the manufacturer, as shown on the working drawings, as specified in this special provision, and as directed by the Engineer.

Material Specifications

Miscellaneous Materials: All miscellaneous hardware such as wire rope clips, thimbles, bolts, shackles, etc. shall be supplied by the manufacturer with the rockfall barrier kit. Shackles shall be used to fasten nets to each other and to the net support ropes, unless specifically not allowed by the manufacturer.

All structural steel components, including anchors and clamps, shall conform to the requirements in ASTM Designation A36. All bolts, nuts, and washers shall conform to the requirements in ASTM Designation A325 and as required to conform to the tested rockfall barrier kit.

Concrete: The minimum concrete strength is to be 4,000 pounds per square inch or as specified on the Plans. All concrete material, proportioning, mixing, transporting, and testing shall be in accordance with *TDOT Standard Specifications for Road and Bridge Construction* and *TDOT "Procedures for the Sampling, Testing, and Acceptance of Materials and Products (SOP 1-1)".*

Ring Net: Ring net shall be defined as fabric consisting of interlocking steel rings with a diameter of no more than 14 inches. Each ring shall connect to the four or six adjoining rings by passing through them; they must be interlocked. Individual rings shall be fabricated from high tensile steel wire with a nominal steel wire diameter of .12-inch (3 mm) with a minimum breaking strength of 198,700 psi. For a type I or type II fence nominal steel wire diameter of 0.07-in (2 mm) with minimum wire breaking strength of 198,700 psi shall be allowed. A minimum of 5 strands shall be bundled into each ring. Steel wire used in the fabrication of the ring net shall be galvanized.

Cable Net / Woven Wire Rope Net: Cable/Woven wire rope nets shall have a uniform grid pattern, shall be constructed of galvanized aircraft cable, with a square or diamond weave, and must have no more than a 12 inch opening size. Nominal opening size for cable nets/wire rope nets may be specified on the contract documents as 6, 8, 10 or 12 inches. Connectors used to fasten adjacent panels shall have a connection strength equal to or greater than the connection strength of the net.

High Tensile Wire Mesh: High tensile wire mesh shall be of woven construction with a minimum nominal wire diameter of at least 0.15-inch (4-mm). The wire shall have ends formed into a loop and twisted with loops fastened together to prevent unraveling of the mesh. This wire shall have a minimum of 250,000 psi breaking strength. The mesh shall have a minimum longitudinal tensile strength or load capacity of at least 10,000 lbs/ft.

Wire Mesh: When added to a rockfall barrier system, wire mesh shall be securely attached to the cable or ring net fence. Spacing of tie wire or connectors shall be in accordance with manufacturer's recommendations. This mesh shall be flush with no gaps exceeding 4 inches. Tie wires or connectors used to fasten the wire mesh to the cable net of adjacent panels shall have a connection strength greater than or equal to the strength of the mesh.

Net Support Columns: Columns shall be fabricated from steel meeting ASTM A36 for preformed steel shapes except as otherwise approved in writing as part of an approved rockfall barrier system prior to letting of contract. Columns shall be as specified in the certified rockfall barrier kit equipment list and substitutions are not permitted unless columns for a higher capacity system by the manufacturer are substituted and the manufacturer certifies that the substitution is acceptable. Test results shall be required to prove that the system and columns are capable of resisting design loads as specified in general requirements above. Substitutions of different net support column members after contracts are issued shall not be allowed.

Net Support and Lateral Bracing Ropes: Braking element design shall have been verified through testing and certification of the rockfall barrier kit to ensure satisfactory performance and a minimum of required maintenance. Written documentation of testing of braking elements used with support or bracing ropes shall be supplied to the Engineer upon request.

Rock and Soil Anchors: Anchors in rock and soil shall be installed per manufacturer's recommendations for the Rockfall Barrier kit and all anchors needed for rockfall barrier kit, including installation shall be included in the rockfall barrier price. Cable anchors shall have a minimum pullout strength of 15 tons (or more if required by specific manufacturer fence design) and must be verified by the contractor in the field. The testing shall consist of a pullout test incorporating 20% of the total number of anchors with locations chosen by the Engineer. If more than 25% of the anchors tested fail, all anchors shall be tested. Failed anchors shall be replaced by the contractor at no additional cost to the owner. Testing shall be performed against a temporary yoke or load frame. No part of the yoke or load frame shall bear within 3 feet of the anchor.

Corrosion Protection: All cables and wire ropes shall meet Federal Specification RR-W-410D or MIL-W-83420E for zinc coating. All miscellaneous material associated with the rock fall barrier such as wire rope clips, bolts, nuts, thimbles, and shackles shall be at minimum hot dipped galvanized.

Spare Parts - The following spare parts are to be supplied with the system by the manufacturer:

Number	Part Name
4	Breaking Element Replacement Kits
2	Replacement Net Panels
2	Wire Rope Anchors
1	Column and column base

Excavation and Foundations

The excavation work by the contractor shall be in accordance with the design drawings. If allowed by the Engineer to leave excavated foundation material on the job, the contractor shall scatter excess excavated material around the vicinity of the rock fall barrier and dress it out to match the existing ground surface, in order to prevent the creation of jumping ramps for falling rocks.

The foundation work for the columns and rock and soil anchors shall be performed in accordance with the typical sections for fence system details shown on the design drawings. The distance from centerline to centerline of the columns must be kept as close as possible to that shown on the manufacturer's approved design drawings. The spacing cannot exceed plus or minus 3 inches of the distance as indicated on the design drawings except as approved by the Engineer. All loose soil or rocks shall be removed from the holes.

Quantities

The Rock Fence will be measured and paid on a linear foot basis. The price for the system shall be full compensation for all material including freight, supervision, engineering, drawings and spare parts; plus labor, equipment, tools, royalties and other incidentals necessary to install a complete system ready to use.

The fence, measured as provided for above, will be paid for at the contract unit price per linear foot for Rockfall Barrier. Such price and payment will be full compensation for all work covered by this special provision, including but not limited to furnishing all wire mesh, hog rings, clamps, rings, wire, anchors, rockfall barrier column installation, anchor installation, rope net placing and securing the wire mesh and rope net, and for all incidentals necessary to complete the work satisfactorily.

Types of Rockfall Barrier Systems

Rockfall barrier systems shall be specified on the plans as Tennessee Type I, II, III, IV, and may also have a supplementary minimum energy rating specified in the plans. If the energy rating on the plans is higher than the minimum energy rating shown for Tennessee Type, plans energy rating shall control. Height of rockfall fence, unless otherwise specified on the plans, shall be 10 feet. Tennessee Type system criteria are listed below:

Tennessee Type	Description	Rockfall Net Material Allowed	Minimum Energy Rating Ranges
I	Lower Impact	Ring Net, Cable Net/ Woven Wire Rope Net, High Tensile Wire Mesh	100 kJ (37 ft-ton) – 500kJ (185 ft-ton)
II	Moderate Impact	Ring Net, Woven Wire Rope Net, High Tensile Wire Mesh	500 kJ (185 ft-ton) – 1000 kJ (370 ft ton)
III	High Impact	Ring Net	1000 kJ (370 ft-ton) - 3000 (ft-ton)
IV	Very High Impact	Ring Net	3000 kJ - 5000 kJ (1843 ft-ton)

Please note: double twisted hexagonal wire mesh is only acceptable as an added mesh to a rockfall barrier system and shall not be used as the primary net.

Qualified Rockfall Barrier Systems Suppliers and Products:

Note: Systems and manufacturers not on this list may be submitted for consideration to the Geotechnical Engineering Section at least 30 days prior to letting in order to be added to the qualified products list. No system shall be approved as substitution for those on this list without prior concurrence and acceptance by the TDOT Geotechnical Engineering Section.

Required for submittal to add product to list:

1. Name, specifications, drawings and design details for rockfall barrier system including materials used, braking element design, foundation design and anchoring system. Designs as submitted to the TDOT Geotechnical Engineering Section shall comply with this special provision.
2. Date and location of previous installations for the barrier system to be considered as well as contact information for an "owner" representative for whom this system was installed.
3. Test reports of rockfall net materials and rockfall systems verifying that the system and elements can withstand the design energy rating.

Geobrugg North America
551 West Cordova Road #730
Santa Fe, NM 87505
Phone: 505-438-6161

Tennessee Type I	AXI System, TXI System – Using "Tecco" Mesh or "Rocco Ring net
Tennessee Type II	RXI System, RX System – Using "Rocco Ring Net" or GBE System using "Tecco Mesh")
Tennessee Type III	RXI System, RX System – Using "Rocco Ring Net"
Tennessee Type IV	RXI System – Using "Rocco" Ring Net

Macafferri
10303 Governor Lane Boulevard
Williamsport, MD 21795
301-223-6910

Tennessee Type I	CTR/05/07B
Tennessee Type II	CTR/05/07B, CTR/10/04/B
Tennessee Type III	CTR/20/04/A, CTR/30/04/A
Tennessee Type IV	CTR/30/04A, CTR/50/07/A

Mountain Management
Financial Plaza Building
1135 Terminal Way, Suite 106
Reno, Nevada, 89502-2145
Phone: 866-466-7223

Fax: 450-455-8762

Tennessee Type I	2 mm Ring Net System Pending Certification
Tennessee Type II	2 mm Ring Net Pending Certification, B1000 (1000kJ)
Tennessee Type III	B1000 (1000kJ), SF200 (2000 kJ), SF300 (3000 kJ) Systems
Tennessee Type IV	SF500 Ring Net System Pending Certification

Rotec
P.O. Box 31536
Santa Fe, NM 87594-1536
505-753-6586

Tennessee Type I	Model Series L/40, M/80 and M-H/120
Tennessee Type II	Model Series M-H/185, M-H/275

Payment will be made under:

Item No.	Pay Item	Pay Unit
707-10.01	ROCKFALL FENCE (TYPE I)	Linear Foot
707-10.02	ROCKFALL FENCE (TYPE II)	Linear Foot
707-10.03	ROCKFALL FENCE (TYPE III)	Linear Foot
707-10.04	ROCKFALL FENCE (TYPE IV)	Linear Foot
707-10.08	WIRE MESH (DESCRIPTION)	Linear Foot

S T A T E **O F** **T E N N E S S E E**

(Rev 10-31-11) January 1, 2021

SPECIAL PROVISION

REGARDING

TRAFFIC CONTROL SUPERVISOR

At the preconstruction conference the Contractor shall designate a Worksite Traffic Supervisor other than the Superintendent to be responsible for initiating, installing, and maintaining all traffic control devices in accordance with all applicable special provisions, standard drawings, plans, specifications, and the most current edition of the Manual on Uniform Traffic Control Devices.

Qualifications. The Worksite Traffic Supervisor shall be certified by the American Traffic Safety Services Association Worksite Traffic Supervisor Certification Program, or the National Highway Institute by having satisfactorily completed training in "Design and Operation of Work Zone Traffic Control" taught by the University of Tennessee Transportation Center. In addition, they shall have at least one-year's experience directly related to worksite traffic control in a supervisory or responsible capacity.

Responsibilities. The Worksite Traffic Supervisor shall:

1. Oversee all operations which contribute to the convenience, safety and orderly movement of traffic.

2. Be available on a twenty-four hour basis with access to all manpower, equipment and materials needed to maintain traffic control devices and handle traffic related situations.

3. Maintain documentation to become part of the final project records of all daily activities including deficiencies found, how they were corrected and the personnel, equipment and traffic control devices utilized.

4. Correct routine deficiencies within a twenty-four (24) hour period after discovery.

5. Be available on the site within 45 minutes after notification of an emergency situation, prepared to effect corrective measures immediately.

6. Make daily inspections of all traffic control devices (at least every third inspection shall be at night).

7. Prepare and submit for approval any revisions to the existing traffic control plan sufficiently in advance to allow Department review prior to implementation.

8. Coordinate project traffic control activities with appropriate local law enforcement and emergency agencies.

9. Coordinate public awareness of changing traffic conditions through TDOT.

10. Educate all employees of the Contractor utilized as flaggers on proper flagging procedures.

Emergency Maintenance. Emergency maintenance shall consist of maintenance, repair, or replacement of traffic control devices that have been damaged, vandalized, or otherwise rendered ineffective to the extent that a serious hazard exists. The Traffic Control Supervisor shall cause such emergency work to begin within two (2) hours after being notified. When emergency maintenance is required during nonworking hours, devices that are classified as "unacceptable" according to ATSSA Quality Standards for Workzone Traffic Control Devices may be used, provided that the devices are effective in reducing the existing hazard, and further provided that they are replaced not later than the next business day. The Traffic Control Supervisor shall keep the Resident Engineer informed of the name, address, and telephone number of the individual responsible for performing emergency maintenance.

Failure to Comply. In the event a routine traffic control deficiency is not corrected within twenty-four (24) hours after discovery, a deduction in the amount of one hundred dollars ($100.00) shall be made from monies due the Contractor for each calendar day that the deficiency is allowed to remain, not as penalty, but as liquidated damages.

In the event that immediate action is not taken to correct an emergency situation, a deduction in accordance with Subsection 712.04 shall be made from monies due the Contractor. In addition, if deemed necessary by the Engineer due to lack of response by the Contractor, State Maintenance Forces may be mobilized to correct the emergency situation with all costs of the corrective action being assessed against monies due the Contractor. This assessment for costs incurred shall be in addition to the assessment of the amount in accordance with Subsection 712.04.

The preceding assessments shall be in addition to any liquidated damages which may be assessed in accordance with Subsection 108.07.

Basis of Payment. The labor costs involved in the provision of the Traffic Control Supervisor, and any equipment, tools, or incidentals necessary to complete the work, are to be compensated fully by the lump sum price bid for Traffic Control Supervisor, Item No. 712-01.04.

STATE **OF** **TENNESSEE**

November 8, 2019
(Rev. 9-1-21)

January 1, 2021

SPECIAL PROVISION

REGARDING

DIGITAL SPEED LIMIT SIGN ASSEMBLY

(VARIABLE SPEED ZONE)

DESCRIPTION

This work shall consist of the furnishing, installation, and operation of a work zone Digital Speed Limit Sign Assembly on interstates and freeways with speed limits greater than 55 MPH or facilities that have significant traffic volumes and impacts. The signs are regulatory speed limit signs with LED displays for the speed limit numbers.

The purpose of Digital Speed Limit Sign Assembly is to easily change work zone speed limits between activities that necessitate the need for a lower speed limit and the ones that do not.

EQUIPMENT

Digital Speed Limit Sign Assembly shall meet the following:

1. The unit shall have a regulatory speed limit sign (R2-1) with minimum dimension of 48 inches x 60 inches.
2. The Digital Speed Limit sign shall be mounted such that the bottom of the sign is 7 feet above the roadway.
3. The LED panel shall be a minimum of 28 inches x 18 inches. The display legend on the LED panel shall be white.
4. The LED numbers shall have a minimum 5 wide by 7 high pixel array with a minimum height of 18 inches.
5. The LED panel shall have auto brightness/dimming capability.
6. The Digital Speed Limit Sign Assembly shall have flashing beacons. Beacons shall be 12 inch diameter LED circular yellow. They shall be mounted above and below sign assemblies and are to be centered horizontally. The beacons shall alternately flash at rates not less than 50 or more than 60 times per minute.
7. The Digital Speed Limit Sign Assemblies shall have operational software and wireless communications that allows for remote operation and data monitoring.

8. The Digital Speed Limit Signs may be trailer mounted or stationary mounted. The unit shall be solar powered and have the ability to operate continuously. It shall be supplemented with a battery backup system which includes a 110/120 VAC powered on-board charging system.
9. The batteries, when fully charged; shall be capable of powering the display for 20 continuous days with no solar power. The unit shall be capable of being powered by standard 110/120 VAC power source. Store the battery bank and charging system in a lockable, weather and vandal resistant box.
10. The Digital Speed Limit Sign Assembly shall be listed on the Department's Qualified Products List No.44. For project applications that require more than one assembly, the same style of digital speed limit sign assembly shall be used.

CONSTRUCTION REQUIREMENTS

The Speed Limit shall be continuously displayed on the signs. The speed limits are the sole authority of TDOT. All speed limits are to be ordinanced by the State Traffic Engineer in order to have a lawfully enforceable speed limit.

1. The Traffic Engineer or designee will approve all Work Zone Speed Limits based on activities and conditions that warrant.
2. All existing static Speed Limit signs within the work zone speed zone shall be covered or removed at the time of Digital Speed Limit Sign Assembly installation. Signs shall be covered with an opaque, form fitting, tear resistant material that fully obscures any text.
3. Coordinate with the Engineer when the Work Zone Speed Limits are to be changed and seek approval by the Engineer or his designee before the Speed Limit is changed.
4. Sign placement shall begin within the advanced warning area with 1 sign placed on the Right side of the road. Subsequent signs shall be positioned at intervals no greater than 2 miles with 1 placed after each entrance ramp within the work zone.
5. Placement of signs shall be on the right side of the road unless infeasible or as directed by engineer. Placement of signs shall not interfere with the function of roadside devices such as guard rail or terminals
6. Flashing beacons shall be activated at the time of any workers present, no earlier than 30 minutes prior to workers arriving and be deactivated at the conclusion of work no later than30 minutes after all workers depart.
7. On a weekly basis for the duration of the project, supply a printable copy of the Tracking Report, reflecting the times of the speed limit changes along with their corresponding speed values.

METHOD OF MEASUREMENT

The Department will measure by each the Digital Speed Limit Sign Assembly, complete in place and accepted, according to the number of Digital Speed Limit Sign Assemblies required per the spacing requirements. Payment will be made for each sign used for the duration of the project.

BASIS OF PAYMENT

The Department will pay for accepted quantities, complete in place, at the contract price as follows:

Item No.	Description	Unit
712-08.09	DIGITAL SPEED LIMIT SIGN ASSEMBLY	EACH

Such payment is full compensation to furnish, coordinate, install, maintain, operate, track, monitor, subsequently remove Digital Speed Limit Sign Assemblies as well as provide the weekly Tracking Report shall be included. The expense of covering or removal, and subsequent restoration of existing Speed Limit or Minimum Speed Limit signs, including any necessary supports, shall be included in the pay item for the Digital Speed Limit Sign Assembly. All installations, relocations, and removals, of supplemental signs, including signs and necessary supports, shall be included in the pay item for Digital Speed Limit Sign Assembly.

S T A T E **O F** **T E N N E S S E E**

(Orig. 01-11-2018) January 1, 2015

SPECIAL PROVISION

REGARDING

CONTRACTOR PROVIDED

UNIFORMED POLICE OFFICER

Description: This work shall consist of furnishing and maintaining a Uniformed Police Officer and an official law enforcement vehicle within the project site limits as specified on the Plans or as directed by the Engineer. It shall be the primary responsibility of the Police Officer to enforce regulatory speed limits and to coordinate the removal of vehicles with the Tennessee Department of Safety and/or other law enforcement agencies having jurisdiction through the work zone. Authorization to move a vehicle involved in a traffic accident is retained exclusively by law enforcement officers.

Definition of Terms

Police Officer: (Uniformed State Commissioned Police Officer) A law enforcement officer, with an official law enforcement vehicle equipped with blue lights, having the authority to write traffic tickets and make arrests at the project site.

All Uniformed Law Enforcement Officers shall have POST certified training and shall have an additional 4 hours of FHWA approved work zone training. Copies of each officer's record of training shall be provided to the Project Supervisor and placed in the project file.

Uniformed Law Enforcement Officers shall have training from a Peace Officer Standards and Training (POST) certified police training academy in the State of Tennessee. These academies are as follows:

a. Tennessee Law Enforcement Training Academy (3025 Lebanon Rd., Nashville, TN 37214-2217)
b. Tennessee Department of Safety THP Training Academy (275 Stewarts Ferry Pike, Nashville, TN 38124)
c. Blount Co. Sheriff's Office Law Enforcement Training Academy (940 E. Lamar Alexander Pkwy., Maryville, TN 37804)
d. Chattanooga Police Department Training Academy (3200 Amnicola Hwy., Chattanooga, TN 37406)
e. Cleveland State Community College Police Training Academy (P.O. Box 3570, Cleveland, TN 37329-3570)
f. Knox Co. Sheriff's Office Regional Training Academy (4900 Maloneyville Rd., Knoxville, TN 37921)

g. Knoxville Police Department Training Academy (220 Carrick St., Suite 202, Knoxville, TN 37921)
h. Memphis Police Academy (4371 O.K. Roberson Rd., Memphis, TN 38128)
i. Metro Nashville Police Department Training Department (2715 Tucker Rd., Nashville, TN 37218)
j. Shelby Co. Sheriff's Office Training Academy (993 Dovecrest, Memphis, TN 38134)
k. Walter State Community College Regional Law Enforcement Academy (215 North College St., Greenville, TN 37743)

Construction Zone Requirements

1. **Contractor Requirements:** The contractor is to provide one or more Police Officers as needed and approved by the Engineer during the period of construction or any time he has activities underway in or adjacent to traveled lanes of the highway project.
2. **Police Officer Patrol Requirements and/or Procedures:** The Police Officer shall enforce the speed limit on the project site. When not driving through the project site, the Police Officer shall position his vehicle at various locations within the construction zone to optimize visibility for the purpose of speed enforcement and other traffic control enforcement as required by the project and requested by the Engineer. The Police Officer shall maintain a detailed written log of his enforcement activities and shall submit the log to the Engineer for verification each month.
3. **Accidents:** The Police Officer shall respond to incidents/accidents within the construction zone and shall contact the appropriate agencies to investigate and discharge the accident. The Police Officer shall provide assistance until arrival of the enforcement agency with authority, and then resume his/her patrol.

Compensation

Basis of Payment: The Department will pay for Uniformed Police Officers provided by the Contractor at the invoice price of the work plus 5%, not to exceed $50 per hour for the hours present on the Project. No compensation will be made for drive time.

S T A T E **O F** **T E N N E S S E E**

(Rev. 10-9-17) January 1, 2021
(Rev. 12-15-20)

SPECIAL PROVISION

REGARDING

TRAFFIC QUEUE PROTECTION

Description

This work consists of providing Traffic Queue Protection when Work activities are performed on control-access or limited access facilities. Pursue efforts for the protection of traffic queues caused by project Work and clearly demonstrate adequate good faith efforts. The queue protection truck is expected to alert motorists (inside or outside of project limits) of all stopped traffic caused by Work activities or incidents within the project limits.

Equipment

Provide a minimum of one (1) queue protection truck for each traveling direction where traffic flow is reduced. One (1) additional queue protection truck shall be onsite in reserve. The system deployed must fulfill the following minimum requirements:

1. A truck mounted attenuator that meets the requirements of and be listed on the Department's Qualified Products List.
2. Four (4) strobe lights (with auto-dimmers) positioned rear facing
   - **a.** Two (2) mounted under rear bumper
   - **b.** Two (2) mounted at cab level
3. One (1) standard cab mounted light bar.
4. A truck mounted message board with a full matrix display and a minimum panel size of 72" W x 35" H mounted as per manufacturer specifications and in accordance with Sections 2L.04 and 6F.60 of the MUTCD for Portable Changeable Message signs
5. All Queue truck operators shall have the following mandatory training:
   - **a.** Four Hour National Traffic Incident Management (TIM) Responder Training for Queue Truck Operators, or
   - **b.** Approved equal training program developed by ATSSA, or
   - **c.** The National Safety Council.

Maintenance of Traffic

The following procedures will be followed until free flow traffic conditions are present: ("free flow" is defined as the absence of a temporary lane or shoulder closure or absence of a temporary shift of traffic lanes with no queue present).

1. The queue protection truck shall be positioned approximately 1/2 mile upstream from the back of the slow moving traffic.
2. The queue protection truck shall be positioned on the shoulder and clear of the traveled way so as not to impede traffic.
3. The queue protection truck shall relocate as needed to maintain approximately 1/2 mile distance from the back of the slow moving traffic.
4. The 2nd queue protection truck shall be held in reserve, on site, and support the primary truck if conditions prevent repositioning by reverse or if the primary truck is otherwise unable to effectively manage the queue. This truck shall not be paid for idle time.
5. Trucks shall be staged within project limits during planned lane closures and other project activities expected to cause a queue.
6. Queue length estimates and traffic conditions shall be reported to the Engineer or designee at the following periods:
   - **a.** At 30 minute intervals.
   - **b.** At significant changes.
   - **c.** When free flow traffic is achieved.

The Queue Protection Truck shall be mobilized as directed by the Engineer or designee and shall be de-mobilized when free flow conditions are reached.

Method of Measurement

The Department will measure, by the day, the Queue Protection Truck, for each truck providing queue protection. Idle or standby time shall be included in the bid price. A day is defined as a work shift.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
712-08.12	QUEUE PROTECTION TRUCK	DAY

Such payment will be full compensation for all work specified including labor, materials, equipment, tools, and incidentals to complete the work.

STATE **OF** **TENNESSEE**

October 12, 2020 January 1, 2021
(Rev. 9-1-21)

SPECIAL PROVISION

REGARDING

SPEED FEEDBACK SIGN ASSEMBLY

Description

This work shall consist of the furnishing, installing and operation of a work zone Speed Feedback Sign Assembly. Equipped with Doppler radar and a LED display, these devices inform motorists of their current speed and/or advisory messages as well as generate data to be used in traffic management strategies.

The purpose of the Speed Feedback Sign Assembly is to provide speed awareness to the motoring public in areas where speed reduction is desired and provide real time information to the Engineer regarding speed and traffic volumes.

Equipment

Speed Feedback Sign Assembly shall meet the following:

1. The LED panel shall be a minimum of 18 inches high and legible at 1000 feet. The display on the LED panel shall be yellow. A placard shall be mounted above or below the feedback display with the legend "YOUR SPEED".

2. The unit shall be radar operated with operational software and capable of recording speed.

3. The LED panel shall have auto brightness/dimming capability.

4. The Speed Feedback Sign Assembly may be trailer mounted or stationary mounted. The unit shall be solar powered and have the ability to operate continuously. It shall be supplemented with a battery backup system.

5. The batteries, when fully charged, shall be capable of powering the display for 20 continuous days with no solar power. The unit shall be capable of being powered by standard 110/120 VAC power source. The battery bank and charging system shall be stored in a lockable, weatherproof and vandal resistant box.

6. The unit shall have a static regulatory speed limit sign attached (R2-1) with minimum dimension of 36 inches x 48 inches.

7. The Speed Feedback Sign Assembly shall be listed on the Department's Qualified Products List No. 44. For project applications that require more than one assembly, the same style of speed feedback sign assembly shall be used.

Construction Requirements

1. The unit shall be located in the advance warning area or within the active work zone but shall not be located after the active work zone. The unit should be placed in area of reduced work zone speed limit.

2. Placement of the unit shall be on the right side of the road unless infeasible or as directed by the Engineer. Placement of signs shall not interfere with the function of roadside devices such as guardrail or terminals.

3. The unit should not be within 500 feet of Advanced Warning Sign or Digital Speed Limit Sign Assembly.

4. The regulatory speed limit sign on the unit shall match the reduced speed displayed on the digital speed limit sign. When the display on the digital speed limit sign is adjusted to the normal speed limit then the speed feedback sign shall be covered or removed so that there are no conflicting speed limits on the project.

5. Coordinate with the Engineer for location of the Speed Feedback Sign Assembly.

6. A data printout of the average vehicle speed and hourly vehicle volume shall be provided to the Engineer weekly.

Method of Measurement

The Department will measure, by Each, the Speed Feedback Sign Assembly, complete in place and accepted, according to the maximum number of Speed Feedback Sign Assemblies required at any given time on the project. Payment will be for the maximum number of assemblies in use with data received at any given time for the duration of the project.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract price as follows:

Pay Item	Description	Unit
712-08.08	Speed Feedback Sign Assembly	Each

Such payment is full compensation to furnish, coordinate, install, maintain, operate, track, monitor, subsequently remove Speed Feedback Sign Assemblies and with the average speed and hourly volume data provided.

STATE **OF** **TENNESSEE**

October 17, 2019
(Rev. 6-30-20)
(Rev. 6-23-21)
(Rev. 3-30-22)

January 1, 2021

SPECIAL PROVISION

REGARDING

CONTRAST PAVEMENT MARKINGS

Description

This work shall consist of the placement of a Contrast Pavement Marking system and/or Contrast Pavement Shadow Marking on concrete surfaces and meet current Standard Specifications except as noted in this Provision.

For new installation of pavement markings on multi-lane concrete roadways, bridges, and ramps, the Contrast Pavement Marking System shall consist of either a white and black or yellow and black pavement marking, (see Details 716CPM-1, 2, 3, 5 & 6) and the Contrast Pavement Shadow Marking shall consist of a black spray thermoplastic pavement marking. (see Details 716CPM-4 & 5) The Contrast Pavement Marking system shall be used for the edge lines and dotted lines only and the Contrast Pavement Shadow Marking shall be used for the lane lines only.

For new installation of pavement markings on 2 lane concrete roadways, bridges, and ramps, the Contrast Pavement Marking System shall consist of either a white and black or yellow and black pavement marking, (see Details 716CPM-1, 2, 3, & 6). The Contrast Pavement Marking system shall be used for all lines.

To enhance existing pavement markings on multi-lane concrete roadways, bridges, and ramps, the Contrast Pavement Shadow Marking shall consist of a black spray thermoplastic pavement marking. (see Details 716CPM-4 & 7) The Contrast Pavement Shadow Marking shall be used as an addition to the existing lane lines only.

Materials

Provide materials that are specified as follows:

A. Thermoplastic Pavement Marking

1. White and Yellow thermoplastic pavement marking material shall meet requirements of **919.01** for the screed extrusion or ribbon dispenser methods.
2. Black contrast thermoplastic pavement marking material shall conform to material requirements in **919.01** for screed extrusion or ribbon dispenser methods or **919.02** for

the spray method. The black contrast thermoplastic pavement shadow marking material shall conform to the material requirements in **919.02** for the spray method. The material requirements should be met with the following exceptions:

a. No Intermix glass beads.

b. Calcium carbonate shall be 95% pure.

c. The percent of pigment shall be based on the manufacturer's recommendations. When applied, the black pigment must produce a completely opaque black pavement marking and 70 hrs. of weatherometer exposure in accordance with ASTM G 155 using Exposure Cycle 1 with a quartz inner filter glass and Type "S" Borosilicate outer filter glass. The black material shall be a colorfast and anti-skid material to form the pavement marking.

3. The thermoplastic material for contrast pavement marking systems shall provide white and black, or yellow and black thermoplastic as matching systems from the same manufacturer.

B. Alternate Contrast Pavement Markings

An alternate to contrast thermoplastic pavement marking material shall be selected from the Department's Qualified Products List 1: Section B, Preformed Plastic Pavement Markings with a thickness of 90 mils minimum or List 1: Section C.2, Preformed Contrast Tape with a thickness of 80 mils minimum.

C. Certification

1. Furnish a manufacturer's certification to the Engineer for each lot furnished, certifying that the material supplied conforms to all requirements specified.

2. The certification shall include or have attached typical results of all required tests and the requirements it represents.

Construction Requirements

Apply the Contrast Pavement Marking system and/or Contrast Pavement Shadow Marking according to the manufacturer's recommendations and specified in **716.03.** Apply to concrete surfaces with the proper application temperatures and after surface preparation as recommended by the material manufacturer.

Do not apply Contrast Pavement Marking to existing or new concrete surfaces unless the ambient air temperature and the temperature of the concrete pavement is 50°F and rising.

To ensure optimum adhesion of the thermoplastic pavement marking material to concrete surfaces, apply a binder sealer material as recommended by the manufacturer.

For new installations of contrast pavement marking on existing concrete surfaces, the existing pavement marking material, thermoplastic or tape, shall be removed by methods in **712.05** or as indicated in the plans and paid as Removal of Pavement Marking (Line).

A. Two Pass Application

1. Apply the black thermoplastic pavement marking material to the concrete surface at a thickness of 40 mils according to the manufacturer's recommendations.
2. Apply the white or yellow thermoplastic pavement marking material by the extruded or ribbon dispensed methods on top of the black thermoplastic pavement marking at a thickness of 100 mils according to the manufacturer's recommendations and Standard Specifications. The white or yellow pavement marking will be applied on top of the black pavement marking to create the Contrast Pavement Marking System with a total thickness of 140 mils.

Detail: 716CPM-1 Contrast Pavement Marking, Two-Pass Application

B. One Pass Application

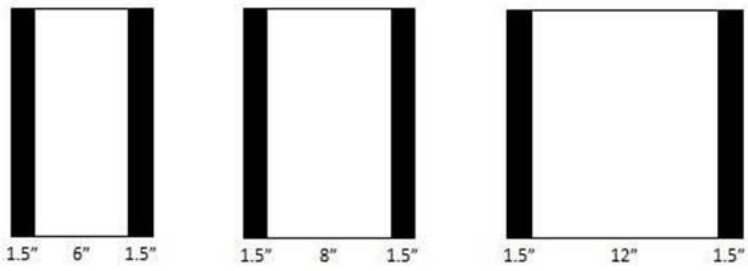
Apply the White or yellow thermoplastic pavement marking material with black contrast thermoplastic pavement marking material simultaneously by the extruded or ribbon dispensed methods at a thickness of 110 mils according to the manufacture's recommendations.

Detail: 716CPM-2 Contrast Pavement Marking, One-Pass Application

C. Alternate Contrast Pavement Markings

Apply the QPL approved Preformed Tape or Preformed Thermoplastic to the concrete surfaces according to manufacturer's recommendations and as specified in **716.06**.

Detail: 716CPM-3 Contrast Pavement Marking, A, B, & C



D. Contrast Pavement Shadow Marking

Apply the black thermoplastic pavement shadow marking material to the concrete surface at a thickness of 60 mils as an addition to the existing lane lines according to Detail: 716CPM-3 & 5 and meeting the manufacturer's recommendations.

Detail: 716CPM-4 Contrast Pavement Shadow Marking, D

Traffic Control

1. Traffic control shall be completed in accordance with the plans and/or contract documents.
2. All traffic control operations shall apply with the MUTCD at a minimum. Any changes must be approved by the engineer.

Method Of Measurement

The Department will measure the length of each of these markings, complete in place and accepted, as listed in the bid schedule, along the center of each line. Only the marked line will be measured for payment.

The Department will measure the pavement marking words and symbols complete in place and accepted, by each for these markings.

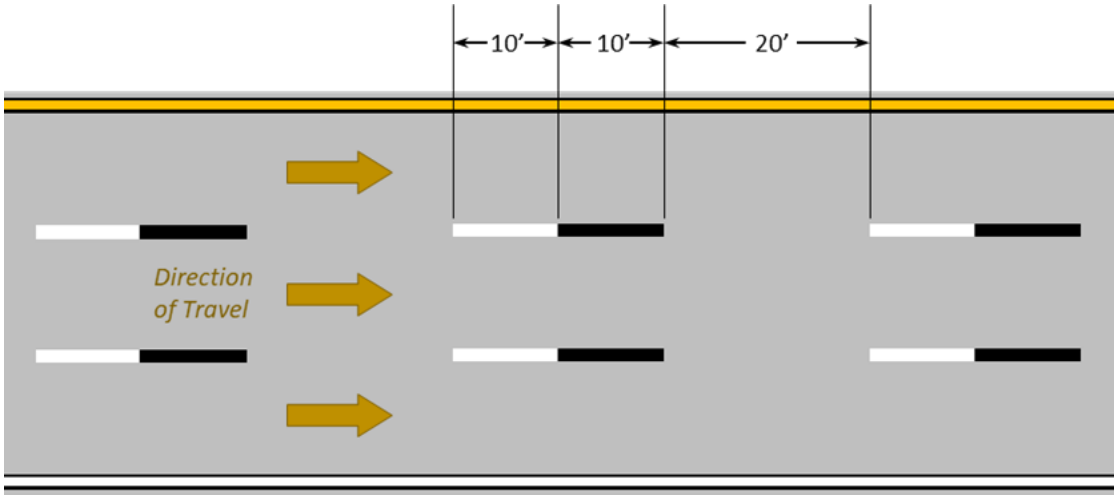
Basis Of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

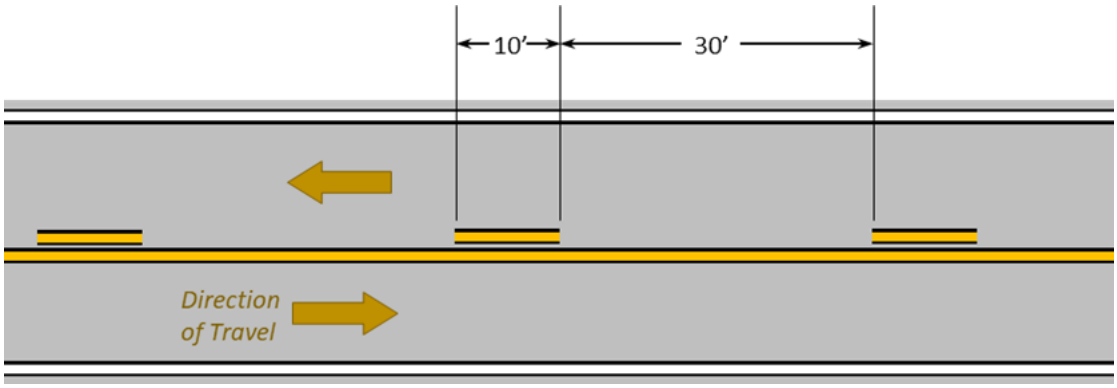
Item No.	Description	Unit
716-09.86	CONTRAST PAVEMENT MARKING 6 INCH	LINEAR MILE
716-09.88	CONTRAST PAVEMENT MARKING 8 INCH	LINEAR MILE
716-09.89	CONTRAST PAVEMENT MARKING 12 INCH	LINEAR FEET
716-09.90	CONTRAST PAVEMENT MARKING 6 INCH DOTTED	LINEAR FEET
716-09.87	CONTRAST PAVEMENT MARKING, WORDS, AND SYMBOLS	EACH
716-09.94	CONTRAST PAVEMENT SHADOW MARKING 6 INCH	LINEAR MILE
716-09.95	CONTRAST PAVEMENT SHADOW MARKING 8 INCH	LINEAR MILE

Such payment is full compensation for preparation, layout, materials, labor, equipment, tools, royalties, and all other incidentals necessary to complete the work.

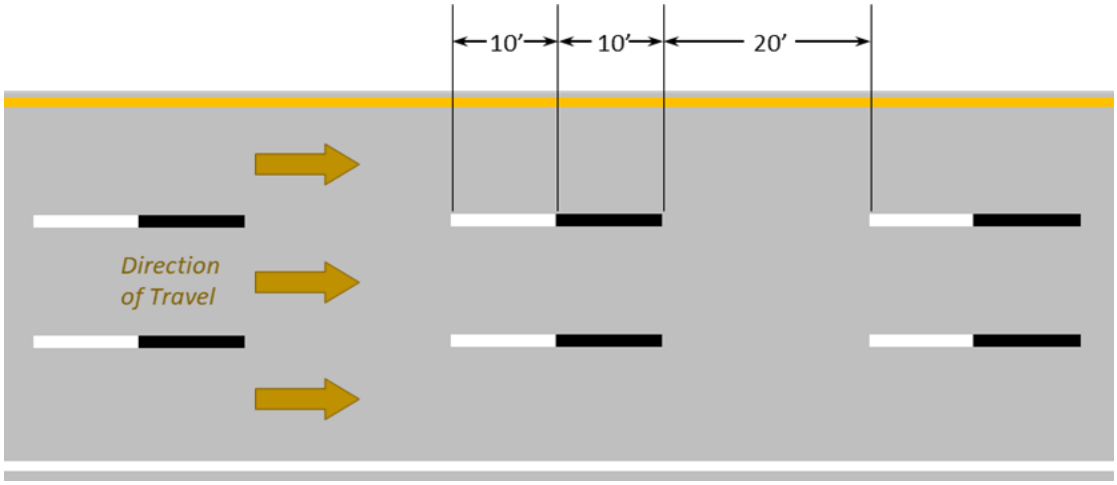
Detail: 716CPM-5: Contrast Pavement and Shadow Marking Multi-Lanes



Detail: 716CPM-6: Contrast Pavement Marking 2 Lanes



Detail: 716CPM-7: Contrast Pavement Shadow Marking Multi-Lanes



S T A T E **O F** **T E N N E S S E E**

(Rev. 10/12/20) January 1, 2021

SPECIAL PROVISION

REGARDING

WET REFLECTIVE PAVEMENT MARKING

Description

This work shall consist of the placement of a Wet Reflective Pavement Marking that is either hot applied thermoplastic pavement marking or preformed wet reflective tape. All work shall be accomplished in accordance with **716** and **919** of the Standard Specifications.

The Wet Reflective Pavement Marking available are approved on the Department's Qualified Products List (QPL) and composed of one of the following:

A. Microcrystalline Ceramic Elements for Double Drop System

Materials

Use thermoplastic pavement marking material meeting the requirements of **919.01** except as specified, and in accordance with the Department's Sampling and Testing Guide.

Double Drop System

The double drop system shall be capable of applying microcrystalline ceramic elements at the rate of 5.29 pounds per 100 square feet of pavement marking material. Followed by an application of Type 3 glass beads at a minimum rate of 5.29 pounds per 100 square feet of pavement marking material.

Use Microcrystalline ceramic elements listed on the Department's Qualified Products List for Wet Reflective Pavement Markings.

Use Type 3 drop on glass beads that meet the requirements **919.01.C** & **D**.

Equipment

Use equipment meeting **716.03** for extruded or ribbon-dispensed thermoplastic material.

Application

Apply thermoplastic pavement marking material meeting **716.03** for extruded or ribbon-dispensed thermoplastic material, except as noted.

When applying traffic stripes and marking over existing markings, ensure that not more than 2 inches on either end and not more than 1 inch on either side of the existing line is visible.

B. Preformed Wet Reflective Tape

Materials

Use preformed wet reflective pavement marking tape meeting **716.06** and **919.03** and listed on the Department's Qualified Products List (QPL) for Preformed Tape.

Equipment

Use equipment based on manufacturer's recommendations.

Application

Apply preformed wet reflective pavement marking tape meeting 716.06, except as noted. The pavement surface shall be prepared in accordance with manufacturer's recommendations.

Apply preformed wet reflective pavement marking tape only to dry surfaces, and when the ambient air and surface temperature is at least 40ºF and rising.

On all Portland cement concrete surfaces, apply a primer, sealer or surface preparation adhesive that is recommended by the manufacturer for the specific pavement marking tape. Offset longitudinal lines at least 2 inches from construction joints of Portland cement concrete pavement.

C. Inverted Profiled Thermoplastic Pavement Marking

Materials

Use thermoplastic pavement marking material meeting the requirements of **919.01**, except as specified, and in accordance with the Department's Sampling and Testing Guide.

1. Composition

Thermoplastic pavement marking material composition shall meet the following requirements:

Component	White	Yellow
Binder, % minimum	19	19
TiO_2 Pigment, % minimum	10	N/A
Yellow Pigment % minimum	N/A	5
Intermix Glass Beads, % minimum	40	40
Calcium Carbonate/Fillers, % maximum	31 (1)	41 (1)

(1) The amount of Calcium Carbonate and inert fillers shall be as recommended by the manufacturer, provided all other specifications are met.

2. Glass Beads

Use reflective glass beads shall meet the requirements of **919.03** and in accordance with the Department's Sampling and Testing Guide.

3. Intermix Glass Beads

Intermix glass beads shall make up a minimum of 40% by weight of the thermoplastic formulation. These beads shall meet all requirements of AASHTO M247 Type 1 and 3 with a minimum of 80% true spheres.

4. Double Drop System

The double drop system shall be capable of applying glass beads at the specified application as specified in **919.01.E.** The retroreflective element drop-on rate shall meet or exceed Section **716** as specified by the manufacturer.

Use Type 3 drop on beads that are dual coated for moisture resistance and adhesion that meet the requirements of AASHTO M247 Type 3, and the beads shall be with 80% true spheres.

Use Type 1 drop on glass beads that are dual coated for moisture resistance and adhesion that meet the requirements of AASHTO M247 Type 1, and the beads shall be with 80% true spheres.

Equipment

Use equipment meeting **716.03** for extruded or ribbon-dispensed thermoplastic material, except as specified in Application, that will produce a consistent pattern for inverted profiled thermoplastic pavement marking. The use of rollers to place grooves in the pavement marking material utilizing a separate vehicle or grooves that are not pressed within 1 second of thermoplastic pavement marking material application will not be allowed.

Use equipment based on manufacturer's recommendations.

Application

Use equipment specially designed for placing hot thermoplastic pavement marking material in a hot molten state on the pavement surface utilizing a pressure type application method. An inverted profiled thermoplastic pavement marking die that can travel along in proximity with the road surface shall form the hot inverted profiled thermoplastic pavement markings. The die is pulled forward by a special linkage that will allow it to automatically level itself as to float and remain parallel with the road surface. The top of the die shall be enclosed and provide entry means for the hot molten thermoplastic to enter the die cavity. The bottom of the die shall contain a movable door that is remote controlled so as to start or stop the flow of thermoplastic on to the pavement surface. When the movable door is open, thermoplastic can flow through the die and will apply thermoplastic material that will be formed rearward of the advancing die. The road surface shall be at the bottom of the die enclosure. Thermoplastic material shall be fed to the die under pressure through flexible oil-jacketed stainless steel hoses. The die shall be formed from a single solid block of steel that is oil-jacketed on 4 sides to keep the die hot at all times.

The inverted profiled thermoplastic pavement marking system consists of a low-pressure drop-on type glass bead dispenser, moisture resistance bead coat. The glass beads shall be dispensed onto the hot thermoplastic material from a height of approximately 1 inch , above the road surface. The point at which the glass beads strike the surface of the pavement marking shall be approximately 3 inches, , behind the strike point of the thermoplastic. The glass bead coat shall utilize Type 3 glass beads and shall provide a surface coating of 50% of the thermoplastic pavement marking surface, and at least 50% of the beads will be embedded to a depth of 60% of their diameter.

A second low-pressure drop-on glass bead dispenser capable of applying a continuous coating of glass beads shall follow approximately 10 inches behind the first bead dispenser. This second glass bead dispenser shall apply adhesion bead coat which will form a continuous drop-on coat of Type 1 glass beads immediately in front of the profile thermoplastic pavement marking die. The second coat of glass beads shall be applied with low impact so that they are not forced into the pavement marking under pressure.

The rotatable wheel for inverted profiled thermoplastic pavement marking die shall be located approximately 8 inches, behind the second bead dispenser. The inverted profiled pavement marking die shall be approximately 7 inches in diameter and shall have a plurality of spaced projections located around its circumference. The inverted profiled pavement marking die shall be wider than the pavement marking material being applied to ensure adequate coverage. The projections on the inverted profiled pavement marking die shall have an angular profiling surface set at an angle to the pavement surface. The inverted profiled pavement marking die shall be mounted with an automatic leveling device to the same carriage assembly as the thermoplastic dispenser. To ensure that no hot thermoplastic material adheres to the die as it rotates and invert profiles the pavement marking, a small air atomized water jet shall apply a thin mist of water to the rotatable die. No water droplets greater than ¼ inch in diameter shall be allowed to accumulate on the pavement surface in proximity to the freshly placed pavement marking.

All parts of the thermoplastic holding tank including manifolds, hoses, pipes, dies, etc., shall be oil-jacketed to insure accurate temperature control. The thermoplastic material shall be preheated in kettles designed specifically for that purpose. Each kettle of preheated thermoplastic material shall be properly mixed and heated to the correct application temperature. The preheated material shall then be fed to the thermoplastic gun for application.

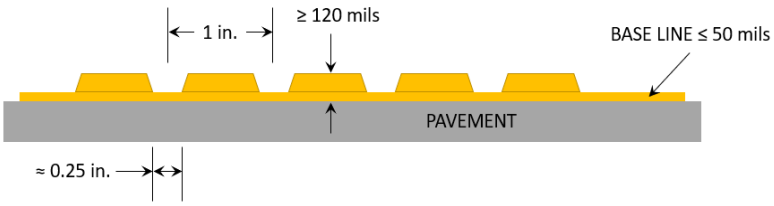
When placing inverted profiled thermoplastic pavement marking material on existing asphalt or concrete pavement that has more than one existing pavement marking material, the existing material shall be removed to the point that 80 percent of the pavement surface is visible.

Dimensions of Inverted Profiled Pavement Marking

The dimensions of the inverted profiled thermoplastic pavement marking shall have a minimum thickness of 120 mils measured from the pavement surface. The thermoplastic pavement marking material in the bottom of the inverted profiles shall have a thickness of up to 50 mils.

The individual inverted profiles shall be located transversely across the entire pavement marking surface at intervals of approximately 1 inch. The bottoms of these intervals shall be between 3/32 inch and 5/16 inch wide. It is acceptable for the top surface of the inverted profiles to be slightly irregular.

Detail : 716WR-1 Inverted Profiled Thermoplastic Pavement Marking



Notification

Notify the Engineer prior to the placement of pavement markings. Furnish the Engineer with the manufacturer's name and batch numbers of the thermoplastic materials, glass beads, and microcrystalline ceramic elements to be used. Ensure that the batch numbers appear on the thermoplastic materials and reflective elements packages.

Protection of Pavement Markings

Do not allow traffic onto or permit vehicles to cross newly applied pavement markings until they are sufficiently dry. Remove and replace any portion of the pavement markings damaged by passing traffic or from any other cause.

Deficiencies

As determined by the Engineer, remove and replace any unsatisfactory raised or inverted profiled thermoplastic pavement markings. The removal and replacement of the unsatisfactory pavement marking material shall be at no additional cost to the Department.

Method of Measurement

The Department will measure by the linear mile, complete in place and accepted, Wet Reflective Pavement Marking in accordance with **716.08.**

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item No.	Description	Unit
716-09.03	WET REFLECTIVE PAVEMENT MARKING (6IN)	LINEAR MILE
716-09.--	WET REFLECTIVE PAVEMENT MARKING(---)	--------

Such payments will be full compensation for all work specified, including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment may be withheld until all deficiencies are corrected.

STATE OF TENNESSEE

(Rev. 10-19-2015) January 1, 2021
(Rev. 10-5-2021)

SPECIAL PROVISION

REGARDING

ROADWAY SWEEPING

General. The work shall consist of the removal by mechanical sweeping, or other approved means, of dirt and debris such as tire and metal fragments, hub caps, rocks, etc. accumulated on the roadway along curbs, gutters, median barriers, bridge curbs and gore areas and ramps at interchanges.

The Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with these specifications and terms of the contract.

Control of Work. The Engineer, or his appointed representative, will decide all questions, which may arise as to the quality and acceptability of the work performed and his decision will be binding on the parties. If at any time the required equipment fails to meet acceptable standards, the Engineer shall notify the Contractor and suspend payments immediately.

Equipment. The Contractor shall furnish all equipment necessary to perform the work within the specified time. The use of mechanized vacuum or broom sweepers is required for this contract. Air flow vacuum sweepers shall have a blower capacity of not less than 17,000 CFM and broom mechanical sweepers shall have a minimum 100 HP @ 2,500 RPM diesel engine. All sweepers shall have a minimum 26,000 GVD and 10 foot sweeper path. All sweeping equipment shall be designed and operated with a water spray system to ensure that dust does not create a traffic hazard. All sweepers shall be equipped with a centrifugal dirt separator at the air return outlet of the hopper. All of the Contractor's equipment shall clearly display the Contractor's name and phone number on each side of the vehicle.

All sweeping equipment shall conform to all Federal, State and Local laws, regulations and ordinances for noise, water and air pollution controls and all Occupational Safety and Health Administration (OSHA) regulations.

All equipment shall be inspected and approved by the Engineer prior to the work beginning.

Hand brooms and other small tools may be required to remove any dirt and debris not removed by the power sweepers.

Work Schedule. Work may be performed between the following hours:

Roadway Classification	Roadway AADT	Working Hours
Interstate and Access Controlled Highways*	AADT ≥ 25,000	8:00 PM – 6:00 AM
	AADT < 25,000	8:00 PM – 6:00 AM
		9:00 AM – 3:00 PM
Multi-lane Highways (# of lanes >2)*	AADT ≥ 25,000	8:00 PM – 6:00 AM
	10,000≤ AADT< 25,000	8:00 PM – 6:00 AM
		9:00 AM – 3:00 PM
	AADT < 10,000	No Working Restrictions
Two Lane Highways (One lane in each direction)*	AADT ≥ 25,000	8:00 PM – 6:00 AM
	5,000≤ AADT< 25,000	8:00 PM – 6:00 AM
		9:00 AM – 3:00 PM
	AADT < 5,000	No Working Restrictions
*Work requiring the use of shoulder closures(only) will be allowed between 9AM -3PM		

Due to discrepancy in COVID-19 AADT data, the contractor shall utilize 2019 AADT data.

The weekday hours of operation may be extended to if working in the non-peak direction of traffic flow (except Friday PM) as directed by the Engineer. Weekend operations shall be restricted to daylight hours.

Weekdays are defined as beginning 8:00 p.m. Sunday and ending 3:00 p.m. Friday. The Engineer may temporarily suspend work activities during periods of inclement weather, during special events or in Maintenance and Construction work zones.

Traffic Safety. Traffic flow around the work in progress shall be maintained. All work shall be accomplished with the traffic flow instead of opposing traffic. All traffic control work zones shall be established by the Contractor in accordance with the requirements of the State's currently adopted edition of the Manual on Uniform Traffic Control Devices (MUTCD). The Contractor shall furnish shadow vehicles as recommended in Chapter 6 (Fig. 6H-4, 6H-17, and 6H-35) of the MUTCD for shoulder, two-lane, and multi-lane mobile traffic control work zones. All optional truck or trailer mounted attenuators for the shadow vehicle(s) in Figures 6H-4, 6H-17, and 6H-35 of the MUTCD are required for the sweeping operation**. All shadow vehicles in a sweeping operation shall be equipped with truck or trailer mounted attenuators.** A work vehicle (sweeper) cannot be utilized as a shadow vehicle.

The sweeping unit and the shadow vehicle(s) shall be equipped with flashing amber lights. Shadow vehicles shall be equipped with a Type C, 48" x 96" flashing arrow panel in accordance with Standard Drawing T-WZ-FAB1. Traffic control will be considered incidental to the work being performed and the cost thereof will be included in the price bid for linear mile of sweeping.

Dump Sites. All accumulated debris and rock materials swept or picked up by the Contractor will be removed from right-of-way to a Class IV dump site facility with the Contractor being responsible for all fees where applicable. The Contractor shall supply the Engineer with copies of dump tickets for each cycle prior to any payments being made.

Method of Measurement. Sweeping will be measured by the number of linear miles swept and cleaned free of all accumulated debris and foreign objects from the area between the edge of the traveled lanes and the face of the curb, barrier wall, bridge, guardrail, or outside edge of the paved shoulder. Sweeping of the described areas for a distance of one mile, measured along the centerline of said roadway, shall be deemed as one linear mile of sweeping.

Basis of Payment. The accepted quantities of linear miles swept will be paid for at the contract unit price per linear mile.

S T A T E **O F** **T E N N E S S E E**

(Rev. 10-08-2015)
(Rev. 09-06-2016)
(Rev. 09-11-2018)
(Rev. 10-02-2019)
(Rev. 10-09-2020)
(Rev. 09-30-2021)

January 1, 2021

SPECIAL PROVISION

REGARDING

REMOVAL AND DISPOSAL OF LITTER

Description. This work shall consist of removal and disposal of litter from the entire highway rights-of-way where accessible (fence to fence where applicable), including shoulders and excluding the travel lanes on designated interstate and state routes.

Definitions.

Litter. Any object or group of objects foreign to the right-of-way which has been discarded or abandoned and is or may become visible from the edge of the roadway or shoulder as a result of mowing, vegetation management, maintenance operations, or traffic. Examples under this definition include but are not limited to paper, plastic, bottles, cans, wood, tires, portions of tire, and metal products.

Continuous Operation. The uninterrupted performance of work on successive working days until the completion of all of the items of work specific to litter removal in the contract are approved by the Engineer.

Working Day. A calendar day, exclusive of State recognized holidays, which weather or other conditions not under the control of the Contractor, will permit litter operations to proceed for at least five (5) hours of the day with the normal working force engaged in performing the controlling item or items of work which are normal to progress at the time, as determined by the Engineer.

Equipment. The contractor shall furnish all necessary equipment for the satisfactory performance of the work. All vehicles used on the project will be equipped with at least two 6" diameter flashing amber lights, visible in both directions and with a covering device to prevent the litter from being blown from the vehicle.

Work Schedule. The litter removal for each section of road shall be accomplished on a schedule that will assure that the spacing between the beginnings of each cycle is constant

throughout the entire life of the contract. For example, if there are twenty-six (26) cycles to be accomplished they are to be started and completed every two weeks. The maximum cycle time allowed for sections with fewer than twelve (12) cycles shall be thirty (30) calendar days. For contracts which require fewer than twelve (12) cycles the Engineer will notify the Contractor in writing at least five (5) working days prior to the beginning of each litter cycle. Work shall begin on the date specified by the Engineer and shall be a continuous operation. Each litter cycle shall begin at the same location and proceed as established in the preconstruction conference or as directed by the Engineer (see Section 105.06 of the January 1, 2021 Standard Specifications). The contractor shall supply sufficient resources to accomplish the work during the allotted cycle time.

Time and Frequency Litter. The number of litter cycles will be indicated in the Special Notes and will correspond to the mowing schedule. One litter cycle will be reserved for winter pick-up (if needed) and scheduled at the discretion of the Engineer. In addition, the Engineer may eliminate an entire cycle or require a partial litter cycle at certain locations. A litter cycle will be considered complete when litter has been removed from the right-of-way specified in the Special Notes and all quantities associated with litter removal have been accepted as complete by the Engineer.

Litter removal operations on controlled access roads in Davidson, Hamilton, Knox, and Shelby shall not be performed during rush hour traffic from 6:00 A.M to 9:00 A.M and 3:00 P.M to 6:00 P.M. However, the contractor shall be allowed to work in the direction opposite to rush hour traffic during these times.

Litter removal shall be performed only during the hours of daylight Monday through Friday, or as directed by the Engineer. If work is performed on Saturday and/or Sunday, the Contractor will be charged a Working Day.

Litter Removal and Disposal. All litter shall be bagged and removed daily from the right-of-way. All litter accumulated each cycle by the Contractor will be removed from the right-of-way to a Class I dumpsite facility. All fees associated with disposal of litter removed from the state right-of way shall be included in the unit price bid for litter (item no. 719-02). The Contractor shall supply the Engineer with copies of dump tickets for each load deposited at the qualified dumpsite facility.

Acceptance of Work. The Department may accept a portion of the project before the entire project is completed. Such portion(s) shall be of reasonable length as determined by the Engineer, and shall be clean and free of litter when the inspection is made.

Additional Work. The Contractor may be required to remove litter in areas not specifically detailed in the Special Notes under the direction of the Engineer. Additional work shall be limited to the counties and systems which are designated in the Special Notes. Payment will be made at the contract unit price for litter removal (item no. 719-02).

Traffic Control. The Contractor shall maintain work zone traffic control and all traffic control devices for litter removal operations according to the requirements contained herein, the State of Tennessee's currently adopted edition of the Manual on Uniform Traffic Control Devices (MUTCD) defined under the Rules of Tennessee Department of Transportation Chapter 1680-3-1, and the Standard Specifications. Although Traffic Control may be included in the cost of other items, the contractor will be responsible for submitting certifications per Materials & Tests Division Standard Operating Procedures.

Warning Signs. The Contractor shall furnish portable signs in accordance with the "Manual on Uniform Traffic Control Devices" to notify the traveling public of litter operations. The Contractor shall place these signs on the highway during litter operations and remove them immediately after the operation ceases. Signs at the beginning point shall be forty-eight inches (48") by forty-eight inches (48") in size; diamond-shaped with black letters on an orange background with a black border with eight- inch high letters. These signs shall be dual mounted, one on each shoulder, for both directions of travel.

Safety Requirements. T he Contractor shall comply with OSHA standards, including the use of Class 3 reflective shirts or vests at all times.

Notification to the Engineer shall be made immediately of any personal injury, accidents involving contractor's equipment, or accidents involving the motoring public.

While equipment is not in use, it shall be parked or stored off the pavement or shoulder of the highway in an inconspicuous place more than thirty (30) feet from edge of pavement or as directed by the Engineer.

The Contractor shall be required to have the company name and phone number on all work zone support vehicles on the left and right sides in a location that is visible to the public. The lettering for the company name and phone number shall consist of a reflectorized material with a minimum height of three inches (3") or five inches (5") in height if non- reflectorized.

Method of Measurement. Litter pickup and disposal will be measured by the centerline mile. Measurement will be made longitudinally along the centerline of the project including bridges, and such single measurement shall include removal and disposal of all litter on interchanges; State maintained crossroads and service roads within the lateral limits of the rights-of-way excluding the travel lanes.

Basis of Payment. Removal and disposal of litter will be paid for at the contract unit price per centerline mile which shall be full compensation for mobilization and performance of the work in accordance with the stipulations, provisions and requirements contained herein.

All costs for traffic control as defined above shall be included in the unit bid price for litter removal Item No. 719-02.

S T A T E **O F** **T E N N E S S E E**

May 27, 2022

Contract: DB2101
County: Hamilton

SPECIAL PROVISION

REGARDING

INTELLIGENT TRANSPORTATION SYSTEM (ITS)

Description

This Special Provision specifies the installation, equipment, and acceptance requirements for all ITS related devices. The Design-Builder shall furnish and install all ITS equipment as specified herein.

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1 GENERAL REQUIREMENTS

1. All commands and references in, or in connection with, the text in this l Special Provisions (SP) document are written to direct Design-Builder responsibility for action unless otherwise specified.

2. This section specifies the minimum general requirements for this contract. Section 1 General Requirements applies to all aspects of the contract, including, but not limited to, the materials, installation, measurement, and payment requirements for all contract items.

3. The Design-Builder shall be responsible for all work required in this SP. All costs associated with the work in this SP shall be included in the contract price for the items included in the project and no separate payment shall be made.

1.1 GENERAL REQUIREMENTS

For specific information about the project, see the Scope of Work in the contract plans. The Design-Builder shall be fully responsible for the completion of all construction activities and all testing of any equipment associated with the Project as shown in the contract documents. This contract includes work on segments of freeways where proposed ITS devices, electrical infrastructure, and system communications are being installed as detailed in this SP, contract documents, and design plans.

The system includes but is not limited to the furnishing and installation of poles, sign structures, cabinets, foundations, conduit, wireless communications, fiber optic cable network, electrical power service, and other required vendor software/hardware necessary to complete a fully functioning system.

All the equipment provided shall comply with the applicable industry approved standards for the subsystems and communications network. Use of approved industry standards and the National Transportation Communications for ITS Protocols (NTCIP) shall be required for the dynamic message sign (DMS) and closed-circuit television (CCTV) devices.

1.1.1 ITS and Network Communications Devices

Quantitative and performance requirements for each type of equipment provided in this SP are mandatory minimum requirements. Functional equivalents proposed by the Design-Builder that fully meet or exceed these SP may be considered, provided the functional equivalent is compatible with the communications, hardware, and software included in the project, and provided that the functional equivalent meets all design and operational objectives of Tennessee Department of Transportation (TDOT). Experimental devices that are not proven in existing field installations at the time they are proposed for this project shall not be considered. All equipment and component parts that are furnished shall be new, with warranty and not used or refurbished, shall meet all requirements of this SP, and shall be in an operable condition at the time of delivery. All parts shall be of high-quality workmanship and no part or attachment shall be applied contrary to the manufacturer's recommendations or standard practices. All materials and installation of all devices shall be in accordance with this SP and Plans and with the manufacturer’s recommendations for the exact intended application. The entire quantity of any particular new item shall

be the exact same manufacturer, model, revision, firmware, etc. In addition, each major component must be provided, integrated, and warranted by a single vendor/manufacturer.

Manufacturers of ITS and Network Communications active electronic equipment and other critical system components shall be required to establish minimal qualifications prior to approval of equipment submittals, by submitting for consideration the following years of experience supplying the general type of device indicated:

- CCTV and DMS: 5 years

- Radar detection system (RDS), Network Switches, Video Communications Equipment, Spread Spectrum, Ethernet and any other wireless communications equipment: 3 years

The experience statements shall include but not be limited to, three (3) owner references and documentation of operational equipment installations. The statement of experience shall identify the number of years of experience as well as the references listed above and shall be provided during the submittal program as outlined in Section 1.8 of this SP.

1.1.2 Applicable Standards

All materials and installation procedures shall conform to the Design Plans, Special Provisions, the TDOT's latest edition of the Standard Specifications for Road and Bridge Construction, the latest edition of the TDOT Standard Roadway and Structure Drawings, the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD), and the supplemental Specifications, as included in the Specifications package. All electrical materials and work shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratories Inc. (UL), the Electrical Testing Laboratories (ETL), the National Electrical Testing Association (NETA), Institute of Electrical and Electronics Engineers (IEEE) and the Electronic Industries Association (EIA), wherever applicable. In addition to the requirements of the approved shop drawings to be prepared by the Design-Builder, and these Technical Special Provisions, all materials and workmanship shall conform to the requirements of the National Electrical Code (NEC), National Electrical Safety Code (NESC) and applicable codes of governing jurisdictions. Unless specified, all standards used for this project shall be the latest edition available.

1. Video Standards and Protocols

    a. One of the major system components to be furnished, installed, and tested under this project is IP addressable CCTV video equipment.

2. Digitization of the video signals for transmission shall utilize the Advanced and High Efficiency Coding (H.264, H.265) standard, MPEG4, Part 10 Standard, MPEG2 as defined by the International Telecommunication Union (ITU), Motion Picture Experts Group (MPEG) and as required by the device specifications within this SP. If necessary for proper operation of the encoding devices, the digitization of the video signal frame timing sequencing shall be properly tuned by the Design-Builder to eliminate video artifacts, and the L, P, and B frame settings for each digitized video stream shall be documented and provided to the Engineer as required by the submission requirements contained in this SP.

3. NTCIP Standard Protocols

    a. The DMS shall be compatible with the latest approved version of the NTCIP as applicable. The Design-Builder shall provide documentation from an independent testing entity, which may be in the vendor's possession, to identify NTCIP objects successfully incorporated and tested. The Design-Builder shall provide the Management Information Base (MIB) for all objects from the sign vendor during the submittal process. Additional NTCIP testing may also be required as part of the Factory Acceptance Test. Deviation from NTCIP compliance shall require advance written approval by the Engineer prior to installation of the offending device. This approval may be withheld at the discretion of the Engineer depending upon the circumstance and/or Federal Highway Administration guidance.

    b. CCTV control protocol for pan, tilt, and zoom in addition to other camera controls shall meet NTCIP requirements.

4. Ethernet and IP Standards and Protocols

    a. The Ethernet communications system and all connected devices shall, as an entire interconnected system, completely implement and be compatible with IEEE 802.3 industry standards for Ethernet and NTCIP standards supporting Ethernet as applicable and required. Ethernet switching equipment is used to transport the digital IP-based video and control data from field devices to hub cabinets. Network equipment at the field master hub switches routes the video and data to the TMC, other facilities and end users as needed.

1.1.3 Device Control Protocols

For all active electronic devices controllable through any type of communications interface, the Design-Builder shall be required to coordinate with, and without seeking additional fees, restrictions, licenses or compensation from TDOT, each respective system representative for each piece of equipment supplied, to support direct communication with and control of devices by the TDOT SmartWay operational systems identified.

A list of all pertinent device makes and models that are already supported by each system will be provided at the project pre-bid meeting. If a supported make and model is provided under this contract, no further coordination with the operating system venders will be required. However, if a new make and/or model is provided, the Design-Builder will be responsible for coordinating with the system venders to ensure sufficient drivers are developed to support the new devices without additional compensation. Complete documentation of the interface protocol and/or MIB shall be provided during the submittal program as outlined in Section 1.8 of this SP.

Unless specified differently by this SP, the Design-Builder shall use the devices specified on the ITS Qualified Product List and the Certified Product List available on the TDOT/ITS website. The website is available on the following link:

https://www.tn.gov/tdot/intelligent-transportation-systems/approved-its-products-list.html

1.1.4 Design-Builder and SubDesign-Builder Qualifications

The Design-Builder or subDesign-Builder selected to perform the ITS portion of the project certifies to be qualified as an expert in the trade, capable of understanding the intent of this SP and constructing the project in accordance with the prevailing standard practice of the trade. Firms qualifying as Design-Builder and or subDesign-Builders to perform ITS work must demonstrate at least five (5) years of experience and at least two projects within the last five (5) years in the type of work they plan to do on this project:

1. Fiber-optic Communications
2. Wireless Communications
3. Radar Detection Systems
4. CCTV camera surveillance
5. DMS
6. Hardware and Software used for Transportation Management Centers

1.1.5 Complete, Compatible Installations

This SP is for materials and equipment necessary to construct the proposed Project; however, every fitting, minor detail, or feature may not be described. Any component not explicitly stated in this SP, but necessary for the ITS sites to function, shall be considered incidental and shall be furnished and installed by the Design-Builder at the sole discretion of the Engineer. The Design-Builder is responsible for providing all miscellaneous, associated, and incidental materials to provide fully operational and complete ITS Roadside Equipment Sites that are readily compatible with the communications technologies utilized, and compatible with the hardware, software, and communications equipment installed at the TMC, and such miscellaneous materials shall be considered incidental to the project.

For location where the Design-Builder is responsible for performing work on actively functioning equipment, the Design-Builder shall support the continuous function of the devices and system. Such work shall be coordinated with the TMC, the Engineer, and the maintenance Design-Builder working on the system.

1.1.6 Complete Operational Systems

The Design-Builder shall furnish and install all necessary equipment for completely operational ITS Roadside Equipment Sites which are of high quality, high reliability, and operational stability. Compliance with minimum requirements for individual items identified in this SP does not, in and of itself, constitute compliance with the reliability and operational stability requirements necessary to provide for the integration of the sites into a complete, integrated system. It is the Design-Builder's responsibility to ensure that the components provided will work together to form a complete working system as described in this SP. It is the Design-Builder's responsibility to notify the Engineer in writing of any components outlined in the Specifications or Plans that would prohibit the Design-Builder from being able to install a complete operational system. The completed system shall be fully integrated with TMC central software already in use.

1.1.7 Communications System/Equipment Software Compatibility

The Design-Builder is responsible for ensuring that all equipment and software versions provided for this project is compatible with the existing communications system, TMC software, and all other equipment provided for this project, as installed, configured and programmed by the Design-Builder and while complying with all system functionality and performance requirements. This compatibility includes but is not limited to, all field devices and their respective controllers, all wired and wireless communications links, all control center hardware, and all software applications and control systems including, but not limited to, the CCTV, DMS, RDS, network switches, video communications equipment, wireless communications system, and the network management system. The Design-Builder shall ensure that the delay in equipment response times throughout the entire system is compatible with the existing software. Any modifications to the vendor software, firmware, and hardware to account for system latency and compliance with the total video response delay performance requirements shall be the responsibility of the Design-Builder.

1.1.8 Equipment and Materials

1. All equipment and materials furnished and installed on this project shall be new and unused.

2. All equipment and materials of a similar type and nature shall be of the same manufacturer, model, revision, firmware, etc.

3. All bolts, nuts, and fastening hardware less than 5/8-inch diameter shall be stainless steel. All bolts, nuts, and fastening hardware 5/8-inch in diameter and greater shall be hot- dipped galvanized. Refer to Subsection 908.04 of the Standard Specifications for High Strength Structural Bolts.

4. All components, materials, and incidentals shall be recommended by the manufacturer as suitable for the intended application, including any material exposed to the weather.

5. All equipment and associated materials shall be installed and configured in accordance with the manufacturer's recommendations and standard practices.

1.1.9 Coordination with Various TDOT Highway and Bridge Construction Design-Builders

The Design-Builder shall coordinate his activities with any other Design-Builders, which may be in the same work area. There are areas within the project limits where roadway activities may be occurring during the same timeframe as this project. Conflicts will be handled at the discretion of the Engineer. The Design-Builder shall notify TDOT in accordance with TDOT standard specs if there are any conflicts which may impact the Design-Builder's schedule or construction activities. The mere presence of these roadway construction activities alone will not be a sufficient reason for schedule delays. Design-Builder is expected to coordinate with these other Design-Builders to the extent possible.

Field adjustments may be needed for conduit and device locations shown throughout the project.

1.2 ABBREVIATIONS AND ACRONYMS

AASHTO - American Association of State Highway and Transportation Officials
ADA – Americans with Disabilities Act
AM – Amplitude Modulation
ANSI – American National Standards Institute
ASCE – American Society of Civil Engineers
ASCII – American Standard Code for Information Interchange
ASN.1 – Abstract Syntax Notation – 1
ASTM – American Society for Testing and Materials
ASSY – Assemblies
ATMS – Advanced Traffic Management System
ATSC – Advanced Television Systems Committee
AWG – American Wire Gauge
AWS – American Welding Association
BER – Bit Error Rate
BICSI – Building Industry Consulting Service International
BNC – Binary Network Connector
BSC – Bare Solid Copper
BSU – Base Station Unit
BTC – Bench Test Component
BTS – Bench Test System
°C – Centigrade
CATV – Community Access Television
CCITT – International Telegraph and Telephone Consultative Committee, now being referred to as ITU
CCTV – Closed-Circuit Television
CIF – Common Intermediate Format
CLD – Camera Lowering Device
CLI – Command Line Interface
COMM – Communications
CORBA – Common Object Request Broker Architecture Protocol
CRC – Cyclical Redundancy Check
D1 - Refers to "full resolution"
DB – Decibel
DHCP – Dynamic Host Configuration Protocol
DMS – Dynamic Message Sign
DSP – Digital Signal Processing
DVMRP – Distance Vector Multicast Routing Protocol
EIA – Electronics Industries Association
EIRP – Effective Isotropic Radiated Power
EMI – Electromagnetic Interference
EOP – Edge of Pavement
EOTL - Edge of Travel Lane
EOTW – Edge of Travel Way
ETL – Electrical Testing Laboratories
°F – Fahrenheit
FAT – Factory Acceptance Test
FCC – Federal Communications Commission
FDS – Fog Detection System
FHWA – Federal Highway Administration
FO – Fiber Optic
FOTP – Fiber Optic Test Procedures
Fps – Frames Per Second
FSK – Frequency Shift Keying
FTP – File Transfer Protocol
GBIC – Gigabit Ethernet Interface Card
GB/S – Gigabytes per Second
GFCI – Ground Fault Circuit Interrupter
GHz – Gigahertz
GIS – Geographic Information System
G.M. – Ground Mounted
GMRP – Generic Multicast Registration Protocol
GOP – Group of Pictures
GPS – Global Positioning System
GR – Guardrail
GVRP – Generic VLAN Registration Protocol
HAR – Highway Advisory Radio
HART - Highway Advisory Radio Transmitter
HARS - Highway Advisory Radio Sign
HDPE – High Density Polyethylene
HSPG – Hub Single Point Ground
HVAC – Heating, Ventilation and Air Conditioning
IAB – Internet Activities Board
IANA – Internet Assigned Numbers Authority
ICC – Intelligent Cruise Control
ICEA – Insulated Cable Engineers Association
IEC – International Electrotechnical Commission
IEEE – Institute of Electrical and Electronic Engineers
IETF – Internet Engineering Task Force
IGMP – Internet Group Multicast Protocol
IMSA – International Municipal Signal Association
IP – Internet Protocol
ISO – International Organization for Standardization
ITE – Institute of Transportation Engineers
ITS – Intelligent Transportation Systems
ITSA – Intelligent Transportation Society of America
ITU – International Telecommunications Union

JPL – Jet Propulsion Laboratories
kAIC – one thousand amps interrupting current
Kbps – Kilobits per second
KHz - Kilohertz
km – Kilometer
LAN – Local Area Network
LCD – Liquid Crystal Display
LED – Light Emitting Diode
LF – Linear Feet
LHCP – Left hand circular polarization
LT – Left
Mbps – Megabits per Second
MGB – Main Ground Busbar
MHz – Megahertz
MIB – Management Information Base
MMFO – Multimode Fiber Optic **MPEG** – Motion Picture Experts Group
MSEC – Millisecond
MTBF – Mean Time Before failure
MUTCD – Manual on Uniform Traffic Control Devices
NAB – National Association of Broadcasters
NEC – National Electric Code
NEMA – National Electrical Manufacturers Association
NESC – National Electrical Safety Code
NETA – National Electrical Testing Association
NHI – National Highway Institute
NIST – National Institute of Standards and Technology
NHTSA – National Highway Traffic Safety Administration
NMS – Network Management System
NOAA – National Oceanic and Atmospheric Administration
NSF – National Science Foundation
NTCIP – National Transportation Communications for ITS Protocol
N.T.S – Not to Scale
NTSB – National Transportation Safety Board
NTSC – National Television System Committee
NWS – National Weather Service
O/H – Overhead
OSP – Outside Plant
OTDR – Optical Time Domain Reflectometer
OVDS – Overheight Vehicle Detection System
P – Power
PB – Pull Box
PC – Intel/Windows-based personal computer
PCB – Printed Circuit Board
PE – Polyethylene
PIT – Pre-Installation test
POCSAG – Post Office Code Standardization Advisory Group
PPM – Parts per Million
PPT – Puncture Propagation Tear
PM – Preventive Maintenance
PSI – Pounds per Square Inch
PTZ – Pan Tilt and Zoom
PV - Photovoltaic
PVC – Polyvinylchloride
RADIUS – Remote Authentic Dial-in User Server/Service
RDS – Radar Detection System
RF – Radio Frequency
RFI – Radio Frequency Interference
RGS – Rigid Galvanized Steel
RMON – Remote Networking Monitoring
ROW – Right-of-Way
RSL – Received Signal Level
RUS – Rural Utilities Service
RT - Right
SAE – Society of Automotive Engineers
SAP – Session Announcement Protocol
SAT – Stand Alone Site Test
SCH. – Schedule
SCTE – Society of Cable Telecommunication Engineers
SCU – Sign Controller Unit
SDP – Session description protocol
SDR – Standard Dimension Ratio
SIA – Security Industry Alliance
SIF – Standard Interchange Format
SMFO – Single Mode Fiber Optic
SNMP – Simple Network Management Protocol
SP –Special Provision
SPD - Surge Protective Device
SST – Sub-system Test
STA. – Station
STMF – Simple Transportation Management Framework
STMP – Simple Transportation Management Protocol
STP – Shielded twisted pair
SU – Subscriber Unit
TACACS – Termination Access Controller Access Control System
TCIP – Transit Communications Interface Protocol
TCP – Transmission Control Protocol
TCP/IP – Transmission Control Protocol / Internet Protocol
TDMA – Time Division Multiple Access
TDOT – Tennessee Department of Transportation
TEES – Transportation Electrical Equipment Specifications
TFTP – Trivial File Transfer Protocol
THHN – Thermoplastic High Heat Resistant Nylon Coated
THWN – Thermoplastic Heat and Water-Resistant Nylon Coated
TIA – Telecommunications Industry Association
TIS – Traveler Information Service
TMC – Transportation Management Center
UDP – User Datagram Protocol
UDP/IP – User Datagram Protocol/Internet Protocol
UL – Underwriter's Laboratory Incorporated
UNII – Unlicensed National Information Infrastructure
UPS – Uninterruptible Power Supply
UTP – Unshielded Twisted Pair
UV – Ultraviolet
VAC – Volts Alternating Current
VDC – Volts Direct Current
VDS – Video Detection System
VLAN – Virtual Local Area Network
VSWR – Voltage Standing Wave Radio

1.3 DESIGN SUMMARY

For specific information about the project, see the Scope of Work in the contract plans.

1.3.1 Phasing

The actual ITS construction phasing shall be coordinated with the Prime Design-Builder and any installation of ITS devices shall be coordinated with each of the project construction phases, such as clearing and grubbing, grading, drainage, roadway, structures, etc. Construction of fiber optic segments and installation of ITS devices and supports shall begin as soon as practical and the overall construction phases have advanced to a point where no further relocation will be required to accommodate any remaining roadway widening or structure repair/construction elements.

The Design-Builder shall ensure continuous operation of any existing fiber optic lines and ITS devices affected by the work activities. Any disconnect of existing devices shall be planned and coordinated with concurrence from the regional TMC prior to the disconnect. Temporary disconnect of the fiber optic communication network or ITS network devices shall not exceed 48 hours. ITS network devices include, but are not limited to, CCTV cameras, Radar Detection Systems (RDS), and Dynamic Message Signs (DMS) within the project limits or those devices outside project limits that may be affected by communication failures caused by this project. Failure to restore communication and ITS devices beyond the specified time frame shall result in liquidated damages in accordance with rates established in Special Provision 108B until communication and/or ITS devices are restored.

Upon Conditional Acceptance, TDOT will assume operations of those devices where practical. This use by TDOT does not constitute Final Acceptance or waive any other requirements in this Contract. Also, the Burn-In period described in this SP does not begin until Conditional Acceptance of all Phases.

1.3.2 Electrical Power

The local electrical service providers within the limits of this contract are listed on the Plans as Utility Owners. The provider shall provide power drops at proposed demarcation points, as appropriate. The Design-Builder shall include the cost of coordinating with the utilities in the bid price for electrical connections. The Design-Builder is required to coordinate with the utility company for the installation of the service. Within 14 days of installation, the Design-Builder shall provide to TDOT the address recorded in the power company records. The address will also be included on the as-built plans required in this SP. The Design-Builder will pay for all monthly service charges until after Conditional System Acceptance. The utility will bill TDOT directly for the additional monthly service charges including the initial install costs. Within the interstate right-of-way, any physical facilities, such as conduit runs, needed by the service provider shall be the responsibility of the Design-Builder to install as shown in Plans. The electrical demarcation points within the existing device project limits will remain in place unless otherwise noted on the plans.

1.4 GENERAL SYSTEM REQUIREMENTS

System-wide requirements for latency to roadside sites shall be as follows:

1.4.1 CCTV and Control Data Latency

Control commands will be generated from the off-the-shelf video control software provided by the Design-Builder and shall pass through the Ethernet network to the field equipment, such as CCTV cameras. Operation of the pan, tilt, zoom, presets, focus, iris, and any other available functions of the CCTV cameras shall be provided. Status data generated by the camera shall be transmitted to the camera control unit and to the TMC. The total video response delay between the operator issuing a command to move a camera (through a mouse, keyboard, or joystick through the TMC Software System), movement of that camera, and the resulting display on the operator's monitor of that camera's viewing image as it is moving, shall be minimized to avoid over steering and operator difficulty in positioning the camera. The maximum allowable total video response delay anywhere in the project shall not exceed an average of one (1.0) second for any ten cameras sequentially randomly sampled and shall not exceed one and one half (1.5) seconds for any one camera sampled.

1.4.2 DMS Control Latency

The total delay in sending a message to a DMS shall not exceed 5 seconds from the time the operator commands the message until the message is displayed on the DMS.

1.4.3 Existing System

Details on the location of the existing devices are included in the Plans. If any additional information regarding the existing system is needed for bidding purposes, it is the Design-Builder's responsibility to request in writing the specific information desired in accordance with the question submittal deadlines in the pre-bid instructions. Questions shall be addressed to the Engineer.

1.5 PROJECT TESTING PLAN REQUIREMENT

The Design-Builder shall conduct a Project Testing Plan as required below in addition to all other project testing and acceptance procedures required elsewhere in this SP and Plans. The Project Testing Plan shall include a series of tests on all project materials occurring at various stages in the project. The Project Testing Plan includes all testing in the Standard Specifications including all modifications and supplemental procedures contained in this SP. All costs associated with the Project Testing Plan shall be included in overall contract prices; no separate payment will be made for any testing.

1.5.1 General Requirements

The Design-Builder is responsible for planning, coordinating, conducting, and documenting all aspects of the Project Testing Plan and providing all required equipment for the tests. The Engineer is responsible

only for attending and observing each test and reviewing and approving the Design-Builder's test results documentation. The Engineer reserves the right to attend and observe all tests.

Each test shall be an individual and separate event for each type of test and for each type of equipment as defined in this SP. The Design-Builder shall follow the testing sequence as described in this SP and shall perform the required tests on all applicable devices and infrastructure.

Test procedures shall be submitted and approved for each test as part of the project submittals. Test procedures shall include every action necessary to fully demonstrate that the material under test is clearly and definitively in full compliance with all project requirements. Test procedure actions shall cross-reference to this SP or Plans requirement that is the subject of the test action. Test procedure actions shall cross-reference the applicable sections of the final approved Project Submittal Compliance Form and the submittal materials for the subject of the test action. Test procedures shall contain test setup and block/wiring diagrams showing all materials being tested and all test and measurement equipment, with calibration documentation, and shall contain documentation regarding the equipment configurations and programming. Test procedures shall include check off blanks for each project requirement included in that test and shall include forms for the documentation of all measured test results.

No testing shall be scheduled until approval of all project submittals for all materials covered under a given test and approval of the test procedures for the given test.

Unless otherwise required herein, the Design-Builder shall request in writing the Engineer's approval for each test occurrence a minimum of 14 days prior to the requested test date. Test requests shall include the test to be performed and the material to be tested. The Engineer reserves the right to reschedule test requests if needed.

For any series of tests on different installations of a given material (e.g., different sections of cable), the Design-Builder shall request in writing the Engineer's approval for the first test occurrence of the series a minimum of 14 days prior to the requested test date, regardless of the notification requirements for subsequent test occurrences.

The Design-Builder shall provide all ancillary equipment and materials as required in the approved test procedures.

The Design-Builder shall document all test results in writing in accordance with the test procedure and submit to the Engineer within 7 days of the test. Any given test session is considered incomplete until the Engineer has approved the documentation for that test session.

The Design-Builder shall repeat all tests if results are deemed by the Engineer to be unsatisfactory, following all test requirements as given here. In the written request for each test occurrence that is a repeat of a previous test, the Design-Builder shall summarize the diagnosis and correction of each aspect of the previous test that was deemed unsatisfactory. Any revisions to the test procedures for a repeated test occurrence shall meet all requirements for the original test procedures, including review and approval by the Engineer.

The satisfactory completion of any test shall not relieve the Design-Builder of his responsibility to provide a completely acceptable and operating system that meets all requirements of this project.

The tests for the Conditional Acceptance may be completed in Phases as described in Section 1.3.1. However, the overall Conditional System Acceptance which starts the Burn-In period shall not be granted

until all elements in this contract have passed the Conditional System Acceptance tests. The phased acceptance testing is only to allow the Design-Builder to receive milestone payment for work completed.

1.5.2 Factory Acceptance Test (FAT)

FATs shall be conducted at the Manufacturer or Design-Builder's facility or at a facility acceptable to all parties. A proof of FAT from previously approved projects is acceptable for the same device models. All equipment to be utilized for this project shall be subject to tests that demonstrate the suitability of the design and manufacturing procedures and compliance with the contract requirements, unless an exception for a specific equipment item is granted by the Engineer. The tests shall be performed on production units identified to be delivered under this Contract. As a minimum, a FAT is required for each of the following project materials:

1. Dynamic Message Signs and controllers

   The FAT procedure shall demonstrate all requirements defined in these special provisions are met, including, but not limited to functional/system performance requirements, electrical requirements, data transmission/communication requirements, safety/password requirements, environmental requirements, and interface requirements with other components of the system including the DMS control software, the Ethernet switches, etc.

   The Engineer reserves the right to witness all FATs. At a minimum, the Engineer will be in attendance at the FAT for the first new DMS. The FAT for the first two signs shall be conducted during the same time period and shall be completed before additional signs are produced.

   The Engineer shall be notified a minimum of thirty calendar days in advance of such tests. Salary and travel expenses of the Engineer and his representatives will be the responsibility of the Department. In case of equipment or other failures that make a retest necessary, travel expenses of the Engineer and his representatives shall be the responsibility of the Design-Builder. This shall include all costs associated with having two of the Engineer's representatives on site including, but not limited to, airfare, automobile rental, lodging, and per diem. These costs, excluding airfare, shall not exceed $500.00, per representative, per day. These costs shall be deducted from the payments due or charged to the withholding account of the Design-Builder when the project is terminated.

   The vendor must complete the FAT on all remaining signs on their own and submit documentation to the Engineer that the FATs were completed. The Engineer reserves the right to randomly attend those FATS.

   No equipment for which a FAT is required shall be shipped to the project site without successful completion of a FAT as approved by the Engineer and the Engineer's approval to ship.

1.5.3 Bench Test Component (BTC)

The Design-Builder shall perform a complete BTC on all equipment and materials as specified in this subsection below. The full contract quantity of all materials shall be tested, unless a different quantity for the purposes of the BTC is given in this subsection below. The quantity listed in the subsection below is a

“minimum” quantity and the Engineer reserves the right to require testing of additional quantities if the initial testing is not deemed adequate. The Design-Builder shall provide the testing location and facility, which shall be in Tennessee and within a 50-mile radius of the project limits. The test location must be approved by the Engineer as part of the BTC test procedure submittal.

The BTC shall demonstrate that all equipment and materials are in full compliance with all project requirements and works “out of the box”, by visual inspection, setup and operation "on the bench", functional testing of the component including manufacturer’s recommended startup diagnostics and testing prior to any field installation of that equipment or material. Test results documentation shall be provided for each equipment item and material in the full contract quantity; test results documentation shall include the manufacturer’s serial number and the project location ID for each item.

As a minimum, a BTC is required for each of the following project materials for quantities as shown.

1. Closed Circuit Television Equipment, 3 units
2. Dynamic Message Sign, 1 complete unit
3. Network Switches, 3 units
4. Radar Detection System, 3 units
5. Off-the-shelf and Vendor Software
6. TMC System Compatibility
7. Equipment Cabinet (Type A), 2 cabinets
8. Equipment Cabinet (Type B), 2 cabinets
9. Equipment Cabinet (Type C), 1 cabinet
10. ITS Communication HUB (Field Junction Cabinet), 1 cabinet
11. ITS Communication HUB (Building), 1 unit

1.5.4 Bench Test System (BTS)

The Design-Builder shall perform a complete BTS on all equipment and materials as specified below. The Design-Builder shall provide the testing location and facility, which shall be within a 50-mile radius of the project limits or as approved by the Engineer. The test location must be approved by the Engineer as part of the BTS test procedure submittal. The Design-Builder shall not request any BTS until the BTCs have been satisfactorily completed for all equipment and materials to be included in the BTS.

The BTS shall demonstrate that all equipment and materials are in full compliance with all project requirements and that a fully set up and configured sample of the project is completely integrated and interoperable in accordance with the project requirements. The BTS shall include all manufacturer’s recommended startup diagnostics, configuration and testing procedures. Equipment items and materials included in the BTS shall be setup in temporary configurations (e.g., cameras, DMS and antenna on mounting stands). At least one camera shall be located a minimum of 20 feet above ground and shall have a clear one mile viewing area in at least one direction. Equipment to be located in cabinets or equipment racks shall be mounted as if in its final installation. Test results documentation shall include the manufacturer’s serial number and the project location ID for each item. All temporary permits, wiring and cabling, equipment mounting, electrical service, and permitting necessary for the BTS shall be the responsibility of the Design-Builder. The Design-Builder shall arrange, at no additional expense to the State, the attendance of qualified technical representatives of all of the equipment manufacturers to attend the BTS.

No field installation of any equipment and materials included in the BTCs shall occur until after the BTS has been satisfactorily completed, and the Engineer has approved test results.

1.5.5 Pre-Installation Tests (PIT)

The Design-Builder shall perform Pre-Installation Tests (PIT) on all device quantities that are not included in the BTC. The Design-Builder shall provide the testing location and facility, which shall be within a 50-mile radius of the project limits or as approved by the Engineer. The test location must be approved by the Engineer as part of the PIT test procedure submittal. The PIT shall be a shortened version of the BTC to ensure the equipment will power up, operate, and was not damaged during shipment. The Engineer reserves the right to attend any PIT as desired; however, the Design-Builder shall submit documentation of the PITs whether the Engineer is present or not.

As part of the pre-installation tests, the Design-Builder shall install bar code labels on all equipment prior to installation as described in Section 18.8 of this SP. The cost of the bar code installation shall be considered incidental and included in the cost of other items.

1.5.6 Stand Alone Site Tests (SAT)

The Design-Builder shall perform a complete SAT on all equipment and materials associated with the field device site, including, but not limited to, electrical service, conduit, pull boxes, fiber optic infrastructure, cable, poles, camera lowering devices, RDS cable, etc. An SAT shall be conducted at every field device site including communications hubs. An SAT shall be conducted for all fiber optic infrastructure.

The SAT shall demonstrate that all equipment and materials are in full compliance with all project requirements and fully functional as installed and in final configuration. The SAT shall demonstrate full compliance with all operational and performance requirements of the project including, but not limited to, detection accuracy for RDS. SATs for the Spread Spectrum radio communications links shall include a demonstration of the radios and antennas at both ends of the link, and a demonstration of the link itself. All SATs also include a visual inspection of the cabinet and all construction elements at the site to ensure they are compliant with the Specifications. The SATs for each site type shall include but are not limited to, the following:

- CCTV Stand Alone Site Test: Shall be conducted at the CCTV Cabinet and shall demonstrate the complete operation of the CCTV, Network Switch, and the link(s) to any RDS that is connected to the Power Supply in the CCTV Cabinet.

- RDS Stand Alone Site Test: Shall be conducted at the RDS Cabinet and shall demonstrate the complete operation and proper configuration of the RDS unit(s).

- DMS Stand Alone Site Test: Shall be conducted at the DMS Cabinet and shall demonstrate the complete operation of the DMS and Network Switch.

- Wireless Equipment Stand Alone Site Test: Shall be conducted from the cabinet at the receiving antenna and shall demonstrate the complete operation of the entire link.

The Design-Builder shall request in writing the Engineer's approval for each test occurrence a minimum of 14 days prior to the requested test date. No more than two (2) SATs shall be scheduled simultaneously at any given time unless otherwise approved by the Engineer. The Design-Builder shall arrange, at no additional expense to the State, the attendance of a qualified technical representative of the equipment manufacturers to attend each test until a minimum of two (2) sites of that particular type are approved.

1.5.7 Conditional System Acceptance Test

The Design-Builder shall perform a complete conditional system acceptance test on all equipment and materials in the project. A conditional acceptance test can be requested and performed on a phased approach as described in Section 1.3.1 as the phases are completed. The Design-Builder shall not request the conditional system acceptance test until the SATs have been satisfactorily completed, all as-built documentation has been submitted and approved, and all other project work has been completed to the satisfaction of the Engineer. Prior to a Conditional System Acceptance Test, the Design-Builder shall provide advance notice of and written test results documentation that the Design-Builder has performed a dry-run of the conditional system acceptance test, and the Engineer reserves the right to require attendance of a dry-run test session.

The Design-Builder shall test all project systems simultaneously from the TMC in a manner equivalent to the normal day-to-day operation of the system. The Conditional System Acceptance Test shall demonstrate that all equipment and materials in the network are in full compliance with all project requirements and fully functional as installed and in final configuration, communicating with and being controlled through the control center at the TMC.

The Engineer reserves the right to require, at no additional expense to the State, the attendance of a qualified technical representative of the equipment and/or software manufacturers to attend any given Conditional System Acceptance Test.

Upon completion and full approval of the Conditional System Acceptance Test for all equipment in all phases, Conditional System Acceptance will be given, and the Burn-In period will begin.

1.5.8 Burn-In Period

1. Burn-In Period

    a. Following the Engineer's written notice of successful completion of the Conditional System Acceptance Test, the entire newly installed system must operate successfully for a three (3) month Burn-In period. The Design-Builder shall be responsible for the full maintenance of the newly installed equipment during the Burn-In period. However, no separate payment will be made beyond the contract unit price bid for the Burn-In period. Successful completion of the Burn-In period will occur at the end of three complete months of operation without a system failure attributable to hardware, software, or communications components. Each system failure during the Burn-In period will require an additional month of successful operation prior to being eligible for Final Acceptance. (i.e., if there are two system failures during the initial three-month period, the Burn-In period would be increased to 5 months.)

2. Burn-In General Requirements

a. Determination of a system failure shall be at the sole discretion of the Engineer.

b. System failure is defined as a condition under which the system is unable to function as a whole or in significant part to provide the services as designed. While a single component failure will not constitute a system failure, chronic failure of that component or component type may be sufficient to be considered a system failure.

c. Components are defined as contract items or major material elements in a contract item. For electrical and electronic contract items, components are defined as the complete assembly of materials that makes up the contract item.

d. Chronic failure of a component or component type is defined as 3 or more failures for components with a contract quantity of 50 units or less. For components or component types that have a contract quantity greater than 50 units, chronic failure will be defined as having a failure of that component type more times than a number equal to 5 percent of the total contract quantity of that unit.

e. Multiple (more than 1) communication outages or failures will be considered a system failure in any case. Communication failure due to a minor component may not be a system failure. A single path/link failure (e.g. CCTV or DMS link) is not considered a system failure.

f. Specifically exempted as system failures are failures caused by accident, acts of God, or other external forces that are beyond the control of the Design-Builder. However, failure of the Design-Builder to respond to the repair request for that failure within 24 hours may be considered a system failure.

g. Any existing devices and equipment are not part of the Burn-In period; therefore, any failures of the existing equipment will not affect the Burn-In period.

h. The Department will advise the Design-Builder in writing when it considers that a system failure has occurred, or chronic failure exists.

i. If multiple system and/or chronic failures continue to occur throughout the Burn- In period due to a single component type, the Design-Builder may be required to replace all units of that component type with a different model or manufacturer.

j. The Design-Builder shall document all failures and subsequent diagnosis and repair. The repair documentation shall include as a minimum:
    i. Description of the problem
    ii. Troubleshooting and diagnosis steps
    iii. Repairs made
    iv. List of all equipment and materials changed including serial numbers
    v. Update of the equipment inventory where needed

k. The Design-Builder shall provide the repair documentation to the Engineer within two (2) days of completing the repair; failure to provide acceptable documentation as required shall be reason to not approve the repair as complete. The Engineer will provide acceptance or rejection of the repair and documentation within seven (7) days.

l. The Engineer reserves the right to require, at no additional expense to the State, the presence of a qualified technical representative of the equipment and/or software manufacturers as related to the diagnosis and/or repair of any system failure.

m. During the Burn-In period the Design-Builder shall perform incidental work such as touching up, cleaning of exposed surfaces, leveling and repair of sites, sodding/grassing, and other maintenance work as may be deemed necessary by the Engineer to ensure the effectiveness and neat appearance of the work sites.

n. During the Burn-In period the Engineer shall maintain a "Burn-In period punch list" that contains required Design-Builder actions but that the Engineer does not define as a system failure. Each Burn-In period punch list action item shall be completed by the Design-Builder to the Engineer's satisfaction within seven (7) days of Design-Builder notification of the action item.

o. During the Burn-In period the Design-Builder shall maintain the system. No separate payment will be made beyond the contract unit prices for the Burn-In period pay item.

p. The overall Burn-In period will be considered complete upon the successful completion of the Burn-In time periods, the Engineer's acceptance of all repairs and repair documentation, completion of all Burn-In period punch list actions and a final inspection as described below.

1.5.9 Final Inspection

Upon successful completion of the Burn-In period, the entire project shall be eligible for Final Inspection. The Final Inspection will be conducted provided the Burn-In period has demonstrated the entire system is operating successfully. The Final Inspection shall include but is not limited to:

1. Monitoring of all system functions at the TMC to demonstrate the overall system is operational.

2. A field visit to each site to ensure all field components are in their correct final configuration.

3. Verification that all Burn-In punch list items have been completed.

4. Verification that all final cleanup requirements have been completed.

5. Approval of final as-built documentation

Prior to conducting the Final Inspection, the Burn-In period shall demonstrate that all requirements defined in this SP have been met, including, but not limited to: functional/system performance

requirements, electrical requirements, data transmission/communication requirements, safety/password requirements, environmental requirements, and interface requirements with other components of the system.

The Design-Builder shall request in writing the Engineer's approval to start the Final Inspection a minimum of 14 days prior to the requested start date. The Engineer reserves the right to reschedule the start date if needed. The start date for the Final Inspection cannot be prior to the successful completion of the overall Burn-In period.

An unsuccessful or incomplete Final Inspection shall require a new Final Inspection after the Design-Builder has made the necessary corrections. Up to 14 days shall be allowed for the Engineer to conduct a Final Inspection. The Engineer reserves the right to require, at no additional expense to the State, the attendance of a qualified technical representative of the equipment and/or software manufacturers to attend a portion of a Final Inspection.

The Design-Builder shall be responsible for the full maintenance of all project equipment and materials as described in Section 18 of this SP during the entire time period from the successful completion of the Burn-In period until Final System Acceptance is granted.

1.5.10 Final System Acceptance

Upon successful completion of the Final Inspection, the Engineer will grant Final System Acceptance.

The Burn-In period and Final Inspection, are integral and substantial part of the project. Only after Final System Acceptance is granted shall the day count stop for the project and the project can be considered substantially complete according to Special Provision 108B.

1.5.11 Beneficial Use of Dynamic Message Signs During Construction

Each DMS shall be roadside controllable (by sign vendor software) within 30 days of attachment to trusses over the roadway (visible to motorists). The Design-Builder's construction schedule shall clearly identify when installation of the signs over the roadway shall occur, and when roadside control shall be established for each sign. The Design-Builder shall not install a DMS over the roadway until all ancillary and infrastructure elements, including cabinets, controllers, conduits, cabling, etc. necessary to operate the sign are in place and functional. Once roadside controllable, the Design-Builder shall display emergency, special event, construction, safety or traveler information messages approved by TDOT, only when requested by TDOT, at no additional cost to TDOT. Normal diagnostic messaging for the purpose of installation and testing shall be determined by the Design-Builder, but shall not be allowed to the extent that excessive power consumption or distraction to motorists occurs as determined by the Engineer. Any beneficial use of the signs to TDOT and the public prior to Final Acceptance does not constitute TDOT acceptance or waive any Design-Builder testing requirements. Failure to make signs roadside controllable within 30 days after installation over the roadway shall constitute failure to meet the Design-Builder's construction schedule and liquidated damages will be assessed as described in Special Provision 108B. The cost that may be incurred by the Design-Builder to display messages as described above during this construction contract shall be considered incidental and included in the cost of other items.

In projects where DMSs are designated to work as a system (e.g. Active Lane Management System and Variable Speed Limit signage), the beneficial use of the signs are considered at the system level. Thus, beneficial usage of the system shall be guaranteed within 60 days of the installation of the first sign. Such beneficial usage (as determined by the engineer) shall be coordinated with the TMC and approved by the engineer prior to the installation of the DMS system.

1.6 TRAINING

Prior to Conditional System Acceptance, the Design-Builder shall provide a four-hour training session covering CCTV and camera lowering device, DMS, RDS, and wireless communications. An additional four-hour session shall be conducted to describe the configuration and operation of all electronic equipment including network switches, video communications equipment, wireless communications equipment, communications hubs and associated equipment, electrical and solar power services, and fiber optic cable network.

The training shall be provided at the TMC for at least six (6) personnel with individual copies of all training materials and manuals provided to each participant. The training must include a complete demonstration of the configuration, operation, and capabilities of each component in the system. The training should also consist of a hands-on demonstration of all software configuration and functionality where applicable.

Each training session shall include a mixture of classroom-style training in equipment operation, hands-on operator training, and question and answer sessions. The Design-Builder shall submit the trainers' qualifications to the Engineer for approval prior to scheduling the training. The qualifications of the trainers must meet, at a minimum, the recommended qualifications of the equipment manufacturer. If qualified personnel are not on the Design-Builder's staff, a representative of the manufacturer shall provide the training.

The Design-Builder shall submit to the Engineer for approval a detailed Training Plan including course agendas, detailed description of functions to be demonstrated, and a schedule.

1.7 WARRANTIES

Each component of the Project shall be warranted against manufacturing defects and workmanship for a period of at least one year from the date of Final Acceptance. These warranties shall cover complete replacement at no charge for the equipment. The Design-Builder will be responsible for all labor, shipping, insurance, and other charges until Final System Acceptance. Equipment covered by the manufacturers' warranties shall have the registration of that component placed in the Department's name prior to Final Inspection. Even though the warranties will be in TDOT's name, the Design-Builder is still responsible for executing the warranties during Annual Maintenance. The Design-Builder is responsible for ensuring that the vendors or manufacturers supplying the components and providing the equipment warranties recognize TDOT as the original purchaser and owner/end user of the components.

1.8 PROJECT SUBMITTAL PROGRAM REQUIREMENTS

The Design-Builder shall develop and conduct a submittal management program that shall meet the following minimum requirements, supplemented by any additional requirements regarding submittals that may appear in subsequent sections of this SP or any other contract documents. All materials used on this project will require a submittal and approval prior to purchase and use regardless of whether or not they are called out specifically in this SP.

With each submittal package, the Design-Builder shall complete a Project Submittal Compliance Form. The compliance form will list each SP subsection and will require the Design-Builder to verify and check that it meets that subsection of the Specification. The Engineer shall provide at contract Notice to Proceed (NTP) blank copies of the contract item specific compliance form.

Submittal packages without these completed forms will be considered unallowable and returned to the Design-Builder without review or consideration.

The Project Submittal Compliance Form will include, but is not limited to, the following data:

1. Contract pay item number
2. Submittal package identification
3. Submittal description with make/model/part number information
4. Reference to SP requirement
5. Compliance or non-compliance statement for each SP requirement
6. Cross-reference to attached documentation for each SP requirement
7. Authorized Design-Builder signature

The Design-Builder shall at minimum provide the following submittals for review and approval by the Engineer. All submittals must be submitted electronically. The table below is meant as a guide and is not all-inclusive. Items not listed below may also be required during the submittal stage.

Item	Catalog Cutsheets and Technical Specifications	Test Procedure	Installation Procedures	Maintenance Manuals	Operational Manuals	Manufacturer's Statement of Experience	Final Documentation	Interface Protocols
CCTV Equipment	X	X	X	X	X	X	X	X
Camera Lowering Device with Tool	X	X	X	X	X	X	X	
Dynamic Message Signs	X	X	X	X	X	X	X	X
Radio and Antennas Type (all types)	X	X	X	X	X	X	X	
Radar Detection System	X	X	X	X	X	X	X	X
Cabinets	X	X	X	X	X		X	
Network Switches (all types)	X	X	X	X	X	X	X	X
All Software	X	X	X	X	X		X	
TMC/Communications HUB Hardware	X	X	X	X	X		X	
Demarcation Point Riser Assembly	X							
Ground Mounted Demarcation Point	X							
Traffic Maintenance Plans	X							
Training Plan							X	
Conduit and Pull Boxes	X							
Fiber Optic Infrastructure	X	X	X	X	X		X	

1.8.1 Fifteen (15) Day Submittals

Within 15 calendar days of Notice to Proceed, the Design-Builder shall submit a written description of his proposed submittal program, including a comprehensive list of all intended submittals and schedule of the submittals for the remainder of the project. The Design-Builder shall develop an appropriate schedule based on the schedule of work, with the exception of the items identified below that have specific due dates. At a minimum, the submittals listed in the table above shall be included in the submittal program. Note that the 15-day submittal is ONLY a schedule of the submittal program. The 15-day submittal does not include any actual equipment submittals.

The Design-Builder shall submit to the Engineer for approval one electronic copy of the program including a complete list and initial schedule of all those materials, components, and structures to be incorporated in the work for which submittals are required. This list shall form the basis for a log of submittals that will be used by the Design-Builder and Engineer to manage the submittal process. The list shall be submitted as an Excel spreadsheet. In addition, the 15-day submittal shall also contain a letter from the Design-Builder certifying that all required interface protocols will be submitted from all vendors as requested.

1.8.2 Forty-Five (45) Day Submittals

Within 45 calendar days of Notice to Proceed, the Design-Builder shall submit the following:

1. Catalog Cut Sheets and Technical Specifications: Within 45 Days of Notice to Proceed, the Design-Builder shall submit to the Engineer for approval equipment catalog cut sheets and technical specifications for all items listed in the above table and any related items. The catalog cut sheets and technical specifications shall include all necessary information to clearly demonstrate that the proposed equipment meets the requirements of this SP and the Plans. In addition, the equipment cut sheets shall include manufacturer's name, model number, and any other descriptive data as necessary to clearly evaluate the item. Interface Protocols for all devices and equipment should also be submitted. All materials included within a specific section of this SP shall be submitted at the same time as a submittal package.

   Specific submittal requirements contained herein shall be supplemented by any requirements shown in the various Special Provisions such as the Traffic Maintenance Plans and Project Schedules as described in section 108.03 of the TDOT Standard Specifications for Road and Bridge Construction. Materials shall not be ordered or released for fabrication without the approval of submittals by the Engineer.

   The review and approval of submittals by the Engineer is based on the information provided in the submittal and the conformance with the design concept of the project. Submittal reviews do not relieve the Design-Builder of the responsibility for making the overall system conform to the requirements of the contract. Approvals at the submittal stage are always conditional upon demonstration that the equipment is fully compliant with the Contract including compatibility with all other equipment in the system.

2. Installation Procedures: Within 45 Days after Notice to Proceed the Design-Builder shall submit to the Engineer the Installation Procedures for approval by the Engineer. The installation submittal shall include step-by-step installation directions as developed by the equipment manufacturer. The Design-Builder will be required to follow these installation procedures during construction.

1.8.3 Ninety (90) Day Submittals

Within 90 Calendar Days of Notice to Proceed the Design-Builder shall submit the following:

1. Shop Drawings and Design Calculations: Within 90 days of Notice to Proceed the Design-Builder shall submit to the Engineer shop drawings and design calculations for all structural elements and attachments including, but not limited to; all sign structures, support poles, structure attachments and foundations.

1.8.4 Other Submittal Timeframes

1. Test Procedures: A minimum of 60 days prior to each desired test date, the Design-Builder shall submit to the Engineer all test procedures for approval by the Engineer. The test procedure

submittal shall include all of the test forms for each of the required tests as required in this SP. The actual test cannot be scheduled until the test procedures are approved.

2. Operational Manuals: A minimum of 60 days prior to bench testing, the Design-Builder shall submit to the Engineer Operational Manuals for approval by the Engineer. The Operational Manual submittal shall include step by step directions for the operators to execute all of the function as required in this SP. The Operational Manuals shall be functionally organized, and identify available (built-in) options to operational characteristics. The Engineer reserves the right to request Operational Manuals during the cut sheet submittal stage if the Engineer deems it necessary to adequately check the operational characteristics of the equipment. Operational Manuals shall be provided in hard copy and on digital copy.

3. Maintenance Manuals: A minimum of 60 days prior to bench testing, the Design-Builder shall submit to the Engineer Maintenance Manuals for approval by the Engineer. The Maintenance Manual submittal shall include all of the necessary steps to maintain the equipment in good working condition, and as indicated by the manufacturer to maintain the warranty. The Engineer reserves the right to request Maintenance Manuals during the cut sheet submittal stage if the Engineer deems it necessary to adequately check the required features of the equipment. Maintenance Manuals shall be provided in hard copy and on digital copy.

4. Final Documentation: Prior to the start of the Burn-In Period, the Design-Builder shall submit 10 copies of final documentation for review and approval by the Engineer. Burn-In Period will not start until final documentation is approved by the Engineer. In addition to any specific final documentation requirements outlined in the individual sections of this SP, final documentation shall include a single binder containing all of the equipment warranties and other manufacturer produced documentation. In addition, final documentation shall include an inventory list of all of the furnished and installed equipment. This list shall include equipment description, manufacturer's part number, model number, serial number, and warranty start and end date.The final documentation shall also include a troubleshooting matrix which can be utilized by the system operators to determine the most appropriate action for various problems that may occur in the system.

1.8.5 Review Process

1. The Engineer will review and return submittals to the Design-Builder within 21 days of receipt.

2. If additional information is requested or if a re-submittal is required, the Design-Builder is required to re-submit within 21 days of receipt of the Engineer's comments.

3. The Engineer will review and return the re-submittals to the Design-Builder within 21 days of receipt.

4. Any additional re-submittals must also meet this 21-day timeline.

5. The Design-Builder shall maintain a file of approved submittals, shop drawings, and operating data for reference purposes and shall provide an electronic copy of that file to the Engineer upon completion of construction.

1.9 SYSTEM DOCUMENTATION

The Design-Builder shall maintain a formal procedure to document the configuration of the as- built system as described in Section 17 of this SP. The program will include maintenance of record drawings and other documentation of the actual location and arrangement of all hardware installed on the project. In addition, the program will include maintenance of records of the system integration procedures. Provisions will be made to accommodate changes to the system both during and after construction.

1.10 PAYMENT TERMS FOR 725 ITEM NUMBERS

Stored Materials Payment will be made for all 725 Item Numbers per TDOT Standard Specifications. For 725 items that describe payment terms based on completing certain testing or installation requirements, those payment terms will apply only to the unit price amount that is in excess of the stored materials payment. For example, if an item says that 50 percent of the contract unit price will be paid upon approval of Bench Test results, this payment will only be applicable if the stored materials payment was not already in excess of 50 percent of contract unit price. At the point which the percentage associated with a testing requirement exceeds the amount previously paid for stored materials, the additional amount will be paid to the Design-Builder at the time that particular test is completed.

2 CONDUIT

2.1 DESCRIPTION

This section specifies the minimum requirements for conduit furnished and installed on this project as shown on the Plans or as directed by the Engineer.

2.2 MATERIALS

The Conduit shall meet the following material requirements:

2.2.1 General Requirements

1. All Continuous Flexible Conduit products and structure mounted multi-cell conduit shall meet the requirements specified herein.

2. All Continuous Flexible Conduit products and structure mounted multi-cell conduit shall have been manufactured and labeled no earlier than in the sixth calendar month preceding the TDOT letting date of the Contract.

2.2.2 Continuous Flexible Conduit (Conduit Duct Bank)

Continuous Flexible Conduit shall meet specifications for ASTM F2160 and ASTM D3350 (Cell Classification 334480C or E) Slow crack growth minimum requirement is F10>96 h per ASTM D1693, condition B, 10% Igepal.

1. Physical and Mechanical Properties and Test Methods
    - Tensile Strength @ yield - 3,000 PSI min. ASTM D-63
    - Density – 0.941 g/cc min ASTM D-4883/1505

2. Conduit shall be extruded from colored material for uniform full-thickness coloring.

3. All Continuous Flexible Conduit shall be labeled with durable identification giving the name of the manufacturer, ASTM F-2160, conduit size (inner diameter trade size and wall thickness/rating), manufacturer/date codes, the legend “TENN DOT”, and sequential foot marking. Labeling shall occur a maximum of every 2 ft.

4. Conduit to be used in bends and sweeps shall have a minimum burn through time of 30 minutes when tested in accordance with Generic Requirement GR-356-CORE.

5. The conduit manufacturer shall have a documented Quality Control/Assurance System.

6. All buried conduit used on this project shall conform to the color scheme and use described below.

   a) Conduit Bank Type 1

      - Green - Drop Fiber and/or RDS Cable

   b) Conduit Bank Type 2

      - Green - Drop Fiber and/or RDS Cable
      - White - RDS Cable, Second Drop Fiber or Spare

   c) Conduit Bank Type 3

      - Green - Drop Fiber and/or RDS Cable
      - Blue - RDS Cable or Second Drop Fiber
      - White - Second RDS Cable or Spare

   d) Conduit Bank Type 4

      - Orange - Trunk Fiber Cable
      - Blue - RDS Cable or Drop Fiber
      - White - Spare or Second RDS Cable
      - Brown - Spare

   e) 2” and 3” Electrical Conduit

      - Grey - Electrical wire

7. 1¼ in. conduit shall conform to ASTM F2160 and meet the following requirements:

   a) SDR 9 for all Bored conduit.

   b) SDR 11 for all other conduit.

8. 2 in. conduit shall conform to ASTM F2160 and meet the following requirements:

   a) SDR 9 for all Bored conduit.

   b) SDR 11 for all other conduit.

9. Coupling

    a) Make every effort to minimize coupling. Couplings are permitted only with the Engineer's prior approval.

    b) Couplings shall be airtight and watertight. All couplings shall be installed in accordance with the conduit and the coupling manufacturer's recommendations. Only couplings of the type specified below and approved by the conduit manufacturer are permitted.

    c) Couplings shall be accomplished only by hydraulic press-on or electro-fusion coupling methods.

        i) Use hydraulic press-on couplings of seamless tool-grade tubular aluminum with sealing ring barbs and center stop.

        ii) Use hydraulic compression duct coupling tools and follow all manufacturer's installation procedures, fully inserting both conduit sections to the coupling center stop.

        iii) Use prefabricated electro-fusion couplings that are field-installed using the coupling manufacturer's recommended automatic self-monitoring fusing machine and installation procedures.

        iv) Do not use any other coupling methods.

2.2.3 Multi-Cell "Factory Installed Bullet Resistant" Fiberglass Conduit System (Structure Conduit Bank)

1. The multi-cell conduit system shall be a pre-assembled conduit manufactured from a minimum of a 4-inch round outerduct containing four (4) factory installed round 1-1/4 inch innerducts.

    a. The innerducts shall be held together in a square (4 conduit system) configuration by a system of spacers or equivalent mechanism.

    b. The coupling system shall be resistant to water infiltration, air loss during cable installation and shall be capable of locking the system tightly together in order to not allow free twisting of the innerducts.

2. The multi-cell conduit system manufacturer shall have a documented Quality Control/Assurance System.

3. Outerduct:
    a. All outerduct shall be a minimum of 4 in. trade size and shall have a nominal 20 ft lay length. Types to be used shall be designated on the Plans.

    b. The spigot end of the duct shall have a circumferential insertion depth mark to ensure that proper insertion depth is achieved.

c. Bullet resistant fiberglass conduit shall have a minimum wall thickness of 0.250 inches. The conduit shall prevent the penetration of a .45 caliber slug fired from a distance of 20 feet. The conduit shall conform to the following requirements when tested in accordance with this SP. All accessories and fittings, including outerduct couplings, expansion joints, anchor and stop rings, etc., shall meet all the same "bullet resistant" requirements as the conduit. All conduit and fittings shall be grey.

d. Outerduct shall be labeled with durable identification giving the name of the manufacturer, manufacturer/date codes and the legend "TENN DOT". Labeling shall occur a maximum of every 2 ft.

e. Physical and Mechanical Properties and Test Methods

i.	Ultimate Tensile Strength – 11,000 PSI Min.	ASTM D-2105
ii.	Dielectric Strength - >=500 Volts/Mil.	ASTM D-149
iii.	Water Absorption – 1% Max.	ASTM D-570
iv.	Specific Gravity – 1.9 – 2.0	ASTM D-792
v.	Glass Content – 68 + - 2%	API Spec 15 LR
vi.	Barcol Hardness – 58-52	ASTM D-2583

f. Where Structure Conduit Bank Type 2 and 4 Structure Conduit w/bank is shown in the plans, the conduit shall be 2" fiberglass conduit and shall meet the same applicable characteristics as the outerduct described above.

4. Innerduct:
   a. Innerducts shall be manufactured from polyvinyl chloride (PVC) or high density polyethylene (HDPE). Innerducts shall be factory treated with an atomized silicone or manufactured in a manner to reduce friction during pulling of fiber optic cable. Innerduct to be used in bends and sweeps shall have a minimum burn through time of 30 minutes when tested in accordance with Generic Requirement GR-356-CORE, Issue 1, October 1995. The dimensions of innerduct shall meet the requirements of the manufacturer's catalog cuts approved by the Department.

   b. HDPE innerduct shall have a permanent dry lubricant extruded within the inner wall and shall incorporate longitudinal ribs within the inner wall.

   c. HDPE innerduct shall conform to the following requirements:
      i. Color of innerducts – 4-way (orange, blue, brown, white)
      ii. Nominal Inner Size – 1 ¼"

5. Coupling Body:
   a. The coupling body shall be designed with 4 bores and so that when the conduit is joined, the outer walls of the innerducts and the inner walls of the outerduct shall be sealed, providing an airtight seal from within the innerduct system and a watertight seal from the outside of the outerduct. The coupling body shall be tested for water tightness and air tightness in accordance with BellSouth Telecommunications Specification BS 622-0004, Latest Issue. The coupling body shall conform to the following requirements:

i. Water tightness – 6 PSI Minimum

ii. Air tightness - no leakage at 100 PSI

6. Bends and Sweeps
    a. Each multi-cell system shall offer a complete line of factory-made fixed bends and sweeps. No flexible bends or field-made bends will be permitted. Bullet resistant fiberglass bends and sweeps shall have compatible bell and spigot ends. In no case shall bends and sweeps exceed a 90-degree direction change.

    b. Fixed bends for bullet resistant fiberglass multicell conduit shall be available in radii no less than 3 ft.

        i. 4 ft. radius: 11 ¼ degrees

        ii. 6 ft. radius: 22 ½ degrees

        iii. 9 ft. radius: 45 and 90 degrees

2.2.4 Rigid Galvanized Steel (RGS) Conduit

All rigid galvanized steel conduit shall meet TDOT Standard Specifications for Road and Bridge Construction.

2.2.5 PVC Schedule 40 Conduit

All PVC Schedule 40 conduit shall meet TDOT Standard Specifications for Road and Bridge Construction.

2.2.6 Marking Tape

The Marking Tape shall meet the following requirements:

1. The color of the tape shall be orange with the legend “TENN DOT FIBER OPTIC CABLE” printed at intervals no greater than every 6 ft.

2. The tape shall be a dielectric, polyolefin film tape, 0.004 in. thick and 3 in. wide. The tape shall be constructed using material and ink colors which will not change when exposed to acids and other destructive substances commonly found in the soil.

    Physical and Mechanical Properties and Test Methods: (PPT - Puncture Propagation Tear; MD/TD - Machine Direction / Transverse Direction)

    a. Standard Weight – 0.02 lb/ft² ASTM D-2103
    b. Thickness-Overall – 0.004 in. ASTM D-2103

c.	3” Tensile Break-MD – 35lbf	ASTM D-882
d.	3” Tensile Strength-MD – 2900 PSI	ASTM D-882
e.	3” Tensile Break-TD – 38 lbf	ASTM D-882
f.	3” Tensile Strength-TD – 3160 PSI	ASTM D-882
g.	Elongation-MD – 530%	ASTM D-882
h.	Elongation-TD – 660%	ASTM D-882
i.	PPT Resistance-MD – 12 lbf	ASTM D-2582
j.	PPT Resistance-TD – 14 lbf	ASTM D-2582
k.	Tear Strength – 3” x 8” – MD – 24 lbf	ASTM D-2261
l.	Tear Strength – 3” x 8” – TD – 32 lbf	ASTM D-2261

2.2.7 Conduit Detection Wire

The conduit detection wire shall meet the following requirements:

Conduit detection wire shall be #10 AWG stranded copper orange-insulated THHN- THWN conductor.

2.2.8 ITS Cable Markers

The Cable Markers shall meet the following requirements:

1. Shall be a six-foot post with an 18” Cable Marker as shown in the plans.

2. Shall be a cylindrical polymeric marker mounted on a 3.5” outside diameter post and may be used for the identification of buried utility services. These markers may be used in road Right-of-Ways and installations requiring 360° visibility, good outdoor durability, and impact resistance.

3. The marker shall be comprised of polymer materials, which are resistant to impact (high MTBF), ultraviolet light, ozone, or hydrocarbon damage. The post and marker shall remain impact resistant in temperatures of -20°F to 140°F.

4. Shall incorporate a cylindrical tube construction.

5. The marker shall be capable of permanent installation on a 3.5” O.D. tube and may utilize an anchor barb below ground level to prevent rotation and marker removal.

6. The marker shall have an outside diameter of 3.5 – 4.0 inches. The wall thickness shall be approximately 0.12 – 0.15 inches and the overall length shall be 18.00 inches.

7. The marker shall be orange in color and be pigmented throughout its entire cross section.

8. The graphics shall consist of a solvent-based ink that is abrasive and UV resistant and include the text, “TDOT ITS Fiber Optic Cable” “Call XXX-XXX-XXXX Before Digging in this Area”. (Phone number will be provided upon approval of cable marker cut sheets)

9. The marker shall have a minimum tensile strength of 2700 pounds per square inch, as measured by ASTM D-638 (specimen type I with separation rate of two inches per minute.) Tensile

strength shall not deviate more than 10 percent from the standard room temperature result when tested at both 140°F and 20°F after a minimum of two hours conditioning at the respective temperature.

10. A "Distance to Conduit" sticker or label shall also be provided. This label shall meet the following minimum requirements:
    a. Lettering shall be a minimum of 1 inch in height.
    b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.
    c. The Label shall have the words "Distance to Conduit - - - Feet" pre-printed on the label. The distance numerals shall be added in the field and shall be manufactured from the same type of reflective sheeting. (See Plans for layout of label).

2.2.9 Pull Tape

The Pull Tape for cable installation shall meet the following requirements:

1. 1250 lb tensile strength
2. Flat, not round, construction
3. Printed sequential foot markings
4. Pre-lubricated for reduced pulling tension at start of cable pull
5. Low susceptibility to absorption of moisture; moisture resistant

2.2.10 Duct Plugs

Duct plugs shall meet the following requirements:

1. Duct plugs intended for underground telecommunications infrastructure shall be installed on conduits.
2. Duct plugs shall be sized to fit the conduits and cables with which they are used.
3. Duct plugs shall provide watertight and airtight gasketed seals by use of mechanical expansion of the duct plug body and gasket. No sealants or caulks shall be used.
4. All metallic components of duct plugs shall be stainless steel.
5. Blank duct plugs are used to seal spare conduits and shall have inner rings to which pull tape can be tied.

6. Cable duct plugs are used to seal conduits that contain a cable. The plug shall be sized to fit the conduit and cable with which it is used and shall be a split plug with a bushing assembly for sealing around the cable by mechanical compression.

2.3 INSTALLATION REQUIREMENTS

2.3.1 General Requirements

1. All material installed shall follow the guidelines in the following sections.

2. Use blank duct plugs to seal the ends of all conduit within 24 hours of conduit placement. This includes but is not limited to intermediate/incomplete sections of conduit prior to conduit splicing or termination in pull boxes and empty conduits in pull boxes prior to cable installation.

3. Conduit shall be installed in a straight-line horizontal path between pull boxes except where shown otherwise in the plans.

2.3.2 Continuous Flexible Conduit (Conduit Duct Bank).

1. Install Conduit Duct Banks by configuring individual continuous flexible conduits into a continuous duct bank from termination point to termination point as shown in the Standard Details and other Contract Documents.

2. Continuous flexible conduit installation in earth shall be trenched, horizontal directional bored or drilled, or plowed at the Design-Builder's discretion, unless otherwise noted on the Plans, at a minimum depth of 24 inches from the top of the conduit. Unless identified as "bored" in the plans, the Design-Builder shall be paid at the unit price bid for Conduit Bank Type X, regardless of what installation method is used.

3. All continuous flexible conduit located under the paved shoulder in the plan sheets shall meet the following requirements. The conduit shall be placed at a minimum depth of 24 inches. Backfill shall meet TDOT Standards for a paved shoulder. All areas in the paved shoulder shall be completely restored daily according to the time frames set under the approved Traffic Control Plan. Unless otherwise approved by the Engineer, the conduit shall only be placed under the shoulder in the areas identified in the plans. There is no separate payment for conduit located under the shoulder. These locations shall be paid at the same unit price as Conduit Bank Type X.

4. All continuous flexible conduit routes underneath asphalt or concrete roadways shall be horizontal directional bored or drilled at a minimum depth of 5 feet from the top of the conduit. No open trenching will be allowed in asphalt or concrete unless specified on Plan sheets. Separate encasement is not required for borings unless needed for proper installation due to poor soil conditions.

5. All conduit to be installed under streams shall be horizontal directional bored or drilled. No open trenching through an area deemed to be a current or wet weather stream will be allowed. All conduit bored under streams shall be a minimum depth of 5 feet below the streambed.

6. Bore Logs will be required for each bore location. The Design-Builder shall submit a proposed bore log format to the Engineer for review and approval.

7. If a drainage or utility conflict arises, the Design-Builder shall submit a plan for resolving the conflict to the Engineer for review and approval.

8. The Design-Builder shall make every effort to minimize coupling. Couplings are permitted only with the Engineer's prior approval and will typically be approved where conduit types change or at locations where conduit reels end. Other locations will be on a case-by-case basis.

9. Conduit shall be placed in the straightest orientation possible, reducing bends, twists, rises, and waves. Conduits shall be held in place during backfilling when necessary to keep straight and at the proper depth. Where field conditions require the trench to change direction and bends are necessary, the bends shall be formed in the trench and should be smooth and even and shall not have less than a 4-foot radius (as measured to the inside surface of the conduit).

10. Every conduit shall be tested after installation and before cable or pull tape is installed. Perform testing on all conduit types in this SP, including but not limited to each cell of multi-cell conduits, each conduit in duct banks, and each conduit. All testing shall be performed using the procedures and mandrel size recommended by the conduit manufacturer. Testing shall be performed in the presence of the Engineer. Payment for all testing is included in the cost of the conduit.

2.3.3 Multi-Cell "Factory Installed Bullet Resistant" Fiberglass Conduit System (Structure Conduit Bank)

1. Conduit will be attached to bridge decks by either clamps or hanger systems as indicated on the Plans.

2. Conduit that is to be hung by a bridge hanger system attached to the bridge decking shall be designed by the Design-Builder and approved by TDOT Structures Division. Hangers shall be spaced no more than 10 feet apart.

3. For all bridge installed conduit, it is the Design-Builder's responsibility to obtain the bridge design drawings from TDOT Structures Division to show the exact location and design of the attachment.

4. The Design-Builder shall secure comprehensive written installation manuals for the complete system from the manufacturer or supplier of the multi-cell system and provide to the TDOT Structures Division. At any time during the construction process, ensure that the manufacturer or supplier provides technical assistance to the Design-Builder and/or the Department.

5. Install expansion and deflection joints, anchors, stop rings, etc. according to the multi-cell conduit system manufacturers and support hanger manufacturer's recommendations. Fiberglass couplings shall be epoxied unless otherwise recommended. Ensure that during the construction process and

at the request of the Department, the multi-cell conduit system or support hanger manufacturer provides on-site technical assistance at no additional cost to the Department.

6. Test every conduit after installation and before cable or pull tape is installed. Perform testing on all conduit types in this SP, including but not limited to each cell of multi-cell conduits, each conduit in duct banks, and each innerduct. All testing shall be performed using the procedures and mandrel size recommended by the conduit manufacturer. Testing shall be performed in the presence of the Engineer. Payment for all testing is included in the cost of the conduit.

7. All holes in concrete for conduit passes shall be core drilled.

8. All conduit passing through abutment walls shall be sealed around, using a sealant approved by the TDOT Structures Division.

9. Damage to paved end fills shall be repaired to the satisfaction of the Engineer at the expense of the Design-Builder.

2.3.4 Multi-Cell "Bullet Resistant" Fiberglass Conduit System (Surface Clamped)

1. Conduit will be attached to accessible exposed bridge or barrier walls by clamps as indicated on the Plans.

2. Clamps shall be spaced no more than 10 feet apart.

3. Test every conduit after installation and before cable or pull tape is installed. Perform testing on all conduit types in this SP, including but not limited to each cell of multi-cell conduits, each conduit in duct banks, and each innerduct. All testing shall be performed using the procedures and mandrel size recommended by the conduit manufacturer. Testing shall be performed in the presence of the Engineer. Payment for all testing is included in the cost of the conduit.

2.3.5 Rigid Galvanized Steel Conduit

1. Exposed conduit runs shall be 2" rigid galvanized steel unless otherwise required by the Plans.

2. All conduit runs on structures and poles shall be properly terminated into the respective device, or a weatherhead shall be installed so as to seal the conduit from moisture, insects, rodents and other foreign material. The costs of the galvanized steel conduit, weatherheads and all associated fittings shall be included in the cost of other items.

3. Bushings shall be installed in conduit at all exposed conduit terminations for protection of the conductors.

2.3.6 PVC Schedule 40 Conduit

1. Shall meet the specifications of Section 2.3.2.

2.3.7 Marking Tape

1. As shown in the Plans Typical Details, install marking tape a minimum of 12 inches above all underground conduit installed by trenching or plowing.

2. Marking tape shall be installed in continuous manufactured lengths. No splicing or overlap is permitted.

3. Install a minimum of 4 feet of marking tape into pull boxes where trenched conduit is terminating. Marking tape shall enter under the lower edge of the pull box.

4. Marking tape is not required when conduit is bored.

2.3.8 Conduit Detection Wire

1. Install one conduit detection wire with all conduits directly above or at the same level as the conduit. Conduit detection wire is required with all conduits installed by any installation method, including trenching, directional boring, or plowing.

2. Only one conduit detection wire is required per installed conduit segment regardless of the number of conduits installed in that segment.

3. Conduit detection wire shall be installed outside of the conduit, except when boring conduit then the detection wire shall be placed in a spare conduit.

4. Conduit detection wire is not required for structure mounted conduit, except where underground segments of structure mounted conduit are greater than 50 feet in length.

5. Conduit detection wire is not required for conduit segments between pull boxes and pole/sign structure foundations, where conduit segments are less than 50 feet in length.

6. The conduit detection wire shall be continuous and unspliced between pull boxes and shall enter the pull boxes at the same location as the conduit with which it is installed, entering under the lower edge of the pull box.

7. Coil and secure 4 feet of conduit detection wire in each pull box or vault.

8. Testing:
    a. Perform a continuity or tone test after installation to confirm that a continuous run of conduit detection wire was installed between pull boxes or vaults.

    b. Design-Builder shall prepare a test plan, supply equipment, conduct the test and document the results. Submit a test plan at least 15 working days prior to the desired testing date. Testing shall not begin until the Engineer has approved the test plan, and all tests shall be conducted in the presence of the Engineer.

2.3.9 ITS Cable Markers

Install cable markers at the following locations:

1. At the back side of the right-of-way (or tree line) laterally even with each pull box, or adjacent pull boxes, on conduit runs parallel to the roadway. If distance between pull boxes is greater than 650 feet one additional cable marker shall be placed at the midpoint between the adjacent pull boxes, at the back of the right-of- way (or tree line). Additional cable markers shall be placed such that no distance between cable markers shall be greater than 650 feet.

    a. Directly beside any pull box that is on the interior of an interchange.

    b. At each end of any bore under a roadway, directly beside the pull boxes.

    c. Any additional locations directed by the Engineer.

2. All cable marker locations shall be approved by the Engineer prior to installation. The proposed schedule for installing the cable markers shall also be approved by the Engineer prior to installation.

3. After the cable markers are installed, the distance to conduit labels shall be applied.

2.3.10 Pull Tape

1. Install pull tape into each empty conduit and empty cell within a multi-cell conduit.

2. Install the pull tape after conduit testing has been completed.

3. Install and secure 5 feet of slacked pull tape in each empty conduit or cell at each pull box.

4. Secure the pull tape by tying it to the blank duct plug for the conduit in which it is installed.

2.3.11 Duct Plugs

1. Install blank duct plugs in each empty conduit that enters a pull box, ground-mounted cabinet, pole foundation, hub, or building entrance.

2. Install cable duct plugs in each conduit containing fiber optic or RDS communications cable that enters a pull box, ground-mounted cabinet, hub, or building entrance.

3. Do not install cable duct plugs on conduits containing power service conductors.

4. Duct plugs shall be installed within 24 hours of the associated duct installation.

2.3.12 Spare Conduits in Foundations

1. A minimum of one 2” spare conduit shall be installed in all pole foundations and a minimum of two 2” conduits shall be installed in the base of all ground mounted cabinets.
2. Spare conduits shall be sealed with blank duct plugs.

2.4 MEASUREMENT

2.4.1 General Requirements

1. All conduit material shall be measured following the guidelines in the following sections.

2. All conduit types shall be measured in linear feet per type to the nearest foot. All conduit types will be measured along the conduit by the following:

3. From center of pull box to center of pull box.

4. No additional measurement will be made for vertical conduit inside the pull box or structure.

5. No additional measurement will be made for conduit between a pull box and the nearby pole or structure, within 10 feet or less.

2.4.2 Continuous Flexible Conduit (Conduit Duct Bank)

1. Unless otherwise specified in the Plans, all costs for materials, trenching, installing, backfilling trench, plowing, directional boring, restoration, repaving of shoulders, marking tape, pull tape, duct plugs, fittings, conduit detection wire, testing, bore logs, and other accessories and hardware necessary for installation of the conduit system shall be included in the overall cost of the conduit or conduit duct bank.

2. Continuous flexible conduit installation in earth or shoulder shall be trenched, horizontal directional bored or drilled, or plowed at the Design-Builder's discretion, unless otherwise noted on the Plans, and shall be measured and paid as the unit items in Section 2.4.2.5.a through 2.4.2.5.d, regardless of installation method used.
3. All continuous flexible conduit routes underneath asphalt or concrete roadways shall be horizontal directional bored or drilled at a minimum depth of 5 feet from the top of the conduit and shall be measured and paid as the unit items in Section 2.4.2.5.i through 2.4.2.5.m. No open trenching will be allowed in asphalt or concrete unless specified on Plan sheets.

4. All conduit to be installed under streams shall be horizontal directional bored or drilled and shall be measured and paid as the unit items in Section 2.4.2.5.i through 2.4.2.5.o. No open trenching through an area deemed to be a current or wet weather stream will be allowed.

5. Continuous Flexible Conduit (Conduit Duct Bank) will be measured by the linear foot for each type of conduit bank indicated after installation and shall include the items identified in Section 2.4.2.1, as well as the type and number of conduit indicated below.

    a. Conduit Bank (Type 1): One – 1 ¼" Continuous Flexible Conduit, One 2" or 3" when electrical is shown

    b. Conduit Bank (Type 2): Two – 1 ¼" Continuous Flexible Conduits, One 2" or 3" when electrical is shown

c. Conduit Bank (Type 3): Three – 1 ¼" Continuous Flexible Conduits, One 2" or 3" when electrical is shown

d. Conduit Bank (Type 4): Four – 1 ¼" Continuous Flexible Conduits, One 2" or 3" when electrical is shown installed in soil or areas with intermittent (non-solid) rock. This pay item applies to areas where trenching is physically possible using typical trenching equipment.

e. Conduit Bank (Type 4–Roadway Shoulder) Four – 1 ¼" Continuous Flexible Conduits, One 2" or 3" when electrical is shown installed in the roadway shoulder. This construction method will only be permitted where traditional construction methods are impractical and only with the approval of the Engineer.

f. Conduit Bank (Type 4–In Rock) Four – 1 ¼" Continuous Flexible Conduits installed in solid rock or solid shot rock fill. The locations for this pay item will be determined in the field and are not identified separately on the plans. Final determination of the applicability of this item will be at the discretion of the Engineer.

g. 2" Conduit: One – 2" Continuous Flexible Conduit or PVC Schedule 40 Conduit.

h. 2" Conduit with Bank: One – 2" Continuous Flexible Conduit installed in the same trench as the related Conduit Bank Type as specified in the Plan Sheet.

i. Conduit Bank (Type 2–Bored): Two – 1 ¼" Continuous Flexible Conduits, One 2" or 3" when electrical is shown

j. Conduit Bank (Type 3–Bored): Three – 1 ¼" Continuous Flexible Conduits, One 2" or 3" when electrical is shown

k. Conduit Bank (Type 4–Bored): Four – 1 ¼" Continuous Flexible Conduits, One 2" or 3" when electrical is shown

l. 2" Conduit (Bored): One – 2" Continuous Flexible Conduit

m. 2" Conduit with Bank (Bored): One – 2" Continuous Flexible Conduit installed in the same bore as the related Conduit Bank Type as specified in the Plan Sheets.

n. 3" Conduit (Bored): One – 3" Continuous Flexible Conduit

o. 3" Conduit with Bank (Bored): One – 3" Continuous Flexible Conduit installed in the same bore as the related Conduit Bank Type as specified in the Plan Sheets.

(Note: Separate encasement for borings is not required unless necessary for proper installation due to poor soil conditions. If encasement is needed in those situations the cost of the encasement shall be included in the cost of the conduit.)

2.4.3 Multi-Cell "Factory Installed Bullet Resistant" Fiberglass Conduit System (Structure Conduit Bank)

1. Unless otherwise specified in the Plans, all costs for materials, cutting asphalt or concrete, trenching, installing, backfilling trench, restoring asphalt or concrete, drilling existing concrete shoulder, replacement of existing transverse joint material, directional boring, bridge hanger materials and assemblies, testing of conduit, pull tape, duct plugs, and bridge attachment design shall be included in the overall cost of structure conduit or structure conduit bank.

2. Conduit will be measured by the linear foot for each type of conduit bank indicated after installation.
    a. Structures Conduit Bank Type 4: One 4" outerduct with four 1 ¼" innerducts installed in the same hanger assembly as the related Conduit Bank type as specified in the Plan Sheets.

    b. Structures Conduit Bank Type 2: Two – 1 ¼" Fiberglass Conduits installed in the same hanger assembly as the related Conduit Bank type as specified in the Plan Sheets.

    c. 2" Structures Conduit with Bank: One 2" Fiberglass Conduit installed in the same Hanger assembly as the related Conduit Bank type as specified in the Plan Sheets.

    d. 3" Structures Conduit with Bank: One 2" Fiberglass Conduit installed in the same Hanger assembly as the related Conduit Bank type as specified in the Plan Sheets.

2.4.4 Multi-Cell "Bullet Resistant" Fiberglass Conduit System (Surface Clamped)

1. Unless otherwise specified in the Plans, all costs for materials, cutting asphalt or concrete, trenching, installing, backfilling trench, restoring asphalt or concrete, clamps, testing of conduit, pull tape, duct plugs, and bridge attachment design shall be included in the overall cost of surface clamped conduit bank.

2. Conduit will be measured by the linear foot for Structure Conduit Bank.

2.4.5 Rigid Galvanized Steel Conduit

Rigid Galvanized Steel Conduit, and all related materials including but not limited to weatherheads, bushings, couplings, mounting straps, bonding to ground, etc., that is installed on sign structures, poles, or between the pull boxes and equipment cabinets is included in the cost of other items and will not be measured separately.

2.4.6 PVC Schedule 40 Conduit

PVC Conduit is included in the cost of other items and will not be measured separately.

2.4.7 Marketing Tape

Marking Tape is included in the cost of the conduit and will not be measured separately.

2.4.8 Conduit Detection Wire

Conduit Detection Wire is included in the cost of the conduit and will not be measured separately.

2.4.9 ITS Cable Markers

Cable Markers will be measured per each and paid for at the contract price per each. The price bid shall include furnishing and installing the complete cable marker and distance sticker/label. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

2.4.10 Pull Tape

Pull Tape is included in the cost of the conduit and will not be measured separately.

2.4.11 Duct Plugs

Duct Plugs are included in the cost of the conduit and will not be measured separately.

2.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

ITEM NO.	DESCRIPTION	UNIT
725-22.21	CONDUIT BANK (TYPE 1)	L.F.
725-22.22	CONDUIT BANK (TYPE 2)	L.F.
725-22.23	CONDUIT BANK (TYPE 3)	L.F.
725-22.24	CONDUIT BANK (TYPE 4)	L.F.
725-22.31	CONDUIT BANK BORED (TYPE 1)	L.F.
725-22.32	CONDUIT BANK BORED (TYPE 2)	L.F.
725-22.33	CONDUIT BANK BORED (TYPE 3)	L.F.
725-22.34	CONDUIT BANK BORED (TYPE 4)	L.F.
725-22.42	CONDUIT BANK IN ROCK (TYPE 2)	L.F.
725-22.44	CONDUIT BANK IN ROCK (TYPE 4)	L.F.
725-22.61	STRUCTURE CONDUIT BANK (TYPE 1)	L.F.
725-22.62	STRUCTURE CONDUIT BANK (TYPE 2)	L.F.
725-22.63	STRUCTURE CONDUIT BANK (TYPE 3)	L.F.
725-22.64	STRUCTURE CONDUIT BANK (TYPE 4)	L.F.
725-22.71	2IN CONDUIT	L.F.
725-22.72	2IN CONDUIT BORED	L.F.
725-22.73	2IN STRUCTURE CONDUIT	L.F.
725-22.74	2IN CONDUIT W/BANK	L.F.
725-22.75	2IN CONDUIT BORED W/BANK	L.F.
725-22.76	2IN CONDUIT STRUCTURE W/BANK	L.F.
725-22.80	3IN CONDUIT W/BANK	L.F.
725-22.81	3IN CONDUIT BORED W/BANK	L.F.
725-23.01	ITS CABLE MARKER	EACH

All Conduit will be paid per linear foot, as applicable, as follows:

1. Stored Materials will be paid per TDOT Standard Specifications.

2. Final Payment will be made after complete installation and testing.

Cable Markers will be paid per each, as applicable, as follows:

1. Stored Materials will be paid per TDOT Standard Specifications.

2. Final Payment will be made after complete installation and testing of the conduits.

3 PULL BOXES

3.1 DESCRIPTION

This section specifies the minimum requirements for furnishing and installing pull boxes and covers as indicated on the Plans.

Standard pull boxes shall be installed by the Design-Builder at the locations shown on the Plans. The Plans will indicate pull box locations relative to the cabinet and other installation details.

3.2 MATERIALS

3.2.1 Type C Pull Box with Cover

The pull box shall meet the following requirements:

1. Minimum dimensions: 25” W x 16” L x 18” D exterior, 24” W x 13” L x 16” D interior.

2. Pull Box cover shall be precast composite polymer concrete product.

3. Pull Boxes and covers shall be single-stack, open-bottom assemblies configured as shown in the TDOT Standard Drawings and Plans.

4. Shall meet or exceed current ANSI/SCTE 77 Tier 22 loading requirements.

5. Pull Box shall meet current NEC standards for handhole enclosures.

6. Pull Box cover shall be labeled (TDOT ITS ELECTRICAL).

7. Type C pull boxes shall only be used for electrical power conduit/wiring.

3.2.2 Type D Pull Box with Cover

1. Minimum dimensions: 24” W x 36” L x 36” D exterior.

2. Pull Box cover shall be precast composite polymer concrete product. NOTE: This is a different Pull Box than shown in TDOT Standard Drawings

3. Pull Boxes and covers shall be single-stack open-bottom assemblies configured as shown in Plans.

4. Shall meet or exceed current ANSI/SCTE 77 Tier 22 loading requirements.

5. Pull Box shall meet current NEC standards for handhole enclosures.

6. Pull Box cover shall be labeled (TDOT ITS COMMUNICATIONS).

7. Each Pull Box shall come equipped with four Cable Racks and twelve Rack Hooks. The Cable Racks shall be a minimum of 24 inches and Rack Hooks shall be a minimum of 7 inches in length. The cable Racks and Rack Hooks shall be Hot- Dipped Galvanized Steel.

8. Type D pull boxes shall only be used for communications conduit/cabling.

3.2.3 Type E Pull Box with Cover

1. Minimum dimensions: 30” W x 48” L x 36” D exterior.

2. Pull Box cover shall be precast composite polymer product. NOTE: This is a different pull box than shown on TDOT Standard Drawings.

3. Pull Boxes and covers shall be single-stack open-bottom assemblies configured as shown in Plans.

4. Shall meet or exceed current ANSI/SCTE 77 Tier 22 loading requirements.

5. Pull Box shall meet current NEC standards for handhole enclosures.

6. Pull Box cover shall be labeled (TDOT ITS COMMUNICATIONS).

7. Each Pull Box shall come equipped with four Cable Racks and twelve Rack Hooks. The Cable Racks shall be a minimum of 24 inches and Rack Hooks shall be a minimum of 7 inches in length. The cable Racks and Rack Hooks shall be Hot- Dipped Galvanized Steel.

8. Type E pull boxes shall only be used for communications conduit/cabling.

3.2.4 Terminator Ring

Shall meet the following requirements:

1. Shall accommodate the number of ducts penetrating into the side of the Pull Box or Manhole.

2. The Terminator shall mount securely to the side of the box or cast into the side of the Manhole. The Terminator shall be a minimum of 1 inch thick and allow adequate spacing of the ducts.

3. The Terminator shall be manufactured from a composite material that will not deteriorate in any type of weather conditions.

3.3 INSTALLATION REQUIREMENTS

3.3.1 Type C Pull Box with Cover

1. This section shall be as per TDOT Standard Specifications for Road and Bridge Construction, latest version.

2. Pull Boxes and covers shall be installed per the design details and Plans.

3.3.2 Type D and Type E Pull Box with Cover

1. This section shall be as per TDOT Standard Specifications for Road and Bridge Construction, latest version.

2. Pull Boxes and covers shall be installed per the design details and Plans.

3. Cable Racks and Rack Hooks shall be installed per the manufacturer's recommendations.

4. Ducts shall enter the side of the Pull Box using a Terminator and shall extend into the box no more than 4 inches and no less than 2 inches.

3.3.3 Terminator

Shall be installed per the manufacturer's recommendations.

3.4 MEASUREMENT

3.4.1 Type C Pull Box with Cover

Pull Box will be measured in units of each and paid for at the contract price per each after the complete installation. The price bid shall include furnishing and installing the pull box, ground rod, and cover including excavation, gravel, restoration, and miscellaneous materials necessary for a complete and accepted installation. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

3.4.2 Type D and Type E Pull Box with Cover

Pull Box will be measured in units of each and paid for at the contract price per each after the complete installation. The price bid shall include furnishing and installing the pull box and cover including excavation, gravel, restoration, cable rack rails and hooks, terminator rings, and miscellaneous materials necessary for a complete and accepted installation. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

3.4.3 Terminator

Shall be included in the measurement and payment of the Type D Pull Boxes, Type E Pull Boxes and Manhole and will not be measured separately for payment.

3.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

ITEM NO.	DESCRIPTION	UNIT
725-20.43	PULL BOX (TYPE C)	EACH
725-20.44	PULL BOX (TYPE D)	EACH
725-20.45	PULL BOX (TYPE E)	EACH
725-20.46	PULL BOX (STRUCTURE MOUNTED)	EACH

Pull boxes will be paid per each as follows:

1. Stored materials will be paid per TDOT Standard Specifications for Road and Bridge Construction, latest version.

2. Final Payment will be made after complete installation and testing.

4 FIBER OPTIC INFRASTRUCTURE

4.1 DESCRIPTION

This section specifies the minimum requirements for fiber optic infrastructure furnished and installed (underground and aerial) on this project. This work includes but is not limited to, cable, splicing, termination, connectors, closures, panels, installation, and testing.

The fiber optic infrastructure will serve as the backbone for the communications systems (wireline) and will be used to transport data and video signals to/from field device locations using an Ethernet protocol.

4.2 MATERIALS

4.2.1 General

1. The Design-Builder shall furnish fiber optic infrastructure materials that meet applicable industry standards including, but not limited to:

    a. Fiber optic cable manufacturer shall comply with RUS Bulletin 1753F-601 and be currently ISO 9001 certified

    b. Provide and install fiber optic cable in accordance with contract drawings, specifications, IEEE C2 (NESC), NFPA 70 (NEC), ICEA S-83-596, UL 1666

    c. EIA/TIA-455 Testing procedures

    d. Telcordia

    e. UL

    f. ITU-T G.652D

    g. Fiber optic cable physical requirements and cable construction shall be in accordance with ICEA S-87-640, ASTM D 4976

    h. Fiber optic cables shall be tested in accordance with ASTM C 338

2. Upon request of the Engineer, provide certification from an independent testing laboratory that certifies that the cable conforms to industry standards.

3. Furnish fiber optic infrastructure materials recommended by the manufacturer for outside plant use and the intended application.

4. Furnish all optical fiber, fiber optic cable, fiber optic branch cable, integrated fiber optic termination unit, optical termination and connector materials, and all ancillary and incidental materials that are single-mode and/or compatible. All materials shall meet the following requirements:

    a. EIA/TIA-568-B.3, 598B, 758, Fiber Optic Connector Intermateability Standard (FOCIS), and Telcordia GR-20 core requirements.

    b. Manufacturer is currently ISO 9001 certified. This requirement applies to assemblers of manufactured components, such as patch cords and termination cabinet interconnection cables.

    c. All cables and termination infrastructure shall be assembled from Corning SMF28e, OFS All Wave or approved equivalent single-mode optical fiber.

    d. All fibers and buffer tubes shall follow EIA/TIA-598B identification using colors. Do not use printed legends.

    e. All cables shall have been manufactured and labeled no earlier than in the third calendar month preceding the TDOT letting date of the contract.

5. Fiber optic installation and testing tools shall be maintained and calibrated in accordance with the tool manufacturer's recommendations. Provide tool manufacturer certified calibration documentation upon Engineer's request. Installation and testing tools include but are not limited to:
    a. Fusion splicers

    b. Cable pulling strain dynamometers and breakaway links

    c. Cable air jetting/blowing systems

    d. OTDRs

    e. Optical attenuation testers (light sources and power meters)

6. Fiber optic installation and testing tools shall be operated only by Design-Builder personnel who have been trained and certified by the tool manufacturer. Installation and testing tools requiring certified operators include but are not limited to:

    a. Fusion splicers

    b. Cable air jetting/blowing systems

    c. OTDRs

    d. Optical attenuation testers (light sources and power meters)

4.2.2 Fiber Optic Cable (144 SMFO Cable)

1. Provide fiber optic cable that meets the following requirements:

    a. All-dielectric outside plant loose tube cable shall have central strength/anti- buckling member.

    b. Dry, water blocking materials and construction

    c. Reverse oscillating "SZ" stranded buffer tube construction

    d. High tensile strength yarn

    e. Medium density polyethylene outer jacket shall be a consistent thickness that is free of holes, splits, and blisters, and containing no metal elements. Outer jacket polyethylene shall contain carbon black for ultraviolet light protection and does not promote the growth of fungus.

    f. 144 fiber cable with 12 active buffer tubes and 12 individual stranded fibers per buffer tube

    g. Maximum diameter 0.90 inches

    h. Maximum weight 0.30 pounds per foot

    i. Rated for conduit and lashed aerial installations

    j. Rated attenuation: 0.35dB/km and 0.25dB/km at 1310nm and 1550nm, respectively

2. Provide Corning ALTOS All-Dielectric, Pirelli FlexLink, OFS MiDia, or approved equivalent cables.

3. Designate this cable as a trunk cable.

4. Ensure that the cable can withstand a maximum pulling tension of 600 lbf during installation and 180 lbf installed long term (at rest).

5. Provide cable with shipping, storage, and operating temperature range of -30°C to +70°C.

6. Provide cable with an installation temperature range of -30°C to +60°C.

7. Provide cable with outer jacket marking using the following template:

    Manufacturer's Name – "Optical Cable" – Month/Year of Manufacture - Telephone Handset Symbol – "TENN DOT" – "144F SM"

8. Include in the outer jacket marking the cable sequential length in accordance with the following:

a. In English units every 2 feet

b. Within -1%/+1% of the actual length of the cable

c. In contrasting color to the cable jacket

d. Marking font height no less than 0.10 inches

e. On any single length of cable on a reel, the sequential length markings do not run through "00000"

4.2.3 Fiber Optic Branch Cable (12 SMFO Cable)

1. Provide fiber optic cable that meets the following requirements:

    a. All-dielectric outside plant loose tube cable shall have central strength/anti-buckling member.

    b. Dry water blocking materials and construction

    c. Reverse oscillating "SZ" stranded buffer tube construction

    d. High tensile strength yarn

    e. Medium density polyethylene outer jacket shall be a consistent thickness that is free of holes, splits, and blisters, and containing no metal elements. Outer jacket polyethylene shall contain carbon black for ultraviolet light protection and does not promote the growth of fungus.

    f. 12 fiber cable with 1 active buffer tube and 12 individual stranded fibers

    g. Maximum diameter 0.48 inches

    h. Maximum weight 0.07 pounds per foot

    i. Rated for conduit and lashed aerial installations

    j. Rated attenuation: 0.35dB/km and 0.25dB/km at 1310nm and 1550nm, respectively

2. Provide Corning ALTOS All-Dielectric, Pirelli FlexLink, OFS MiDia, or approved equivalent cables.

3. Designate this cable as a branch cable.

4. Ensure that the cable can withstand a maximum pulling tension of 600 lbf during installation and 180 lbf installed long term (at rest).

5. Provide cable with shipping, storage, and operating temperature range of -30°C to +70°C.

6. Provide cable with an installation temperature range of -30°C to +60°C.

7. Provide cable with outer jacket marking using the following template:

    a. Manufacturer's Name – "Optical Cable" – Month/Year of Manufacture - Telephone Handset Symbol – "TENN DOT" – "12F SM"

8. Include in the outer jacket marking the cable sequential length in accordance with the following:

    a. In English units every 2 feet

    b. Within -1%/+1% of the actual length of the cable

    c. In contrasting color to the cable jacket

    d. Marking font height no less than 0.10 inches

    e. On any single length of cable on a reel, the sequential length markings do not run through "00000"

4.2.4 Fiber Optic Fusion Splice (FO Splice, Fusion)

1. Provide fusion splices for splicing of all fibers on the project. Do not provide any other type of fiber splicing.

2. Perform fusion splicing with a fully automatic portable fusion splicer that provides consistent low loss (max 0.10 dB) splices. Splicer shall provide three-axis fiber core alignment using light injection and loss measurement techniques. The fusing process shall be automatically controlled. The splicer shall provide splice loss measurements on an integral display, as well as a magnified image of the fiber alignment. The Design-Builder shall retain ownership of the fusion splicer.

4.2.5 Fiber Optic Connectors

1. Provide fiber optic connectors compliant with this SP for all fiber optic infrastructure including, but not limited to, fiber optic termination cabinets, fiber optic branch panels, and fiber optic patch cords.

2. Provide only factory-installed keyed LC compatible connectors for all fiber optic infrastructure. Provide only factory-installed connectors of a type other than LC when required by the Network Switches. Do not use field-installed connectors. Do not use adapter couplers to change connector types.

3. Use ceramic ferule connectors factory-installed with a thermal-set heat-cured epoxy and machine polished mating face. Install connectors as per manufacturer application and recommendations, including proper termination to the outer-tubing (900 micron tubing, 3 mm fan out tubing, etc.) required for the application.

4. Use connectors rated for an operating temperature of -40°C to +75°C.

5. Provide connectors that have an installed insertion loss of less than 0.50 dB, a typical loss of 0.20 dB, and an optical return loss of less than 45 dB.

6. Use simplex connectors for all male LC connectors. Provide latching cover for two male connectors being used in a duplex configuration. Female couplers may be duplex but must allow simplex mating connectors.

7. Label each fiber position on panels and termination cabinets containing duplex couplers with the port/position ID as shown in the Plans.

8. Provide dust caps for all exposed male connectors and female couplers at all times until permanent connector installation.

9. LC connectors shall comply with TIA/EIA-4750000-C and TIA/EIA-604-10A.

4.2.6 Fiber Optic Termination Units (FO Termination Units – 144F)

1. Provide fiber optic termination units in communications hubs, and field junctions as shown in the Plans for full termination of 144 fiber outside plant (OSP) cables.

2. Use termination units that are fully compatible with all components of the fiber optic infrastructure as specified, including, but not limited to, fiber optic cable, fiber optic fusion splices, and fiber optic connectors.

3. Use rack-mount termination units designed to fit standard 19-inch EIA equipment racks.

4. Provide all mounting hardware and supports to mount the termination units in the locations shown in the Plans.

5. Use fiber optic termination units providing 144 fiber connectors and capable of storing 144 fusion splices in splice trays.

6. Use termination units that integrate the splice trays and connector modules into one compartment within one cabinet or houses the splice trays and connector modules in separate compartments integrated into one cabinet.

7. Maximum dimensions of a complete termination unit shall be 7 rack units high (12.25 inches) by 16.0 inches deep.
8. Use fiber optic termination unit with fully enclosed metallic construction and with a protective hinged front cover for the connector ports.

9. Provide cable access on all sides of the enclosed area behind the connector port panel.

10. Provide sufficient splice trays for storing 144 fusion splices in 12 splice increments.

11. Provide termination cabinets with fiber optic connector modules in a 12-fiber configuration of 4 rows of 1 duplex connector couplers.

12. Connector modules shall mount vertically in the termination cabinet front panel.

13. Connector modules shall include clearly legible and permanent labeling of each of the 12-fiber connector couplers, and shall be labeled and identified as shown in the Plans.

14. Provide factory-assembled 12 fiber termination interconnect cables (pigtail cables) to be fusion spliced to the outside plant cable and connected to the rear of the connector modules.

    a. Termination interconnect cables shall be all-dielectric single jacketed cable with high tensile strength yarn surrounding 12 individual single mode fibers following EIA/TIA-598B color identification with factory-installed connectors.

15. Provide all incidental and ancillary materials including, but not limited to, grommets, cable strain relief and routing hardware, blank connector panels, and labeling materials.

4.2.7 Fiber Optic Closure (FO Closure)

1. Provide fiber optic closures (splice closures) designed for underground outside plant use for splicing cables in pull boxes.

2. Use fiber optic closures that are impact and corrosion resistant and waterproof when immersed in 10 feet of water.

3. Use fiber optic splice closures that are fully compatible with all components of the fiber optic infrastructure as specified, including, but not limited to, fiber optic trunk cable, fiber optic branch cable, integrated fiber optic termination unit, and fiber optic fusion splices.

4. Use a cylindrical dome-type splice closure with cable entry at one end only and a sealed single-molded piece dome body of high-density polyethylene or equivalent non-metallic material.

    a. The cable entry end shall be manufactured of a similar material as the dome body and shall seal the closure with flexible thermoplastic rubber or polymer gasket seals.

    b. The cable entry end shall include cable entrance ports that shall seal the cable and port opening with flexible thermoplastic rubber or polymer gasket seals with mechanical compression.

    c. Closures shall be re-enterable and re-sealed without the need for specialized tools or equipment, or the use of any additional parts.

d. Do not use any heat shrink or caulk/encapsulate materials for sealing the assembled closure or terminated cables.

5. Provide splice closures with maximum outer dimensions of 8.0 inches diameter and 21.0 inches length.

    a. Splice closures shall provide cable entrance ports for at least five fiber optic cables.

    b. At least two cable entrance ports shall accommodate cables of at least 0.60 inches outer diameter.

    c. The closure shall allow for the storage and express of at least 6 unopened buffer tubes.

6. Provide a splice closure with a cable entry end with pre-template cable ports and a split- plate design permitting installation of the closure in mid-span cable segments.

7. The splice closure size shown in the Plans specifies the minimum number of fusion splices to be accommodated by the closure. With the splice closure, provide all materials to accommodate the number of splices specified by the closure size, including splice tray, storage, and organizing materials.

4.2.8 Fiber Optic Branch Panel (FO Branch Panel, 12F)

1. Provide fiber optic branch panels designed for outside plant use for terminating branch cables in equipment cabinets.

2. Use fiber optic branch panels that include fiber optic branch cable as an integral component.

3. Use fiber optic branch panels that are fully compatible with all components of the fiber optic infrastructure as specified, including, but not limited to, fiber optic trunk cable, fiber optic closures, integrated fiber optic termination unit, fiber optic fusion splices, and fiber optic connectors.

4. Use fiber optic branch panels that are factory manufactured assemblies of fiber optic branch cable with factory-installed fiber connectors and integral ruggedized fiber connector enclosures.

5. Use branch panels with 12 fiber connectors (duplex LC).

6. Use ruggedized fiber connector enclosures of thermally stable rigid plastic housings fully potted with a thermally stable epoxy filling that encapsulates the branch cable fan out, fibers, and connector bodies.

7. Use permanent labels on the enclosure with contrasting color to identify each connector body by its associated fiber number.

8. Fiber connectors shall be arranged in rows of one duplex connector couplers. All fiber connectors shall be arranged on one of the long (vertical) faces of the enclosure.

9. Provide a unique serial number permanently attached on the enclosure body of each branch panel.

10. Provide an outer non-metallic cable strain-relief boot where the branch cable enters the fiber connector enclosure and that secures the cable and to the enclosure; the strain-relief boot shall fully encircle the cable for a minimum of 2 inches from the enclosure's outer surface.

11. Use fiber connector enclosures on the branch panel that are no more than 2 inches wide and deep (the maximum dimension of the enclosure plus fiber connector body) and no more than 11 inches long.

12. Provide a 0.125-inch thick aluminum mounting plate that secures to the fiber connector enclosure. The mounting plate shall have at least four mounting holes near the plate's corners that permit horizontal or vertical mounting flush to a panel and are spaced appropriately for vertical mounting to an EIA equipment rack rail using two of the mounting holes.

13. Test all completed and assembled fiber optic branch panels at the point of manufacture and provide two copies of the manufacturer test documentation. Test each connected fiber in the branch panel to demonstrate compliance with all requirements for cables and connectors as detailed in this SP. Include in the test documentation the location station number where the branch panel is to be installed, the serial number of the branch panel, the branch cable sequential length markings at each end of the branch cable, and the total branch cable distance.

4.2.9 Integrated Drop Cable / Fiber Optic Termination Unit

1. The integrated fiber optic termination unit will provide the connectivity between the fiber optic splice and the end of line termination at field cabinets.

2. Proposed units shall conform to the following:

    a. The cable should be of a modular design.

    b. 12-port, single mode component.

    c. Component should use LC connectors.

    d. The component should be constructed out of a rugged molded material to ensure that the component is not vulnerable to the elements.

    e. The component must be a pre-terminating fiber optic cable.

    f. The fiber cable should be a maximum length of 275 feet including 75 feet of coiled cable in the adjacent pull box.

    g. The components must be pretested by manufacturer to ensure quality and safety.

h. The component should be equivalent to Fiber Connections Gator Patch, or the Nordx/CDT FiberExpress Bar.

3. Proposed units shall be:

    a. Factory tested.

    b. This unit has a pre-terminated, rugged, and modular design.

    c. The housing material consists of a molded unit of ABS plastic.

    d. 12-port compact design where unit is 13.00 inches by 1.50 inches by 1.35 inches.

    e. For single mode, the insertion loss is 0.15dB typically from the Fiber Connections Gator Patch and 0.5dB from the MTP connector.

    f. This unit uses LC connectors.

4.2.10 Cable Labels

1. Provide cable labels that meet the following requirements:

    a. Self-coiling wrap-around type.

    b. PVC or equivalent plastic material with UV and fungus inhibitors.

    c. Base materials and graphics/printing inks/materials designed for underground outside plant use including solvent resistance, abrasion resistance, and water absorption.

    d. Minimum size of 2.5 inches wide by 2.5 inches long.

    e. Minimum thickness of 0.010 inches.

    f. Orange label body with pre-printed text in bold black block-style font with minimum text height of 0.375 inches.

2. Pre-print the following text legibly on labels used for all fiber optic trunk cables (FO Cable):

TENN DOT OPTICAL CABLE

3. On all cable labels, print the text specified above twice on the label with the text of the second image inverted. The end result shall be text which “reads correctly” when the label is coiled onto a cable.

4.2.11 Fiber Optic Patch Cords

1. Provide fiber optic patch cords consisting of a length of fiber optic cable terminated on both ends.

2. All patch cords shall be factory preconnectorized assemblies adhering to all applicable cable and fiber specifications stated in this SP.

3. Provide patch cords of the appropriate length for the necessary connections, maintaining minimum bend radius, and with no residual strain at the connector or anywhere on the patch cord itself beyond self-support. Patch cords shall not have excess length beyond what is necessary for equipment connection and routing.

4. All patch cords shall be duplex zip-cord fiber optic cable with simplex LC connectors, except as otherwise allowed in Section 4.2.5.

    a. The two connectors of each end of the patch cord shall be differentiated by different colors.

    b. Provide sufficient flexibility at each end to disconnect one connector without disturbing the other, or to allow swapping of the two connectors within the same duplex coupler without disturbing the remainder of the patch cord.

    c. Provide strain relief and reinforcement at the point where the duplex cable separates for the individual simplex connectors.

5. Fiber optic cable shall be 3mm jacketed cable with high tensile strength yarn protecting the inner fiber manufactured into a duplex zip-cord configuration. All Inside Plant patch cords shall meet NEC jacketing requirements.

6. Connector strain relief boots shall be fixed to the outer jacket and strength yarn.

7. Use yellow outer jackets for single mode fiber.

8. No splices of any type are allowed within a patch cord assembly.

9. Fully test each patch cord assembly at the source of manufacture and place those test results on a test tag for each mated pair of connectors. Attach the associated tag to one end of each fiber within the duplex assembly.

4.2.12 Fiber Optic Attenuator Patch Cords

1. Provide fiber optic attenuator patch cords that meet all requirements of Section 4.2.11 for fiber optic patch cords.

2. Each fiber in the attenuator patch cord shall contain a passive optical attenuator with the following performance characteristics:

    a. Dual-wavelength capability (1310 and 1550nm)

b. Fixed attenuation value of 6dB +/- 15%.

c. Maximum optical return loss 40 dB

d. Operating temperature range no less than -30 to +65 C

4.2.13 Project Submittal Program Requirements

1. General Requirements

    a. The Design-Builder shall provide project submittals for all fiber optic infrastructure as required in Section 1.8 of this SP, including scheduling requirements. The project submittals for fiber optic infrastructure shall include but are not limited to, the additional specific requirements in this subsection.

2. Fiber Optic Installation and Testing Tools

    a. Provide project submittals including manufacturer-recommended operations, maintenance, and calibration procedures for the following equipment:

        i. Fusion splicers

        ii. Cable pulling strain dynamometers and breakaway links

        iii. Cable air jetting/blowing systems

        iv. OTDRs

        v. Optical attenuation testers (light sources and power meters)

    b. Submit documentation and proof of manufacturer-recommended operator training and certification for the following equipment:

        i. Fusion splicers

        ii. Cable air jetting/blowing systems

        iii. OTDRs

        iv. Optical attenuation testers (light sources and power meters)

4.3 INSTALLATION REQUIREMENTS

4.3.1 General

Install all fiber optic infrastructure according to the manufacturer's recommended procedures and specifications.

4.3.2 Cable Shipping and Delivery

1. Package the cable for shipment on factory reels. Each package shall contain only one continuous length of cable. Radius of the reel drum shall not be smaller than the minimum bend radius recommended by the manufacturer for the media. Construct the packaging so as to prevent damage to the cable during shipping and handling.

2. Seal both ends of the cable to prevent the ingress of moisture.

3. Include with each reel a weatherproof reel tag attached identifying the reel and cable that can be used by the manufacturer to trace the manufacturing history of the cable and the fiber. Include with each cable a cable data sheet containing the following information:

    a. Manufacturer name

    b. Cable part number

    c. Factory order number

    d. Cable length

    e. Factory measured attenuation of each fiber

4. Cover the cable with a protective and thermal wrap.

5. Securely fasten the outer end of the cable to the reel head so as to prevent the cable from becoming loose in transit.

6. Project the inner end of the cable a minimum of 6.5 feet into a slot in the side of the reel or into a housing on the inner slot of the drum, in such a manner to make it available for testing.

7. Plainly mark each reel to indicate the direction in which it is to be rolled to prevent loosening of the cable on the reel.

4.3.3 Cable Handling and Installation

1. Do not exceed the maximum recommended pulling tension during installation as specified by the cable manufacturer.

2. Continuously monitor pulling tensions with calibrated measuring devices, such as a strain dynamometer.

3. Protect all pulled installations with calibrated breakaway links.

4. Do not violate the minimum recommended bend radius during installation as specified by the cable manufacturer. Unless the manufacturer's recommendations are more stringent, use the following guidelines for minimum bend radius:

    a. 20 X Cable Diameter Short Term - During Installation

    b. 10 X Cable Diameter Long Term – Installed

5. Before cable installation, carefully inspect the cable reels and reel stands for imperfections or faults such as nails that might cause damage to the cable as it is unreeled.

6. Take all necessary precautions to protect reeled cable from vandals or other sources of possible damage while unattended. Any damage to reeled cable or the reel itself shall necessitate replacement of the entire cable section at Design-Builder's expense.

7. Whenever unreeled cable is placed on the pavement or surface above a pull box, provide means of preventing vehicular or pedestrian traffic through the area in accordance with the approved Maintenance of Traffic provisions.

8. Keep the cable continuous throughout the pull. Cable breaks and reel end splices are permitted only as shown in the Plans.

9. Where a cable ends in an underground fiber optic closure, secure and store all unused fibers and buffer tubes in splice trays in preparation for future reel end splicing and continuation.

4.3.4 Cable Storage

1. Properly store all cable to minimize susceptibility to damage.

    a. Maintain proper bend radius, both short and long term, during cable storage.

    b. Storage coils shall be neat in even length coils, with no cross over or tangling.

    c. Storage coils of different cables shall be kept completely separate except when the cables terminate in the same splice closure.

    d. Storage coils shall be secured to cable racking hardware with tie wraps, Velcro straps, or non-metallic cable straps with locking/buckling mechanism.

    e. Do not use adhesive or self-adhering tapes, metal wires and straps, or rope/cord.

2. Unless otherwise noted on the Plans, the following are the requirements for cable slack storage for underground applications:

    a. Trunk fiber optic cable in Type “D” Pull Box – 25 feet

    b. Trunk fiber optic cable in Type “E” Pull Box – 200 feet

    c. Trunk fiber optic cable in pad-mount cabinet – 25 feet

    d. Trunk fiber optic cable in aerial splice – 50 feet on each side of the splice closure

    e. Branch fiber optic cable in Type “D” Pull Box – 25 feet

    f. Branch fiber optic cable in Type “E” Pull Box – 100 feet

    g. Branch fiber optic cable in pad-mount cabinet – 25 feet

4.3.5 Fiber Optic Fusion Splice (FO Splice, Fusion)

1. Perform fusion splicing of all fiber optic splices as shown in the Plans in the locations shown.

2. Perform fusion splicing only in enclosed spaces such as splice trailers or tents specifically intended for this operation.

3. Completed fusion splices shall have no more than 0.10dB optical loss as measured in accordance with Section 4.2.4.2.

4. Adequately protect all fusion splices in splice trays in a splice closure or termination cabinet. Provide the splice with strain relief and protection of the stripped fiber splice in a manner recommended by the fiber and the splice tray manufacturers.

5. Use fusion splice protectors of a heat shrink tubing that protects the splice and extends over the fiber coating. Splice protectors shall be compatible with and as recommended by the fiber and the splice tray manufacturers.

6. No bare fiber may be exposed.

4.3.6 Fiber Optic Termination Unit (FO Termination Unit – 144F)

1. Install only one outside plant cable per termination cabinet, including within the separate splice tray storage compartment if so equipped. Install the connector modules for fibers 1 through 144 as shown in the Plans. Equip any remaining unused connector module slots with blank panels.

2. Install all fibers, buffer tubes, and cables following minimum internal and external bend radius, proper management, routing, fastening and protection, and with no residual strain on any connector, fiber, buffer tube or cable.

3. Install one cable buffer tube to one termination cabinet interconnect cable, matching fiber to fiber. Keep all fibers of the outside plant cable buffer tube and their corresponding termination-interconnect cables complete within the same splice tray.

4. Label the front and rear of the termination cabinets with the trunk cable segment ID of the cable terminated within; use permanent clearly legible labels with minimum 0.5 inch text height.

5. Label each end of termination cabinet interconnect cables to identify the 12 trunk cable fibers/buffer tube connected; use permanent overlapping cable labels with clearly legible text.

4.3.7 Fiber Optic Closure (FO Closure)

1. Install fiber optic splice closures where, and of the size, shown in the Plans. Install splice closures in the center ± 3 feet of the entire length of stored cable coils, or install at the end of cables that terminate in the pull box.

2. Store FO closures and cable coils on the pull box cable rack hooks. Keep all closures and cable coils off of the bottom of the pull box. Secure closures and/or cable coils as needed to hold them in place.

4.3.8 Fiber Optic Branch Panel (FO Branch Panel, 12F)

1. Prior to factory manufacture of fiber optic branch panels, verify the final installed location of all portions of each branch cable route from the splice closure to the equipment cabinet (including, but not limited to, the cabinet location, all conduit and pull boxes, and the splice closure location) to determine the required length of branch cable, including all splice closure and storage coils, to be factory manufactured with each branch panel. Do not use the Plans quantity for determining the branch cable length to be factory manufactured.

2. Using the branch panel mounting plate, install branch panels on the side panel of equipment cabinets. Mount the fiber optic branch panel with the connectors horizontal or facing downward and route the branch cable up or down as necessary. Route and secure the branch cable such that it is fully strain-relieved, does not violate the manufacturer's recommended bending radius, and does not interfere with the operation of or access to any cabinet equipment or electrical components.

3. Place one copy of the manufacturer test documentation in the equipment cabinet, where the branch panel is installed, and submit the other copy to the Engineer.

4.3.9 Aerial Fiber Optic Splice Closure (Aerial FO Closure)

1. Install aerial fiber optic splice closures where and of the size shown in the Plans.

2. Secure aerial fiber optic splice closures to messenger cable using manufacturer recommended hanger kit.

3. Coil 50 feet of fiber optic cable on either side of splice closure. Bending radius shall not exceed manufacturer recommended bending radius.

4.3.10 Integrated Fiber Optic Drop Cable / Termination Unit

1. Secure integrated fiber optic drop cable / termination unit to side of equipment cabinet in an accessible location.

2. Coil 75 feet of cable in the adjacent pull box.

4.3.11 Cable Labels

1. Install cable labels on all trunk cables. Clean the installed cable of all dirt and grease before applying any label.

2. Label all cables in or at every location where the cable is exposed outside of a conduit, innerduct or pole, using the cable IDs for trunk cables. As a minimum, install cable labels in the following locations:

    a. Within 12 inches of every cable entry to a pull box, equipment cabinet, or communications hub.

    b. Within 12 inches of the exterior entry point of every fiber optic splice closure, termination cabinet, and branch panel.

    c. Every 30 feet for the entire length of cable in any storage coil in pull boxes.

4.3.12 Fiber Optic Patch Cords

1. Install fiber optic patch cords to connect all electronic equipment with the fiber optic infrastructure. Follow port assignments as shown in the Plans.

2. Install fiber optic patch cords to connect all active optical paths between fiber optic termination cabinets in communications hubs as shown in the Plans.

3. Neatly route and dress all patch cords to the connected devices and within cable management facilities.

4.3.13 Fiber Optic Attenuator Patch Cords

Provide fiber optic attenuator patch cords in accordance with Section 4.2.11.

4.3.14 Project Testing

1. General Requirements
    a. The Design-Builder shall conduct a project testing program for all fiber optic infrastructure as required in Section 1.5 of this SP. The project testing program for fiber optic infrastructure shall include but is not limited to, the additional specific requirements in this subsection.

b. All test results shall confirm physical and performance compliance with this SP including, but not limited to, optical fibers and fusion splices. No event in any given fiber may exceed 0.10 dB. Any event measured above 0.10 dB shall be replaced or repaired at the event point.

c. In addition to the notification requirements of Section 1.5, provide the tentative date, time and location of fiber optic infrastructure testing no less than 10 days in advance of the test. Provide confirmed date, time and location of fiber optic infrastructure testing no less than 48 hours before conducting the test.

d. Provide test results documentation in electronic format (1 copy) and printed (3 copies) format. Electronic formats shall be readable in Microsoft Excel or other approved application. Printed copies shall be bound and organized by cable segment.

e. Provide all test results in English units.

f. Submit all test results documentation to the Engineer within 14 days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 1.8.

2. Pre-Installation Test (PIT)

a. Perform a PIT on all FO Cable prior to any cable removal from the shipping reels. Perform a PIT on each cable reel delivered to the job site.

b. The PIT for FO Cable shall include but is not limited to:

i. A visual inspection of each cable and reel

ii. An OTDR Test and documentation as required in the SAT below, for three randomly selected fibers from each buffer tube.

iii. An Optical Attenuation Test is not required. If the Design-Builder decides to perform one for their own protection, said test should be documented and provided to the Engineer.

3. Standalone Acceptance Test (SAT)

a. Perform an SAT on all fiber optic infrastructure after field installation is complete, including, but not limited to, all splicing and terminations.

b. An SAT for each fiber in each cable shall include OTDR Tests and Optical Attenuation Tests.

c. All fibers in all FO Cables and FO Branch Cables shall be tested from termination point to termination point, including:

i. Fibers from FO Termination Cabinet to FO Termination Cabinet

ii. Fibers from FO Termination Cabinet to FO Branch Panel

iii. Fiber from FO Branch Panel to FO Branch Panel

iv. Fibers from FO Termination Cabinet to the end of the cable run in the last FO Closure

d. Fiber that is not terminated shall be temporarily terminated in order to perform OTDR testing.

e. All test results shall confirm compliance with this SP including, but not limited to, optical fibers and fusion splices. No event in any given fiber may exceed 0.10 dB. Any event measured above 0.10 dB shall be replaced or repaired at the event point.

f. Test documentation shall include but is not limited to:

i. Cable & Fiber Identification

- Cable & Fiber ID and Location – Physical location (device ID and station number of FO Termination Cabinet, FO Branch Panel, or cable end FO closure), fiber number, and truck or branch cable ID for both the beginning and end point.
- Operator Name
- Engineer's Representative
- Date & Time

ii. Setup and Test Conditions Parameters

- Wavelength
- Pulse width Optical Time Domain Reflectometer (OTDR)
- Refractory index (OTDR)
- Range (OTDR)
- Scale (OTDR)
- Ambient Temperature

iii. Test Results for OTDR Test (each direction and averaged)

- Total Fiber Trace (miles)

- Splice Loss/Gain (dB)
- Events > 0.05 dB
- Measured Length (Cable Marking)
- Total Length (OTDR Measurement)

iv. Test Results for Attenuation Test (each direction and averaged)

- Measured Cable Length (Cable Marking)
- Total Length (OTDR Measurement from OTDR Test)
- Number of Splices (Determined from As-Builts)
- Total Link Attenuation

g. OTDR Test

i. Conduct the OTDR Test using the standard operating procedure and recommended materials as defined by the manufacturer of the test equipment.

ii. Use a factory patch cord ("launch cable") of a length equal to the "dead zone" of the OTDR to connect the OTDR and the fiber under test.

iii. Conduct bi-directional OTDR Tests for each fiber. Calculate bi-directional averages.

iv. Conduct all tests at 1310 and 1550 nm for single mode cable.

h. Optical Attenuation Test

i. Conduct the Optical Attenuation Test using the standard operating procedure and recommended materials as defined by the manufacturer of the test equipment.

ii. Conduct bi-directional Optical Attenuation Tests for each fiber. Calculate bi-directional averages.

iii. Conduct all tests at 1310 and 1550 nm for single mode cable.

4.4 MEASUREMENT

4.4.1 Fiber Optic Cable (SMFO Cable, 144F)

Single Mode Fiber Optic Cable (SMFO Cable, 144F) will be measured in units of linear feet and paid for at the contract price per linear feet. The price bid shall include: the length in feet of actual cable installed as measured from the cable sequential length markings, cable labels, patch cords, ancillary and incidental materials, mounting brackets, testing, documentation and all labor and equipment necessary to complete the work. No measurement for payment will be made for cable storage amounts in excess of that required in this SP or the Plans. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

4.4.2 Fiber Optic Branch Cable (SMFO Cable, 12F)

Single Mode Fiber Optic Cable (SMFO Cable, 12F) will be measured in units of linear feet and paid for at the contract price per linear feet. The price bid shall include: the length in feet of actual cable installed as measured from the cable sequential length markings, cable labels, patch cords, ancillary and incidental materials, testing, documentation and all labor and equipment necessary to complete the work. No measurement for payment will be made for cable storage amounts in excess of that required in this SP or the Plans. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

4.4.3 Fiber Optic Splice, Fusion (FO Splice, Fusion)

Fiber Optic Splice, Fusion (FO Splice, Fusion) will be measured in units of each splice and paid for at the contract price per each individual splice. The price bid shall include but not limited to all ancillary and incidental materials, testing, documentation, reel end splices, and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

4.4.4 Fiber Optic Connectors

Fiber Optic Connectors are included in the quantities of other pay items and will not be measured separately for payment.

4.4.5 Fiber Optic Termination Unit (FO Termination Unit – 144F)

Fiber Optic Termination Unit (FO Termination Unit – 144F) will be measured in units of each and paid for at the contract price per each but not limited to fiber optic connectors, cable labels, patch cords, splice tray, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

4.4.6 Fiber Optic Closure (FO Closure)

Fiber Optic Closure (FO Closure) will be measured in units of each and paid for at the contract price per each. The price bid shall include but not be limited to, cable labels, patch cords, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

4.4.7 Fiber Optic Branch Panel (FO Branch Panel, 12F)

Fiber Optic Branch Panel (FO Branch Panel, 12F) will be measured in units of each and paid for at the contract price per each. The price bid shall include but not limited to fiber optic connectors, cable labels, patch cords, manufacture with the fiber optic branch cable, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

4.4.8 Integrated Fiber Optic Drop Cable / Termination Unit

Integrate Fiber Optic Drop Cable / Termination Unit will be measured in units of each and paid for at the contract price per each. The price bid shall include but not limited to, cable lengths up to 275 feet, cable labels, mounting hardware, ancillary and incidental materials, testing, documentation and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

4.4.9 Cable Labels

Cable Labels are included in the quantities of other pay items and will not be measured separately for payment.

4.4.10 Fiber Optic Patch Cords

Fiber Optic Patch Cords are included in the quantities of other pay items and will not be measured separately for payment.

4.4.11 Fiber Optic Attenuator Patch Cords

Fiber Optic Attenuator Patch Cords are included in the quantities of other pay items and will not be measured separately for payment.

4.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

ITEM NO.	DESCRIPTION	UNIT
725-23.16	FIBER OPTIC CABLE (144 F)	L.F.
725-23.21	FIBER OPTIC DROP CABLE (12 F)	L.F.
725-23.26	FIBER OPTIC CLOSURE (12 F)	EACH
725-23.27	FIBER OPTIC CLOSURE (144 F)	EACH
725-23.28	FIBER OPTIC SPLICE FUSION	EACH
725-23.29	FIBER OPTIC TERMINATION CABINET	EACH
725-23.31	FIBER OPTIC DROP PANEL (12 F)	EACH

Fiber optic infrastructure, except as specified below, will be paid per linear foot or per each, as applicable, as follows:

1. Initial 25% of the contract unit price upon delivery and PIT test.

2. Additional 35% of the contract unit price for complete installation of cables.

3. Additional 30% of the contract unit price for completion of SAT testing and documenting of all fibers in any linear foot and in each splice or termination/connectorization location, and submission of and acceptance of all test documentation.

4. Final 10% of the contract unit price upon Final System Acceptance

Fiber optic splices, fusion, will be paid per each as follows:

1. Initial 60% of the contract unit price upon completion of the splice.

2. Additional 30% of the contract unit price for completion of SAT testing and documenting of all fibers in any lineal foot and in each splice or termination/connectorization location, and submission of and acceptance of all test documentation.

3. Final 10% of the contract unit price upon Final System Acceptance.

5 ELECTRICAL EQUIPMENT

5.1 DESCRIPTION

This section describes the minimum requirements for the electrical systems to be furnished and installed on this project. The work required includes all materials, labor, coordination, auxiliaries, and incidentals necessary to furnish, install, and test a complete electrical system as indicated on drawings and as specified in this section. The electrical systems will provide power to the ITS devices installed as part of this project including, but not limited to, communications hubs and field cabinets.

5.2 MATERIAL

5.2.1 Demarcation Points for Electrical Service (Riser and Ground-Mounted)

1. Demarcation points for power service installations shall include a service power meter base, fusible disconnect switch with fuse(s) and/or power distribution breaker panel (Mini Load Center) and enclosure, SPD, wire, conduit and appurtenances, wire splices, and all labor materials associated with the installation of these devices except as approved by the Engineer. Where multiple power circuits are originating from the same demarcation point, the demarcation point shall include all equipment needed for all circuits. All work and materials required to provide electric service at each individual site shall be in accordance with manufacturer's recommendation, local electric codes, the National Electrical Code (NEC) and National Electrical Safety Code (NESC).

2. All demarcation point conduit shall be Rigid Galvanized Steel (RGS).

3. Conduit for the pole mounted electrical service pertains to the RGS riser assembly and any underground conduit connected to the riser and extending to the nearby pull box.

5.2.2 Electrical Cable

Electrical cable shall be stranded copper wire with XHHW (cross-linked polyethylene (XLPE) high heat-resistant, water-resistant) insulation, rated at 600V.

5.2.3 Surge Protective Device (SPD)

1. All SPD shall be UL listed and bear the UL label.

2. All metal oxide varistors used for surge protection shall be rated in the appropriate voltages.

3. Surge suppressors operating temperature shall be between -40°C to +85°C.

4. Power Carrying Conductors
    a. The SPD shall be installed on the load side of the main circuit breaker with leads as short and straight as possible. This shall be required for all voltage levels.
    b. The SPD shall have a clamping voltage response time of less than 5 nanoseconds.
    c. The SPD shall have a Voltage Protection Rating (VPR) of 700V or less for L-N, L-G, & N-G.
    d. The SPD shall have a Maximum Continuous Operating Voltage (MCOV) of 150V.
    e. The SPD peak surge current shall be equipped with a minimum surge current rating of 70 kA per phase.
    f. The SPD shall be UL1449 listed.
    g. The SPD shall be located adjacent to the electrical power service and distribution panel.
    h. The SPD shall have a visual indicator of loss of protection.
    i. The SPD shall include one set of Normally Open (NO), Normally Closed (NC) Form C contacts for remote monitoring.

5.2.4 Transformers

1. Provide demarcation and cabinet transformers as indicated on the Plans.
2. Each of the transformer Types shall meet the following requirements:
    a. UL listed
    b. 60 Hz operation
    c. Built in accordance with ANSI short term overload capability
    d. Meet or exceed NEMA ST-20 sound levels. (37dB for 0-9KVA; 42dB for 10- 30KVA)
    e. Tested in accordance with NEMA, ANSI, and IEEE Standards.
    f. Dry Type Transformers: ANSI/NEMA ST 20: factory-assembled, non-vented, dry type transformers; ratings as shown in Plans.
    g. Voltage rating for transformers shall be single phase, dry type step-up/down as noted within the plans.
    h. The average temperature rise shall be 115°C.
    i. Shall comply with NEC standards for transformers and disconnects.

j. Basic Impulse Level (BIL): 10 KV for transformers less than 300 KVA.

k. Coil Conductors shall be continuous copper windings with terminations brazed or welded.

l. Enclosure: Non-Ventilated, NEMA 3R enclosure standard. Suitable for outdoors. Provide lifting lugs or brackets.

m. Isolate core and coil from enclosure using vibration-absorbing mounts.

n. Nameplate: Include transformer connection data and rating.

o. Provide transformer with lug kits which are compatible with the type and amperage of the windings.

p. All cores to be constructed of high grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point.

q. Terminations shall consist of wire leads with minimum insulation rating of 125 degrees Celsius.

3. Pad Mounted Transformers

   a. Provide transformer capable of being pad mounted.

   b. Provide concrete pad for pad mounted transformers as indicated on the plans.

4. Rack Mounted Transformers

   a. Provide transformers mounted on a channel steel frame as indicated on the Plans.

   b. Concrete pad shall be an extension of proposed cabinet foundation or stand alone as indicated on the plans.

   c. Provide a galvanized steel stand constructed of 3-inch channel with welded construction.

   d. Legs shall be bolted to or buried into concrete pad to depths indicated on the Plans.

   e. Provide knee bracing as required to prevent excess stand movement.

   f. Stand shall not be installed to prohibit safe working clearances or obstruct access doors to any equipment.

   g. Bond equipment grounding conductor to the steel frame.

5.2.5 Power Distribution Breaker Panel

1. Power distribution breaker panels shall be 120/240 volt, 1 phase, 10 kAIC minimum rated, 12 space maximum, 4 space minimum, and Main Circuit Breaker (MCB) panels. Shall be in a NEMA 3R enclosure for use in outdoor locations. Ampere rating of each power distribution breaker panel shall be as indicated on the Plans.

2. Panels shall be bottom feed and capable of being surface mounted inside a cabinet.

3. Power distribution breaker panel schedules shall be filled in by the PDE manufacturer with descriptions of each circuit in accordance with Article 110-22 of the National Electric Code.

4. Molded Case, bolt-on thermal magnetic trip circuit breakers, with common trip handle for all poles shall be provided factory installed in accordance with the power distribution breaker panel schedules on the Plans.

5.2.6 Disconnect Switches

1. Provide fused disconnect switches, ampere rating, voltage rating, number of poles, and fuse size as indicated on the Plans.

2. Disconnect switches shall be in a NEMA 3R enclosure for use in outdoor locations and able to be locked in both the on and off positions.

5.2.7 Solar Power

The Design-Builder shall provide required solar power equipment as shown in the Plans at required RDS and wireless radio sites as per the guidelines stated in this document. The photovoltaic power supply shall include but not be limited to: the battery, photovoltaic modules and all required peripherals. The Design-Builder shall be responsible for conducting a performance design study and for designing the solar power supply for the sites shown on the Plans. The Design-Builder shall submit all design calculations for solar power to the Engineer for approval. The solar power generated should be able to optimally operate the ITS device for which it is intended.

1. Photovoltaic Power Supply - The following criteria shall be used for the purpose of specifying solar electric modules for procurement:

    a. The solar module shall have cells made of high efficiency single crystal silicon and processed with textured optimized pyramidal type surface for maximum amp-hours delivered per day.

    b. The cells shall have dual interconnect ribbons soldered using a continuous flow process (not spot welds) that fully span both the top and bottom of each cell to ensure cell interconnection even when glass is shattered.

c. The solar module shall be constructed using a specially formulated EVA polymer to bond the solar cells to a "Solar Grade" tempered glass for maximum protection and light transmission.

d. A white tedlar back sheet shall be used in the lamination process to reduce cell temperature and act as a moisture barrier maximizing cell and module output.

e. The solar module shall incorporate built-in bypass diode protection in the weatherproof junction box to preserve array output power even during periods of local shading.

f. The solar module shall feature UL rated junction boxes designed for easy wiring, safety, and environmental protection.

g. The solar module shall be certified that it has passed the environmental tests required by JPL 5101-16 (Block V).

h. The solar module shall meet UL 1703 requirements and be listed under file No. E79555.

i. The solar module shall be certified that it is performance tested in accordance with the method specified in IEC 904 and 1036.

j. The modules shall be comprised of Single Crystalline Silicon.

k. They shall have a minimum of (10) year limited warranty.

2. Performance Design Study - A performance design study is to be custom created for the specific project site. This design study shall include, but is not limited to:

a. The daily Solar Insulation data averaged on a monthly basis.

b. An efficient Tilt Angle for the solar array.

c. The daily Array Output, in Amp-Hours, averaged on a monthly basis.

d. The total Daily Load requirement, in Amp Hours, averaged on a monthly basis.

e. A monthly Loss of Load Probability (LOLP) of the designed power supply.

f. A minimum of 21 days battery autonomy. (Based on the 100 hour discharge rate @ 77 F to 1.75vpc)

g. The monthly Average Battery State of Charge.

h. The statistical Interval to Loss of Load, in years.

i. Worst-case design parameter of 2 KWH/Sq. M/average December day.

3. Battery - The battery(s) used in this system shall have the following design features:

    a. Batteries shall be Valve Regulated Sealed Lead Acid batteries.
    b. Batteries shall be Absorbed Glass Mat (AGM) design.

    c. Meet DOT shipping requirements, 49 CFR

    d. Shelf Life of 6 months at 68 – 77

5.2.8 Uninterruptible Power Supply

The Uninterruptible Power Supply shall be designed to meet the following:

1. Provide The uninterruptible power supply (UPS) system must be sized to be able to provide 2 hours of run time for each load supported.

2. Loads supported include all devices controlled and energized in each ITS cabinet.

3. The Design-Builder shall provide the cabinet vendor with a list of all the loads to be powered at each ITS cabinet.

4. The UPS vendor shall perform load calculations based on the loads at each cabinet to select a UPS unit sized as capable of powering these loads for a minimum of 2 hours under temperature extremes that are typical of the area of the site where these units are being installed.

5. The vendor shall provide for submittal approval, cabinet internal wiring and load calculations, as well as cabinet layout showing the ups unit physically sized adequately to fit within the cabinet spaces available.

6. All calculations and layouts, wiring, and overcurrent protection shall meet NEC, be UL listed and be adequate for the weather conditions typically to be expected at each cabinet site.

7. Should there be any changes in the configuration of each cabinet, it shall be the responsibility of the Design-Builder to advise the cabinet vendor for any adjustments required o the sizes of the cabinets or the UPS as required to meet any new load demands.

5.3 INSTALLATION REQUIREMENTS

5.3.1 Electrical Connections (Demarcation Points)

Electrical power service, from the power service provider, shall be provided at the Demarcation Points as indicated on the Plans. The Design-Builder shall be responsible for all coordination with the power service provider, including size and type of transformer, if required, to be provided at each demarcation site, as well as all materials, labor, or any other means to install electrical service to the field cabinets as indicated on the Plans.

5.3.2 Demarcation Points for Electrical Service (Riser and Ground-Mounted)

1. The installation of all electrical devices including wire sizing, conduit sizing, electrical conductor splicing in pull boxes, and grounding/bonding shall be as shown in Plans and in accordance with the National Electrical Code (NEC) and National Electrical Safety Code (NESC).

2. The size and rating of all electrical devices shown in the Plans shall be considered minimums and the Design-Builder is responsible for determining, furnishing, and installing larger size and ratings as required by Code and/or the utility provider.

3. Cumberland Electric Membership Corporation is the electric service provider for the project area.

4. Design-Builder is responsible for contacting the electrical utility company for service feed information.

5. It is the Design-Builder's responsibility to coordinate with the electrical utility well ahead of the desired (scheduled) date for electrical service, so that proper procedures can be followed for the electrical utility provider.

6. It is the Design-Builder's responsibility for obtaining the address for each electrical demarcation point.

7. The Design-Builder shall get all finished electrical demarcation points inspected by the appropriate authority, as determined by the electrical utility provider, prior to asking for required activation from the electrical utility.

8. The Design-Builder shall coordinate with the electrical utility to ensure conformance with interface requirements for point of attachment and metering. The Design-Builder shall determine required voltages for electrical services based on the field devices at each individual demarcation site. The Design-Builder shall submit all load calculations to the Engineer for approval.

9. The Design-Builder shall not order service activation more than 60 days before anticipated installation of the roadside equipment cabinet to be served, so as not to incur unwarranted service costs.

10. Electrical service may not be connected to a cabinet or other device until all required grounding installation is complete.

5.3.3 Electrical Cable

Design-Builder shall abide by the following installation requirements:

1. Conductors of the type, size, and specification shall be installed at the location shown on Plans or as directed by Engineer.

2. Conductors in conduits shall be carefully pulled into place using methods in conformance with standard industry practice and the cable manufacturer's recommendations.

3. When wire or cable is brought up into the base of a foundation, sufficient slack shall be left to enable the connections to be made outside the foundation.

4. Powdered soapstone, talc, or other approved inert, non-oily cable lubricant shall be used in placing conductors in conduit.

5. Conductors shall be handled and installed in such a manner as to prevent kinks, bends, or other distortion, which could cause damage to the conductor or outer covering.

6. All wires and cables within a single conduit shall be pulled at the same time. When cables are pulled through hand holes, in pole shafts, etc., a pad of firm rubber or other suitable material shall be placed between the cable and the edges of the opening to prevent cable damage.

7. Cable, entrances into panels, transformers, cabinets, and conduit outlets shall be sealed from moisture, insects, rodents, and foreign material with a sealing compound manufactured for this application.

8. Splices and taps for circuits rated below 600 volts shall be performed in accordance with the NEC and materials shall be used that will be compatible with the sheath and insulation of the cable and suitable for direct burial.

9. Straight splices shall be made with tubular copper compression type connectors, or bronze or copper split bolt connectors.

10. Tap splices shall be made with parallel tubular copper compression type connectors or parallel groove bolted connectors.

11. Compression connectors shall be crimped with the connector manufacturer's recommended compression tool and die.

12. The compression tool shall be of the type which will prevent removal of the tool until the crimp has been completely closed.

13. After a conductor splice is made, it shall be insulated with a rubber insulating tape and then covered with material suitable for direct burial.

14. The tape shall be applied half-lap with a minimum of two full laps of each tape to a point approximately three (3) inches from the conductor splice.

15. All sharp points and edges of the connector shall be padded, and all voids filled with insulating putty.

16. The tape shall not be stretched in such a manner as to cause creeping. All spliced joints shall be watertight.

17. Splices and taps for circuits rated above 600 volts shall be made using a splice kit as supplied by the cable manufacturer suitable for direct burial and splices shall be made in accordance with manufacturer instructions and recommendations for the particular cable and voltage level.

18. Splices shall be completed the same day started and shall not be done during damp or inclement weather.

19. Medium and high voltage cables exposed at equipment terminations shall be provided with a suitable insulating sleeve from over the cable insulation to terminal points of the equipment.

20. Special attention shall be given to the shielded cable to maintain the continuity of the metallic shielding tape and to the proper termination and grounding of the shield at each splice of the cable run and at each end.

21. Cable warning tape shall be installed in all conduit trenches as specified.

22. Junction boxes containing conductors of different voltages shall be permanently labeled to identify voltage and disconnecting location. Conductors shall be color coded to identify voltage.

5.3.4 Grounding Wire

1. Grounding splices shall not be insulated.

2. The grounding conductor shall be continuous and shall be connected to the ground system at all supporting poles and structures, to each transformer, to each sign support assembly, to each gate, and to each grounding conductor in a multi-conductor cable assembly. Additional grounding rod electrodes shall be installed to obtain a maximum value of 10 ohms to ground.

3. Single ground rods shall be driven vertically until the top of the rod is at least 12" below the finished ground.

4. A length of #6 base copper, seven-stranded wire shall be attached to the ground rod with suitable ground rod clamps and connected to the grounding system.

5. Bolted grounding connections of solder-less type made of the high strength electrical bronze with silicon bronze clamping bolts and hardware may be used; designed such that, bolts, nuts, lock washers and similar hardware which might nick or otherwise damage the ground wire will not directly contact the ground wire.

6. Non-dielectric circuit going into and leaving communication equipment cabinet shall be equipped with Department-approved Surge Protective Device (SPD) system.

7. Exothermic welded ground connections shall be used where specified.

5.3.5 Surge Protective Device (SPD)

1. The Design-Builder shall provide SPD on all electrical service points at the load side of distribution panels.

2. The Design-Builder shall install SPD as follows:

    a. The placement of equipment and wiring within an outside enclosure shall be arranged so that the surge suppressors are located near the conductor's point of entry.

    b. Surge suppressors shall be located as close as possible to the electrical panel board.

    c. SPD shall be mounted on the underside of riser and ground-mounted demarcation point breaker panel enclosures.

    d. The surge suppressor grounding conductor shall be free from sharp bends.

5.3.6 Transformers

Transformer installation shall meet the following requirements:

1. Set transformer plumb and level on concrete pads. The pad is to extend a minimum of 6" from the edge of all sides of the transformer.

2. All transformers shall be installed to form a complete installation ready for operation.

3. Check for damage and tight connections prior to energizing transformer.

4. Measure primary and secondary voltages and make appropriate tap adjustments with transformer 100 percent design load.

5. After installation is completed, the transformer shall be tested prior to acceptance.

6. Operational test shall be performed in the presence of the Engineer.

7. The test shall include a voltage, current, and insulation resistance test.

8. Test shall be performed in accordance with TDOT Standard Specifications Section 714.

5.3.7 Power Distribution Breaker Panel

Power distribution breaker panels shall be installed on the demarcation pole as shown on the Plans.

5.3.8 Disconnect Switch

1. Disconnect switches installed at the demarcation shall be fused and secured to the demarcation pole.

2. Disconnect switches installed at transformer locations shall be fused and secured to the primary side of the transformer.

5.3.9 Solar Power

The Design-Builder shall be responsible for all testing and documentation required for establishing approval and acceptance of the product. At a minimum, the following tests shall be conducted for both RDS and Wireless radio sites:

1. Perform field tests at the site of the solar power unit to verify that each device to be connected operates optimally.

2. Verify Array Output (Amp-Hours).

3. Verify Daily load requirement (Amp-Hours).

4. Verify Loss of Load Probability (LOLP) of the designed power supply.

5. Verify the Expected Battery Reserve Days.

6. Verify the Average Battery State of Charge.

7. Verify the statistical Interval to Loss of Load.

5.3.10 Uninterruptible Power Supply

The Design-Builder shall install the Uninterruptible Power Supply (UPS) per manufacturer recommended specifications. The Design-Builder shall be responsible for all testing and documentation required for establishing approval and acceptance of the product.

5.4 MEASUREMENT

5.4.1 Electrical Connections (Demarcation Points)

Electrical Connections shall be measured in units of each and shall include the Design-Builder's time and costs for coordinating with the utility companies as described in this SP. This price does NOT include any charges from the utilities as the utility will invoice TDOT directly for any installation charges associated with providing power to the demarcation points.

5.4.2 Demarcation Site (Overhead)

Demarcation Site (Overhead) for power service shall be measured in units of each and shall include the power service meter base, power distribution breaker panel or mini load center, SPD, all RGS conduit risers and weatherhead, conduit from nearest pull box to the pole, connection hardware, grounding,

wiring, and all related appurtenances as necessary to provide power service to each site. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.4.3 Demarcation Site (Underground)

Demarcation Site (Underground) for power service shall be measured in units of each and shall include the power service meter base, fusible disconnect switch, power distribution breaker panel, SPD, mounting brackets, concrete poles, RGS conduit from nearest pull box to the demarcation point, connection hardware, grounding, wiring, and all related appurtenances as necessary to provide power service to each site. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.4.4 Electrical Cable

The Electrical Cable will be measured in units of linear feet per cable installed and paid for at the contract price per linear feet of each cable. The price bid shall include furnishing, installing, configuring, and testing of the electrical power cable including all required splices and other ancillary items required for complete installation of the cable. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

5.4.5 SPD

The SPD is included in the quantities of other pay items and will not be measured separately for payment.

5.4.6 Transformers

The transformer will be measured in units of each and paid for at the contract price per each. The price bid shall include but not be limited to furnishing and installing of the transformer, mounting brackets, transformer disconnect switch, SPD, protection bollards, incidental connecting wire and conduit to an adjacent equipment cabinet, conduit riser or ground-mounted brackets and all work, equipment, and appurtenances as required effecting the full operation of the transformer. The price bid shall also include all documentation including configuration drawings, equipment interconnect diagrams, full operation documentation, block diagrams, and other material necessary to document the installation of the cabinet transformer and testing according to this SP detailed herein, within the Plans and/or in the contract document. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

5.4.7 Power Distribution Breaker Panel

The Power Distribution Breaker Panel is included in the quantities of other pay items and will not be measured separately for payment.

5.4.8 Disconnect Switch

Fused disconnect switch shall be included in the quantities of other pay items and shall include connection hardware, grounding, wiring, and all related appurtenances as necessary to provide a disconnecting means to equipment and is inclusive coordination efforts for all labor, tools, materials, equipment and incidentals necessary to complete the work.

5.4.9 Solar Power for RDS

The Solar Power assembly power service shall be measured in units of each and shall include the photovoltaic modules, battery(s), connection hardware, grounding, wiring, and all related appurtenances as necessary to provide power service to each site. This price shall also include coordination efforts and for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

5.4.10 Uninterruptable Power Supply

The Uninterruptible Power Supply (UPS) for temporary power service shall be measured in units of each and shall include all necessary equipment to provide operational battery backup system to provide power to ITS Devices for a minimum of two hours under temperature extremes that are typical of the area of the site where these units are being installed.

5.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

ITEM NO.	DESCRIPTION	UNIT
725-20.53	CABLE (1/C #10 AWG.)	L.F.
725-20.54	CABLE (1/C #8 AWG.)	L.F.
725-20.55	CABLE (1/C #6 AWG.)	L.F.
725-20.56	CABLE (1/C #4 AWG.)	L.F.
725-20.57	CABLE (1/C #2 AWG.)	L.F.
725-20.58	CABLE (1/C #1/0 AWG.)	L.F.
725-20.71	ELECTRICAL CONNECTION	LS
725-21.43	DEMARCATION SITE (OVERHEAD POWER)	EACH
725-21.44	DEMARCATION SITE (UNDERGROUND POWER)	EACH
725-21.85	UNINTERRUPTIBLE POWER SUPPLY	EACH
725-21.97	SOLAR POWER FOR RDS	EACH
725-24.xx	TRANSFORMER (VARIES)	EACH

All other 725 Electrical items listed above will be paid per each as follows:

1. Stored materials will be paid per TDOT Standard Specifications.

2. Final Payment will be made after complete installation, testing and Final Systems Acceptance.

6 EQUIPMENT CABINETS

6.1 DESCRIPTION

This section specifies the minimum requirements for equipment cabinets furnished and installed on this project as shown in the Plans. The cabinet will provide a protective outdoor housing enclosure in which to install field hardware required for ITS devices to communicate with the TMC. Major elements of the equipment cabinet include the cabinet housing and equipment mounting hardware, interior wiring and termination facilities, power supplies, electrical accessories, and field installation.

6.2 MATERIALS

6.2.1 General

1. Furnish only new equipment and materials.

2. Furnish equipment cabinets and integral materials recommended by the manufacturers for outside plant use and the intended application. This requirement includes wiring and electrical materials and configurations (including connector pin- outs) that are wholly or partially related to the field device applications (CCTV, RDS, etc.).

3. Furnish and configure equipment cabinets to be installed at locations as shown in the Plans. Furnish and configure all equipment and materials for each specific location as shown in the Plans.

4. Provide electrical system and components with UL-listings.

5. Unless otherwise specified, provide wire and cable with stranded copper conductors, 75°/90° Celsius wet/dry rated insulation, and sized for the maximum voltage and current in the circuit.

6. All components specified as rail-mounted shall be compliant as follows:

    a. DIN EN 50022 (NS35) component rails

    b. Component rails shall be the perforated type and of sufficient length as to protrude beyond the mounted components for fastening to cabinet panels as specified herein

    c. UL 1059

    d. UL 486E

    e. NEMA ISC-4

7. Terminal blocks and component terminals shall be nickel-plated copper, copper alloy, or brass.

8. Terminal blocks shall have voltage and current ratings greater than the ratings of the wires that are terminated, be able to terminate wires from #8 AWG to #4/0 AWG wiring and shall be assembled into housing enclosures such that all exposed surfaces are touch-safe. Conductor fastening screws shall be captive. Terminal block housings shall be colored as follows:

    a. 120 VAC line/hot: black

    b. 120 VAC neutral: white

    c. 24 VDC positive: red

    d. 24 VDC negative: gray

    e. RS485 communications: orange

    f. Ground: green or green/yellow

9. Provide door locks for all cabinet doors, keyed to TDOT standard Corbin #B4R01365 using #8960 heavy-duty blanks and mastered to #B4R87965. Provide one key with each cabinet.

10. Provide sunshields and mounting fasteners on all cabinets. Sunshields and fasteners shall meet the following minimum requirements:

    a. Sunshields shall be 0.125-inch aluminum with smoothed, deburred edges and rounded corners. Provide cutouts for door handles and/or locks as required.

    b. Cabinets shall be equipped with press-in threaded inserts on the cabinet wall interior surface. Sunshields shall be mounted by fasteners and aluminum, or stainless-steel standoffs tightened into the threaded inserts.

    c. Provide a minimum of four inserts/fasteners for top face sunshields.

    d. Provide a minimum of six inserts/fasteners for any door or side sunshield.

    e. For doors or sides greater than 54 inches tall, provide inserts and fasteners sufficient for a maximum vertical or horizontal distance of 27 inches between any fasteners.

    f. Furnish and install a top face sunshield on all cabinets.

    g. Furnish and install door or side sunshields on all cabinet faces except for pole attachment faces (for pole-mounted cabinets only).

11. Provide agency name, device name and ID labels on all cabinets. Labels shall meet the following minimum requirements:

a. The Device IDs shall be consistent to the device IDs shown in the plans or as approved by TDOT.
b. Labels shall be flat black lettering on a reflective white background. Lettering shall be a minimum of 1 inch in height.

c. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

d. The agency name labels shall be "TDOT ITS" in one continuous adhesive sheet.

e. The device ID labels shall include the device name as an acronym and a hyphen and shall be one continuous adhesive sheet. Device name acronyms are "CCTV- ", "RDS-",or "DMS-".

f. The device ID shall be numerals corresponding to the location and shall be installed adjacent to the acronym sheet. Multiple device IDs of the same type shall be on the same line separated with a space. Examples: "CCTV-040XX", "RDS- 040XX 040XX", "DMS-040XX".

g. Labels shall be installed along the top of the cabinet door (front cabinet door on Type B cabinets), with TDOT ITS label at the top and the device ID labels immediately underneath.

12. Provide a voltage label on all cabinets or enclosures in accordance with the NEC labeling requirements. Voltage labels shall meet the following minimum requirements:

    a. Labels shall be flat black lettering on a reflective yellow background. Lettering shall be a minimum of 1 inch in height.

    b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

    c. Labels shall include the voltages entering the cabinet and shall be one continuous adhesive sheet. Examples are "120VAC" or "24VDC".

    d. Labels shall be installed on all cabinet doors.

6.2.2 Type A Cabinet

1. Type A cabinets will be used to support RDS site with solar power and radio communications.

2. Provide a Type A cabinet intended for outdoor use with a minimum NEMA 3R rating.

3. The cabinet enclosure shall be manufactured from 0.125-inch aluminum.

4. The cabinet shall provide a minimum of one ventilation louver on at least two sides. Any louver opening greater than 3/16 inch in any dimension shall be screened to prevent insect entry.

5. The cabinet shall be intended for strapped pole-mounting; provide all mounting hardware necessary including ½-inch stainless steel mounting straps.

6. Provide a Type A cabinet enclosure with dimensions of 18 inches (H) by 14 inches (W) by 8 inches (D) with a tolerance of +/- 0.25 inches.

7. Cabinet door shall reveal the entire front opening of the cabinet for accessibility. The hinge shall be designed to prevent the door from sagging.

8. Include a single-piece 0.125-inch aluminum back panel covering no less than 90% of the cabinet back wall. Back panel shall be affixed to the enclosure with threaded fasteners and shall be removable from the enclosure with hand tools only and without requirement to remove the cabinet door, mounting straps, or any other components other than communications or device wiring.

9. The cabinet shall be furnished with doorstops, which retain the doors open in a 90 degree and 120-degree positions.

10. Provide on the back panel a grounding lug capable of terminating #6 AWG wire and directly bonded to the back panel.

11. All Type A cabinets supporting RDS units, shall be identical in manufacture and assembly regardless of the number of RDS units shown in the Plans at a specific location.

12. All Type A cabinets supporting RDS units, shall provide a remote RDS communications wiring module, comprised of DIN rail-mounted components, that includes the following:

    a. Component rail physically and electrically fastened to the cabinet back panel

    b. Strain relief brackets for the RDS cable(s) and the RDS unit harness cables

13. Din Rail mount, UL 497B Listed, series connected SPD for the two pair RS-485 data signal consisting of three stages of surge suppression.

14. Din Rail mount, UL 497B Listed Parallel or Series-connected surge suppressor for the 12-24VDC power supply for the RDS units with integral or separate terminals for a minimum of three RDS cables and two RDS unit harness cables.

15. Local/remote communications disconnect module for the RS-485 data signal that includes the following:

    a. Terminal facilities for one remote RDS cable connection from the surge suppressor, bus-connected to two separate local/remote disconnect switches, one for each RDS unit that simultaneously makes/breaks all of the RS-485 signal lines for a given RDS unit.

b. Separate terminal facilities for each of the RDS unit harness cables on the local side of the local/remote disconnect switch.

c. Separate DB9 connectors with gold-plated pins/sockets and shell for each of the RDS units, bus-connected with the RDS unit harness cable terminals on the local side of the local/remote disconnect switches. Provide protective covers for DB9 connectors.

d. Provision for installing RS-485 terminating resistors on the terminals on the remote side of the local/remote disconnect switch. Provide terminating resistors at cabinet locations in accordance with the RDS manufacturer's recommendations.

e. Alternately, provide two separate local/remote communications disconnect modules, one per RDS unit, with jumper wiring between the remote side terminals of the two modules.

16. Connection/jumper wiring between the surge suppressors and the local/remote communications disconnect module(s) shall be of the same conductor size, type, and insulation color as in the RDS cable.

6.2.3 Type B Cabinet

1. Type B cabinets will be used to support collocated CCTV and RDS units.

2. All Type B cabinets (except those at solar power locations) shall be identical in manufacture and assembly, capable of supporting two RDS units, one CCTV location, one Type A network switch, one Type A radio/antenna, RDS cable and fiber drop panel terminations, regardless of the devices shown in the Plans at a specific location.

3. A complete Type B cabinet shall be an assembly consisting of a cabinet housing, electrical subsystems, and a RDS communications subsystem.

4. Provide a Type B cabinet housing meeting the following requirements:

   a. Conforms to the standards for a Type 170 336S (approximate exterior dimensions 46 inches (H) x 24 inches (W) x 23 inches (D)), including standard EIA 19-inch rack cabinet cage, as defined in the latest version of the Caltrans Transportation Electrical Equipment Specifications (TEES). The minimum clear vertical inside dimension of the 19-inch rack for equipment mounting shall be 39.5 inches. Standard cabinet accessories for traffic signal operations, such as controller, power distribution assembly, input/output file and termination panels, and the police panel, are not required as part of this cabinet assembly.

   b. Provide a thermostatically controlled 100 CFM fan and louvered air intake in door with a pleated filter.

   c. Provide all mounting hardware necessary including ¾-inch stainless steel mounting straps.

d. Includes hooks, welded to the inside of each cabinet door, for hanging a side- opening, re-sealable, opaque, heavy-duty plastic documentation pouch with metal or hard-plastic reinforced holes for the door hooks. Provide one pouch with each cabinet.

e. Includes a rack-mounted cabinet sliding storage drawer in accordance with the following:

i. Approximate exterior dimensions 1.75” H x 16” W x 14” D.

ii. Telescoping drawer guides to allow full extension from the rack cage.

iii. Opening storage compartment lid to access storage space for cabinet documentation and other items.

iv. Supports a weight of 25 lb. when extended.

v. Non-slip plastic laminate surface attached to the compartment lid which covers a minimum of 90% of the surface area of the lid.

vi. Mounted in the rack cage with the bottom surface approximately 9 inches above the bottom of the rack cage.

f. Includes side panels within the two sides of the rack cabinet cage, inserted and fastened from the inside of the cage. Use side panels fabricated from 0.125-inch 5052 sheet aluminum alloy and sized to the full inside dimensions of the rack cabinet cage. Side panel surfaces for equipment mounting are denoted by cabinet side, with the “right” side being the support pole side, and by upper or lower as related to the sliding storage drawer. Upper right-side panel (support pole side of cabinet, above the drawer) and lower left side panel (opposite side from the support pole, below the drawer) are example side panel surface names.

g. Includes a 12-inch-long DIN rail (for future components) mounted in the horizontal and vertical center of the lower left side panel.

5. Provide Type B cabinet electrical subsystems meeting the following requirements: (Note: Type B Cabinets at Solar Power Locations are not required to meet Section 6.2.3.5 requirements)

a. Includes an electrical distribution module comprised of the following DIN rail- mounted components:

i. Service entrance terminal block with positions for 120VAC line, neutral, and ground and capable of terminating minimally #6 through #8 AWG wire, located at one end of the mounting rail with an approximately 0.75-inch blank spacer module adjacent to the main cabinet breaker.

ii. Main cabinet automatic overcurrent 15A circuit breaker that is UL-listed and of the mechanical-magnetic type rated for use from -18° C to 50° C minimum.

iii. Main cabinet surge suppressor for single-phase 120VAC service entrance, UL 1449 3rd Edition Listed, parallel wired with a Voltage Protective Rating (VPR) of 700V or less for L-N & N-G, and a minimum surge current rating of 40kA per mode.

iv. Main cabinet filter for power line noise and switching transient suppression, integral to, or separate from and wired to, the main cabinet surge suppressor.

v. Electrical distribution terminal block for line and neutral conductors parallel wired to the main cabinet surge suppressor but non-filtered, with a minimum terminating capability of six conductors of #10 to #18 AWG. Label the terminal block as "ACCY POWER".

vi. Electrical distribution terminal block for line and neutral conductors for circuits on the load/equipment side of the power line filter, with a minimum terminating capability of six conductors of #10 to #18 AWG. Label the block as "EQUIP POWER".

vii. Electrical distribution terminal block for grounding and bonding conductors located on the same rail but separate from the service entrance terminal block and connected to the entrance ground with a #6 AWG green insulated wire. The grounding block shall have a minimum terminating capability of two #6 AWG conductors and ten #10 to #18 AWG conductors.

viii. Ground fault interrupt duplex receptacle (NEMA 5-15R) with 2.5A circuit breaker connected to the ACCY POWER distribution block. Permanently affixed to the receptacle, provide two red, orange, or green/yellow labels with minimum 0.25-inch lettering with the legend "300 WATTS MAX". This receptacle is for technician use only and shall not be used to power equipment.

ix. Interconnection wiring between all electrical distribution module components and the other systems included in or housed in the Type B cabinet.

b. Include a cabinet lighting subsystem comprised of the following components:

i. One fluorescent lighting fixture, minimum 15 watt, mounted on the inside top front portion of the cabinet, with a cool white lamp with shatter-proof cover and operated by a normal power factor UL listed ballast.

ii. A resistor-capacitor network noise suppressor installed across the light fixture power terminals.

iii. Two door-actuated switches installed to turn on the cabinet light when either door is opened.

iv. Powered from the ACCY POWER distribution block.

c. Include two duplex non-GFCI equipment power receptacles (NEMA 5-15R) connected to the EQUIP POWER distribution block mounted on the upper rear corner of the cabinet upper right-side panel. Provide two red, orange or green/yellow labels with minimum 0.25-inch lettering with the legend "75 WATTS MAX" permanently affixed to the receptacle.

6. Provide a Type B cabinet RDS communications subsystem meeting the following requirements: (Note: Type B Cabinets at Solar Power Locations are not required to meet Section 6.2.3.5 requirements)

   a. Include a remote RDS communications wiring module as specified in Section 6.2.2.12, regardless of the number of RDS units shown in the Plans at a specific location.

   b. Include a headend RDS communications wiring module, comprised of DIN rail- mounted components, that includes the following:

      i. Nominal 24VDC output power supply, capable of user setting between 23 and 28VDC minimum, with minimum 1A output rating and minimum operating temperature range of -25° C to +70° C. Power supply shall provide terminal facilities for a minimum of three sets of #14 AWG conductors (in the RDS cable). Maximum size of the power supply shall be 1 inch (W) X 7 inches (H) X 7 inches (D). Connect the power supply to the EQUIP POWER distribution block for 120VAC input.

      ii. Surge suppressor for the RS485 data signal, wired between the video encoder and the RDS units. The surge suppressor shall protect the 4-wire RS485 data signal with hybrid multi-stage suppression components including gas tube and silicon avalanche diode. The surge suppressor shall have a response time no greater than 1 nanosecond. The surge suppressor shall provide terminal facilities for a minimum of four two-pair cables of #22 AWG conductors (in the RDS cable or wired to the adjacent remote RDS communications wiring module).

   c. Include interconnection wiring between the RDS communications subsystem and the video encoder.

   d. Complete subsystem of remote and head end modules mounted on the same DIN rail located on the bottom half of the cabinet upper right-side panel.

6.2.4 Type C Cabinet

Type C cabinets will be used to support DMS units and fiber junctions. (For the DMS Type C Cabinets see Section 10 of this specification for additional requirements.) The Type C cabinet shall meet the following requirements:

1. Shall meet the same lighting, 19” rack, and ventilation requirements as Caltrans Type 170 model 332 cabinet.

2. Shall meet the applicable requirements of a Type B equipment cabinet in Section 6.2.3.

3. Shall be ground mounted.

4. Shall be constructed of 5052 sheet aluminum alloy with a minimum thickness of 1/8 inch.

5. All inside and outside edges shall be free of burrs.

6. The outside surface of the cabinet shall have a smooth, uniform, and natural aluminum finish.

7. All welds shall be neatly formed and free of cracks, blow holes, and other irregularities.

8. All welds shall be made by using the Heli-arc welding method.

9. The cabinet should be of sufficient size to hold all of the Field Junction support equipment as shown in the Plans.

10. Cabinet hinges shall be 14 Gauge diameter stainless steel or 1/8-inch diameter aluminum.

11. The hinge pins shall be constructed of stainless steel.

12. Shall be furnished with a three-point latching system (top, bottom, center locations).

13. Shall be furnished with a doorstop, which retains the door at a 90 degree and 120 degree positions.

14. Shall have thermostatically controlled fan located at the top of the cabinet.

15. Minimum fan rating of 100 cubic feet per minute.

16. Fan thermostat shall have a user adjustable range from 80 to 125oF.

17. Minimum of 2-½ inch galvanized anchor bolts shall be used to secure the cabinet to the foundation.

18. Shall be provided with a minimum 20-Watt fluorescent lamp with a clear shatter-proof shield.

19. The lamp shall automatically turn ON when either cabinet door is open.

20. Shall include a three wire GFCI 115 VAC duplex convenience receptacle.

21. The receptacle shall be protected by a 15 Amp circuit breaker.

22. Shall include a main circuit breaker, which shall turn off all power to the cabinet.

23. Provide Type C cabinet electrical subsystems meeting the following requirements:

    a. Includes an electrical distribution module comprised of the following DIN rail- mounted components:

        i. Service entrance terminal block with positions for 120VAC line, neutral, and ground and capable of terminating minimally #8 through #6 AWG wire, located at one end of the mounting rail with an approximately 0.75-inch blank spacer module adjacent to the main cabinet breaker.

        ii. Main cabinet automatic overcurrent 15A circuit breaker that is UL-listed and of the mechanical-magnetic type rated for use from -18° C to 50° C minimum.

        iii. Main cabinet surge suppressor for single-phase 120VAC service entrance, UL 1449 Listed, parallel wired with a Voltage Protection Rating (VPR) of 700V or less for L-N & N-G, a minimum surge current rating of 40kA per mode, and I-nominal rating of 20kA.

        iv. Main cabinet filter for power line noise and switching transient suppression, integral to, or separate from and wired to, the main cabinet surge suppressor.

        v. Electrical distribution terminal block for line and neutral conductors parallel wired to the main cabinet surge suppressor but non-filtered, with a minimum terminating capability of six conductors of #10 to #18 AWG. Label the terminal block as “ACCY POWER”.

        vi. Electrical distribution terminal block for line and neutral conductors for circuits on the load/equipment side of the power line filter, with a minimum terminating capability of six conductors of #10 to #18 AWG. Label the block as “EQUIP POWER”.

        vii. Electrical distribution terminal block for grounding and bonding conductors located on the same rail but separate from the service entrance terminal block and connected to the entrance ground with a #6 AWG green insulated wire. The grounding block shall have a minimum terminating capability of two #6 AWG conductors and ten #10 to #18 AWG conductors.

        viii. Ground fault interrupt duplex receptacle (NEMA 5-15R) with 2.5A circuit breaker connected to the ACCY POWER distribution block. Permanently affixed to the receptacle, provide two red, orange or green/yellow labels with minimum 0.25-inch lettering with the legend “300 WATTS MAX”. This receptacle is for technician use only and shall not be used to power equipment.

        ix. Interconnection wiring between all electrical distribution module components and the other systems included in or housed in the Type B cabinet.

b. Include a cabinet lighting subsystem comprised of the following components:

   i. One fluorescent lighting fixture, minimum 20 Watt, mounted on the inside top front portion of the cabinet, with a cool white lamp with shatter-proof cover and operated by a normal power factor UL listed ballast.

   ii. A resistor-capacitor network noise suppressor installed across the light fixture power terminals.

   iii. Two door-actuated switches installed to turn on the cabinet light when either door is opened.

   iv. Powered from the ACCY POWER distribution block.

c. Include two duplex non-GFCI equipment power receptacles (NEMA 5-15R) connected to the EQUIP POWER distribution block mounted on the upper rear corner of the cabinet upper right-side panel. Provide two red, orange or green/yellow labels with minimum 0.25-inch lettering with the legend "75 WATTS MAX" permanently affixed to the receptacle.

6.2.5 Fiber Optic Termination Cabinet (ITS Field Junction Cabinet)

Field Junction Cabinet to be installed as shown on plans and meet all criteria for a Type C Cabinet as described above.

1. Provide fiber optic termination units in the field junction cabinet for full termination of 144 fiber outside plant (OSP) cables.

2. Use termination units that are fully compatible with all components of the fiber optic infrastructure as specified, including, but not limited to, fiber optic cable, fiber optic fusion splices, and fiber optic connectors.

3. Use rack-mount termination units designed to fit standard 19-inch EIA equipment racks.

4. Provide all mounting hardware and supports to mount the termination units.

5. Use fiber optic termination units providing 144 fiber connectors and capable of storing 144 fusion splices in splice trays.

6. Use termination units that integrate the splice trays and connector modules into one compartment within one cabinet or houses the splice trays and connector modules in separate compartments integrated into one cabinet.

7. Maximum dimensions of a complete termination unit shall be 7 rack units high (12.25 inches) by 16.0 inches deep.
8. Use fiber optic termination unit with fully enclosed metallic construction and with a protective hinged front cover for the connector ports.

9. Provide cable access on all sides of the enclosed area behind the connector port panel.

10. Provide sufficient splice trays for storing 144 fusion splices in 12 splice increments.

11. Provide termination cabinets with fiber optic connector modules in a 12-fiber configuration of 4 rows of 1 duplex connector couplers.

12. Connector modules shall mount vertically in the termination cabinet front panel.

13. Connector modules shall include clearly legible and permanent labeling of each of the 12-fiber connector couplers and shall be labeled and identified.

14. Provide factory-assembled 12 fiber termination interconnect cables (pigtail cables) to be fusion spliced to the outside plant cable and connected to the rear of the connector modules.

15. Termination interconnect cables shall be all-dielectric single jacketed cable with high tensile strength yarn surrounding 12 individual single mode fibers following EIA/TIA-598B color identification with factory-installed connectors.

16. Provide all incidental and ancillary materials including, but not limited to, grommets, cable strain relief and routing hardware, blank connector panels, and labeling materials.

6.3 INSTALLATION REQUIREMENTS

6.3.1 General

1. Install and configure cabinets as shown in the Plans, including installations and dimensions given for pole-mounting in relationship to the surrounding grade.

2. Provide a level technician standing pad at every cabinet door for level ground locations. For locations with a grade steeper than 4:1 (H:V), platform shall be constructed out of pressure treated lumber.

3. Bond all cabinets to the pole grounding lug with minimum #6 AWG stranded copper bare or green-insulated cabinet grounding wire.

4. Do not install electrical service or electronic devices in the cabinet or connect to the cabinet until ground testing for the pole or structure has been successfully completed and accepted, and the cabinet ground connection has been installed.

6.3.2 Type A, B and C Cabinets

1. Install and configure equipment in the Type A, B and C cabinet in accordance with the requirements for that equipment, including RDS units, CCTV, Type A network switches, radio/antennas, RDS cables, fiber distribution or drop panels, and/or solar panel power supply.

2. Do not install electronic devices in the cabinet until electrical service has been installed and activated, and the cabinet ventilation fan is operational.

3. Install Type A network switches in the topmost area of the cabinet rack. Use the equipment receptacles for power.

4. Install supporting equipment/electronics for CCTV on the lower area of the cabinet upper left side panel. Ensure there is no physical or access conflict with the network switch. Use the EQUIP POWER distribution block for the power source.

5. Install fiber drop panels in a vertical configuration on the lower rear edge of the cabinet upper right-side panel.

6.3.3 Fiber Optic Termination Cabinet (ITS Field Junction Cabinet)

The Fiber Optic Termination Cabinet (ITS Field Junction Cabinet) shall be installed as shown on the plans.

1. Install and configure equipment in the Type C cabinet in accordance with the requirements for that equipment, including Type B network switch and fiber distribution panel.

2. Do not install electronic devices in the cabinet until electrical service has been installed and activated, and the cabinet ventilation fan is operational.

3. Install Type B (Level 3) network switches in the topmost area of the cabinet rack. Use the equipment receptacles for power.

4. Install the connector modules for fibers 1 through 144 as shown in the Plans. Equip any remaining unused connector module slots with blank panels.

5. Install all fibers, buffer tubes, and cables following minimum internal and external bend radius, proper management, routing, fastening and protection, and with no residual strain on any connector, fiber, buffer tube or cable.

6. Install one cable buffer tube to one termination cabinet interconnect cable, matching fiber to fiber. Keep all fibers of the outside plant cable buffer tube and their corresponding termination-interconnect cables complete within the same splice tray.

7. Label the front and rear of the termination cabinets with the trunk cable segment ID of the cable terminated within; use permanent clearly legible labels with minimum 0.5-inch text height.

8. Fiber optic termination unit is included in the quantities of other pay items and will not be measured separately.

6.3.4 Project Testing

1. General Requirements

    a. The Design-Builder shall conduct a project testing program for all equipment cabinets as required in Section 1.5 of this SP. The project testing program for equipment cabinets shall include but is not limited to, the additional specific requirements in this subsection.

    b. All test results shall confirm physical and performance compliance with this SP.

    c. Submit all test results documentation to the Engineer within 14 days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 1.8.

2. Standalone Acceptance Test (SAT)

    a. Perform an SAT on all equipment cabinets on this project after field installation is complete, including, but not limited to, all field devices (DMS, RDS, CCTV, communications electronics, etc.) to be installed in or connected to that given cabinet.

    b. A SAT for a given equipment cabinet shall only be performed in conjunction with the SAT for all devices installed in or connected to that given cabinet.

        i. Visual inspection of installation.

        ii. Inspection of cabinet documentation.

        iii. Functional test of all cabinet equipment, including circuit breaker, receptacles, fan and thermostat, and lights and door switches.

        iv. Measurement of DC power supply operating under full load.

6.4 MEASUREMENT

6.4.1 Cabinets and ITS Communications Hub (Field Junction Cabinet)

Cabinets (Type A, B, C and Fiber Optic Termination Cabinet) will be measured in units of each and paid for at the contract price per each. The price bid shall include but not be limited to furnishing and installing the equipment cabinet and all related material and equipment specified in the Plans and this SP, and all labor, system integration, testing, 144 FDC, system documentation and miscellaneous materials necessary for a complete and accepted installation. The unit price shall also include but is not limited to, the cabinet and all interior materials, mounting hardware foundations, protection bollards, external conduit entrances including conduit bodies and nipples, electrical service and pole grounding terminations, technician work pads, and protection bollards. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

6.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

ITEM NO.	DESCRIPTION	UNIT
725-24.01	CABINET (TYPE A)	EACH
725-24.02	CABINET (TYPE B)	EACH
725-24.03	CABINET (TYPE C)	EACH
725-24.11	ITS COMMUNICATION HUB (FIELD JUNCTION CABINET)	EACH

Equipment Cabinet will be paid per each as follows:

7. Initial 40% of the contract unit price for delivery of the cabinet housings.

8. Additional 40% of the contract unit price for complete installation of equipment cabinet and all interior components, electrical service feed (activated), interior cabinet components, all conduit entrances, grounding connection, and testing.

9. Additional 10% of the contract unit price for completion of Standalone Acceptance Test of all field devices housed or connected to the equipment cabinet at each site.

10. Final 10% of the contract unit price upon Final System Acceptance.

7 POLES AND STRUCTURES

7.1 DESCRIPTION

This section specifies the minimum requirements for equipment poles and structures furnished and installed in accordance with this SP and the Plans. This work shall consist of furnishing, installing, and testing 50' and 80' galvanized steel camera poles with foundations; 35'detection poles and foundations; and overhead sign structures all in accordance with this SP and the TDOT Standard Specifications for Road and Bridge Construction.

7.2 MATERIALS

7.2.1 Galvanized Steel Poles

Fifty-foot (50') and Eighty-foot (80') CCTV pole and foundation with lowering device, conduit, connections, clamps, anchor bolts, shoe bases, and all other members shall be designed and fabricated in accordance with the Standards and requirements listed below. Design and materials documentation shall be furnished as part of the approval request submittal. Certifications will be furnished upon request by the Engineer.

1. AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, current edition, including all interims and updates shall be met. Design life shall be 50 years for all poles. The "Fatigue Category", "Galloping Loads" category and "Truck-Induced Gust Loads" would NOT apply to the poles but would apply to the sign structures.

2. Shall be designed to withstand the forces specified in the most current AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, current edition, including all interims and updates, and including those forces produced by the wind with gust effect factor.

3. The Design-Builder shall submit manufacturer's shop drawings, layout drawings and specifications for equipment and appurtenances for the approval of the Engineer ninety (90) days after notice to proceed.

4. Fabricator: The Fabricator shall be certified under Category I, "Conventional Steel Structures" as set forth by the American Institute of Steel Construction Quality Certification Program. Proof of this certification will be required.

5. Welding: All welding shall be in accordance with Sections 1 through 8 of the American Welding Society (AWS) DI. 1 Structural Welding Code.

6. Tackers and welders shall be qualified in accordance with the American Welding Society Structural Welding code.

7. Tube longitudinal seam welds shall be free of cracks and excessive undercut, performed with automatic processes, and be visually inspected. Inspection records will be furnished to the Engineer.

8. Longitudinal welds suspected to contain defects shall be magnetic particle inspected. All circumferential butt-welded pole and arm splices shall be ultrasonically and radio graphically inspected. Inspection records will be furnished to the Engineer.

9. Camera Pole System shall consist of a pole, anchor bolts, base plate, ground rod array, and communication and power conduits to nearest pull box, grounding conduit, spare conduit, and foundation.

10. Design computations for the camera poles shall be complete and shall include but not be limited to the following:

    a. Consideration for all parts of the structure.

    b. Consideration for all possible loading combinations including wind and ice loads.

    c. Design stresses and allowable stresses for all components which comprise the proposed structure.

    d. The top of the pole deflection shall not exceed the following:

        i. 1 inch deflection from center (2-inch deflection diameter) due to 30 mph (non-gust) winds for the 50 foot poles.

        ii. 1.5 inches deflection from center (3-inch deflection diameter) due to 30 mph (non-gust) winds for the 80 foot poles.

    e. All complete shop drawings and design computations shall bear the stamp of a registered Professional Engineer.

    f. Shop drawings shall be approved prior to fabrication. Approval of the shop drawings does not relieve the Design-Builder of responsibility for the design, fabrication, and erection of the structure.

    g. The Engineer reserves the right to reject a pole design if the calculated deflection exceeds that specified herein.

    h. The foundation design shall be based on actual soil conditions from soil borings conducted by the Design-Builder. The cost of the soil borings shall be included in the cost of the pole.

11. The calculations shall include a pole, base plate, and anchor bolt analysis. The pole calculations shall be analyzed at the pole base, 5-foot pole intervals, and at each slip joint splice.

12. For each pole as shown in the plans, the following information shall be given:

    a. The pole's diameter, thickness, section modulus, moment of inertia, and cross-sectional area.

    b. The centroid, weight, projected area, drag coefficient, velocity pressure, and wind force of each trapezoidal pole segment.

    c. The axial force, shear force, primary moment, total moment, axial stress, bending stress, allowable axial stress, allowable bending stress, and combined stress ratio (CSR) at each elevation.

    d. The pole's angular and linear deflection at each elevation.

13. Pole Mounted Cabinet Access Conduit Nipple

    a. Each pole will be manufactured with a 2" diameter rigid threaded nipple for conduit connection to a pole mounted cabinet.

    b. The height of this nipple above the base of the pole shall be such that a cabinet mounting height of 3 feet above ground height can be achieved as shown in the typical details in the plans.

14. Hand Holes

    a. The hand hole openings are reinforced with 2" wide hot rolled steel bar. The opening shall be rectangular and 5" x 8" nominal.

    b. The cover shall be 11-gauge steel and shall be secured to a clip-on lock with a tamper-proof screw.

    c. The reinforcing rim shall be provided with a ½" tapped hole and ½" hex head cap screw for grounding.

    d. For poles with lowering devices two (2) hand holes shall be approximately 18" apart, center to center, or as recommended by the lowering device manufacturer.

    e. The hand holes shall be fully compatible with the Camera Lowering Device and Portable Lowering Tool. If desired and compatible with the lowering device, one larger hand hole may be provided in place of two separate hand holes.

    f. Hand holes on poles with pole mounted cabinets and transformers shall be placed toward oncoming traffic. For all other poles, hand holes shall face away from traffic.

g. Hand holes shall not be oriented on the same side of the pole as the CCTV camera.

15. Pole Top Junction Box: All 80’ camera poles shall have a pole top connector box fastened to the pole top for cable strain relief.

16. Cable Supports (J-Hooks & Eyelets): Top and bottom J-hooks and eyelets shall be located within the pole directly aligned with each other.

17. Base Plate:

    a. Base plates shall conform to ASTM A572.

    b. Plates shall be integrally welded to the tubes with a telescopic welded joint or a full penetration butt weld with backup bar.

    c. Plates shall be hot dip galvanized.

18. Anchor Bolts:

    a. Anchor bolts shall conform to the requirements of AASHTO M314-90 (105 ksi min. yield.) The upper 12” of the bolts shall be hot dip galvanized per ASTM A153.

    b. Each anchor bolt shall be supplied with two (2) hex nuts and two (2) hardened washers.

    c. The strength of the nuts shall equal or exceed the proof load of the bolts.

    d. The top nut shall be torqued so as to produce 60% yield stress of anchor bolt.

    e. The Design-Builder shall not grout between bottom of base plate and top of concrete foundation.

7.2.2 Camera Lowering Device Requirements for 50’ and 80’ Poles

1. All poles shall have a heavy-duty Camera Lowering Device(s) (CLD) with the design capabilities of supporting both IP Base and analog base CCTV cabling. The camera lowering system shall be designed to support and lower a Simultaneous DUAL Analog & IP closed circuit television camera, lens, housing, PTZ mechanism, cabling, connectors and other supporting field components without damage or causing degradation of camera operations. The camera lowering system device(s) and the pole are interdependent; and thus, must be considered a single unit or system. The lowering system shall consist of a pole, suspension contact unit, divided support arm, and a pole adapter for attachment to a pole top tenon, pole top junction box, conduit mount adapter and camera connection box. The CLD shall also meet the following requirements. The Camera Lowering Device shall be safely operable by one technician working alone, to lower the Camera Assembly to ground level for maintenance as necessary and return the Camera Assembly to the pole top mounting and secure it in place, eliminating the need for access by a bucket truck.

2. The camera lowering device's contact block shall support 1000Base-T Ethernet communication.

3. Weatherproof connectors (camera to the lowering device) shall allow for adaptation of the camera and the dome type housing for lowering and hoisting and be provided as an integral part of the design to provide a water-resistant seal when the camera is raised and secured in place for surveillance operation.

4. Lifting and lowering shall be done with a motorized gear box (winch).

5. The CLD should be a stand-alone device mounted on a camera pole to be supplied by the Design-Builder and included in the cost of the associated pole.

6. An integrated CLD with pole assembly may be procured provided it meets all specifications.

7. The Camera Lowering Device shall be designed to preclude the lifting cable from contacting the power or video cabling. In the case where there is dual lowering devices the lifting cable shall not come in contact with the other CCTV's lifting cable, power and video cabling. The only cable permitted to move within the pole or lowering device shall be the stainless steel lowering cable(s). All other cables must remain secure and separate from the lowering cable.

8. The Camera Lowering Device shall support the Camera Assembly a minimum of 20" from the pole.

9. The composite cable between the camera and the CCTV cabinet will be a continuous run with available slack. No pole top interconnections or splices will be permitted.

10. The tenon top shall be a plate mounted tenon that allows for field modification of the arm/camera orientation up to 360 degrees. The tenon shall have mounting holes and slots as required for the mounting of the CLD. Unless otherwise noted, when DUAL mount lowering devices, the mounting slots shall be 180 degrees apart.

11. For dual lowering devices on the same pole the lowering devices shall be designed and installed to work independently of the other. The CLD shall be installed such that the cables from either CCTV will not come into contact with the other's cabling.

7.2.3 Portable Camera Lowering Device Tool

The Design-Builder shall furnish and test one Portable Lowering Tool capable of being operated by a hand winch and an electric drill motor, which is fully compatible with the Camera Lowering Device and the Steel Camera Pole and meets the following requirements:

1. The Portable Lowering Tool shall be one recommended by the manufacturer of the Camera Lowering Device.

2. The Portable Lowering Tool shall have a minimum load capacity of 200 pounds with a 4:1 safety factor.

3. The tool shall consist of a lightweight metal frame and winch assembly with cable, a quick release cable connector, an adjustable safety clutch, and a variable speed industrial duty electric drill motor.

4. This tool shall be compatible with the hand hole of the pole and the Camera Lowering Device inside the hand hole.

5. When attached to the hand hole, the tool will support itself and the load assuring lowering operations and provide a means to prevent freewheeling when loaded.

6. The Portable Lowering Tool shall be delivered to the Engineer upon project completion.

7. The Portable Lowering Tool shall have a reduction gear to reduce the manual effort required to operate the lifting mechanism.

8. The Portable Lowering Tool shall be provided with an adapter for operating the lowering device by a portable drill using a clutch mechanism. The Portable Lowering Tool shall be equipped with a positive locking mechanism to secure the cable reel during raising and lowering operations.

7.2.4 Suspension Unit

1. The Design-Builder shall design the required pole mounting adapters, brackets, and mounting hardware.

2. The Camera Lowering Device shall have a minimum load capacity 200 pounds with a 4 to 1 safety factor.

3. The enclosure receptacle and camera enclosure shall incorporate a mating device.

4. The mating device shall have a minimum of 2 latching devices. These latching devices shall securely hold the camera housing and its control equipment free of vibration or motion between the enclosure receptacle and camera enclosure.

5. The latching devices shall lock and unlock by alternately raising and lowering the camera enclosure.

6. When the camera enclosure is latched, all weight shall be removed from the lowering cable.

7. The enclosure receptacle and camera enclosure shall have a heavy-duty tracking guide.

8. The tracking guide and latching devices shall lock the camera enclosure in the same position each time.

9. Electrical contacts shall be provided to support all camera functions including both IP and analog based CCTVs. The electrical contacts shall be brass, or copper and gold coated to prevent corrosion. The contacts shall be minimum 0.09" diameter, or as approved by the Engineer.

10. Replaceable gaskets shall be provided to seal the electrical contacts and latching devices from moisture and dust.

11. The only cable permitted to move within the pole or lowering device during lowering or raising shall be the stainless-steel lowering cable. All other cables shall remain stable and secure during lowering and raising and shall be secured such that it will not come in contact with the steel lowering cable.

12. The Camera Lowering Device shall be designed to permit a ±3 degree of horizontal adjustment for leveling the dome enclosure.

13. The lowering cable shall be a minimum 5/32" diameter stainless steel aircraft cable with a minimum breaking strength of 1740 pounds.

14. Weights and/or counterweights shall be provided to assure the alignment pin and connectors for the camera connection can be raised into position without binding and that it can be lowered properly.

7.2.5 Light Standards (for RDS)

1. This work shall consist of furnishing detection poles with foundations. Heights shall be as indicated on the Plans or as directed by the Engineer. All work shall be in accordance with the TDOT Standard Specifications for Road and Bridge Construction. The poles supplied shall be standard TDOT luminaire poles.

2. The Design-Builder shall supply poles as specified on the Plans and install as shown on the Plans.

3. Light Standards for RDS shall consist of, but not limited to a pole, anchor bolts, breakaway base, base plate, ground rod array, communication and power conduit to nearest pull box, grounding conduit, spare conduit, and foundation as shown in Plans.

7.2.6 DMS Overhead Mounting Structures

This section describes the requirements for the span type structures (Sign Bridge) to support the DMS elements.

1. The work to be completed by the Design-Builder includes the design, assembly of the component parts and installation including sign span type structures, footings, associated attachment hardware, conduit, wiring, and testing of the structure.

2. The sign structure shall have demonstrated long-term durability to withstand extreme temperatures and weather conditions.

3. Each structure shall be fully warranted for but not limited to rust, corrosion, and structural failure as a complete assembly by the manufacturer for a period of five (5) years, and prorated for up to seven (7) years.

4. The following are the DMS structural design criteria that must be adhered to by the Design-Builder:

    a. Minimum vertical clearance between pavement or shoulder to the lowest DMS or DMS sign component: 20 feet.

    b. Design wind load on signs and mountings shall be based on the TDOT standard wind velocity, no less than 90 mph from any direction.

    c. The sign design area for wind load shall be the width of the entire roadway times the height of the DMS sign times 1.5.

    d. The foundation design shall be based on actual soil conditions from soil borings conducted by the Design-Builder. The cost of the soil borings shall be included in the cost of the structure.

5. The Design-Builder shall provide to the Engineer additional calculations as necessary to design the connections between DMS and the structure and special attachment details.

6. The sign manufacturer shall consider truck induced wind loading in deflection calculations. The natural frequency response of the structure to truck induced wind loads when span type DMS structures are used shall be considered. More information can be obtained on this subject in the Transportation Research Board (National Research Council) "Truck Induced Wind loads on Variable Message Signs," Research Record No. 1594, published in 1997.

7. The Design-Builder shall provide the Engineer calculations and shop drawings for all items associated with the manufacturing, construction, and installation of the sign structure, its attachments, and its foundation.

8. The Design-Builder shall determine the actual length of support columns for all sign structures on the basis of existing field conditions.

7.3 INSTALLATION REQUIREMENTS

All equipment shall be installed according to the manufacturer's recommendations and Plans. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.

7.3.1 Poles

Standards and posts for the camera poles shall be installed as indicated on the Plans and shall conform to the following requirements:

1. All poles shall be installed in accordance with the National Electric Safety Code and ASSHTO.

2. Foundations:

    a. The Design-Builder shall submit a design for pole foundations that has been sealed by a registered Professional Engineer.

    b. The foundation design shall adhere to the prescribed loading and wind deflection as specified in TDOT Standards Specification and AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, current edition, including all interims and updates.

    c. The foundations shall be constructed in accordance with the TDOT Standard Specifications and shall adhere to the approved shop drawings for the loading specified.

    d. If soil conditions require the use of any shoring, casings, or sonotube for proper installation of the foundations, the cost of the shoring, casings or sonotube shall be included in the cost of the pole and foundation.

3. The dimensions and reinforcing steel shall be in accordance with the requirements of Specifications and the foundation designed prepared by the Design-Builder.

4. Cast-in-place concrete pole foundation shall cure a minimum of 7 days before any load is applied to the foundation.

5. Conduit shall be installed in the pole foundation for access and includes conduit to the nearest pull box as shown in Plans.

6. A minimum of one 2" spare conduit shall be installed in all pole foundations as shown in the Plans Typical Details. Spare conduits in pole foundations shall be sealed with blank duct plugs.

7. Grounding System

    a. The Design-Builder shall supply and install a grounding system with ground rod array at the base of all poles as shown on the Plans.

b. The ground rod array system shall be connected to the pole through an appropriate ground clamp.

c. A #6 AWG copper stranded bonding wire shall be installed between the pole and the field cabinet providing a common ground system for each site.

d. All ground bonding wires shall be unspliced.

8. The installation method for the CCTV poles and cameras shall be such that the camera can be rotated as needed around the pole for optimum placement.

7.3.2 DMS Structure Construction Requirements

1. DMS Structures shall be installed according to the manufacturer's recommendations and Plans.

2. The Design-Builder shall procure all overhead sign structures required for the project according to the Specifications shown in the Plans.

3. All sign structure plans and calculations shall be approved by the Engineer. Materials certifications, including mill test reports, shall be submitted to the Engineer prior to erection of the sign structure.

4. It should be noted that no soil borings have been conducted. The Design-Builder shall perform soil borings to be included in the cost of the structure. All soil data utilized by the Design-Builder shall be part of the as-built design plan set for the project.

5. If soil conditions require the use of any shoring, casings, or sonotube for proper installation of the foundations, the cost of the shoring, casings, or sonotube shall be included in the cost of the pole and foundation.

6. DMS structures shall be grounded in accordance with the DMS and the structure manufacturers' recommendations and the Standard Specifications.

7.4 MEASUREMENT

7.4.1 CCTV Pole and Foundation (50' Pole)

CCTV Pole and Foundation (50' Pole) will be measured in units of each and paid for at the contract price of each. The price bid shall include but is not limited to an 50' steel strain pole, lowering device, foundation, conduit inside foundation and to the nearest pull box, wiring between camera and field cabinet, connections to support structures, and satisfactory completion of testing and training requirements, and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the CCTV site complete in place and ready for use. This price shall

be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

7.4.2 CCTV Pole and Foundation (80’ Pole)

CCTV Pole and Foundation (80’ Pole) will be measured in units of each and paid for at the contract price of each. The price bid shall include but is not limited to an 80’ steel strain pole, lowering device, foundation, conduit inside foundation and to the nearest pull box, wiring between camera and field cabinet, connections to support structures, and satisfactory completion of testing and training requirements, and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the CCTV site complete in place and ready for use. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

7.4.3 DMS Structures

DMS Structure will be measured in units of each and paid for at the contract price of each. The price shall include but is not limited to support structures, foundations, catwalk, connection hardware, conduit on the structure, inside foundation and to the nearest pull box, repaving and material restoration around the foundation, satisfactory completion of testing, and all work, equipment, and appurtenances as required to have the structure complete, in place and ready for use. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

7.4.4 Lowering Tool for Camera Lowering Device

Lowering Tool for Camera Lowering Device will be measured in units of each and paid for at the contract price of each. The price bid shall include the complete operational device including all attachments. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

7.4.5 Light Standard (for RDS)

Light Standards, for RDS, will be measured in units of each and paid for at the contract price of each. The price bid shall include but is not limited to a light standard pole, breakaway base, foundation, conduit inside foundation and to the nearest pull box as indicated in the plans, wiring between RDS and field cabinet, connections to support structures, satisfactory completion of testing and training requirements, and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the RDS site complete in place and ready for use. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

7.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

ITEM NO.	DESCRIPTION	UNIT
714-08.16	LIGHT STANDARDS (35’ POLE HEIGHT)	EACH
725-20.01	CCTV POLE & FOUNDATION (50FT POLEW/LWRNG DVICE)	EACH
725-20.02	CCTV POLE & FOUNDATION (80FT POLEW/LWRNG DVICE)	EACH
725-20.03	LOWERING TOOL FOR CAMERA LOWERING DEVICE	EACH
725-20.22	STEEL OVERHEAD SIGN STRUCTURE (SPANS 51FTTO 70FT)	EACH
725-20.23	STEEL OVERHEAD SIGN STRUCTURE (SPANS 71FTTO 90FT)	EACH
725-20.24	STEEL OVERHEAD SIGN STRUCTURE (SPANS 91FT TO110FT)	EACH
725-20.25	STEEL OVERHEAD SIGN STRUCTURE (SPANS 111FT TO120FT)	EACH
725-20.27	STEEL OVERHEAD SIGN STRUCTURE (SPANS 131FT TO 1500FT)	EACH
725-20.30	STEEL OVERHEAD SIGN STRUCTURE (SPANS 201FT TO 250FT)	EACH

The CCTV 50’ and 80’ Pole and Foundation Items, Light Standards Pole, and Steel Overhead Sign Structures will be paid per each as follows:

1. Initial 25% of the contract unit price upon complete installation of foundations.

2. Additional 45% of the contract unit price upon delivery of poles or structure to the site.

3. Final 30% of the contract unit price upon complete installation of poles or structure.

Lowering Tool for Camera Lowering Device will be paid at the unit price for each device when delivered to TDOT.

8 CCTV CAMERA SYSTEM

8.1 DESCRIPTION

This Section specifies the minimum requirements for CCTV Camera Systems furnished and installed on this project. The CCTV Camera System selected for use on this project shall be pre- approved and listed on the TDOT ITS Qualified Product List.

The CCTV Camera System will provide TMC personnel with live streaming video of the roadway network via CCTV Camera Systems installed at locations shown in the Plans. It is the Design-Builder's responsibility to furnish, program, install, and integrate the CCTV camera system in the field and at the TMC. The Design-Builder installed CCTV cameras shall be integrated by the Design-Builder into the existing video display wall and the PTZ video control system at the TMC.

The Design-Builder shall submit a plan for display of the IP CCTV cameras on the existing video wall equipment and submit it to the Engineer for approval. The Design-Builder shall work with the video wall manufacturer and the IP CCTV manufacturer to create a plan for the integration of the cameras into the video wall. This coordination and integration effort shall be included in the cost of the CCTV.

8.2 MATERIALS

All materials furnished, assembled, fabricated or installed shall be new, corrosion resistant and in strict accordance with all of the details described in this SP.

The CCTV Camera System shall comply with the following minimum materials specifications:

8.2.1 General Capabilities and Performance Requirements

Overall CCTV Camera System capabilities and performance requirements include the following:

1. CCTV Camera System shall be placed at fixed locations as shown on the Plans to provide full coverage within the project limits including the mainline travel lanes and shoulders.

2. The CCTV Camera System components shall be compatible with each other and be of rugged design and suitable for reliable operation when mounted in the configuration as specified in this SP and the Plans.

3. The CCTV Camera System shall be capable of attended and unattended, continuous 24 hours per day operation at the sites as shown on the Plans.

4. The CCTV Camera System shall respond to camera control signals from an operator of the system; and transmit video images to remote locations interfaced to the system for observation.

5. The camera shall be fully digital, IP addressable and compliant with the H.264 video encoding standard.

6. The camera shall operate over wide dynamic light conditions ranging from low light/dusk to full sunlight having day (color)/night (monochrome) switchover and iris control, with user-selectable manual and automatic control capabilities.

7. The CCTV Camera System shall be capable of being remotely controlled and programmed.

8. The camera shall be mounted together with the zoom lens and integrated into the pan and tilt device within the enclosure forming a totally integrated, easily removable assembly.

9. The camera shall include a high-quality integrated camera/lens combination.

10. The camera shall be equipped with an auto-iris lens capability compatible with the zoom lens supplied.

11. Iris capability shall include a provision for manual override via software.

12. The camera shall be capable of auto-focus during zoom-in or zoom-out, with provisions for override via software.

13. Overexposure protection shall be provided - the camera shall not be degraded or damaged under normal reasonable operating conditions.

14. The capability for local control of pan, tilt and zoom functions shall be provided at the roadside cabinet using vendor-supplied software installed on a laptop computer.

15. The camera shall have image stabilization to reduce image jitter during viewing of the video.

16. The Vendor shall provide a minimum three (3) year warranty that covers manufacturing defects and workmanship. The warranty shall cover complete replacement at no charge for the equipment.

8.2.2 Camera Unit

The minimum Camera Unit requirements include:

1. Image Sensor Size: Not less than Diagonal 6mm (1/3” type)

2. Image Resolution: Not less than 1280 x 720

3. Day/Night Operation: Adjustable (Auto, Color and Mono Modes) via removable IR cut filter
4. Maximum Lens Aperture: Not less than f/1.6 (wide) to f/2.8 (tele)

5. Optical Zoom Range: Not less than 30X

6. Optical Zoom Speed: Two speeds

7. Horizontal Angle of View: Optical: Not less than 55.2° to 3.2°

8. Minimum Focus Distance: Not greater than 0.01m (wide); 1.0m (tele)

9. Auto Focus: Selectable Auto/Manual; Minimum Scene Illumination for Reliable Auto Focus shall be no more than 50% video output.

10. Manual Shutter: Selectable

11. Auto Iris; Selectable auto/manual; Iris shall automatically adjust to compensate for changes in scene illumination to maintain constant video level output within sensitivity specifications.

12. Sensitivity: Scene Illumination minimums; F1.6 @ 50% Video
    a. 1.8 Lux (0.18 fc) @ 1/30 shutter, color mode

    b. 0.1 Lux (0.01 fc) @ 1/30 shutter, mono mode

8.2.3 H.264/MJPEG Encoding Engine

The IP Camera Positioning System (IPCPS) shall fully integrate within its enclosure an H.264/MJPEG encoding component with functions as specified below. The Design-Builder may submit a nonintegrated solution installed in the traffic control cabinet or separate CCTV cabinet if it provides the same capabilities and is hardened for extreme temperatures, under approval by the TDOT Traffic Operations Division.

1. Video Encoding: H.264 (Main Profile/Level 3.1) and MJPEG standards.

2. Video Streams: Two independently configurable streams; (1) H.264 and (1) MJPEG.

3. Video Stream Configuration Properties

    a. Stream Settings

        i. Video Stream 1: H.264.

        ii. Video Stream 2: MJPEG.

    b. Video Resolution: Not less than 480p and 720p.

    c. Streaming Mode: Capable of selectable CBR or VBR.
    d. Frame Rates: 30, 15, 7, 4, 2, 1 fps

4. Data Rate: Adjustable in a range of not more than 256 Kbs up to 8Mbs for streaming video.

5. Connection Types: Uni-cast and multi-cast.

6. IPCPS Video Latency: <150ms

7. Supported Network Protocols: RTP, RSP, UDP, TCP, IP, DHCP, DNS, HTTP, HTTPS, ARP, ICMP, IGMPv2 and SMNPv2c/v3 as a minimum.

8.2.4 Positioning Drive

1. Pan Movement; 360 degrees continuous rotation.

2. Pan Speed; Variable from 0.1 to 90 degrees/second or better.

3. Pan Repeatability; +/- 0.25-degree precision or better.

4. Pan Preset Speed; 180-degree movement < 2 Seconds.

5. Tilt Movement; Minimum of +90 to –90 degrees.

6. Tilt Speed; Variable from 0.1 to 45 degrees/second or better.

7. Tilt Repeatability; +/- 0.25-degree precision.

8. Tilt Preset Speed; 180-degree movement < 3 Seconds or better.

8.2.5 Operational

1. The CCTV camera shall utilize NTCIP v 1.08 communication protocol.

2. Presets: Minimum of 64, with each preset consisting of a pan, tilt, zoom and focus coordinate.

3. Preset Tours; Minimum 8 tours required, each tour shall consist of up to 32 pre-programmed presets, with individual dwell time property per preset per tour.

    a. Tour presets shall be useable in any order.

    b. Presets may be used multiple times in tour.

    c. Tours shall stop upon receipt of any pan/tilt positioning command.

    d. Tour data shall be stored in non-volatile memory and shall not be lost if a power failure occurs.

4. Sector Zones: Provide a minimum of up to 16 user defined sector zones with each zone having a unique 24-character ASCII title programmed for description purposes.

5. Camera Site ID: Provide up to 2 lines of up to 24 ASCII characters each on video for user site description ID. If both lines are programmed, line 1 of ID shall always appear above line 2 regardless of top or bottom selection.

6. Preset ID: Provide 1 line of up to 24 ASCII characters on video for Preset ID description. When a preset position is recalled, the corresponding preset ID shall be displayed. The preset ID shall remain displayed until a pan, tilt, zoom, manual focus, auto focus select, or another preset command is received.

7. Scalable Zoom: Variable speed pan/tilt ranges based off of zoom position. This add the capability of limiting the maximum pan/tilt speed, while maintaining variable speed capability, throughout the zoom range of the camera.

8. Updates: The IPCPS shall allow updates of firmware for new features via the Ethernet network communication channel. An internal IPCPS web server shall be provided for performing this task.

9. The IPCPS shall return to previous position and state of operation upon power loss and restoration.

8.2.6 IP Management

The IPCPS shall provide at minimum the following network configuration properties:

1. IP Configuration: DHCP or Static IP address entry.

2. Net mask address entry.

3. Gateway address entry.

8.2.7 Power Input

The IPCPS shall fully comply with and include independent laboratory test results confirming compliance with the following electrical operating conditions:

1. Power; <100 Watts Maximum.

2. Operating Voltage; 100-240 VAC

3. The nominal voltage shall be 120 VAC, Per NEMA-TS2 para 2.1.2.

8.2.8 Mechanical

1. Connectors weatherproof non-corrosion type.

2. Weight; Maximum 25lbs.

3. Construction: Light Colored Powder Coated aluminum; all internal and external parts corrosion protected, stainless steel fasteners.

4. Faceplate shall be optically correct glass.

5. Camera Mount; Provided to match pole locations on plans. See plans for variable types of poles.

6. Camera housing shall be equipped with a 1.5" NPT pipe thread to allow for connection to the Camera Lowering Device connection box.

8.2.9 Environmental

The IPCPS shall fully comply with and include independent laboratory test results confirming compliance with the environmental operating conditions in this section. Testing completed by Florida Department of Transportation for acceptance to their Qualified Products List (QPL) may be submitted for approval by TDOT Traffic Operations Division, in lieu of the following specifications:

1. Temperature; The operating ambient temperature range be from -34°C (-30°F) to +60°C (+140°F).

2. Vibration: Per Nema-TS2 paragraphs 2.1.9 and 2.2.3, 5-30Hz sweep @ 0.5g applied in each of 3 mutually perpendicular planes.

3. Shock; Per Nema-TS2 paragraphs 2.1.10 and 2.2.4, 10g applied in each of three (3) mutually perpendicular planes.

4. Water Spray; Per IEC 60529+A1, 1999, Para 14.2.6, Solid water stream delivered thru 12.5mm nozzle @ 25 gallons/minute @ 9ft for 3 minutes.

5. External Icing; Per Nema-TS2 250-2003, paragraphs 5.6.

6. Corrosion Protection; Per NEMA 250-2003, paragraphs 5.10.

7. Humidity; The IPCPS shall withstand the effects of humidity up to 100%, in accordance with MIL-E-5400T, paragraphs 3.2.24.4.

8. Minimum Standards: IP66.

8.2.10 Certifications

1. CE (24VAC).

2. FCC Class A.

8.2.11 Surge Protection

All CCTV Camera System electrical interconnects shall be protected from transient over-voltages (surges) including lightning and external electromagnetic fields coming into the cabinet. All cables shall be protected from a surge coming in on the ground and load side of the cabinet. The minimum surge protection requirements include:

1. Surge protectors shall be furnished for all non-dielectric cable and conductors (video, data/signal and device/assembly power) between the CCTV Camera System and the equipment cabinet.

2. The surge protectors shall have leads that are kept to a minimum length as recommended by the surge device manufacturer.

3. All surge protection devices shall be designed and selected to meet the temperature and humidity requirements expected in this type of outdoor application. Surge suppressors including variable temperature components (i.e., PTCs) shall not impede signals at any elevated temperatures.

4. All Surge protectors shall be U.L. listed (UL 1449 3rd Edition, UL 497, 497A, 497B,) and bonded to the same single-point ground point. Any DIN rail mounted SPDs shall be grounded via conductor and shall not rely solely upon the DIN rail's mechanical connection as a grounding point.

5. Any directional SPDs shall be clearly marked as "Protected Side" and "Unprotected Side" and installed such that the Protected Side faces the equipment and the Unprotected Side faces the conductors coming into the cabinet.

6. If coaxial cable surge protectors are used from acceptance by the Engineer, the Coaxial Cable Surge protectors for coaxial cable shall meet/provide the following functionality:
    a. Attenuation: 0.3dB @ 10 MHz, typical.

    b. Input/Output Impedance: 75 ohms nominal.

    c. Operating Voltage of the surge protector shall match characteristics of the ITS device/assembly.

    d. Peak Surge Current: 5,000-amperes for an 8x20 microsecond waveform.

    e. Response Time: 1 nanosecond or less.

    f. Surge suppressor shall be self-resetting.

g. Coaxial SPDs shall be installed in a manner that prevents ground loops and resulting signal deterioration. This is usually caused where the cable has different references to ground at either end and connecting SPDs at both ends that have only Pin to Shield protection completes a ground loop circuit through the Shield. SPDs having Pin to Shield protection, and separate Shield to Ground protection are acceptable to eliminate ground loops.

7. Low Voltage/Signal Cable Surge protectors for data/signal/control cable shall meet/provide the following functionality:

    a. Peak Surge Current: 10,000-amperes for an 8x20 microsecond waveform.

    b. Shall be rated for the appropriate voltage.

    c. Response Time: 1 nanosecond or less.

    d. Life Expectancy: Capable of surviving at a minimum of 25 occurrences at 2000-amperes.

    e. Surge suppressor shall be self-resetting.

8. CCTV power surge protectors for power from equipment cabinet power distribution to the CCTV Camera System shall meet/provide the following functionality:

    a. Frequency: DC to 10MHz.

    b. Clamping Voltage: < 30VAC (rms) or 42VDC.

    c. Insertion Loss: < 0.2dB

    d. Input/Output Impedance: 75 ohms, typical.

    e. Peak Surge Current: 3000-amperes.

    f. Response Time: 1 nanosecond or less.

    g. Surge suppressor shall be self-resetting.

8.2.12 NDAA Telecommunications and Video Equipment Restrictions

Installation of telecommunication and video surveillance equipment, services or systems shall contain no components from providers as listed in Title 2 Code of Federal Regulations (CFR) Part 200.216.

It is prohibited to install equipment, services, or systems from the providers described in section 889 of the NDAA 2019 to include:

1. Telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities);

2. Video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities);

3. Telecommunications or video surveillance services provided by such entities or using such equipment; or

4. Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country. The term "covered foreign country" means the People's Republic of China.

8.3 INSTALLATION AND INTEGRATION REQUIREMENTS

All equipment shall be installed according to the manufacturer's recommendations and as follows:

1. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.

2. Shall include all materials needed to permanently mount the CCTV camera to the support structure as indicated in the plans.

3. Furnish and install power, video, and data cables, and any and all ancillary equipment required to provide a complete and fully operational CCTV system site.

4. Verify all wiring meets NEC requirements where applicable.

5. Cameras shall be mounted in positions which allow 360-degree continuous rotation.

6. Furnish and install all appropriate field surge protection devices and ensure proper ground per manufacturer recommendations.

7. Coordinate with TMC IT for IP addresses, and video encoding settings prior to turn-on/installation and site testing.

8. The CCTV system shall be compatible with and integrated into the existing TMC video wall and CCTV control software. It shall be the Design-Builder's responsibility to coordinate with the TMC operations personnel for Vendor integration of the new CCTV cameras into the existing video wall and video control software systems. It is the Vendor's responsibility to integrate and test all video control and display of the cameras at the TMC.

8.4 MEASUREMENT

CCTV Camera System will be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing, installing, system integration, training, documentation, and testing of a complete CCTV Camera System including the CCTV Camera Assembly, PT unit, zoom lens, enclosure, camera controller/receiver, coaxial cable (if required and approved), outdoor rated category 5e cable, control/signal cable, power cable, surge suppressors and conduit between the camera and the cabinet, connections to support structures, attachment hardware and brackets and all incidental items to provide and install the CCTV Camera System as intended, as well as the satisfactory completion of all testing requirements and all work, equipment and appurtenances as required for a fully functional CCTV Camera System. The price bid shall also include all local configuration and control manufacturer software, system documentation including: shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams and other materials necessary to document the operation of the CCTV Camera System. The price bid shall include integration and configuration into the existing TMC video wall and controller and testing for display of the video on the existing video wall. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

8.5 PAYMENT

The contract unit price shall be full compensation for all the work specified in this Section. Payment will be made under:

ITEM NO.	DESCRIPTION	UNIT
725-20.06	CCTV MAINTENANCE WORKPAD	EACH
725-20.91	CCTV CAMERA SYSTEM	EACH

The CCTV Camera System will be paid per each as follows:

1. Initial 50% of the contract unit price upon approval of Bench Test Component, Bench Test System and Pre-Installation test results.

2. Additional 20% of the contract unit price upon approval of Stand-Alone Site Test results.

3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results including CCTV video display on existing video wall.

4. Final 10% of the contract unit price upon Final System Acceptance.

9 TMC SYSTEMS

9.1 DESCRIPTION

This section describes the Region X Transportation Management Center (TMC) equipment and software specifications and requirements for this project. The work consists of providing all labor, materials, software, and incidentals necessary to furnish, install, integrate, and test the Region 1 Rural ITS SmartWay system deployment. The work includes all additional licensing, documentation and training necessary to operate the system as required in this SP.

The Design-Builder will be responsible for integrating the ITS devices provided in this contract into TDOT's legacy central control software system. This system currently support multiple ITS device makes and models. Therefore, this Contract is a total "turn-key" solution that ensures the DMS, RDS, and CCTV subsystems are fully functioning with the central software in place.

For all active electronic devices controllable through any type of communications interface, the Design-Builder shall be required to voluntarily, and without seeking additional fees, restrictions, licenses or compensation from TDOT, coordinate with each respective system representative for each piece of equipment supplied, to support direct communication with and control of devices by the TDOT SmartWay operational systems identified. The Design-Builder will be responsible for coordinating with the system venders to ensure sufficient drivers are developed to support the new device make and/or model provided under this contract without additional compensation.

9.2 MATERIALS

9.2.1 General Requirements

The TMC system procured and installed under this Contract shall support daily operations and maintenance activities associated with the SmartWay ITS.

1. TMC Systems Design Report Submittal

   The Design-Builder shall document and submit a TMC Systems Design Report to the Department for review and approval prior to any integration of new ITS field devices within the TMC. The TMC Systems Design Report shall document the Design-Builder's overall TMC design including overall network modification configuration, and confirmation of device support by the TMC legacy system developers. Detailed submittal requirements are included in Section 9.2.6. The cost for this submittal is considered incidental and included in the cost of other items.

2. Local Area Network (LAN)

   a. The SmartWay shall operate over a TCP/IP client/server architecture, which will support operations over the TMC SmartWay local area network (LAN) and the TDOT network.

b. The Design-Builder shall document in the TMC Systems Design Report submittal the TMC building infrastructure (e.g., cabling, patch panels/cords, etc.) requirements needed to support their TMC system configuration.

3. TMC Hardware / Equipment

    a. The Design-Builder shall be responsible for the integration, configuration, and testing of all ITS field devices with TMC hardware and equipment through the legacy software as specified herein.

    b. It is the Design-Builder's responsibility to ultimately install, configure, integrate and test the TMC SmartWay LAN modifications and legacy software along with the field network devices and ITS subsystems.

4. Communications

    a. The TMC shall be able to communicate with field devices via wireless/radio and fiber optics that support Ethernet communications.

9.2.2 CCTV Software

The Design-Builder is responsible to determine TDOT's current operating software at the TMC for video management. The Design-Builder's responsibility related to this Software is to coordinate with the software developer to ensure that supported drivers include all new CCTV elements added as part of this contract.

9.2.3 DMS Software

The Design-Builder shall provide vendor supplied software capable of testing DMS commands from the TMC over the network. This software will be used for testing and verification only. Cost of the DMS Software shall be included in the cost of the DMS units. The software shall not require serial data converters (i.e., terminal servers) to establish DMS communications.

For the multi-color DMS, the central software support shall be available for up to three years from the date of final acceptance.

9.2.4 RDS Software

RDS devices will be used to drive this project's speed feedback DMS through the use of programmable logic controllers (PLC). The programing of these PLCs to achieve the described special feature operation will be the direct responsibility of the Design-Builder.

The Design-Builder shall also provide vendor supplied software capable of testing RDS data from the TMC over the network. This software will be used for testing and verification only. Cost of the RDS Software shall be included in the cost of the RDS units.

9.2.5 System Integration

System Integration shall include all integration tasks that are needed to meet all specification requirements but are not included specifically in the cost of other items.

This includes, but is not limited to, integration with the identified legacy system, efforts associated with meeting the general requirements of this SP, integration with the building UPS monitoring systems, coordination with the TDOT IT department, system integration diagrams to document the overall configuration of the system, and other related system and integration activities.

9.2.6 Project Submittal Program Requirements

1. General Requirements

    a. The Design-Builder shall provide project submittals for all TMC Systems as required in Section 1.8 of this SP, including scheduling requirements. The project submittals for TMC Systems shall include but are not limited to the additional specific requirements in this subsection.

2. TMC Systems Design Report Submittal

    a. The Design-Builder shall submit to TDOT for review and approval a TMC Systems Design Report submittal, which documents the detailed TMC integration approach and includes all the elements specified in this section of this SP as follows:

        i. Client/server network and operating system requirements, if different from that specified in this section.

        ii. The Design-Builder shall review the equipment/hardware/infrastructure (workstations, servers, cabling, patch cords, etc.) specifications provided in this section. If the Design-Builder requires something different from that currently specified to support their System Integration efforts and configuration, they shall provide their rationale/reasons with supporting documentation for the requested changes or modifications as part of this submittal. If the Design-Builder is in full agreement with the hardware/equipment specifications as specified in this section they shall provide an affirmative acknowledgement/statement of this fact within the submittal.

        iii. The Design-Builder shall provide documentation on application data file format/structure as specified herein.

iv. The Design-Builder shall provide description and integration details of the video wall subsystem.

v. The Design-Builder shall provide proposed expansions to the network addressing schemes and network traffic routing modifications.

vi. The Design-Builder shall provide ten (10) bound copies including one (1) signed original to TDOT for review and approval thirty (30) calendar days prior to any procurement.

vii. The Design-Builder shall provide three (3) CD copies of the TMC Systems Design Report submittal.

b. The Design-Builder shall also provide detailed discussion and rationale for any and all requested changes or modifications to system design configuration, hardware and software operating system requirements as specified in this section of this SP.

c. The Design-Builder may request that one or more of the requirements as specified herein be modified or replaced in support of their system solution. Any and all requested modifications and changes to requirements shall be documented in detail in the submittal for consideration and approval by TDOT. The Design-Builder will be responsible for any additional costs resulting from the requested changes.

d. The cost of the TMC Systems Design Report shall be included in the cost of other items, as are all submittals.

9.3 INSTALLATION REQUIREMENTS

All equipment and software shall be installed according to the manufacturer's recommendations and the Plans.

Any beneficial use by TDOT of any portion of the TMC hardware or integrated software system does not constitute TDOT acceptance or waive any Design-Builder responsibility or testing requirements.

9.3.1 General

1. The Design-Builder shall configure, integrate, and test the TMC hardware and equipment in accordance with the Plans and this SP.

2. All patch cords and cabling within the TMC shall be consistent and meet the minimum cabling requirements as specified in this SP.

3. The Design-Builder is responsible for ensuring that all cables, connectors, interfaces, supplies, and any other items necessary for the proper operation and function of any component or

software product shall be installed, integrated, and tested to provide a fully operational system. Note that TDOT will provide the network cabling from the equipment room out to the floor boxes under each console. The Design-Builder will be responsible for all other cabling between the equipment and floor boxes and between equipment within the Equipment Room.

4. IP address ranges for all devices will be provided by TDOT.

5. The Design-Builder shall be responsible for obtaining any MIB (Management Information Base) information for all field devices supporting SNMP. The Design-Builder shall configure the NMS software to meet all requirements of Section 10.2.7. In the NMS user interface, the Design-Builder shall configure the ITS Device IDs for each SNMP device on the network.

9.3.2 Testing Requirements

The Design-Builder shall conduct a project testing program for System Integration as required in Section 1 of this SP and as follows:

1. In addition to demonstrating that the System Integration functionality meets this SP, the Bench Test Component test shall demonstrate that TDOT furnished equipment operates with Design-Builder furnished and installed software.

2. The Design-Builder shall use TMC servers during the Bench Test System (BTS) to demonstrate that the System Integration meets the requirements of this SP and is operable with the new and existing system.

9.3.3 IP Addresses

The Design-Builder shall utilize the IP Addressing Schema provided by TDOT and the municipalities to create a Project specific list for all new/existing ITS devices that are installed / reconfigured as part of the project.

The Design-Builder shall request IP ranges from TDOT and the municipalities sixty (60) calendar days prior to the test procedure submittal due date. The Design-Builder shall utilize the IP ranges to develop the IP addressing scheme and naming convention as part of the test procedures. The IP addressing scheme and naming convention shall be adhered to while installing new devices along the project corridor.

The Design-Builder shall submit a document listing all IP addresses utilized in the project in an easily understood format depicting at a minimum, the following information:

1. Page Number (from Plans)

2. Mile Marker (MM)

3. Global Positioning System (GPS) coordinates

4. Device

5. IP Address

TDOT and the municipalities shall review and approve the Design-Builder's IP Addressing Schema submittal prior to the Design-Builder's implementation of the schema.

The Design-Builder shall design and deploy multiple VLANs to segment ITS field devices into logical workgroups. The Design-Builder shall ensure that the new ITS devices are configured in new sets of VLANs. The existing and replacement ITS devices shall be maintained in the existing VLANs.

9.4 MEASUREMENT

9.4.1 CCTV System Software

For all active CCTV related devices controllable through any type of communications interface, the Design-Builder shall be required to voluntarily, and without seeking additional fees, restrictions, licenses or compensation from TDOT, coordinate with the current CCTV System Software representatives, to support direct communication with and control of devices by the TDOT SmartWay video distribution system and video wall.

9.4.2 DMS System Software

DMS Software is vendor software for testing only; therefore, there is no separate payment for this item. For DMS devices controllable through any type of communications interface, the Design-Builder shall be required to voluntarily, and without seeking additional fees, restrictions, licenses or compensation from TDOT, coordinate with the current DMS System Software representatives, to support direct communication with and control of devices by the TDOT SmartWay system.

9.4.3 RDS System Software

PLC programing to extract data from RDS devices used to drive this project's speed feedback sign, truck information lane traffic signals, and associated queue backup detection is the direct responsibility of the Design-Builder. Payment for PLC programing is embedded in that item and there is no separate payment for this item.

RDS Software is vendor software for testing only; therefore, there is no separate payment for this item. For RDS devices controllable through any type of communications interface, the Design-Builder shall be required to voluntarily, and without seeking additional fees, restrictions, licenses or compensation from TDOT, coordinate with the current RDS System Software representatives, to support direct communication with and control of devices by the TDOT SmartWay system.

9.4.4 Additional Software

Any additional application software, tools, and associated licenses that are not listed in the items (9.4.1 through 9.4.3) above but are needed to provide a complete and operational system as well as meet the requirements of this SP shall be considered incidental and shall be included in the cost of the most appropriate item.

9.4.5 System Integration

System Integration will be paid for on a lump sum basis wherein no measurement will be made. The price bid for system integration shall include all integration tasks that are needed to meet all specification requirements but are not included specifically in the cost of other items. This includes but is not limited to integration with the video wall controller, integration between the various software packages, efforts associated with meeting the general requirements of this SP, integration with the Hub UPS and security monitoring systems, integration with the building UPS monitoring systems, coordination with the TDOT IT department, system integration diagrams to document the overall configuration of the system, and other related integration activities. This item shall also include the network cabling from the equipment room to the workstations (Cat-5e network cable), rack-mounted video monitor and keyboard, UPSs, KVM switch, and interface adaptors.

This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

9.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-24.51	SYSTEM INTEGRATION	LS

System Integration will be paid on a lump sum basis as follows:

1. 20% of the contract unit price upon successful completion of the bench test system (BTS) as stated in Section 1.5.4 of this SP.

2. Additional 70% of the contract unit price upon conditional system acceptance as stated in Section 1.5.7 of this SP.

3. Final 10% of the contract unit price upon Final System Acceptance.

10 COLORED DYNAMIC MESSAGE SIGN

10.1 DESCRIPTION

This Section describes furnishing, installing, and integrating a high-resolution color electronic Dynamic Message Sign (DMS) assembly on a full span structure over the roadway and ground testing of sign. The DMS assembly selected for use on this project shall be pre-approved and listed on the TDOT ITS Qualified Product List. The Design-Builder shall supply a complete operating Light Emitting Diode (LED) sign including the sign case, sign controller unit (SCU), roadside DMS controller cabinet, all cabling, conduits, electrical service, surge suppression, and all hardware associated with a complete installation as required by this SP. Note that the DMS item used to include a Roadside DMS Controller Cabinet. Now a separate Type C cabinet item is included in the plans and utilized as the Roadside DMS Controller Cabinet.

The DMS assemblies will provide TMC personnel with a means to visually communicate with motorists regarding any incidents, accidents, special events, travel times, graphical representations of common road and construction signs, and the use of those graphics forlane management of the roadway during a roadway construction project. The DMS system shall also include manufacturer software that allows the creation, placement and display of graphics on the DMS. This software shall be installed in the Regional TMC with TMC operator access to the DMS field controller to allow display status and operational status.

10.2 MATERIALS

10.2.1 General

1. Each DMS assembly shall consist of the following minimum components and general requirements:

    a. Full matrix LED sign with walk-in sign case.

    b. Mounting brackets.

    c. Associated SCU and software.

    d. Cabling between the various components.

    e. All electrical components shall be of the solid-state design. Use of vacuum or gaseous tube devices is not acceptable.

2. Provide door locks for all sign case and DMS cabinet doors, keyed to TDOT standard Corbin #2 that will be provided and confirmed during the submittal process. Provide two keys with each DMS location.

3. Provide a voltage label on all sign cases and DMS cabinets or enclosures in accordance with the NEC labeling requirements. Voltage labels shall meet the following minimum requirements:

    a. Labels shall be flat black lettering on a reflective yellow background. Lettering shall be a minimum of 1 inch in height.

    b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

    c. Labels shall include the voltages entering the cabinet and shall be one continuous adhesive sheet. Examples are “120 VAC” or “120/240 VAC”.

    d. Labels shall be installed on all sign case and DMS cabinet doors.

10.2.2 Sign Display

The sign display shall meet the following requirements:

1. Each sign display shall have a single plane surface constructed of a single array of pixels.

2. The multi-color DMS system shall include manufacturer’s central control software.

3. Each sign display shall be able to display full color, a minimum of 24 bit displayable color.

4. Each full matrix sign display shall be able to display three (3) lines of twenty-one (21) - 18” tall characters that adhere to the respective MUTCD required NEMA TS 4 font sizes for electronics changeable massage signs.

5. Each line shall contain a continuous matrix of pixels allowing the display of at least three (3) lines of 21 characters per line using a standard 18-inch high font (23 X 15 pixel typical). Due to high-resolution aspect of the sign, pixel spacing between characters shall be determined as most compliant to latest version of MUTCD and NEMA TS 4 Hardware standard spacing.

6. Pixel columns and rows shall be perpendicular. The Pixel Matrix shall have a minimum of 96 rows x 400 columns.

7. Graphics shall be able to be formed on the multi-color DMS.

8. Each sign shall be able to display graphic shapes including but not limited to arrows, roadway signs, and interstate shields, each of which can be designed and/or altered by the user through the supplied software.

9. Pixel spacing shall be such that three lines of text shall each have a nominal height of 18 inches with appropriate inter line spacing.

10. Vertical and horizontal spacing between pixel centers shall be equal.

11. A minimum 12” border shall surround the LED pixel array.

12. Provide an automated light intensity measurement through electronic light sensors that can be easily maintained. The sensors shall be mounted in a manner to measure front, rear and ambient light conditions to set brightness levels.

10.2.3 Character Set

The signs shall support the following character display requirements:

1. Characters and/or shapes shall be formed on a matrix comprised of rows and columns forming a continuous line.

2. Individual characters shall be formed by pixels within a character matrix defined by the character font.

3. All upper-case characters shall be displayed over the entire height of each character matrix.

4. Character to character spacing shall be determined by the font selected by the user.

5. Lower case lettering that extend below the bottom (g, j, p, q, y) must be proportioned in location and style per line.

6. Both fixed-space and proportional spaced fonts shall be supported.

7. Shall be capable of auto line centering, left, and right justified in the specific line.

8. Each sign shall be able to display a message composed of any combination of the following characters and shapes:

    a. All upper-case letters "A" through "Z".

    b. All lower-case letters "a" through "z".

    c. All decimal digits "0" through "9".

    d. A blank or space.

    e. Punctuation marks shown in brackets [. , ! ? - ' " / ( )]

    f. Special characters shown in brackets [# $ % & * + < >]

g. 32 (or more) special graphic shapes, each of which can be designed and/or altered by the user.

9. Character height to stroke width ratio and character spacing shall be designed and constructed to achieve optimum legibility.

10. Character sets shall be submitted for review and approval.

11. Pixel size, pixel center-to-center distance, character height to stroke width ratio, and character spacing shall be designed and constructed to achieve legibility at 900 feet with a standard 18" font.

10.2.4 Physical Properties

The sign physical properties shall meet the following requirements:

1. Access for all maintenance shall be from within the sign case and from the rear (i.e. the side opposite of the display surface) of the sign display.

2. The sign design shall allow unobstructed and convenient access to all non-structural components. Structural components are defined as the metal sign case and Lexan display cover.

3. All serviceable components shall be modular, interchangeable, and removable from within the sign case.

4. The sign display shall be composed of identical and readily interchangeable display modules and drivers.

5. Each display module shall contain one or more display pixels.

6. The replacement of any display module shall not require the use of any special tools.

7. All wiring interconnecting individual display modules shall be modular harness assemblies with latching push-on/pull-off or twist on/off connectors.

8. The removal of any combination of one or more display modules shall not alter the structural integrity of the sign display assembly, nor of the sign case.

9. The removal of any combination of display modules shall not affect the operation of the remaining operational modules in any way.

10. The performance of the sign shall not be impaired due to vibration caused by wind, traffic, or any other source.
11. All serviceable components shall weigh 50 pounds or less.

12. Mating connectors shall be designated by the connector number and male/female relationship. Connectors shall be keyed or pinned to prevent improper insertion of the wrong connector or PCB.

10.2.5 Pixels

Each pixel shall meet the following requirements:

1. Each pixel shall contain the quantity of discrete LEDs needed to output white colored light at a minimum of 12,400 Candelas/m2 (white).
2. The number of necessary LED's shall be determined by the Vendor and be provided to the Engineer for approval.
3. Pixel to pixel luminous intensity shall not vary by more than a 2:1 ratio.
4. The optical axis of all pixels shall be perpendicular to the face of the sign display.
5. Pixels shall be replaceable either individually or in groupings. Groupings with three or more pixels shall be permitted only if bench level repairs and replacements to individual pixels are possible.
6. The failure of an LED in one string within a pixel shall not affect the operation of any other string or pixel.
7. Pixel Pitch shall be 20 mm (0.81 in).
8. Pixel power shall not exceed 1.5 watts per pixel, including the driving circuitry.
9.

10.2.6 LED Technology

LEDs used to form a display pixel shall meet the following minimum requirements:

1. The manufacturer shall be the same for all LED's in all signs.

2. The LED manufacturer shall perform color and intensity sorting to the bins. Each color and intensity of the LED's shall be obtained from no more than two (2) consecutive color 'bins' as defined by the LED manufacturer.

3. Each LED driver board shall be microprocessor controlled and shall communicate with the sign controller on a wire or fiber optic communications network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostics, and report pixel status.

4. Red LEDs shall utilize AlInGaP semiconductor technology and shall display a red color at a wavelength of 615 nm – 630 nm (± 5 nm).

5. Green LEDs shall utilize InGaN semiconductor technology and shall display a green color at a wavelength of 520 nm – 530 nm (± 5 nm).

6. Blue LEDs shall utilize InGaN semiconductor technology and shall display a blue color at a wavelength of 465 nm – 470 nm (± 5 nm).

7. The LED shall have a nominal viewing cone of 30° with a half-power angle of 15° measured from the longitudinal axis of the LED. Viewing tolerances shall be a specified in the LED manufacturer's product specifications and shall not exceed ± 5°. Using optical enhancing lenses with 15° LED's will not conform to 30° half-power viewing cone specifications and will be cause for rejection.

8. The LED size shall be nominally 0.20 inches.

10. The luminous output shall be a minimum of 3,000 mcd luminous intensity at 20 mA forward current.

11. Current flow through any LED shall not exceed the following values under any light output level:

    a. RMS current of 25 mA

    b. Peak current of 30 mA

12. LED life shall be nominally rated for 100,000 hours of operation under field conditions, which shall include operating temperatures between -22° and +185°F (- 30° and +85°C).

13. LED life shall be defined as time it takes for the LED light output to degrade to half of the LED's initial light output.

14. To maximize LED service life, LED drive currents will not be allowed to exceed the manufacturer's recommendations for the 100,000-hour life,but shall be sufficient to supply the required intensity.

15. The LED pixels shall be directly driven using pulse width modulation (PWM) of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels.

10.2.7 Sign Case

The DMS Sign Case shall meet the following requirements:

1. Be a walk-in type, weatherproof enclosure that houses electrical, communication, and electronic control devices necessary for the operation of the sign. All steel components shall be stainless steel, unless otherwise noted in these specifications.

2. The sign case shall comply with AASHTO Design Standards for "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffc Signals" and with the fatigue requirements of the National Cooperative Highway Research Program (NCHRP). All sign case and structural drawings shall be stamped by a Professional Engineer registered in the State of Tennessee.

3. Be attached to and become an integral part of the support structure.

4. The dimensions of the sign case (including walk-in cabinet) shall be as specified in this SP. Sign case dimensions shall be approved by Engineer.

5. The sign case shall present a clean, unbroken, neat appearance.

6. The front of the sign case shall not have any visible text or logos on it.

7. The sign case shall be weatherproof and protect the interior from moisture, dust, dirt and corrosion.

8. Positive corrosion protection shall be provided between dissimilar metals.

9. The angular alignment of the sign case shall be adjusted in the vertical direction down by three (3) degrees and incorporated into the face of the display so as to leave the internal walkway as level as possible. If the sign can only be tilted using external brackets to the case, provisions shall be made to make the internal walkway level.

10. The sign case shall be constructed of aluminum sheeting to be 5052-H32 and structural members to be 6061-T6.

11. Aluminum sheeting shall be not less than 1/8 inch thick with all seams continuously welded by the inert gas process.

12. The front of the sign case shall have a flat black matte finish applied in accordance with American Architectural Manufacturers Association (AAMA 2605) with an expected outdoor service life of 10 to 15 years.

13. All other surfaces shall have a bare aluminum mill finish.

14. Weep holes shall be provided to allow moisture to escape.

15. The sign case shall have an interior, non-skid walkway where the walkway shall extend the entire length of the sign case.

16. The unobstructed walkway shall be at least 24 inches wide and at least 75 inches high.

17. The interior walkway shall be capable of supporting a concentrated load of 300 pounds per square foot at any location, and a total load of 1000 pounds within any ten-foot section of the walkway.

18. Sign case shall have two lifting eyes for placement of sign on structure.

19. Complete sign, including casing, all peripherals and electronics shall weigh no more than 4200 lbs.

20. Total sign case dimensions shall not exceed:

a. Width: 31 feet (9.44 m)

b. Height: 9 feet (2.74 m)

c. Depth: 4.5 feet (1.4 m)

10.2.8 Access Door

The sign shall have an access door on the side of the sign case. The door shall meet the following requirements:

1. Access to the interior of the sign case shall be via a gasketed door that opens out. Door size should be no larger than 25 inches.

2. The door shall be located in the side of the sign case nearest the shoulder of the road and the catwalk when looking at the sign face.

3. The door, latches, and locks shall be engineered in such a way that the door can always be opened from inside of the sign to prevent a technician from being locked in the sign case.

4. The door latching mechanism shall be a three-point draw roller type.

5. The door latching pushrods shall be turned edgewise at the outward supports and have a cross section of 0.25 inch thick by 0.75 inch wide, minimum.

6. Gasketing shall be provided on all door openings and shall meet the following requirements:

    a. Be dust tight.

    b. Meet NEMA 3R requirements.

    c. Permanently bonded to the door metal.

    d. Shall not stick to the mating metal surface.

7. A gasket top channel shall be provided to support the top gasket on the door (in order to prevent gasket gravitational fatigue).

8. When the door is closed and latched, the door shall be locked. The lock shall meet the following requirements:

    a. The lock and lock support shall be rigidly mounted on the door.

    b. In the locked position, the bolt throw shall extend a nominal 0.25-inch into the latch cam area.

c. A lid or seal shall be provided to prevent dust or water entry through the lock opening.

d. The locks shall be Corbin #2 type and shall match the master number of the existing TDOT signs.

e. Two keys shall be supplied with each lock.

f. The keys shall be removable in the locked position only.

g. The locks shall have rectangular, spring loaded bolts.

9. The door shall have catch mechanism that is capable of holding the door open at 90° in 60 mph wind acting at an angle perpendicular to the plane of the door.

10.2.9 Sign Case Ventilation

The sign case shall include ventilation system that meets the following requirements:

1. Louvered vents or hoods shall be installed in the back or side walls of the sign case.

2. No vent(s) or hood(s) shall be installed in the door.

3. Ventilation openings shall be louvered or hooded.

4. Ventilation openings shall be covered with screens so as to prevent the entrance of birds or insects.

5. The number and size of louvered vents shall be determined by the DMS manufacturer to be of sufficient size to provide adequate ventilation.

6. Air filters shall be installed behind each vent and shall meet the following requirements:

   a. Replaceable industrial grade pleated.

   b. Shall completely cover the vent opening area.

   c. Shall be manufactured per ASHRAE Standard 52.2P or later version.

   d. Shall be of fire retardant and water resistant construction, able to withstand temperatures up to 300oF.

   e. Filter replacement is to be accomplished without tools with easy access.

6. The sign case shall be equipped with one or more fans that meet the following requirements:

   a. Positive pressure ventilation system.

b. The continuous duty electric fans shall include ball or roller bearings.

c. Sign case venting fan(s) shall have a minimum combined capacity to keep the signs housing internal temperature to a maximum of thirty (30) degrees Fahrenheit above external ambient temperature.

d. LED cooling fans shall be provided to vent the air between the display module and the sign face cover.

e. Sufficient LED cooling fans shall be provided to keep the air surrounding the LEDs to a maximum temperature not exceeding the rated temperature for the LEDs.

f. The sign shall be equipped with a minimum of one (1) ambient temperature sensor, one (1) internal temperature sensor, and one (1) sensor that measures relative humidity of the air inside the housing. Mount the sensors such that they will never be in direct sunlight, and easy to maintain/replace. All sensors shall report data to the SCU.

g. Provide sign case ventilation calculations and LED cooling calculations to show sufficient air circulation is provided to meet this SP requirements under worse case air humidity, solar loading, internal heat generation with 50% of all sign pixel turned on at maximum light out level. All sign case temperatures shall be measured at ceiling level.

h. The fan(s) shall be mounted within the housing.

i. The fan(s) shall be downstream from the air filters.

j. The sign case venting fan(s) shall blow the air into the sign case.

k. The DMS manufacturer shall determine the number, placement, and size of the electric fans.

l. The fans shall be thermostatically controlled. The thermostat shall meet the following requirements:

    i. Shall be manually adjustable to turn off and on between 91 and 149 degrees Fahrenheit.

    ii. On and off hysteresis shall not exceed 3 degrees Fahrenheit.

    iii. The manual adjustment shall be graded in 5 degrees Fahrenheit increment scale.

    iv. Measure sign case temperature at ceiling level.

m. The fan circuit shall be protected at 125% of the fan motor capacity.

10.2.10 Sign Face Cover

The sign face display cover shall meet the following requirements:

1. The sign face cover shall be attached to the front of the sign case.

2. The sign face cover shall be a weatherproof, multi-window assembly, which allows an unobstructed view of the sign display.

3. The window material shall meet the following requirements;

    a. Be scratch resistant and ultraviolet stabilized polycarbonate plastic panels (Lexan with stabilizer or equivalent).

    b. Be not less than 1/8 inch thick.

    c. Shall not exhibit any flaws as a result of normal cleaning, installation or removal, ventilation, vibration and/or positive or negative pressure caused by wind or the passing of large vehicles.

4. Documentation shall be provided the Engineer showing the materials used in the manufacture of the window material.

5. The window attachment mechanism shall provide for the replacement of individual windows without disturbing adjacent windows.

6. The removal of any combination of windows shall not adversely affect the integrity of the sign display cover.

7. The attachment mechanism shall allow the windows to expand and contract with changes in the temperature.

8. A weatherproof seal shall be maintained when the window expands and contracts.

9. The windows shall be installed with a reusable gasket or caulking. The gasket or caulking shall meet the following requirements:

    a. Designed for outside plant use.

    b. Design life of at least ten (10) years.

    c. Remain flexible for at least ten (10) years.

10. Internal strip heaters shall be provided inside the sign case at the bottom of the sign face to prevent fogging of the sign face cover.

11. The internal axial or strip heaters shall be thermostatically controlled. The thermostat shall meet the following requirements:

    a. Shall be manually adjustable to turn on and off between -20 degrees Fahrenheit to 50 degrees Fahrenheit

    b. On and off hysteresis shall not exceed 3 degrees Fahrenheit.

    c. The manual adjustment shall be graded in 5 degrees Fahrenheit increment scale.

10.2.11 Redundant Power Supply

The DMS display power supply and driver electronics shall meet the following requirements:

1. Shall be auto-ranging regulated DC power source.

2. Operate from 90 VAC, 60 Hz (or 240 VAC, 60 Hz). Require NEMA TS 2 voltage input requirements.

3. Have an output of less than 24 VDC.

4. Shall be wired in a redundant parallel configuration that uses multiple supplies to power a single load.

5. Shall be rated such that if one power supply fails, the remaining supplies will be able to operate up to 75% of the pixels in their display section at full brightness.

6. Shall incorporate short circuit protection.

7. Shall incorporate power failed alarm under the following conditions:

    a. Output voltage below 15% of normal.

    b. Internal temperature outside the design operational range.

8. Power supply failure alarm and power supply location or number shall be reported to the Sign Controller Unit.

10.2.12 Sign Electrical Requirements

1. The 120/240 Volt electrical service panel shall be rated for 100 amperes maximum.

2. The panel shall have an interrupt rating of not less than 10KA.

3. Internal sign case illumination shall meet the following minimum requirement:

    a. Mounted near the DMS ceiling.

    b. Provide uniform light distribution in the sign case.

    c. The lighting shall be via compact fluorescent lamps with a life of at least 10,000 hours of operation and a minimum 30-watt rating.

    d. A minimum of one (1) compact fluorescent light fixture shall be installed every eight (8') feet of DMS width. The lamps shall provide uniform light distribution throughout the inside of the assembly.

    e. The lamps shall be self-ballasted and be rated for cold weather.

    f. The lamps shall be shielded with a protective wire cage.

    g. The lights are to be controllable with a manual timer having an adjustable maximum on-time of four (4) hours.

    h. Two of the light fixtures shall be located approximately two feet from each end of the sign case, and one fixture shall be located in the center of the sign case.

4. The sign case shall be constructed to prohibit any interior light from being visible from the outside when the door is shut.

5. The sign case shall be equipped with three, 15 amp, 120 VAC duplex GFCI (NEMA 15-R) AC receptacles.

6. Two AC receptacles shall be located approximately four feet from each end, and one receptacle shall be located in the center of the sign case.

7. The AC receptacle shall be mounted on the back wall of the sign case.

8. The interior lighting circuits shall be protected by ground-fault circuit-interrupters.

9. The ground-fault circuit interruption shall occur on 6 mA of ground-fault current and shall not occur on less than 4 mA of ground-fault current.

10. All lighting and receptacle circuits shall use #12 AWG wiring enclosed in thin wall ¾ or ½-inch conduit or other measures.

10.2.13 Sign Controller Unit (SCU)

The Sign Controller Unit (SCU) shall control the operation of all equipment housed at the Dynamic Message Sign site. The SCU shall meet the following requirements:

1. Shall include a front panel interface with graphical LCD and keypad for direct (local) operation and diagnostics.

2. Shall respond to the direct commands from the system computer and the portable, field- testing computer.

3. Shall be mounted in the roadside DMS cabinet and not in the sign enclosure.

4. Shall receive and interpret commands sent by the system computer and cause the immediate message to be displayed on the sign, and shall provide a return message to the computer that provides information concerning the status of the sign.

5. Shall continuously monitor command messages from the system computer.

6. Shall either blank the display, or continue to display a given message, depending on the option selected by the operator, when a computer system poll is not received within a user-definable threshold period.

7. Shall maintain a library of not less than 60 different display messages and related parameters. The SCU shall support uploading and downloading the message library.

8. Shall monitor and report internal sign case temperatures.

9. Shall be capable of detecting power failures. Power failure is defined when the power is out of limits for 3 or more cycles.

10. Shall include a battery backup that allows the controller to operate for a minimum of 30 minutes while the incoming AC power source has failed.

11. The battery backup circuit shall supply enough power capacity to operate the following equipment:

    a. SCU

    b. All communication equipment within the DMS roadside cabinet

12. Shall perform the following function when power is restored after a power failure is detected:

    a. Display the same message prior to power failure if the outage is less than the user specified period.

    b. The sign display shall be blank if the power is restored after the user specified period.

13. Shall provide contact closure inputs alarms for the following functions:
    a. Sign case door switch.
    b. Roadside DMS cabinet door switch for each door.
14. Shall perform the following actions upon receiving a contact closure input alarm:
    a. For sign case and roadside door open alarm, the SCU shall report a door open alarm.
    b. For over-height vehicle detection alarm, the SCU shall perform the following actions:
        i. Display a user programmable non-volatile message.
        ii. The message shall overwrite any current message.
        iii. The message shall be displayed for a user programmable time interval.
        iv. The operator at the TMC must be able to override the message if needed.
15. Shall incorporate memory with the following requirements:
    a. Permanent memory.
    b. Non-volatile memory capable of retaining the data in memory for a minimum of 30 days without power.
16. Schedule and all configurable controller data shall be stored in non-volatile memory.
17. Shall have a user configurable IP address.
18. Shall have a user interface that allows resetting of the sign control unit.
19. Shall have a user interface that initiates a manual test of each pixel in the sign.
20. Shall have circuitry to perform the following functions:
    a. Drive the sign display,
    b. Determine ambient lighting levels,
    c. Control pixel luminance levels, and
    d. Monitor the internal sign case temperature by mounting temperature sensors on the sign case.

21. Shall have a hardware watchdog timer that shall check its own operation. While the SCU program is running, the hardware watchdog timer shall be periodically reset. If the watchdog timer is not reset, the watchdog timer shall reset the SCU.

22. A slide-out notebook shelf, power, and connections to the Sign Controller Unit shall be provided at the roadside DMS cabinet to allow for control of the sign from the roadside cabinet with a laptop computer.

23. The presence of ambient radio signals, magnetic or electromagnetic interferences, including those from power lines, transformers, or motors within the proximity of any components of the system, shall not impair the performance of the system.

24. The system shall not radiate any electrical or electromagnetic signals that could adversely affect any other electrical or electronic device.

25. The sign controller as a function of the ambient light conditions shall automatically set the luminous intensity of the sign display pixels. Shall support brightness table with a minimum of 255 levels for automatic settings. Manually adjustable and may re set from 1% to 99% in 1% increments.

26. The controller shall monitor ambient light levels through a photo sensor assembly that senses the ambient illumination level using three (3) photodiodes oriented as follows:

    a. Cell 1 –Monitors the change from “day” to “night”.

    b. Cell 2 – Facing towards oncoming traffic; monitors prevailing ambient light levels in the upstream traffic.

    c. Cell 3 – Facing passed traffic; monitors prevailing ambient light levels in the downstream traffic.

27. In the event of communications failure, the sign shall blank and/or display a programmable stored message as determined by the Engineer at delivery time.

28. In the event of a controller lock-up due to any circumstance, the sign shall blank.

29. Shall be capable of auto line centering, left, and right justified in the specific line.

10.2.14 Communications

The DMS controller shall provide interfaces for local and remote communications meeting the following minimum requirements:

1. Communication interface shall be 10/100 Base TX Ethernet for all DMS devices. No serial to Ethernet converters (i.e., terminal servers) are permitted either internal or external to the controller.

2. Communication interface shall comply with NTCIP 1203 v03 or later version.

3. All DMS components shall be in compliance with FCC Part 15. All DMS components may not cause harmful wireless interference and must accept any interference received, including interference that may cause undesired operations. Manufacturer certification of compliance or declaration of conformity with FCC rules shall be provided to TDOT to ensure compliance.

10.2.15 NTCIP Requirements

This SP references several standards through their NTCIP designated names and numbers. Each NTCIP Component covered by these project specifications shall implement the most recent version of the standard, including any and all prepared Amendments to these standards.

Profile Implementation Conformance Specifications (PICS) for each NTCIP standard required shall be submitted for review and approval to the Department.

1. Ethernet Interface

   Communication interfaces using Ethernet shall conform at a minimum with all mandatory objects of all mandatory Conformance Groups of the following standards:

   a. 1101 – NTCIP Simple Transportation Management Framework (STMF)

   b. 1203 – NTCIP Object Definition for Dynamic Message Signs

   c. 2301 – NTCIP AP-STMF

   d. 2202 – NTCIP TP-Internet

   e. 2104 – NTCIP SP-Ethernet

2. RS-232 Interface

   Communication interfaces using RS-232 shall conform at a minimum with all standards:

   a. 1101 – NTCIP Simple Transportation Management Framework (STMF)

   b. 1203 – NTCIP Object Definition for Dynamic Message Signs

   c. 2301 – NTCIP AP-STMF

   d. 2201 – NTCIP TP-Transportation Transport Profile

   e. 2104 – NTCIP SP-PMPP/RS232

3. Subnet Level

For each communication interface, the Subnet Level shall meet the following minimum requirements:

a. NTCIP Components may support additional Subnet Profiles at the manufacturer's option.

b. At any one time, only one Subnet Profile shall be active on a given communication interface.

c. The NTCIP Component shall be configurable to allow the field technician to activate the desired Subnet Profile.

4. Transport Level

For each communication interface, the Transport Level shall meet the following minimum requirements:

a. Communication interfaces may support additional Transport Profiles at the manufacturer's option.

b. Response data-grams shall use the same Transport Profile used in the request.

c. Each communication interface shall support the receipt of diagrams conforming to any of the identified Transport Profiles at any time.

5. Application Level

For each communication interface, the Application Level shall meet the following minimum requirements:

a. All communication interfaces shall comply with NTCIP 1101 and shall meet the requirements for Conformance Level 1.

b. Optionally, the NTCIP Component may support SNMP traps.

c. A communication interface may support additional Application Profiles at the manufacturer's option.

d. Responses shall use the same Application Profile used by the request.

e. Each communication interface shall support the receipt of application data packets at any time allowed by the subject standards.

6. Information Level

All communication interfaces Information Level protocol shall meet the following minimum requirements:

a. All communication interfaces shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications unless otherwise indicated below.

b. The maximum Response Time for any object or group of objects shall be 200 milliseconds.

c. All communication interfaces shall implement all mandatory objects of all mandatory Conformance Groups as defined in NTCIP 1203 and their respective Amendments.

d. The sign shall blank if a command to display a message contains an invalid Message CRC value for the desired message and shall provide a return message.

e. Shall also implement all mandatory objects of the following optional conformance groups of NTCIP 1201.

    i. Time Management Conformal Group

    ii. Report Conformal Group. Table 4 indicates the modified object requirements.

f. Implement all objects of the Font Configuration Conformance Group, as defined in NTCIP 1203.

g. Implement all objects of the DMS Configuration Conformance Group, as defined in NTCIP 1203.

h. Implement all objects of the Multi Configuration Conformance Group, as defined in NTCIP 1203.

i. Implement all objects of the Multi Error Configuration, as defined in NTCIP 1203.

j. Implement all objects of the Illumination/Brightness.

k. Sign Status, as defined in NTCIP 1203.

l. Status Error, as defined in NTCIP 1203.

m. Pixel Error Status, as defined in NTCIP 1203.

n. Since the display of graphics is currently not defined within the NTCIP Standards or their amendments, the vendor shall propose, and provide detailed documentation (i.e., interface protocol description level), how the specified graphical shapes can be displayed.

10.2.16 NTCIP Compliance Documentation

Software shall be supplied with full documentation of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

1. The relevant version of each official standard MIB Module referenced by the device functionality.

2. If the device does not support the full range of any given object within a Standard MIB Module, a manufacturer specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro.

3. A MIB Module in ASN.1 format containing any and all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.

4. A MIB containing any other objects supported by the device.

Additionally, the manufacturer shall provide a test procedure that demonstrates how the NTCIP compliance of both, the data dictionaries (NTCIP 1201, 1203, and their amendments) and the communications protocols have been tested.

The manufacturer shall allow the use of any and all of this documentation by any party authorized by the Procuring Agency for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.

10.2.17 Dynamic Message Sign Operation

The Dynamic Message Sign shall support three distinct modes.

1. System Control: System control is the normal mode of operation. The SCU responds to commands from the system computer.

2. Local Control: This is the mode of operation that is used to test the sign operation. In this mode, the SCU responds to commands from a portable computer that is interfaced to the SCU.

3. Failed Condition: This is the mode of operation that is used when the hardware watchdog timer or the communications watchdog timer is not reset, or a communications error is detected, or an error is detected by the SCU. In this mode, the sign face is blank (all LED pixels are off).

10.2.18 Sign Control Test Software

The Design-Builder shall provide Test Software that meets the following requirements:

1. The software shall operate on a laptop computer.

2. The software shall interface with the SCU using the SCU Ethernet port and crossover cable.

3. The software shall provide interface using Active Directory Service Interfaces (ADSI).

4. The software shall initiate a test pattern that energizes and verifies each individual pixel in the sign.

5. The test pattern shall be supported by a test report that documents the results of the test.

6. The software shall include a communication monitoring function that meet the following requirements:

    a. Display on the screen of the portable computer the commands received by the SCU from the system computer.

    b. Display the response transmitted by the SCU to the system computer.

    c. Display function shall be real-time and be functional when the SCU is operating in the system control mode.

10.2.19 Central Control Sign Software

The Design-Builder shall provide Test Software that meets the following requirements:

1. The software shall operate on TMC operator's workstation PCs. It shall be a client- server type architecture, and be able to be installed on an existing server running Windows Server 2016. Design-Builder shall verify current software version being used by TDOT TMC. The relationship shall support multiple operator-client workstations that interface with the Server. One server license shall be required for multiple PC use.

2. The Display Control, the software shall be able to view, group and monitor multiple DMS's in real time.

3. Shall be able to communicate to any NTCIP-compliant sign communicating with the TMC, including portable NTCIP-compliant signs.

4. Shall be able to support list view and map view of signs. The map shall be configured to show all applicable signs in the Region, as required by the Engineer.

5. Shall support full-color text, shape and graphic message creation.

6. Shall be able to change messaging based on various input data, including time, temperature, date and speed

7. Shall be able to generate graphics, such as roadway signs and interstate shields, as well as clip art, shapes and free form creations. Standard MUTCD symbols shall be included in the graphics generator. The editing tool shall be able to move text and images on the editing area with graphical editing tools.

8. Shall be able to display multiple graphics, including shields and arrows for lane designation or lane management.

9. Shall be able to schedule by date and time, up to one minute increments via a calendar view, with options for schedule recurrence.

10. Shall be able to configure message flash rates, scrolling, beacons, templates and fonts to provide optimal DMS legibility.

11. Shall provide spell check and be able to create a list of prohibited words that can only be accessed for edit by an administrator.

12. Shall be able to log events and subsystem failures.

13. Shall be able to run diagnostics and alert for all system failures, including pixel tests and failures, power failures, environmental status, and other failure notifications.

14. Shall have built in security levels of access, including login/password access.

15. The software shall be provided with the ability to install the client on Operator Workstations.

16. The Central Software shall include full software maintenance support for a duration of three (3) years.

17. The software shall also include the following functionality:

    a. Full diagnostic test of peripherals

    b. Remote SCU reset and password override

    c. Set/view brightness levels

    d. View NTCIP conformance group values

    e. Separate windows for multi-monitor display

    f. Support the latest NTCIP 1203 font table changes and graphics objects

g. Display real time date/time/speed/temperature fields

h. Variable spacing between characters

i. View and Run Schedule Day Plans by week, month, year

10.2.20 Roadside DMS Cabinet (Type C Cabinet)

The Design-Builder shall provide a ground-mounted cabinet for each DMS. The DMS cabinet is labeled as a Type C cabinet in the Plans (See section 10.2.13 for additional Roadside DMS Cabinet requirements). The cabinet shall meet the following requirements:

1. Shall meet the same lighting, 19" rack, and ventilation requirements as Caltrans Type 170 model 332 cabinet.

2. Shall meet the applicable requirements of a Type C equipment cabinet in Section 6.

3. A slideout notebook shelf, power, and connections to the Sign Controller Unit (SCU) shall be provided at the roadside DMS cabinet to allow for control of the sign from the roadside cabinet with a laptop computer.

4. Shall be ground mounted.

5. Shall be constructed of 5052 sheet aluminum alloy with a minimum thickness of 1/8 inch.

6. All inside and outside edges shall be free of burrs.

7. The outside surface of the cabinet shall have a smooth, uniform, and natural aluminum finish.

8. All welds shall be neatly formed and free of cracks, blow holes, and other irregularities.

9. All welds shall be made by using the Heliarc welding method.

10. The cabinet should be of sufficient size to hold all of the DMS support equipment (i.e. controller, power distribution panel, etc.), cabinet accessories (slide-out notebook shelf, etc.), and communication equipment as shown in the Plans.

11. Cabinet hinges shall be 14 Gauge diameter stainless steel or 1/8 inch diameter aluminum.

12. The hinge pins shall be constructed of stainless steel.

13. Shall be furnished with a three point latching system (top, bottom, center locations).

14. Shall be furnished with a doorstop, which retains the door at a 90 degree and 120 degree positions.

15. Shall have thermostatically controlled fan located at the top of the cabinet.

16. Minimum fan rating of 100 cubic feet per minute.

17. Fan thermostat shall have a user adjustable range from 80 to 125oF.

18. Minimum of 2-½ inch galvanized anchor bolts shall be used to secure the cabinet to the foundation.

19. Shall be provided with a minimum 20-Watt or equivalent light source.

20. The lamp shall automatically turn ON when either cabinet door is open.

21. Shall include a three wire GFCI 115 VAC duplex convenience receptacle.

22. The receptacle shall be protected by a 15 Amp circuit breaker.

23. Shall include a main circuit breaker, which shall turn off all power to the cabinet and the DMS sign case.

24. Shall include separate circuit breaker to power the sign case.

25. Shall include transient suppression meeting the following requirements:

    a. Shall be UL Listed and labeled to UL 1449.

    b. Shall have an I-nominal rating of 20kA.

    c. SPD surge current rating shall equal or exceed 50 kA per mode. Per phase rating shall equal or exceed 100kA per phase.

    d. Leads shall be as short and straight as possible

    e. All metal oxide varistors used for surge protection shall be rated in the appropriate voltages and it's operational status shall be monitored via visual indicator.

    f. SPD operating temperature shall be between -40ºF to 185ºF

26. Shall include both serial and Ethernet communication cable surge protection devices with the following characteristics:

    a. Hybrid Multi-stage Suppression components, including gas tube and silicone avalanche diode

    b. Response time to greater than 1 nanosecond

c. UL listed (UL 1449, UL 497, 497A, 497B, etc as appropriate) and bonded to the same single-point ground point. Any DIN rail mounted SPD's shall be grounded via conductor and shall not rely solely upon the DIN rail's mechanical connection as a grounding point.

d. Sides shall be clearly marked 'protected' and 'unprotected'

27. Provide sunshields and mounting fasteners on all roadside DMS cabinets. Sun shields and fasteners shall meet the following minimum requirements:

    a. Sunshields shall be 0.125 inch aluminum with smoothed, deburred edges and rounded corners. Provide cutouts for door handles and/or locks as required.

    b. Cabinets shall be equipped with press-in threaded inserts on the cabinet interior. Sunshields shall be mounted by fasteners and aluminum or stainless steel standoffs tightened into the threaded inserts. Provide a minimum of four inserts/fasteners for top face sunshields.

    c. Provide a minimum of six inserts/fasteners for any door or side sunshield.

    d. For doors or sides greater than 54 inches tall, provide inserts and fasteners sufficient for a maximum vertical or horizontal distance of 27 inches between any fasteners.

    e. Furnish and install a top face sunshield on all cabinets.

    f. Furnish and install door or side sunshields on any cabinet face that is within 60 degrees in either direction of due south. A minimum of two door or side faces shall have sunshields on any cabinet. A cabinet with a face exactly perpendicular to the south shall have three shields.

28. Provide agency name, device name and ID labels on all roadside DMS cabinets.

    Labels shall meet the following minimum requirements:

    a. Labels shall be flat black lettering on a reflective white background. Lettering shall be a minimum of 1 inch in height.

    b. Labels shall be manufactured from pre-coated adhesive backed reflective sheeting material meeting the minimum requirements of AASHTO M268 Type 1.

    c. The agency name labels shall be "TDOT ITS" in one continuous adhesive sheet.

    d. The device ID labels shall include the acronym and hyphen "DMS-" and shall be one continuous adhesive sheet.

    e. The device ID shall be numerals corresponding to the location and shall be installed adjacent to the acronym sheet. Example is "DMS-06501".

f. Labels shall be installed along the top of the cabinet door (front cabinet door on DMS cabinets), with TDOT ITS label at the top and the device ID labels immediately underneath.

10.2.21 Warranty

The complete Dynamic Message Sign assembly shall carry a one-year manufacturer's warranty from the date of final acceptance against any imperfections in workmanship or materials. The warranty shall include but not be limited to sign face panels (LED), Sign Controller Unit, sign communications hardware, and sign ventilation system.

10.3 INSTALLATION REQUIREMENTS

10.3.1 General Requirements

1. All equipment shall be installed according to the manufacturer's recommendations and the Plans. The Design-Builder shall have a DMS manufacturer representative commission the signs after installation.

2. DMS structures, sign cases, and cabinets shall be grounded in accordance with the DMS and the structure manufacturers' recommendations and the Standard Specifications.

3. Do not install the DMS sign case on the support structure until the structure grounding systems have been successfully completed and accepted, and the structure ground connection has been installed.

4. Do not install electrical service or electronic devices in the roadside DMS cabinet or connect to the cabinet until the cabinet grounding systems have been successfully completed and accepted, and the cabinet ground connection has been installed.

5. Bundle all like cabling to minimize crosstalk and electrical interference. Route wiring to prevent conductors from being in contact with devices in the cabinet and metal edges. Arrange wiring so that any removable assembly may be removed without disturbing or unhooking conductors.

6. All power and communications wiring shall be one continuous run from cabinet to sign structure. No splicing of wiring will be permitted unless approved by the Engineer.

7. Do not install electronic devices in the cabinet until electrical service has been installed and activated, and the cabinet ventilation fan is operational.

8. A minimum of two 2 inch spare conduits shall be installed in the base of all DMS cabinets and shall terminate in the adjacent communications cable pull box. Spare conduits in the cabinet base and the pull box shall be sealed with blank duct plugs.

9. Prior to installation, all sign cases and cabinets must be stored in a location and manner approved by TDOT. The signs shall not be sitting directly on the ground or in a manner where standing water, mud, or debris will come in contact with the sign. The storage location should be free from excessive debris or other matter that may harm or deteriorate the sign. During storage, sign cases shall be structurally supported in accordance with the DMS manufacturer's recommendations.

10. The Design-Builder is responsible for coordinating with the Department for IP addresses and integrating the DMS system into the manufacturer provided DMS central control software.

10.3.2 Documentation

The documentation for the Dynamic Message Signs shall consist of the following: Communications Protocol, Operator's Manual, Maintenance Procedure Manual, Equipment Drawings, and Electrical Schematic Diagrams.

1. Operator's Manual

   This document shall fully describe the operation of the Dynamic Message Signs using the Windows based software that runs on a notebook computer. This document shall clearly define all functions that are supported by the software. The manual shall define the normal operation of the signs and the software including resetting and restarting the software package. Ten hardcopies of this document shall be supplied. Additionally, an electronic copy shall be provided that includes the capability for word searches. The manual shall include the following:

   a. General Description
   b. General Characteristics
   c. Installation
   d. Adjustments
   e. Theory of Operation
   f. Maintenance
      i. Preventive Maintenance
      ii. Trouble Analysis
      iii. Trouble Shooting Sequence Chart
   g. Wave Forms
      i. Voltage Measurements
      ii. Alignment Procedures
      iii. Parts List
      iv. Communications Protocol
      v. Schematic and Logic Diagrams

2. Maintenance Procedure Manual

   This manual shall document the preventive and corrective maintenance procedures that should be followed to maintain the Dynamic Message Signs at the highest level of operational efficiency. The manual shall include step-by-step field and bench trouble-shooting procedures to isolate and repair faults. The document shall include descriptions of normative waveforms and test voltages. A detailed parts list shall be included. For each part or assembly, a circuit diagram or pictorial shall be provided. Ten hardcopies of this document shall be supplied. Additionally, an electronic copy shall be provided that includes the capability for word searches.

3. Equipment Drawings and Diagrams

   A pictorial drawing showing the physical location and identification of each component shall be provided for each different electronic assembly and each different subassembly. Wiring diagrams shall be provided for each sign case. These diagrams shall depict the location and interface of all components located within the sign case. Three hardcopies of these drawings shall be supplied. Additionally, an electronic copy (using common drawing software such as MicroStation) shall be provided.

4. Electrical Schematic Diagrams

   An electrical schematic, wiring diagram, and a logic diagram shall be provided for each different type of equipment. A stage-by-stage explanation of the circuit theory shall be provided with the circuit wiring diagrams. Connection diagrams for each DMS subsystem including block diagrams, terminal numbers, and conductor color codes shall be provided. Three hardcopies of these diagrams shall be supplied. Additionally, an electronic copy (using common drawing software such as MicroStation) shall be provided.

10.3.3 Warranty

The complete Dynamic Message Sign assembly shall carry a one-year manufacturer's warranty from the date of final acceptance against any imperfections in workmanship or materials. The warranty shall include but not be limited to sign face panels (LED), Sign Controller Unit, sign communications hardware, and sign ventilation system.

10.3.4 Testing Requirements

The Vendor shall complete and submit the Colored Dynamic Message Sign Specification Compliance Form to the TDOT Traffic Operations Division. Following the Traffic Operations Division's written approval confirming the Colored Dynamic Message Sign meets the minimum requirements outlined in QPL, a sample DMS panel and controller will be tested by TDOT Traffic Operations staff or TDOT TMC staff. The vendor shall be responsible for coordinating with the appropriate staff for delivery of equipment.

1. Any system failure during the testing period may require an additional amount of time to fully evaluate the Colored Dynamic Message Sign.

2. Determination of a system failure shall be at the discretion of the TMC, TMC IT, or Traffic Operations Division.

3. The overall testing period will be considered complete upon the successful completion of the test, as determined by TDOT TMC or Traffic Operations staff.

10.4 TESTING REQUIREMENTS

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2. Determination of a system failure shall be at the discretion of the TMC, TMC IT, or Traffic Operations Division.

3. The overall testing period will be considered complete upon the successful completion of the test, as determined by TDOT TMC or Traffic Operations staff.

10.5 MEASUREMENT

10.5.1 Dynamic Message Sign

The Dynamic Message Sign will be measured in units of each and paid for at the contract unit price per each. The price shall include furnishing, installing, system integration, and testing of the complete dynamic message sign including the sign case, light sources, display apparatus, wiring, controller, communications interface, wiring between the sign case and DMS cabinet, structure mounted conduit, fittings, and junction boxes, sign case support connections to the sign support structure, satisfactory completion of testing and training requirements, wireless communication platform, and all work, equipment, and appurtenances as required to effect the full operation including remote and local control

of the sign complete in place and ready for use. (NOTE: this item does not include the sign support structure). The price bid shall also include all system documentation including: shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other material necessary to document the operation of the DMS. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

10.5.2 DMS Communications and Power Cable

The DMS Communications and Power Cable will be measured in units of linear feet per cable installed and paid for at the contract price per linear feet of each cable. The price bid shall include furnishing, installing, configuring, and testing of the cable including all required splices and other ancillary items required for complete installation of the cable. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

10.5.3 DMS Conduit Bank

The DMS Conduit Bank will be measured in units of linear feet per conduit bank installed and paid for at the contract price per linear feet per length of bank. The price bid shall include furnishing, installing, configuring, and testing of the conduit bank including any and other ancillary items required for complete installation. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

10.6 PAYMENT

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

ITEM NO.	DESCRIPTION	UNIT
725-21.02	DYNAMIC MESSAGE SIGN	EACH
725-21.18	DMS COMM CABLE	L.F.
725-21.19	DMS POWER CABLE	L.F.
725-21.20	DMS CONDUIT BANK (STRUCTURE MOUNTED)	L.F.
725-22.50	DMS CONDUIT BANK	L.F.

Dynamic Message Signs sites will be paid per each as follows:

1. Initial 50% of the contract unit price upon satisfactory Factory Acceptance Test results, delivery to the site, and Pre-Installation Test results.
2. Additional 20% of the contract unit price upon satisfactory Stand Alone Site Test results.

3. Additional 20% of the contract unit price upon satisfactory Conditional System Acceptance Test results.
4. Final 10% of the contract unit price upon Final System Acceptance.

11 RADAR DETECTION EQUIPMENT

11.1 DESCRIPTION

This section specifies the minimum requirements for Radar Detection Systems (RDS) furnished and installed on this project. The work shall consist of providing all labor, materials, equipment, and incidentals necessary to furnish, install, test, and operate a RDS System.

The RDS will provide roadway monitoring capabilities via microwave radar detectors transmitting data over both wireline and wireless network equipment specified in this SP. The data provided includes, but is not limited to, lane occupancy, speeds, classification, and volume. The RDS device shall support high-definition radar consisting of multiple radar beams. Two receive antennas shall be positioned side-by-side with enough space between to create two separate high-definition beams.

It shall be the Design-Builders responsibility to ensure that the submitted RDS is compatible with the TMC travel time central software and can operate as designed in the plans. It shall be the Design-Builder's responsibility to submit a product that is in compliance with this specification and the locations on the plans. The Design-Builder shall notify the Engineer of any deviation or issue with the plans or specifications prior to submitting, furnishing and installing the RDS.

11.2 MATERIALS

11.2.1 Microwave Transmission

The microwave radar detector shall transmit on a frequency band of 24.0-24.25 GHz or another approved spectral band. It shall comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority. The RDS shall not interfere with any known equipment.

11.2.2 Area of Coverage

The RDS's field of view shall cover an area defined by a beam its maximum detection range shall be as follows:

1. Elevation Beam Width 40 degrees or more
2. Azimuth Beam Width 15 degrees or less
3. Range 6 to 250 feet

11.2.3 Detection Zones

The minimum number of detection zones defined shall be no less than twelve (12) lanes simultaneously.

11.2.4 Capabilities

The RDS shall be a true presence detector. It shall be suitable for mounting on roadside poles or on overhead structures and provide the following:

1. Presence indication of moving or stopped vehicles in either direction in its detection zones, provided by contact closure to existing controllers.

2. Shall have TCP/IP connection.

3. Traffic data, periodically accumulated over user defined time intervals in a 20 to 600 sec range, shall be transmitted via serial RS-485 communications lines to a serial port and via TCP/IP communications over CAT5 (minimum) to the local ethernet switch.

4. Traffic data shall be available simultaneously with detection zone contact closures and serial communications.

5. Side-fired configuration data shall include the following in each of up to twelve (12) detection zones (lanes):

    a. Volume

    b. Lane occupancy

    c. Average speed

    d. Vehicle classification by length in a minimum of 6 user defined classes.

6. RDS in forward-looking configuration shall monitor traffic in one lane and be capable of providing the following data:

    a. Volume, occupancy, average speed and travel direction in the lane

    b. Per vehicle speed and direction

    c. Binning of Volume data in up to 15 speed bins

7. RDS shall allow the user to define the contents of transmitted data.

8. Furnish the unit with the required software for data collection, processing, configuration and set-up, and data logging and retrieval. An operator shall be able to use the software to set detector

count periods, sensitivities, and other operational features and parameters. The software must be capable of providing both manual and automatic setup and calibration.

11.2.5 Measurement Accuracy

The following error levels shall be achievable and demonstrated during testing:

Parameter	Error Percentage
Presence	5%
Volume	8%
Lane Occupancy	10%
Average Speed	10%
Length Classification limits	10%
Time Event	10 ms
Input Voltage	2%

11.2.6 Environmental Conditions and Protection

Except as stated otherwise herein, the equipment shall meet all its specified requirements during and after subjecting to any combination of the following:

1. Ambient temperature range of -37°C to +74° C

2. Relative humidity from 5 to 95 percent, non-condensing

3. Winds up to 90 mph (sustained) with a 30% gust factor

4. Rain and other precipitation up to 2 inches/hr

5. Power surge of ± 1kV (rise time = 1.2 µsec, hold = 50µsec) applied in differential mode to all lines, power and output, as defined by IEC 1000-4-5 and EN 61000-4-5 standards.

6. Printed circuit boards shall be conformal coated for protection against humidity.

7. Except as may be otherwise stated herein for a particular item, no item, component, or subassembly shall emit a noise level exceeding the peak level of 55 dB when measured at a distance of three feet away from its surface.

8. The microwave radar detector shall be resistant to vibration in accordance with IEC 68-2- 30 (test Fc), NEMA TS-1 (Section 2.1.12), or approved equivalent.

9. The microwave detector shall be resistant to shock in accordance with IEC 68-2-27 (test a), NEMA TS-1 (Section 2.1.13), or approved equivalent.

11.2.7 Mechanical

1. The microwave radar detector shall be enclosed in a rugged weatherproof box and sealed to protect the unit from wind up to 90 mph, dust and airborne particles, and exposure to moisture (NEMA Type 3R or 4X enclosure).

2. Max. weight of the microwave radar detector assembly: 7 pounds

3. The mounting assembly shall have all coated steel, stainless steel, or aluminum construction and shall support a load of 20 pounds or more. The mounting assembly shall incorporate a ball-joint, or other approved mechanism that can be tilted in both axes and then locked into place, to provide the optimum area of coverage.

11.2.8 Electrical

1. The RDS unit shall be operable from 12 - 24 VDC.

2. The RDS unit shall include Power Management features, allowing remote shutdown or cyclical shutdown of the unit.

3. The RDS unit shall include a Low-Voltage disconnect feature for battery protection.

11.2.9 Cables

1. Cable connectorization and termination pin-out on all cables shall be in accordance with the manufacturer's recommendations.

2. Connection between the RDS and the cabinet equipment shall be provided by a single RDS harness cable that is MS-connector terminated at the RDS and terminated to the RDS communications wiring module in the equipment cabinets or terminal block at the base of the RDS pole. No splices are permitted in the harness cable. The cable shall provide power and the RS-485 serial data interface to the RDS unit.

3. The RDS harness cable shall be outdoor wet/dry rated UV-resistant and provide multiple twisted pairs of stranded AWG #20 or #22 wire with a common shield rated at 300V with a temperature rating of 105oC.

4. The MS connector pins must be crimped to the cable conductors and assembled and tested by the manufacturer prior to installation and pulling of cable on site.

11.2.10 Electrical Isolation and Surge Protection

All power lines, contact closures and the serial port shall be surge protected within the unit. Contact closures and the serial port shall be isolated.

11.2.11 Data Interface

Data communications shall be full duplex asynchronous, configurable as:

1. RJ-45 port for ethernet communications.

2. RS-485 port at rates from 2,400 up to 115,200 bits per second.

3. Serial data format shall be standard binary 8 bits data, 1 stop bit, No parity.

4. Both point-to-point and multi-dropped configurations shall be supported.

11.2.12 RDS Cable

1. Provide RDS Cable that is a composite twisted-pair power limited tray cable with UV- resistant PVC or polyethylene outer jacket rated for wet/dry underground use when RDS poles are separated from an equipment cabinet, as shown in the Plans. RDS Cable shall contain a minimum of two shielded twisted pairs of communications conductors designed for RS-485 data signaling and two low voltage power conductors. Individual conductor insulation ratings shall be equal or greater than the outer jacket ratings.

2. Communications conductors shall be a minimum of two twisted pairs and one shield drain wire of #22 AWG 7-strand tinned copper conductors with a continuous foil or braid shield. RS-485 signal ground shall be provided by the shield drain wire, an additional conductor, or an additional shielded pair, in accordance with the RDS unit manufacturer's recommendations. Twisted pairs shall be identified by separate insulation colors. Communications pairs shall be individually or commonly shielded.

3. Low voltage power conductors shall be two #14 AWG 19-strand tinned copper conductors. One conductor shall have red insulation and the other conductor shall have a black insulation. Low voltage power conductors shall not be shielded in common with the communications pairs.

4. Provide cable with outer jacket marking using the following template:

   Manufacturer's Name – "RDS Cable" – Month/Year of Manufacture - Telephone Handset Symbol – "TDOT"

5. Provide cable labels that meet the following requirements:

a. Self-coiling wrap-around type

b. PVC or equivalent plastic material with UV and fungus inhibitors

c. Base materials and graphics/printing inks/materials designed for underground outside plant use including solvent resistance, abrasion resistance, and water absorption

d. Minimum size of 2.5 inches wide by 2.5 inches long

e. Minimum thickness of 0.010 inches

f. Orange label body with pre-printed text in bold black block-style font with minimum text height of 0.375 inches

g. Pre-print the following text legibly on RDS Cable labels:
   i. RDS CABLE
   ii. TENN DOT

h. On all cable labels, print the text specified above twice on the label with the text of the second image reversed. The end result shall be text which "reads right" when the label is coiled onto a cable.

11.3 INSTALLATION REQUIREMENTS

1. The RDS shall be mounted in side-fired configuration on poles as shown in the Plans, using mounting brackets. The brackets shall be attached with approved ¾-inch wide stainless steel bands. The various mounting configurations include: attaching to new light standard poles where the wiring shall be installed inside the pole; attaching to new CCTV poles where the wiring shall be installed inside the pole, and attaching to existing light poles where conduit risers will be required on the outside of the pole.

2. The Design-Builder shall install the detector unit on a pole at the manufacturer's recommended height above the road surface so that the masking of vehicles is minimized and that all detection zones are contained within the specified elevation angle as suggested by the manufacturer.

3. When installing a detector near metal structures, such as building, bridges, or sign supports, the sensor shall be mounted and aimed so that the detection zone is not under and does not pass through any structure to avoid distortion and reflection.

4. The RDS mode of operation, detection zones, and other calibration and set up will be performed using a Microsoft Windows-based software and a Notebook PC. The software shall allow verification of correct setup and diagnostics. It shall include facilities for saving verification data and collected data as well as saving and retrieving sensor setup from disk file.

5. Unused conductors in the RDS unit harness cable shall be grounded or un-terminated in the cabinet in accordance with the manufacturer's recommendations. Un- terminated conductors shall be individually doubled back and taped, then loosely bundled and secured.

6. Design-Builder shall install a local / remote disconnect switch or a RDS communications wiring module as shown on the plans.

11.3.1 RDS Cable Shipping and Delivery

1. Package the cable for shipment on reels. Each package shall contain only one continuous length of cable. Construct the packaging so as to prevent damage to the cable during shipping and handling.

2. Seal both ends of the cable to prevent the ingress of moisture.

3. Include with each reel a weatherproof reel tag attached identifying the reel and cable that can be used by the manufacturer to trace the manufacturing history of the cable. Include with each cable a cable data sheet containing the following information:

    a. Manufacturer name

    b. Cable part number
    c. Factory order number

    d. Cable length

    e. Factory measured continuity and attenuation of each conductor and shield

11.3.2 RDS Cable Installation

1. Do not exceed the maximum recommended pulling tension during installation as specified by the cable manufacturer. Continuously monitor pulling tensions with calibrated measuring devices, such as a strain dynamometer.

2. Before cable installation, carefully inspect the cable reels and reel stands for imperfections or faults such as nails that might cause damage to the cable as it is unreeled.

3. Take all necessary precautions to protect reeled cable from vandals or other sources of possible damage while unattended. Any damage to reeled cable or the reel itself shall necessitate replacement of the entire cable section.

4. Whenever unreeled cable is placed on the pavement or surface above a pull box, provide means of preventing vehicular or pedestrian traffic through the area in accordance with the approved Maintenance of Traffic provisions.

5. Keep the cable continuous throughout the pull. Terminate the cable only in equipment cabinets on terminal blocks. Cable splices are not permitted.

11.3.3 RDS Cable Storage and Labeling

1. Properly store all cable to minimize susceptibility to damage. Maintain proper bend radius, both short and long term, during cable storage. Storage coils shall be neat in even length coils, with no cross over or tangling. Storage coils of different cables shall be kept completely separate. Storage coils shall be secured to cable racking hardware with tie wraps, Velcro straps, or non-metallic cable straps with locking/buckling mechanism. Do not use adhesive or self-adhering tapes, metal wires and straps, or rope/cord.

2. Unless otherwise noted on the plans, the following are the requirements for cable storage for underground applications:
    a. Cable in Type C pull box – 20 feet

    b. Cable in Type D pull box – 20 feet

    c. Cable in Type E pull box – 20 feet

3. Install cable labels on all RDS Cables. Clean the installed cable of all dirt and grease before applying any label.

4. Label all cables in or at every location where the cable is exposed outside of a conduit, inner-duct, or pole. As a minimum, install cable labels in the following locations:

    a. Within 12 inches of every cable entry to a pull box or equipment cabinet.

    b. Every 10 feet for the entire length of cable in any storage coil in pull boxes.

11.3.4 RDS Test Requirements

1. General Requirements

    a. The Design-Builder shall conduct a project testing program for RDS units as required in Section 1.5 of this SP. The project testing program for RDS units shall include but is not limited to the additional specific requirements in this subsection.

    b. All test results shall confirm physical and performance compliance with this SP.

2. Bench Test Component (BTC)

a. During the bench test, the Design-Builder must demonstrate proper operation of the RDS through the 2nd serial port on the CCTV Video Encoders. Design-Builder is responsible for ensuring compatibility between the devices and for ensuring the data can be transmitted from the RDS to the encoder at the distances shown on the plans.

3. Bench Test System (BTS)

    a. During the bench test system, the Design-Builder must demonstrate the configuration of the device and demonstrate the required operational characteristics of the device including the counting of volume and speed. The bench test system must include operation through the maximum total length of RDS Cable required in this project.

4. Standalone Acceptance Test (SAT)

    a. During the standalone tests, the Design-Builder must demonstrate the accuracy requirements specified in Section 12.2.5.

11.3.5 RDS Cable Test Requirements

1. General Requirements

    a. The Design-Builder shall conduct a project testing program for all RDS Cable as required in Section 1.5 of this SP. The project testing program for RDS Cable shall include but is not limited to the additional specific requirements in this subsection.

    b. All test results shall confirm physical and performance compliance with this SP.

    c. In addition to the notification requirements of Section 1.5, provide the tentative date, time and location of RDS comm. cable testing no less than 7 days in advance to the test. Provide confirmed date, time and location of RDS Cable testing no less than 48 hours before conducting the test.

    d. Provide test results documentation in printed (3 copies) format. Printed copies shall be bound and organized by cable segment.

    e. Provide all test results in English units of measure of length.

    f. Submit all test results documentation to the Engineer within 14 days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 1.8

g. All RDS Cables under test shall be removed from all wiring termination devices until testing is completed. All RDS Cables conductors shall be connected to ground immediately after testing to ensure elimination of all capacitive charges and potentials.

2. Pre-Installation Test (PIT)

    a. Perform a PIT on all RDS Cables prior to any cable removal from the shipping reels. Perform a PIT on each cable reel delivered to the job site.

    b. The PIT for RDS Cables shall include but is not limited to:

        i. A visual inspection of each cable and reel

        ii. A Continuity Test on all conductors and shield in the cable.

3. Standalone Acceptance Test (SAT)

    a. Perform a SAT on all RDS Cables on this project after field installation is complete but without cable termination.

    b. An SAT for each conductor and each shield in each cable shall include but is not limited to Continuity Tests and Insulation Resistance Tests.

    c. All RDS comm. cables shall be tested from termination point to termination point. Complete all RDS Cable SATs for all cables prior to implementing any RDS communications or power service.

    d. All test results shall confirm compliance with this SP and the manufacturer's published specifications.

    e. Test documentation shall include but is not limited to:

        i. RDS Cable Identification

            - Cable ID and Location – physical location (device ID and station number of equipment cabinet) and conductor/pair/shield ID for both the beginning and ending point.

            - Operator Name

            - Engineer's Representative

            - Date & Time

        ii. Setup and Test Conditions Parameters

            - Battery charge and proper operation of ohmmeter

- Battery charge and proper operation of insulation resistance tester
- Ambient Temperature

iii. Test Results for Continuity Test

- Conductor continuity
- Resistance (ohms)
- Measured Length (Cable Marking)

iv. Test Results for Insulation Resistance Test

- Measured Cable Length
- Insulation resistance (exceeds manufacturer's specifications for at least 60 seconds.)

11.4 MEASUREMENT

11.4.1 Radar Detection System

The Radar Detection System (RDS) will be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing and installing of the RDS including the unit, all conduit, risers, and weatherhead between the RDS and the cabinet, interconnection wiring to the ethernet switch, connections to support structures (includes all incidental components, attachment hardware, mounting brackets, mounting arms, bolts, or any other items to mount the RDS as intended), and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the RDS site complete in place and ready for use. Furnishing and installing of RDS harness cabling to be bid under the RDS Comm Cable pay item. The price bid shall include system integration and testing of a complete RDS including the unit, the RDS harness cabling, all conduit, risers, and weatherhead between the RDS and the cabinet, interconnection wiring to the video encoder serial port or terminal server port, connections to support structures (includes all incidental components, attachment hardware, mounting brackets, mounting arms, bolts, or any other items to mount the RDS as intended), satisfactory completion of testing and training requirements and all work, equipment, and appurtenances as required to affect the full operation including remote and local control of the RDS site complete in place and ready for use. The price bid shall also include all system documentation including: shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other material necessary to document the operation of the RDS. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

In locations where a Radar Detection System is connected back to an existing cabinet via RDS Cable, the price bid for the Radar Detection System shall include furnishing, installing, and testing of a RDS

communication subsystem inside the existing cabinet. This RDS communications subsystem shall meet the specifications in Section 6.2.3.6.

11.4.2 RDS Cable

RDS Cable will be measured in units of linear feet and paid for at the contract price per linear feet of actual cable installed as measured from the cable sequential length markings. The price bid shall include furnishing, installing, system integration, and testing of a complete RDS cable installation with operational RDS units and shall include cable labels and all ancillary and incidental materials, testing, documentation and all labor and equipment necessary to complete the work. No measurement for payment will be made for cable storage amounts in excess of that required in this SP or the Plans. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

11.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

ITEM NO.	DESCRIPTION	UNIT
725-21.91	RADAR DETECTION SYSTEM	EACH
725-21.96	RDS COMM CABLE	L.F.

Radar Detection System (RDS) will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component, Bench Test System and Pre-installation test results.

2. Additional 20% of the contract unit price upon approval of Stand Alone Site Test results.

3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results.

4. Final 10% of the contract unit price upon Final System Acceptance.

RDS Cable will be paid per linear foot as follows:

1. 25% of the contract unit price upon delivery and reel test.

2. Additional 35% of the contract unit price for complete installation of cables.

3. Additional 30% of the contract unit price for successful completion of Standalone Acceptance Testing of the complete cable in any lineal foot between terminations in equipment cabinets, and Stand Alone Site Testing of all RDS units communicating through this section of cable.

4. Final 10% of the contract unit price upon Final System Acceptance.

12 WIRELESS RADIO COMMUNICATIONS

12.1 DESCRIPTION

This section specifies the minimum requirements for the wireless communications to be furnished and installed on this project. The radios will provide one communications link for standalone RDS sites to network connected CCTV sites on this project. The work includes complete Federal Communications Commission (FCC) licensing services and all documentation necessary to operate and maintain the equipment. The radio link shall transmit data across the link with no added delay to data transmitted.

The radio equipment in this contract includes the following type (or similar):

1. Ethernet Radio & Antenna (Type D): This is a 4.9 GHz Ethernet Transceiver Link that is used to support video and data communications along the corridor.

12.2 MATERIALS

The radio and antenna equipment shall comply with the following minimum material specifications:

12.2.1 Ethernet Radio Transceiver (TYPE D)

1. The radio transceiver shall directly interface with the field Ethernet Gigabit port at the radio field hub sites. Software to remotely control the radios will be provided and included in the price of the Radio's. No additional payment will be made for configuration and troubleshooting software.

2. The Radios will be a truly point to point link system that delivers a 300 Mbps data rate link at distances of over 5 miles (8 km). The link shall supply very low latency of not more than 3 ms over long distances.

3. The Design-Builder is responsible for the propagation study and assessment of the wireless link prior to submitting the product and desired frequency. The Design-Builder shall perform this study with industry approved test equipment and submit the study to the Engineer for review and approval. Should a frequency other than 4.9 GHz be submitted, the Design-Builder shall fully justify the use of this frequency through testing documentation.

4. Security

    a. Tiered security layering

    b. Use of AES-CCM 128 bit Encryption

c. Internal MAC Address Control List, Radius based Authentication

5. Network Gateway Features:

    a. DHCP Server & relay

    b. NAT with Standard ALGs

    c. Bridging

    d. Routing (RIP v2 and IP tunneling)

    e. Syslog

    f. SNTP

6. Network QoS:

    a. Asymmetric Bandwidth Control

    b. Packet Classification

    c. Scheduling

7. The radio shall adhere to the 802.1Q Management VLAN with Transparent, Access and Trunk mode

8. Wired Ethernet Interface

    a. Two auto MDI-X RJ45 10/100/1000 Mbps Ethernet ports, one being PoE in + data, and the second with PoE out + data

    b. Industrial Weatherproof Ethernet Connector

    c. Cat6 Industrial outdoor rated cable

9. Channel Size of 40 MHz, 20 MHz, and capable of 10 MHz and 5 MHz

10. Management

    a. Local RS-232 serial port with capability to interface via DB9

    b. Telnet

    c. SSH

d. SNMPv3

e. SSL

f. TFTP

g. Web GUI

11. Wireless Modulation shall utilize OFDM with BPSK, QPSK, QAM16, QAM64, and Enhanced MIMO techniques for non-line-of-sight and near- line-of-site capability.

12. Radio Transmit Power

    a. Up to 18 dBm

13. Antenna Configurations

    a. Integrated 23dBi panel or external as needed

14. Power

    a. 7 Watt typical, 17 Watt max

    b. POE power injector with PoE Surge Arrestor and power cords to allow the radio to be powered from a minimum 24-volt power supply.

15. Environmental

    a. Hardened
    b. Operating Temperature: -40°F to 140°F (-40°C to 60°C)
    c. Operating Humidity: 100% maximum relative humidity, non- condensing
    d. 125 MPH wind loading
    e. Meets IP67 requirements
    f. Mean Time Between Failure shall not be less than 80,000 hours.

12.3 INSTALLATION

1. Before submitting poles or wireless radio units and antennas, the Design-Builder shall verify all wireless links for proper frequency, height and line of site, based on the plan design and specifications. Should the Design-Builder encounter interference in the path, or immoveable objects that interfere with the wireless path, the Design-Builder shall prepare and submit a solution for review and acceptance by the Engineer.

2. The Design-Builder shall furnish, install, and integrate Ethernet radio transceivers between receive and transmit sites shown in the Plans. Antenna alignment shall be performed in accordance with the manufacturer's installation requirements. Testing of the link and attached Ethernet switches shall happen before cut over of all existing devices to the radio link and the cutting of the trunk fiber optic cable for termination in the field radio hub cabinet.

3. The Design-Builder shall furnish and install all supports, clamps, cables, connections and other materials to secure the Ethernet radio transceiver and antenna at the selected locations for a complete installation. All cables shall be permanently labeled at all access points. Label identification shall be stamped or engraved on metal tags, or neatly and legibly lettered with permanent ink on nylon tags. Each cable shall have a unique identifier. Cables shall be labeled immediately upon installation.

4. The type of mounting poles to be supplied and the location of their installation shall be as depicted in the Plans unless otherwise approved by the Engineer.

5. The Design-Builder shall coordinate with the existing TDOT Region TMC Network Maintenance representative for all necessary configuration of the radio link. The radio link shall be configured to operate in the current network configuration and shall allow all existing video and data to transmit across the link with no degradation. After coordinating with the Network Maintenance representative, the Design-Builder shall submit the network configuration to the representative and Engineer for approval.

6. Design-Builder will also install a Battery backup system for the field radio. See electrical section 5.2.5 for specifications

12.3.1 Testing

1. General Requirements

    a. The Design-Builder shall conduct a project testing program for Radio and Antenna equipment as required in Section 1.5 of this SP. The project testing program for Radio and Antenna Equipment shall include but is not limited to the additional specific requirements in this subsection.

    b. All test results shall confirm physical and performance compliance with this SP.

12.4 MEASUREMENT

Radio & Antenna (Type D) will be measured in units of each and paid for at the contract price per each, but shall act as one seamless pair of point-to-point radios. The prices bid shall include furnishing, installing, system integration and testing of the unit and shall include the radio transceiver/ modem unit,

Battery backup system, mounting hardware, RF coaxial cables, cables and connectors, power control unit, surge suppressors, antenna with mounting accessories, SWR/wattmeter test equipment and all work, equipment and appurtenances as required to provide a fully functioning radio and antenna. The price bid shall also include all configuration and system software and documentation including shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other materials necessary to document the operation of the unit. Price shall include installation and removal of wireless equipment, including the pole and all wiring associated with the temporary installation. This equipment shall be turned over to TDOT. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

12.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section. Payment will be made under:

Item No.	Description	Unit
725-03.07	RADIO AND ANTENNA (TYPE D)	EACH

Radio and Antenna (TYPE D) will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component, Bench Test System and Pre-installation test results.

2. Additional 20% of the contract unit price upon approval of Stand Alone Site Test results.

3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results.

4. Final 10% of the contract unit price upon Final System Acceptance.

13 FIELD VIDEO ENCODER UNIT

13.1 DESCRIPTION

This section specifies the minimum requirements for Field Video Encoder Units furnished and installed on this project.

The Field Video Encoder Unit will provide for the encoding and transmission of digital video signals from new CCTV units to the TMC installed at locations shown in the Plans.

13.2 MATERIALS

13.2.1 General Capabilities and Performance Requirements

Furnish a field-hardened video encoder designed for unheated/uncooled "outdoor" applications such as roadside control cabinets. The video encoder shall be installed in traffic signal controller cabinets and shall allow for the encoding and transmission of digital video signals from new CCTV units that will be provided under this Project.

The unit shall be shelf-mountable and shall allow for converting digital video signals from new CCTV units into two digital video streams; one in H.264 format (high-resolution) and one in MPEG-4 format (low-resolution), that can be transported over Ethernet. High resolution streams shall allow video bit rates from 1 to 3 Mbps and the low-resolution stream shall allow video bit rates from 64 kbps to 2 Mbps. The Design-Builder shall initially configure these formats for 2 Mbps and 64kbps, respectively. The video encoder shall also transmit pan-tilt-zoom control data from all CCTV control points to the CCTV camera via a serial connection to the CCTV camera resident on the CODEC.

The video encoder shall support the following digital transport standards at a minimum: RTP/IP, UDP/IP, TCP/IP, and unicast/multicast IP. The Design-Builder shall initially use UDP/IP for video transport and TCP/IP for camera control transport unless otherwise approved by the Engineer.

The video shall support resolutions of CIF (352 (H) x 240 (V)), 1/2 D1 (352 (H) x 480 (V)), and D1 (720 (H) x 480 (V)) at a minimum. The video encoder units shall provide a display showing diagnostic data such as data rate, quality level, frame rate, and video status on the front panel. All supporting user interface software shall be provided with each encoder unit.

The video encoder shall be equipped with at least one NTSC video input, two RS-232/422 serial ports and one 10/100BaseTX Ethernet port. The 10/100BaseTX port shall support half-duplex or full-duplex and provide auto negotiation and shall be initially configured for full-duplex.

The video encoder shall be remotely manageable using standard network applications such as telnet, SNMP monitors, and/or web interface administration. The video encoder shall be equipped with LED or other approved indicators for the following functions:

1. Power
2. Link
3. Activity
4. Port Speed (10/100 Mbps)

13.2.2 Electrical Requirements

The video encoder shall operate from 115 VAC (+/-10%) input power at 60 Hz. The Design-Builder shall furnish any external step down transformers, power converters, and/or regulation equipment needed to operate the video encoder.

13.2.3 Physical and Environmental Requirements

The video encoder enclosure shall be constructed of non-corrosive materials (galvanized steel or an approved equal). For Design-Builder-supplied cameras, the video encoder shall be installed in equipment t cabinets and secured to the cabinet in a manner that is approved by the Engineer. The video encoder enclosure, including adapters/connectors, shall fit neatly within the confines of the equipment cabinet. All necessary mounting hardware shall be provided by the Design-Builder.

The video encoder shall meet or exceed NEMA TS-2 requirements for shock, temperature, humidity, and vibration. The video encoder shall operate at ambient temperatures from -40° to 158° F (-40° to 70° C) and ambient relative humidity from 0% to 90% (non-condensing). No cooling airflow shall be required.

13.2.4 Communication Interface Requirements

The video encoder shall comply with the 10/100BaseTX standard and have at least one standard RJ-45 interface. The 10/100BaseTX port shall operate as half-duplex or full-duplex and provide auto negotiation.

The video encoder shall have at least two serial ports – one for pan-tilt-zoom camera control and the other for local maintenance or other data transport. The two serial ports shall support RS-232 and RS-422 data transmission and shall be transparent to the central system using TCP/IP network access methods. Interconnection with camera control receivers with or without adapters or converters (i.e., RS-422/232 for compatibility with CCTVs) shall provide opto-isolated surge

suppression. The optical isolation shall provide an isolation of no greater than 2000 VAC for data signals and ground.

13.2.5 Cables and Connectors

The Design-Builder shall furnish and install all cables and connectors necessary for video encoder installation. This shall include at a minimum CAT 5E cables with RJ-45 connectors to connect the Video Encoder to the Field Ethernet Switch in the equipment cabinet or traffic controller cabinet and standard serial data cables to connect the Video Encoder to the CCTV camera for pan-tilt-zoom functions and local configuration administration.

13.3 INSTALLATION REQUIREMENTS

Field Video Encoders shall be configured for transmitting video to the Ethernet switch at the data rates listed above in Section 13.2.1. MPEG-4 video resolution parameters shall be configured for 720x480 pixels unless otherwise approved by the Engineer. The Design-Builder shall demonstrate CCTV command/control using vendor software upon completion of each Video Encoder installation.

13.4 MEASUREMENTS

Field Video Encoder Units will be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing, installing, system integration, training, documentation, and testing of a complete Field Video Encoder Unit including the video encoder, power supply, power cable, attachment hardware and brackets and all incidental items to provide and install the Field Video Encoder as intended, satisfactory completion of all testing requirements and all work, equipment and appurtenances as required for a full Field Video Encoder installation. The price bid shall also include all system documentation including shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other materials necessary to document the operation of the Field Video Encoder Units. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

13.5 PAYMENT

The contract unit price shall be full compensation for all the work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-20.99	VIDEO ENCODER	EACH

The Field Video Encoder Unit will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component, Bench Test System and Pre-Installation test results.

2. Additional 20% of the contract unit price upon approval of Stand Alone Site Test results.

3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results.

4. Final 10% of the contract unit price upon Final System Acceptance

14 TERMINAL SERVERS

14.1 DESCRIPTION

This section specifies the minimum requirements for Terminal Servers furnished and installed on this project. The work shall consist of providing all labor, materials, equipment, and incidentals necessary to furnish, install, and test Terminal Servers.

The Terminal Server device, also commonly referred to as a Port Server device, will be used to communicate bi-directionally between IP-based Ethernet network systems and existing field devices that communicate or are controlled via a full-duplex serial interface.

14.2 MATERIALS

The equipment and software shall comply with the following minimum material specifications:

14.2.1 General Capabilities and Performance Requirements

The Terminal Server shall meet the following general requirements:

1. 10/100 Base-TX Ethernet port connection
2. RS-232/485 selectable or programmable serial connections
3. Baud rates up to 230 Kbps
4. TCP/IP protocol
5. SNMP protocol
6. HTTP protocol
7. Remote TELNET connection
8. ARP-Ping for IP address assignment
9. LED status for link and power
10. All terminal servers shall be mechanically and electrically interchangeable within the network.

14.2.2 Data Interface Requirements

The minimum data interface requirements include the following:

1. The Terminal Server shall support a minimum of two (2) bi-directional serial communication channels over an Ethernet 10/100 Base-TX uplink.

2. Each Terminal Server shall have a minimum of two (2) EIA-232/485 Serial interface ports. These ports shall be individually and independently configurable, directly by switching or over the network, to EIA-232/485 mode of operation as defined by the EIA for data format, data rate, and data structure (e.g., the number of bits, parity, stop bits, etc.). Each serial port shall support up to 230 Kbps.

3. Each serial port shall support IP addressing, and shall not use proprietary encapsulation methods, which would restrict the use of standards-based virtual COM port connectivity software.

4. The equipment shall provide the capability to establish an IP connection directly from a workstation to any device IP address.

5. Each Terminal Server shall have an Ethernet Interface (10/100Base-TX protocol, Full/Half-Duplex, Auto Sense (802.3), RJ-45).

14.2.3 Physical and Environmental Specifications

The minimum physical and environmental requirements include:

1. Each Terminal Server shall have the following ports:

    a. Network Ethernet Port: Minimum one (1) 10/100 Mbps RJ-45.

    b. Serial Data Interfaces: Two (2) 232/485 9 pin ports.

2. Operate in a temperature range of -35°C to 74°C.

3. Operate in relative humidity of 5% to 95% non-condensing.

4. Maximum Dimensions: 8”W x 6”D x 3”H.

5. Provide external markings:

    a. All connectors, indicators, and replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list.

    b. The external markings shall include the product function name, model number, serial number and manufacturer’s name.

6. Terminal Servers shall be shelf mountable or rack mountable. Shelf for the cabinet shall be provided if needed. Other mounting options may be submitted for review and approval by the Engineer.

14.2.4 Management Capabilities

The minimum management system requirements shall include:

1. Remote Management and Port Configurable.
2. SNMP compatible.
3. Local Configuration Port.
4. Port Configurable via Telnet.

14.2.5 Electrical

The minimum electrical/power requirements include:

1. 120 VAC.
2. External power supply unit is acceptable.

14.3 INSTALLATION REQUIREMENTS

All equipment shall be installed according to the manufacturer's recommendations, the Plans, this SP, and as follows:

1. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.
2. The Design-Builder shall furnish all tools, equipment, materials, supplies and manufactured hardware, and shall perform all operations and equipment integration necessary to provide complete, fully operational communications equipment as specified herein, within the Plan set, and/or in the Contract Documents. It is the responsibility of the Design-Builder to ensure DCE/DTE conflicts are addressed and that the equipment performs its required function when installed.
3. The Design-Builder shall provide the Department with a written inventory of items received and the condition in which they were received. Once received, the equipment becomes the Design-Builder's responsibility. The Design-Builder shall provide all labor and equipment necessary to move inventory out of the designated storage facility and to transport it to the

installation location. All equipment shall be installed according to the manufacturer's recommendations or as directed by the Department.

14.3.1 Testing Requirements

Testing shall include, but not be limited to, the following:

1. General Requirements:

    a. The Design-Builder shall conduct a project testing program for all Terminal Servers as required in Section 1.5 of this SP. The project testing program shall include but is not limited to the additional specific requirements in this subsection.

    b. All test results shall confirm physical and performance compliance with this SP.

    c. The Design-Builder shall submit all test results documentation to the Engineer within 14 days of completion of the tests. The Engineer will review test documentation in accordance with the Submittal Review Process in Section 1.8.

2. Bench Test System (BTS) and Standalone Acceptance Test (SAT)

    a. The Design-Builder shall also demonstrate the ability of the Terminal Server to communicate with the attached RDS's through the serial port.

14.4 MEASUREMENT

The Terminal Servers will be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing, installing warranties, full operation and configuring the Terminal Server in accordance with applicable Standards, Specifications, and requirements. The price bid shall also include the mounting hardware, Cat-6e patch cords, serial port cables or connectors, power cable, power adapters, user manuals, testing, warranties, and any and all other equipment required to complete installation of the unit. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

14.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-21.21	TERMINAL SERVER	EACH

The Terminal Servers Equipment will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component, Bench Test System and Pre-Installation Test results.

2. Additional 20% of the contract unit price upon approval of Stand Alone Site Test results.

3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results.

4. Final 10% of the contract unit price upon Final System Acceptance.

15 LOCAL AREA NETWORK

15.1 DESCRIPTION

15.1.1 Overview

1. Segments of the project deployment will have multiple ITS field devices concentrated via agency owned fiber optic network. The Design-Builder will furnish and install new L2 Field Ethernet Switches at these locations identified in the Plans. Where applicable, the Design-Builder shall integrate the L2 Field Ethernet Switches with the TDOT communications network.

2. Design-Builder shall use the models specified on the certification published on the TDOT/TOD/ITS website for proprietary item regarding Local Area Network devices.

15.1.2 Virtual Local Area Network (VLANS)

1. For the L2 Field Ethernet Switches installed in the field, VLANs shall be developed to group devices by type. Where utilized, the management VLAN will be logically separate from all other VLANs to ensure manageability during network events and to provide additional security.

2. Common/consistent ports shall be used for the edge devices for common devices. Up to two ports shall be reserved for future device classes. One port shall be reserved for network connection by a laptop computer at the equipment cabinet. This shall be the only port configured with access to the management VLAN.

15.1.3 Requirements Definition Document

1. Prior to commencing work, the Design-Builder shall develop a Requirements Definition Document (RDD) that will form the basis for the overall network architecture and design. It is expected that the Design-Builder will work closely with TDOT IT to define the network. The document will contain:

    a. Complete description of the proposed implementation of the access, distribution and core layers for the ITS network as described in the Plans and this SP.

    b. Development of an IP Design Scheme with ranges assigned to each node to be integrated by the Design-Builder using guidance from TDOT (e.g. address ranges, geographic distribution, standards for addresses within each cabinet).

c. Proposed IP subnet definition and addressing including any and all masks.

d. Proposed IP multicast configuration including multicast routing (i.e., PIM sparse or dense) and Rendezvous Point (RP) designation as necessary

e. Proposed recommendations for failover and redundancy including network device power, supervisor cards, and network ports

f. Proposed configuration and guidelines for L3 routing (OSPF, VRRP, EIGRP, RIP, etc.);

g. Proposed configuration and guidelines for Virtual LAN assignments including management VLANs, device VLANs and routing VLANs.

h. Proposed configuration and guidelines for L2 broadcast storm prevention, loop prevention and fault tolerance mechanisms. (Spanning Tree diagram with designated, blocking and forwarding ports indicated. Root bridge and backup root bridge must also be specified.)

i. Proposed configuration and guidelines to mitigate common security threats such as denial of service, man in the middle, MAC/IP spoofing and brute force dictionary attacks.

j. Proposed configuration and guidelines for 802.1p Class of Service (COS) queue assignments

k. Proposed configuration and guidelines for specific port assignments on each of the L2 and Ethernet bridge device.

2. The Engineer will provide the Design-Builder with an IP address range or ranges from which the Design-Builder will develop the IP address scheme. The RDD shall be prepared by a qualified networking professional (minimum CCNA or a manufacturer-approved equivalent based on the approved hardware vendor) and will be approved by the Engineer. The Qualified network professional will be present during the installation and testing of the local area network as well as during system testing.

15.2 MATERIALS

15.2.1 General

1. Furnish equipment for the LAN that complies with applicable IEEE 802 standards. Furnish Ethernet LAN switches that are fully compatible and interoperable with the network monitoring software, the existing network architecture and configuration, and the existing firewall and switch at the TMCs.

2. Furnish Ethernet Switches that comply with the following electrical safety requirements: UL60950 or CSA C22.2 No. 60950 (safety requirements for IT equipment) and FCC Part15 Class A for EMI emissions.

15.2.2 Network Switch (Type A) (L2 Field Ethernet Switch)

Design-Builder shall use the models specified on the certification published on the TDOT/TOD/ITS website for proprietary item regarding Local Area Network devices.

Generally, L2 Field Switches shall meet the following requirements:

1. L2 Field Switches will be placed in locations shown on the Plans. L2 Field Switches fabricated for use in traffic signal controller cabinets shall meet or exceed NEMA TS- 2 requirements for temperature, shock, humidity, and vibration.

2. Furnish L2 Field Ethernet Switches that have the option for din rail mounting as well as rack mounting.

3. Furnish Field Ethernet switches with a vendor's approved Power Supply meeting the following power supply requirements:

    a. Shall be supplied by the same vendor as the L2 switch.

    b. 90 to 264 VAC (50/60Hz)/ 106 to 300VDC.

    c. Power supply shall have two stage isolation accomplished via two transformers: first steps down from primary AC/DC to 48VDC; the second steps down from 48VDC to the final DC voltage required by the switch.

    d. A power cord of not less than 5 feet in length shall be supplied

4. Furnish Field Ethernet Switches that weigh no more than 15 lbs and are no more than 250 cubic inches in volume.

5. Furnish field Ethernet switches with the following minimum characteristics and features:

    a. Minimum of eight (8) 10/100/1000 Ethernet downlink ports

    b. Minimum of four (4) dual-purpose ports

    c. Minimum of four (4) 1000 Base-X SFP module slots

    d. Support PoE and PoE+ for all Ethernet downlink ports

6. Furnish SFP modules rated to service the Field Ethernet to Field Ethernet optical uplinks

and Field Ethernet to Gig-E Hub Uplink rated for optical attenuation required to service the link. Use SFP modules that are LX or ZX and are matched and compatible with the SFP module it is mated with. Furnish attenuators if required to service link without saturating receiving optics.

7. Furnish SFP modules rated for use with the optical cable furnished under this project

8. Furnish SFP modules with LC connector or other connector approved by the Engineer

9. Furnish fiber jumper cables with appropriate connectors to connect with switch and adjacent drop cable connectors and/or other switches.

10. SFP modules shall be considered incidental to the field Ethernet switch

11. Management console port

12. 10/100BaseTX ports:

    a. RJ45 connectors

    b. Cable type: Category 6, unshielded twisted pair (CAT 6 UTP)

    c. Auto-negotiation support (10/100Mbps)

    d. Auto MDIX crossover capability

    e. Full Duplex operation (IEEE 802.3x)

    f. SPD (Surge Protective Device) between Line +/-, Line +/ground, and Line

    g. Ground to protect the circuitry

13. Networking Requirements

    a. The switch shall support automatic address learning of up to 8000 MAC

addresses

i. The switch shall support the following advanced L2 functions:

- IEEE 802.1Q VLAN, with support for up to 1000 VLANs
- IEEE 802.1p priority queuing
- IEEE 802.1w rapid spanning tree
- IEEE 802.1s multiple spanning tree
- IEEE802.3AD link aggregation
- IEEE 802.3x flow control
- IGMPv2 with 256 IGMP groups
- Port Rate Limiting
- Configuration via test file which can be modified through standard text editor
- Forwarding/filtering rate shall be 14,880 packets per second (PPS) for 10Mps,148,800 for 100Mps, 1,488,000 for 1000Mps
- DHCP Option 82

ii. Network Management Functionality Requirements

- Shall be interoperable with the existing network infrastructure (Cisco core multi-layer switches, distribution multilayer switches, firewalls, and routers)
- Shall have the ability to run container applications
- SNMPv2 and SNMPv3

- RMON
- GVRP, or VTP
- Port Mirroring
- 802.1x port security
- Radius Server and TACACS+ Server
- SSL – Secure Socket Layer
- SSH – Secure Shell
- TFTP
- Network Time Protocol (NTPv3)
- Simple Network Time Protocol (SNTPv3)
- Management via web only if HTTPS SSL and SSH

15.2.3 Network Switch (Type B) (L3 Field Aggregation Ethernet Switch)

Design-Builder shall use the models specified on the certification published on the TDOT/TOD/ITS website for proprietary item regarding Local Area Network devices.

Generally, L3 Field Switches shall meet the following requirements:

1. L3 Ethernet Switches shall be Cisco Catalyst 9500 Series Switches or as approved by TDOT. At a minimum, the L3 Ethernet switch shall be Cisco Catalyst C9500-40X-A that supports forty (40) 10G SFP+ with full L3 capabilities. Cisco DNA Premier License shall be provided for a minimum of 5 years.
2. L3 Switches shall be rack mounted
3. Meet IEEE 802.1 standards for multiple spanning tree protocol and per-VLAN rapid spanning tree reconvergence
4. Have a minimum of forty-eight (48) 1G SFP fiber ports

5. Furnish SFP modules for a minimum of twenty-four (24) 1G SFP fiber ports with LC connector or other connector approved by the Engineer. 1G SFP module shall support a link length of 25 miles or greater.

6. For L3 Ethernet Switches to be installed at ITS Communications Hub locations:

    a. A minimum of two (2) ports among the forty-eight (48) ports shall be able to support POE+ and 1000BASE-X connections.

    b. The two downlink ports can be 1G copper ports.

    c. Expansion modules or network switches meeting all requirements in Section 15.2.2 can be utilized.

    d. The installation costs will not be paid separately and shall be included in the unit cost of the L3 Ethernet switch.

7. IOX operating system

8. CPU x86 complex with 8-GB memory, and 16 GB of flash and external USB 3.0 SSD pluggable storage slot

9. USB 2.0 slot to load system images and set configurations

10. Modular uplink with a minimum of forty (40) 10G SFP+ ports

11. Furnish SFP+ modules for a minimum of eight (8) 10G SFP+ fiber ports with LC connector or other connector approved by the Engineer. 10G SFP+ module shall support a long haul link length of 50 miles or greater.

12. Furnish fiber jumper cables with appropriate connectors to connect with switch and adjacent drop cable connectors and/or other switches.

13. SFP and SFP+ modules shall be considered incidental to the L3 Ethernet switch

14. Shall have switching bandwidth of up to 480 Gbps

15. Line-rate, hardware-based Flexible NetFlow (FNF)

16. Built in IEEE 802.1ba AV Bridging (AVB)

17. Precision Time Protocol (PTP; IEEE 1588v2)

18. SD-Access:

    a. Edge to cloud automation

b. Segmentation and micro-segmentation with predictable performance and scalability

c. Have the option to embed wireless controller software packages and when enabled, function as co-located boarder and control plane

19. Shall have enable/disable plug-and-play feature

20. Security:

a. Encrypted traffic analytics

b. Support for AES-256 with the powerful MACsec 256-bit encryption algorithm

c. Meet IEEE 802.1 AE standards for authenticating and encrypting data packets

d. Hardware anchored secure boot and secure unique device identification for the purpose of verifying the identity of hardware and software packages

e. Built in protection against runtime attacks

21. Power Supply:

a. Shall be supplied by the same vendor as the L3 switch

b. Shall have dual redundant power supplies

c. Shall have AC and PoE power supplies, as recommended by the switch manufacturer

22. L3 Field Ethernet Switches will be placed in locations as shown on the Plans.

a. The L3 Field Ethernet Switch should be in 1 RU form factor.

b. The L3 Field Ethernet Switch should support at least 48 interfaces of 10Gb SFP.

c. The L3 Field Ethernet Switch should have reprogrammable ASICs, so that future features/encapsulations can be supported in hardware, should the need arise. Today's examples are MPLS or VxLAN.

15.2.4 Ethernet Bridge

1. The field bridge shall provide bridging Ethernet across one or more T-1 leased lines through Multilink Point-Point Protocol (MLPPP). The functions of the field bridge shall be to:

a. Provide physical and link layer protocol compatibility for bridging

b. Support virtual extension and integration of field CCTV cameras with the TMC Ethernet LAN via one or more T-1 communication links. The field bridge shall provide multilink bonding of multiple T-1 links to form a single aggregate data channel between the wireless Ethernet radio system and the TMC router

c. Combine all Ethernet messages into a common Ethernet at the physical, link, and network level

d. Incorporate TCP/IP, supporting network bridging

e. Buffer data as required to accommodate input/output data rates without loss of data and without causing transfer delays

f. Transparently manage lower level protocols

g. Accommodate full-duplex data transmissions on all T-1 interfaces

h. Conduct built-in test and report failures via alarms and indicators

2. The field bridge shall be required to bridge between Ethernet and T-1 protocols. The Ethernet bridges shall provide an Ethernet LAN virtually extended via one or more T-1s from TMC- to-CCTV demarcation and vice versa using telephone service provider T-1 circuits (MLPPP).

3. Ethernet bridges installed at each communication hub/concentrator shall include a minimum of two T-1 interfaces (expandable to four T-1s) and shall also include at least three 10/100Mbps full-duplex auto-sensing switched Ethernet ports with auto-negotiation capabilities. Each bridge shall be equipped with internal CSU/DSUs for direct termination of the telephone service provider T-1 circuits. To prevent the loss of data during extended power outages, Ethernet bridge configuration settings, commands, and programming shall be stored in non-volatile memory, and forwarded to the network according to pre-defined criteria.

4. The Design-Builder shall assure that compatible bridging and network management protocols are used in all Ethernet bridges. The Ethernet bridges shall sustain throughput over the aggregate T-1 links of at least 1.5 Mbps for each T-1 link. Field bridges shall be fully communications-compatible with the video encoders and wireless Ethernet radios supplied per these Special Provisions.

5. The Ethernet bridge chassis shall be provided with slides that allow the electronic drawer to be removed from the rack and be locked into a maintenance position. The slides also shall allow the drawer to be completely removed from the field cabinet by activating mechanical unlocking devices. The chassis shall be constructed from non-corrosive materials. The front panel shall be of ergonomic design for ease of use and include indicators that display Power, Self-Test, and Alarm status.

6. The TMC Ethernet Bridge will include all requirements of the Multi-T1 Ethernet Bridge devices except shall provide instead a T-3 interface.

7. All switches, indicators, and connectors shall be clearly and permanently marked as to identity and function and all removable components shall be identified by appropriate markings. All printed circuit boards shall have permanent markings, including a part number and functional name. Each removable module shall, as a minimum, include a permanently attached (e.g., stamped, etched, etc.) part number. Each removable module shall also include a permanently attached serial number. All component identifications shall correctly correspond to schematics, parts lists, and written narratives included in maintenance manuals.

8. All software required to operate and update network configuration/bridging, and to maintain the field Ethernet bridge shall be provided with the equipment. If the field Ethernet bridge requires loadable software for either operations or maintenance, the software shall be provided on a magnetic media compatible with the delivered equipment.

15.2.5 Electrical Requirements

Network Switch (Type B) L3 Field Ethernet Switch must be capable of operating on a nominal voltage of 120 volts alternating current (VAC) in the Hub building.

Each Ethernet bridge shall operate subject to the following electrical power specifications:

1. Input Voltage: 115 VAC +/-10% at 60Hz

2. Where surge protection is not internally provided, the Design-Builder may provide external surge protection. The input power cable shall be no less than 5’.

15.2.6 Physical and Environmental Requirements

1. Ensure that the L3 Field Ethernet Switch to be installed in the Hub Building has an operating temperature range of 0° Celsius to 40° Celsius and has a storage temperature range of -20° Celsius to 65° Celsius.
2. Each Ethernet bridge shall be rack or shelf mountable in a 19" EIA-310 style equipment rack, and shall not exceed 2 rack units in height (3.5") and shall fit sufficiently within the depth of the field cabinet. These dimensions shall be inclusive of any required external devices including, but not limited to power supplies. Each Ethernet bridge shall be industrially hardened for application in a non-environmentally controlled cabinet.
3. The field Ethernet bridge shall operate within temperatures ranging from -4°F TO 149°F (- 20°C to 65°C) with a relative humidity between 0% and 90%.

15.2.7 Network Management and Remote Monitoring Software (NMS)

1. TDOT currently uses an existing NMS platform to monitor the field network. The existing platform is SNMPc by CastleRock. Network Configuration Management and Network Performance Monitoring modules are monitored using Orion by SolarWinds.

2. Design-Builder shall coordinate with TDOT IT to update the NMS with the Design-Builder's proposed changes.

15.3 INSTALLATION REQUIREMENTS

15.3.1 General

1. Coordinate all work at, near, or inside buildings with the Engineer. Do not work on buildings or enter buildings without prior, written authorization from the Engineer. Coordinate and obtain approval from Engineer regarding allowable working time in buildings. Obtain necessary permits and inspections. Work shall not commence until the necessary permits are issued, posted on site, and approved plans are available on site. The Design-Builder shall coordinate installation with TDOT staff at least two (2) weeks in advance of needing access to the installed cable(s)/network equipment.

2. Furnish MAC addresses in a spreadsheet for all equipment utilized as part of this project, in addition to the equipment models, serial numbers, and firmware revisions. Equipment shall be registered in the name of TDOT. Affix a MAC Address label to each device utilized. Furnish IP addresses for all equipment utilized as part of this project. Affix final IP address to each device utilized. Use labels that do not smear or fade.

3. In field equipment cabinets, fully integrate new Ethernet switches with the fiber optic termination panels. Integrate all field equipment as called for in Plans.

4. Fully integrate proposed switches with existing TMC Core switches and computer and central system hardware to form a complete local area network that allows users from TDOT TMC as shown on the Plans to access applications on application servers and the CCTV central hardware and the proposed field communication network.

5. Fully integrate upgraded LAN to accomplish/maintain L2 Field Switch, L3 Aggregation Switch, and L3 Core Switch failover and fault tolerance.

6. Fully integrate LAN equipment to provide user authentication and security functions to prevent unauthorized users and data from entering the freeway system LAN.

7. No Ethernet switch purchase, configuration, or deployment can occur until the Design-Builder's RDD has been approved in final form by the Engineer.

8. Mount the Network Switches as shown in the Plans. Ensure that the Network Switches are resistant to all electromagnetic interference (EMI). Ensure that the Network Switches are mounted securely and are fully accessible by field technicians.

15.3.2 Ethernet Bridge

All equipment shall be installed according to the manufacturer's recommendations these specifications and the Plans.

1. Each T-1 service port shall be protected from line surges from telephone-company outside plant cables. Each bridge shall be provisioned to support streaming video over the aggregate bandwidth back to the TMC. At the TMC a central switch/router will be the primary destination for receiving all field camera video feeds over one telephone service provider multiple T-1 circuits. The Design-Builder shall be responsible for establishing the MLPPP parameters to interface with the telephone service provider T-1 circuits for communication with the TMC central system. Each communication hub shall be configured initially to accept up to four (4) T-1, with an aggregate total of 1.544 Mbps per T-1.

2. The video encoder's data port associated with the CCTV control shall each be configured to transmit at a minimum of 9600bps (or higher data rates as compatible with the CCTVs).

3. Under this contract, the Design-Builder shall be required to submit an IP addressing convention to the Engineer for approval, prior to configuring the Ethernet Bridge and video encoder addresses. The non-volatile configuration files for each Ethernet bridge, when appropriate, shall be provided electronically (CD-ROM, USB drive, or approved equal) to the Engineer as part of the as-built documentation for the system configuration.

15.3.3 Coordination with Central System Provider / Integrator

The Design-Builder shall coordinate his/her efforts with those of the TDOT's Central System Provider (SwRI's SWCS platform). The Design-Builder shall accommodate the System Provider's work in every way including planning and testing support for system integration. In general, the Design-Builder shall install and test the field equipment and accompanying communication infrastructure. The Design-Builder shall also provide software and firmware, which is not already available to the System Provider, necessary for proper operation of the equipment the Design-Builder supplies as part of this Contract. Additionally, the Design-Builder shall provide testing computers and appropriate software that shall be used to test and demonstrate proper and acceptable operation of all equipment and communications infrastructure provided and/or installed by the Design-Builder. The Design-Builder shall coordinate device locations and settings with the Provider and notify the Provider in the event any settings are changed as a result of direction from the Engineer and/or installation problems in the field.

15.4 MEASUREMENT AND PAYMENT

1. Network Switch (Type A) L2 Field Ethernet Switch & Network Switch (Type B) L3 Field Ethernet Switch will be measured in units of each and paid for at the contract price per each unit furnished, installed, and accepted. All SFP modules, optics, cabling, jumper cables, patch cables, attenuators, configuration, and testing or other labor or materials required to install and integrate the field Ethernet Switch will be considered incidental and not be paid for separately.

2. Ethernet Bridge will be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing, installing, system integration, training, documentation, and testing of a complete Ethernet Bridge including the Ethernet bridge, modules, power supply, power cable, ancillary cabling between the Ethernet bridge and the radio and/or video encoder, hardware and brackets and all incidental items to provide and install the Ethernet Bridge as intended, satisfactory completion of all testing requirements and all work, equipment and appurtenances as required for a full Ethernet Bridge installation. The price bid shall also include all system documentation including: shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other materials necessary to document the operation of the Ethernet Bridge. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

3. Network Configuration Update will be paid for and measured as lump sum. LAN integration includes configuration and integration of all LAN hardware, firmware, and software to complete the LAN architecture, and submittal of the RDD. Integration of Design-Builder-provided network equipment with the existing TDOT firewall and integration of Internet based software applications with TDOT's existing Internet connection infrastructure shall be incidental and not paid for separately. All cabling, hardware, accessories, labor, and materials not provided with TDOT furnished network equipment required to make the unit function as part of this project shall be considered incidental and not paid for separately. Coordinating/updating/configuring TDOT's existing LAN Network Management and Remote Monitoring Software (NMS) shall be included as part of the LAN integration and not paid for separately. Partial payments for this item will be made on the following schedule: 30% upon completion and acceptance of the RDD; 30% upon installation, integration and acceptance of LAN equipment at L3 Aggregation Switch locations including integration with the TMC Core Switches, 10% upon acceptance of the NMS configuration updates, and 30% upon installation, integration and acceptance of the entire project furnishing of and acceptance of network as-built documentation.

4. Payment for all cabling, jumpers, adapters, sockets, LAN patch panels, wall outlets, and other hardware shall be considered incidental and no separate payment will be made. Payment will be made under:

Item No.	**Description**	**Unit**
725-21.11	NETWORK SWITCH (TYPE A)	EACH
725-21.12	NETWORK SWITCH (TYPE B)	EACH
725-21.14	NETWORK CONFIGURATION	LS
725-21.16	ETHERNET BRIDGE (FIELD)	EACH

725-21.17 ETHERNET BRIDGE (TMC) EACH

L2 Field Ethernet Switch, L3 Field Ethernet Switch and Ethernet Bridge will be paid per each as follows:

1. 50% of the contract unit price upon completion Bench Test Component, Bench Test System, Pre-installation test results.

2. 20% of the contract unit price upon completion of Stand Alone Testing at the demarcation cabinet.

3. 20% of the contract unit price upon Conditional System Acceptance test results.

4. Final 10% of the contract unit price upon Final System Acceptance.

Network Configuration Update will be paid on a lump sum basis as follows:

1. 100% of the contract unit price upon Conditional System Acceptance.

16 FORWARD LOOKING INFRARED CAMERA SYSTEM

16.1 DESCRIPTION

This section specifies the minimum requirements for Forward Looking Infrared (FLIR) Camera Systems furnished and installed on this project.

The FLIR Camera System will provide TMC personnel with live streaming video of the roadway network, through both a daylight color camera and a thermal imaging camera, via FLIR Camera Systems installed at locations shown in the Plans.

16.2 MATERIALS

All materials furnished, assembled, fabricated, or installed shall be new, corrosion resistant and in strict accordance with all of the details shown in the Plans and described in this SP.

The FLIR Camera System shall comply with the following minimum materials specifications:

16.2.1 General Capabilities and Performance Requirements

Overall FLIR Camera System capabilities and performance requirements include the following:

1. FLIR Camera System shall be placed at fixed locations as shown on the Plans to provide full coverage within the project limits including the mainline travel lanes and shoulders.

2. The FLIR Camera System components shall be compatible with each other and be of rugged design and suitable for reliable operation when mounted in the configuration as specified in this SP and the Plans.

3. The FLIR Camera System shall be capable of attended and unattended, continuous 24 hours per day operation at the sites as shown on the Plans.

4. The Design-Builder shall ensure that the installed equipment provides unobstructed video of the roadway, traffic, and other current conditions around a roadside FLIR field site; that it responds to camera control signals from an operator of the system; and that the video images can be transmitted to remote locations interfaced to the system for observation.

5. The camera shall be fully compliant with all aspects of the National Television Standards Committee (NTSC) specification, and produce NTSC compatible video.

6. The camera shall operate over wide dynamic light conditions ranging from low light/dusk to full sunlight having day (color)/night (monochrome) switchover and iris control, with user-selectable manual and automatic control capabilities.

7. The FLIR Camera System shall be capable of being remotely controlled and programmed.

8. Dome type enclosures shall be provided with the ability to be pressurized for environmental protection.

9. The camera shall be mounted together with the zoom lens and integrated into the pan and tilt device within the dome enclosure forming a totally integrated, easily removable assembly.

10. The camera shall include a high quality integrated camera/lens combination.

11. The camera shall also be equipped with an auto-iris lens capability compatible with the zoom lens supplied.

12. Iris capability shall include a provision for manual override via software.

13. The camera shall be capable of auto-focus during zoom-in or zoom-out, with provisions for override via software.

14. Overexposure protection shall be provided - the camera shall not be degraded or damaged under normal reasonable operating conditions.

15. The capability for local control of pan, tilt, and zoom functions shall be provided at the roadside cabinet using vendor-supplied software installed on a laptop computer.

16. FLIR cameras shall support the NTCIP 1205 v1.08 communication protocol.

16.2.2 Camera Unit

The minimum Camera Unit requirements include:

1. The camera unit shall incorporate solid-state design and provide digital signal processing (DSP) capable of providing clear and low-bloom color video pictures during daylight hours and monochrome video at night when the roadway is illuminated with minimal roadway lighting.

2. The camera unit shall be equipped with a low light level sensor to automatically switch the camera to Black and White mode.

3. The camera unit shall be equipped with an override capability to allow the camera to be manually switched via software to turn off the automatic low light level sensor switch feature for Color or Monochrome operation.

4. Image sensor: 1/4 inch charge-coupled device (CCD) employing digital video signal processing (DSP) technology with a minimum Effective Picture Elements of 768 horizontal x 494 vertical pixels.

5. Sensitivity: The camera shall maintain usable video under both day and nighttime lighting conditions. The Design-Builder shall provide an explanation of how their proposed camera equipment will provide usable video meeting the performance requirements specified herein. This explanation shall take into account as a minimum, the following parameters: usable video level (full video), reflectance (day and night scenarios), F-Stop, AGC and Shutter Speed.

6. Video output synchronization shall be 2 to 1 interlace and will observe the NTSC (color) and EIA RS-170 (black and white) standards.

7. Resolution: 540 lines horizontal and 350 TV lines vertical, NTSC equivalent.

8. Signal-to-noise ratio: 48 dB, minimum with AGC off, un-weighted, and 4.5MHz filter.

9. Video Signal Format: National Television Standards Committee (NTSC) composite video output of 1 Voltp-p at 75 ohms, unbalanced.

16.2.3 Camera Lens

The minimum camera lens requirements include:

1. The camera lens shall have a minimum F-Stop of 1.4 to 1.6.

2. Optical and Digital Zoom: Shall provide an optical zoom of 35X and a digital zoom of 8X, minimum.

3. Zoom Control: The zoom magnification shall be fully controllable via the remote PTZ mechanism. The time to pass through the full range of movement of iris, zoom, and focus shall in no case exceed 10 seconds.

4. Iris and Focus: Support automatic iris and focus control with manual override capability. The iris shall be in a closed position when there is no power.

5. White or Color Balance: Support automatic or set to yield optical results under various outdoor lighting conditions.

6. Shutter Speed: Support automatic or set to yield optimal results under low lighting conditions without blooming or smearing, auto-iris on. Provide electronic shutter that is selectable in steps.

7. The lens shall be equipped for continuous remote control of zoom, focus, and iris.

8. Mechanical or electrical means shall be provided to protect motors from overrunning in extreme positions.

9. The zoom lens shall be an integrated camera/lens combination.

10. Vibration or ambient temperature changes shall not affect the automatic iris function, focus mechanism and zoom mechanism.

11. The lens shall be optically clear, impact resistant and acrylic. The acrylic lens shall not yellow and shall not introduce appreciable light loss or geometric distortion over a 10-year service life when exposed to the environment.

12. The zoom mechanism shall be designed for maintenance-free operations. All gearing and bearings shall be self-lubricating with lubrication and gearing tolerances compatible with the environmental specifications contained herein.

16.2.4 Character Generator

The minimum character generator requirements include:

1. The capability of generating and superimposing lines of English language text on the video image/stream shall be provided.

2. A minimum of 20 characters per line that are between 10 and 30 horizontal TV lines in height shall be provided.

3. Control (enable, disable, and edit) of this feature shall be available remotely and at the field site using a laptop computer.

4. The text messages shall be stored in non-volatile memory.

5. Characters shall be white with a black border to ensure legibility in varied scenes.

6. The following minimum text insertion requirements shall be provided with the ability to individually turn each one on or off:

    a. Camera ID

    b. Sector Message

    c. Alarm Messages

    d. Pan/Tilt Azimuth/Elevation

    e. Compass Direction in 8 discreet zones

16.2.5 Dome Enclosure

The minimum dome enclosure requirements include:

1. Sealed, pressurized dome enclosure that provides complete protection for the camera and lens assembly from moisture and airborne contaminants.

2. Environmental resistant and tamper proof meeting NEMA 4X or IP-67 rating requirements.

3. The dome enclosure shall be constructed in such a way that unrestricted camera views can be obtained at all camera and lens positions.

4. Dome environmental control shall be provided by nitrogen pressurization with a Schrader Valve for pressurization and purging. The enclosure shall be designed to be pressurized at 5 PSI of dry nitrogen. The notation "CAUTION – PRESSURIZED" shall be permanently printed on the rear plate of the enclosure and shall be clearly visible and readable.

5. An alarm shall be displayed under low-pressure conditions and displayed on the camera video. The low-pressure alarm shall be on/off selectable by the operator at the TMC.

6. The dome enclosure shall consist of a two-piece (upper and lower half) dome. The bottom half of the dome shall be attached to the upper half with a plastic-coated safety cable to prevent the lower half from falling to the ground.

7. A harness and cables shall be provided with each enclosure to extend the video, power and data from the FLIR Camera System to the field cabinet. No harness shall be exposed. All entry points shall have gaskets to prevent moisture entry. A sealed connector shall be at the top of the dome.

8. The dome enclosure shall assist in preventing lens fogging and effectively reduce internal temperatures.

9. The enclosure shall minimize glare and provide overexposure protection for the camera when pointed directly at the sun.

10. The enclosure shall be equipped with a heater, a defroster, and a thermostat.

11. The camera equipment inside the dome enclosure shall meet all its specified requirements when operating under the following conditions:

    a. Ambient Temperatures: -34ºC to +74ºC (-30ºF to +165ºF). A heater/blower shall be used to maintain internal dome temperatures within the manufacturer required operating temperatures for their equipment.

    b. Relative Humidity: 5% and 95%, non-condensing.

12. Total weight of FLIR cameras (including the housing, sunshield, and all internal components) shall be less than 18 pounds.

13. Dome enclosure shall be secured with a mounting plate/attachment designed to withstand a 90 mph sustained wind speed with a 30% gust factor.

16.2.6 Pan and Tilt Unit (PTU)

The minimum Pan and Tilt Unit requirements include:

1. The motorized, remotely controlled Pan/Tilt unit shall be mounted within the dome enclosure. The unit shall be integrated with the FLIR control system.

2. The unit shall provide continuous tilt (vertical) movement of 90 degrees from horizontal and continuous pan (horizontal) movement of 360 degrees.

3. Tilt speed shall be variable from zero up to 40 degrees per second, minimum, and the pan speed shall be variable from zero up to 80 degrees per second, minimum.

4. The unit shall be capable of simultaneous pan, tilt movements and zoom on one camera

5. Drive motors shall be capable of instantaneous reversing, be corrosion resistant, not require lubrication, and have overload protection.

6. Braking shall be provided in both pan and tilt movements to enable fast stop and reversal and to prevent drifting.

7. The viewing limits shall be set by a minimum of 8 discreet privacy zones that are software selectable.

16.2.7 Camera Control Receiver – Driver

The minimum camera control receiver-driver requirements include:

1. The camera control receiver shall provide a single point interface for control, power and video communications.

2. The camera control receiver-driver shall be included within the dome enclosure and control the camera, pan/tilt and lens functions at each FLIR site.

3. The unit shall provide alphanumeric generation for on-screen titles.

4. The unit shall provide the ability to display diagnostic information on the screen in response to user commands.

5. The diagnostic information shall include current pan, tilt, zoom, and focus positions, and error codes for power, communication, position, and memory problems.

6. The capability for programmed tours shall be provided.

7. The camera control receiver shall use non-volatile memory to store the required information for presets, camera ID and sector text.

8. Presets shall meet the following requirements:

    a. A minimum of 64 presets shall be supported. Each preset shall consist of pan, tilt, zoom, and focus positions.

b. The Design-Builder shall develop and install ten (10) presets for each camera. The Design-Builder shall submit the preset locations to the Department for review and approval.

9. Protocols: FLIR cameras shall support the NTCIP 1205 v1.08 communication protocol. No camera control receiver-driver shall use non-published protocols. The Design-Builder shall provide protocol documentation.

10. Communications Interface: The communications interface shall support communications compliant with RS-422 and/or 485 (user selectable).

11. The communications interface shall be compatible with the Video Encoder serial port as defined in Section 16 of this SP.

12. Connectors: Standard connectors compatible with communications and interface equipment/cables shall be provided.

13. The video input and output connections shall be the BNC type.

14. Connector(s) shall also be used for connecting the control outputs from the control receiver-driver unit to the camera, lens, and pan/tilt mechanisms.

16.2.8 Electrical

The minimum electrical requirements include:

1. The FLIR Camera System shall be furnished with any and all equipment required for a fully functional system, including all appropriate power and communications cables as defined by the manufacturer.

2. The power cables shall be sized to meet the applicable National Electrical Code (NEC) requirements.

3. Total power consumption shall not exceed 125 Watts.

4. All devices supplied as system components shall accept, as a primary power source, 120 volts of alternating current (VAC) at an input of 60 hertz. Any device that requires source input other than 120 VAC at 60 hertz, such as cameras, PTUs, receiver/drives and dome heaters/blowers that operate at 24 volts or other, shall be furnished with the appropriate means of conversion.

16.2.9 Coaxial Cabling

The minimum coaxial interconnect cable requirements include:

1. The coaxial cable from the FLIR Camera System to the equipment cabinet shall be Belden 8281 or approved equivalent.

2. RG 59/U, 20AWG, bare copper conductor, polyethylene insulation.

3. 98% tinned copper, double braid shield, black polyethylene jacket.

4. Characteristic Impedance: 75 ohms (□), nominal.

5. Capacitance (conductor to shield): 21pF/ft; Inductance: 0.131uH/ft, nominal.

16.2.10 Surge Protection

All FLIR Camera System electrical interconnects shall be protected from voltage surges caused by lightning and external electromagnetic fields. The minimum surge protection requirements include:

1. Surge protectors shall be furnished for all non-dielectric cable and conductors (video, data/signal and device/assembly power) between the FLIR Camera System and the equipment cabinet.

2. The surge protectors shall have leads that are kept to a minimum length as recommended by the surge device manufacturer.

3. All surge protection devices shall be designed to meet the temperature and humidity requirements expected in this type of outdoor application.

4. All Surge protectors shall be UL listed (UL 1449, UL 497, 497A, 497B, etc., as appropriate) and bonded to the same single-point ground point.

5. Coaxial Cable Surge protectors for coaxial cable shall meet/provide the following functionality:

    a. Attenuation: 0.1dB @10 MHz, typical

    b. Input / Output Impedance: 75 ohms nominal

    c. Operating Voltage of the surge protector shall match characteristics of the ITS device/assembly

    d. Peak Surge Current: 5,000-amperes for an 8x20 microsecond waveform

    e. Response Time: 1 nanosecond or less

6. Low Voltage/Signal Cable Surge protectors for data/signal/control cable shall meet/provide the following functionality:

    a. Peak Surge Current: 10,000-amperes for an 8x20 microsecond waveform

    b. Response Time: 1 nanosecond or less

    c. Life Expectancy: Capable of surviving at a minimum of 25 occurrences at 2000- amperes

7. FLIR power surge protectors for power from equipment cabinet power distribution to the FLIR Camera System shall meet/provide the following functionality:

    a. Frequency: DC to 10MHz

    b. Clamping Voltage: < 30VAC (rms) or 42VDC

    c. Insertion Loss: < 0.2dB

    d. Input / Output Impedance: 75 ohms, typical

    e. Peak Surge Current: 3000-amperes

    f. Response Time: 1 nanosecond or less

16.3 INSTALLATION REQUIREMENTS

All equipment shall be installed according to the manufacturer's recommendations, the Plans and as follows:

1. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.

2. Shall include all materials needed to permanently mount the FLIR camera to the support structure as indicated in the plans.

3. Furnish and install power, video, and data cables, and any and all ancillary equipment required to provide a complete and fully operational FLIR system site.

4. Verify all wiring meets NEC requirements where applicable.

5. All above requirements apply to both new FLIR sites as well as sites where an existing FLIR is being replaced under the contract.

16.4 MEASUREMENT

FLIR Camera System will be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing, installing, system integration, training, documentation, and testing of a complete FLIR Camera System including the FLIR Camera Assembly, PT unit, zoom lens, enclosure, camera controller/receiver, coaxial cable, control/signal cable, power cable, surge suppressors and conduit between the camera and the cabinet, connections to support structures, attachment hardware and brackets and all incidental items to provide and install the FLIR Camera System as intended, removal of existing equipment (FLIR, cables, cabinet interface equipment, etc.) at locations where an existing FLIR is being replaced, satisfactory completion of all testing requirements and all work, equipment and appurtenances

as required for a full FLIR Camera System. The price bid shall also include all system documentation including shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams, and other materials necessary to document the operation of the FLIR Camera System. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

16.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-20.93	CCTV CAMERA SYSTEM (INFRARED)	EACH

The FLIR Camera System will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component, Bench Test System and Pre-Installation test results.

2. Additional 20% of the contract unit price upon approval of Stand Alone Site Test results.

3. Additional 20% of the contract unit price upon approval of Conditional System Acceptance Test results.

4. Final 10% of the contract unit price upon Final System Acceptance.

17 PROJECT ACCEPTANCE

17.1 DESCRIPTION

This section specifies the minimum requirements for acceptance procedures and tasks that must be completed prior to project acceptance. These items include the project testing program, burn-in period, training, warranties, project submittals, system documentation, and as-built documentation.

17.2 TASK REQUIREMENTS

17.2.1 Project Testing Program

1. The project testing program requirements and acceptance procedures are outlined in Section 1 of this SP. Additional specific testing requirements are detailed in the individual SP sections.

2. The burn-in period requirements are outlined in Section 1 and Section 18 of this SP.

17.2.2 Training

1. The training requirements are outlined in Section 1 of this SP. Additional specific training requirements are detailed in the individual SP sections.

17.2.3 Warranties

1. The warranties requirements are outlined in Section 1 of this SP. Additional specific warranty requirements are detailed in the individual SP sections.

17.2.4 Project Submittal Program

1. The project submittal program requirements are outlined in Section 1.8 of this SP. Additional specific submittal requirements are detailed in the individual SP sections.

17.2.5 System Documentation

1. The system documentation requirements are outlined in Section 1.9 of this SP. Additional specific system documentation is detailed in the individual SP sections.

17.2.6 As-Built Documentation

1. Prior to the Conditional System Acceptance Tests, all Department approved changes shall be incorporated by the Design-Builder into all submitted documents and drawings, including the project Plans. Copies of the updated drawings shall be submitted to the Department to serve as the final as-built configuration drawings. In the Project Plans, each drawing shall be identified under the sheet number block, with the words "AS- BUILT", the date and the approval. The as-built drawings shall consist of a neatly marked-up set of plans using a red permanent marker. The drawing shall indicate the as-built location of all equipment including, but not limited to: poles, cabinets, conduit, pull boxes, gates, etc. As part of the as-built drawings, the Design-Builder shall use a hand-held GPS unit to determine the GPS coordinates (in a format approved by the engineer) for all standalone devices, structures, and outside plant infrastructure including field devices, poles and sign structures, pull boxes, equipment cabinets, signs, etc. These coordinates shall be summarized in a GPS Coordinates Database in a Microsoft Excel or Access table that indicates the following minimum information:

    a. Device/equipment name and number (where applicable)

    b. Roadway name and station number

    c. Sheet number in Plans

    d. GPS coordinates

    This information shall also be included in the equipment inventory and maintenance database described in Section 18.

2. In addition to submitting an original hardcopy of the AS-BUILT drawings, the Design-Builder shall submit a PDF file (with markups created using digital entries) of each AS-BUILT sheet. High Quality marked sheets shall be submitted electronically in a PDF format. The Design-Builder shall also submit AS-BUILT plans in a MicroStation. The as-built drawings shall consist of a neatly marked-up set of plans using a red font in a MicroStation file. The Design-Builder must contact TDOT and request the original plans in MicroStation so that they may be edited for the As-Builts.

3. As-built documentation shall be prepared and submitted in the following two stages:

    a. Preliminary as-built documentation shall include all materials, devices, and infrastructure included in this contract. Preliminary as-built documentation shall be submitted and approved prior to requesting the Conditional System Acceptance Test.

b. Final as-built documentation shall be an update reflecting any changes that occurred during the burn-in period. Final as-built documentation shall also include installation data forms provided by TDOT to the Design-Builder throughout the project that shall be completed by the Design-Builder. These forms require various information such as cable length IDs into and out of each pull box, site specific information, etc. Final as-built documentation shall be submitted and approved as part of the Final Inspection.

4. As part of the as-built drawings, the Design-Builder shall also submit a complete System Equipment Inventory of all equipment utilized on the project. The Design-Builder shall create and maintain the System Equipment Inventory as a Microsoft Access database. The System Equipment Inventory shall include GPS coordinate information from the as-built documentation. As an alternate, the GPS Coordinates Database and the System Equipment Inventory may be combined in one relational database provided that all required data components are maintained.

   As a minimum, the System Equipment Inventory shall include the following information about each equipment item:

   a. Device/equipment item name

   b. Pay item number

   c. Location (station and device ID)

   d. Sheet number in Plans

   e. GPS coordinates

   f. Make, model and mfr part number

   g. Serial number

   h. Barcode equipment ID

   i. Barcode location ID

   j. Revision ID

   k. Firmware ID

   l. Purchase date

   m. Installation date

   n. Manufacturer contact information

5. The Design-Builder shall provide project submittals for as-built documentation in accordance with the requirements in Section 1.8 of this SP. The project submittals for as-built documentation shall include but are not limited to, the following:

    a. GPS Coordinates Database (template shall be submitted for approval)

    b. System Equipment Inventory (template shall be submitted for approval)

6. Beginning with the first activities of field construction, all as-built documentation, including, but not limited to, updated drawings, completed installation data forms, GPS Coordinates Database, and System Equipment Inventory, shall be kept up-to-date on a weekly basis and shall be made available for review by the Engineer upon request.

17.3 MEASUREMENT

17.3.1 Project Testing Program

Project testing shall be included in the cost of other pay items and will not be measured separately for payment, except for burn-in period as specified herein.

17.3.2 Training

The Training item shall be a lump sum item and shall include all labor, equipment, materials, travel, facilities, production and reproduction, and miscellaneous items needed to conduct the training as specified.

17.3.3 Warranties

Warranties shall be included in the cost of other pay items and will not be measured separately for payment.

17.3.4 Project Submittal Program

Project submittals shall be included in the cost of other pay items and will not be measured separately for payment.

17.3.5 System Documentation

System documentation shall be included in the cost of other pay items and will not be measured separately for payment.

17.3.6 As-Built Documentation

As-built plans shall be a lump sum item and shall include all labor, equipment, materials, production and reproduction, and miscellaneous items needed to produce the as-built plans as specified.

17.4 PAYMENT

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-24.55	AS-BUILT PLANS	LS
725-24.61	TRAINING	LS

1. As-Built Documentation will be paid on a lump sum basis as follows:

    a. 90% of the contract unit price for approved as-built documentation prior to Conditional System Acceptance.

    b. Final 10% of the contract unit price upon Final System Acceptance.

2. Training will be paid on a lump sum basis as follows:

    a. 100% of the contract unit price upon completion of required training.

18 SYSTEM MAINTENANCE REQUIREMENTS

18.1 DESCRIPTION

The purpose of this Section is to describe the required maintenance activities that the Design-Builder must provide during the Burn-in period with an option for a period up to 3 months following Final System Acceptance by the Engineer. The Design-Builder will provide these maintenance activities for all equipment installed as part of this Contract. The maintenance requirements described in the Section shall include all necessary labor, materials, equipment, tools, transportation, supplies, and incidentals required to complete the work. The maintenance period is divided into Preventative Maintenance and Unscheduled Maintenance. The duration of the maintenance period will be subject to the exercising of the Annual Maintenance options at the discretion of TDOT.

18.1.1 Definitions

Preventive Maintenance (PM) for the System consists of regularly scheduled activities such as, but not limited to, electrical testing, replacement of necessary parts, cleaning, and lubrication. The Design-Builder shall perform all preventive maintenance activities recommended by this SP as well as the equipment manufacturer within the periodic intervals recommended. This shall include the periodic inspection and cleaning of the equipment and updating the resulting documentation of this inspection.

Repair maintenance consists of responding to the various failures reported concerning the various field components of the system. Repair maintenance will include the reactive, day-to- day repair, replacements, and diagnostic work necessary to keep the System fully operational.

Both Preventive Maintenance and Repair Maintenance shall be included in the cost of the Burn- in Period pay item (725-24.41).

A repair maintenance response is defined as the Design-Builder receiving notice from the TDOT of a failure and the Design-Builder responding with a field assessment of the problem, preparation of a plan and schedule for repair and submission of that report to the TDOT. The response report may be via email or fax.

Failures after Conditional Acceptance caused by acts of God or other construction activities outside the control of the Design-Builder shall be defined as Unscheduled Maintenance and the Design-Builder shall be compensated separately for those activities. Unscheduled maintenance may also include other special requests from TDOT. If these special requests require additional equipment or expertise beyond a normal maintenance activity, the Design-Builder may negotiate a different rate for those special requests.

18.1.2 General Requirements

The Design-Builder shall manage all ITS assets within the project limits and will perform work that produces end results in accordance with the Department Specifications including all Supplemental Specifications and Special Provisions. These include, but are not limited to:

1. TDOT Standard Specifications for Road and Bridge Construction (Latest Edition).

2. Manual on Uniform Traffic Control Devices (Latest Edition).

3. TDOT Roadway and Structure Drawings (Latest Revised).

Proper health and safety measures shall be taken to ensure safety for the traveling public, TDOT employees, Design-Builder employees, and SubDesign-Builder employees.

Maintenance of traffic is solely the responsibility of the Design-Builder. Under no circumstances will maintenance of traffic be an additional pay item.

TDOT will pay all monthly electric & leased line communication bills. Responsibility for maintaining power to devices will be as follows:

1. From the utility to the demarcation point - Local Utility Companies

2. From the demarcation point to the control cabinet or breaker and from the control cabinet or breaker to and within the devices - Design-Builder.

The Design-Builder shall maintain an electronic maintenance log which shall detail all maintenance action items and the dispositions of the items contained in the log. The log will be kept on the maintenance computer within the TMC. Prior to the beginning of the burn-in period, TDOT will provide the Design-Builder an empty Microsoft Access database file that contains the required formatting for the database.

All overhead work over impacted traffic lanes shall include proper lane closures in accordance with MUTCD, except when the Design-Builder is working inside a DMS enclosure. TDOT must approve all lane closures in advance. Requests for lane closures shall be submitted at least seven days in advance of work for all preventative maintenance activities.

The Design-Builder is required to provide all operational crews with working cell phones at all times. In addition, the Design-Builder shall provide a single phone contact for the Design-Builder's supervisor. The Design-Builder shall provide to the TDOT and keep current all cell phone contact numbers. It is essential that the operating crews can contact the TMC to ensure correct operation of equipment and verify equipment status in the control center.

TDOT will appoint a representative that will act as contract administrator with the responsibility of ensuring that work is done to a specified standard defined in this SP. This representative will be responsible for verifying that the Design-Builder satisfactorily completes the work. The TDOT representative will be responsible for the overall monitoring of the Design-Builder's work.

18.1.3 Form of Contract

Under the terms of this Contract there are several requirements:

The first requirement will be for performing the preventive maintenance for the System. This will be included in the price bid for the burn-in period. Preventive maintenance consists of regularly scheduled activities such as, but not limited to, communications and electrical testing, replacement of necessary parts, cleaning, and lubrication. The Design-Builder shall perform all preventive maintenance activities recommended by this SP as well as the equipment manufacturer within the periodic intervals recommended. This shall include the periodic inspection and cleaning of the equipment and the resulting documentation of this inspection.

The second requirement is for performing Repair Maintenance. Repair Maintenance consists of responding to the various failures reported concerning the various field components of the system. Repair Maintenance will include the reactive, day-to-day maintenance, replacements, and diagnostic work necessary to keep the System operational. The Design-Builder must provide all necessary labor, tools, equipment, and engineering for the repair maintenance work. A response report containing the items identified must be submitted to TDOT within the time frames noted below. Notice of a failure will be communicated to the Design-Builder via a phone call and a follow up email or fax.

The Repair Maintenance during the Burn-in Period shall be included in the cost bid for the Burn- in Period. With the exception of acts of God as described below, no separate payment will be made for keeping the system operational during the burn-in period. Repair Maintenance beyond the Burn-in Period will be considered “Unscheduled Maintenance”.

Work items generated by failures caused by acts of God, other construction activities, or other special requests from TDOT shall be considered Unscheduled Maintenance. The Design-Builder must provide the required number of personnel and all necessary tools, equipment, and engineering for the unscheduled maintenance work. All labor and material items described above shall be included in hourly unit price as described in the payment section.

If a failure involves a DMS Sign, multiple cameras, or poses a safety threat to the motoring public as determined by TDOT, the Design-Builder shall respond on-site within four (4) hours of notice of a failure by TDOT. This four-hour response requirement applies 24 hours a day, 7 days a week.

For other failures that do not include a DMS sign, multiple cameras, or do not pose a safety threat, the Design-Builder shall respond on-site within eight (8) hours of notice of a failure by TDOT. This eight hour response requirement is limited to normal business hours (8:00 am to 5:00 pm) Monday thru Friday.

The Design-Builder and TDOT will work together to develop a tracking system to document and track all Unscheduled Maintenance Labor. Once a repair task is complete, the Design-Builder shall submit final paperwork within three (3) business days. Failure to submit this paperwork within the specified time is subject to non-payment.

The third requirement is for the purchasing and storing of spare parts. The amount of required spare parts by equipment type is defined in this document. The initial Spare Parts will be paid at the lump sum price bid (based on the quantities shown in the Spare Parts section). The cost of storing and maintaining the inventory of spare parts and equipment should be included in the lump sum cost of the spare parts. The cost for replenishing used spare parts for under the Equipment Replacement pay item. A 15% markup on the invoice price shall be allowed on direct material costs.

In addition to the items of work described above, there may be special circumstances where TDOT requests work that cannot be adequately covered by one of the pay items included in this contract. (Example situations may include pole knock downs, re-location of facilities to accommodate other construction activities, minor system modifications or expansions, etc.). If and when those situations occur, the Design-Builder will be asked to submit a separate cost proposal and schedule to TDOT for consideration and approval. Once approved the Design-Builder shall start the work within 10 days of approval and prosecute the work with due diligence according to the schedule agreed upon. It will be TDOT's sole decision to determine whether or not a specific item of work can be completed within the existing pay items.

18.2 SCHEDULE OF WORK

TDOT will permit access to facilities as required by the Design-Builder for the purposes of maintenance. The Design-Builder shall provide the Maintenance Activities throughout the entire contract period.

The TDOT reserves the right to either cancel this Maintenance Agreement in part, or in its entirety without liability to the TDOT on thirty (30) days written notification to the Design-Builder or at the end of an option period. The TDOT shall direct that the work under this Maintenance Agreement be performed by the Design-Builder in one-year increments with each yearly increment being exercised at the sole option of the TDOT. Failure of the TDOT to exercise an option will terminate the Contract. The Department shall have no obligation in excess of the amount contracted for, or for services rendered by the Design-Builder, which are not performed within the specified period.

18.2.1 Monthly Status Meetings

Each month the Design-Builder shall hold a status meeting with TDOT. At these meetings the Design-Builder shall discuss the previous month's repairs, anticipated work for the next month, spare purchases for the month, and other operational problems that may arise. The Design-Builder is responsible for taking and distributing the minutes of these meetings. These minutes must be transmitted to TDOT within seven days for approval by TDOT. Progress payments for Annual Maintenance may be withheld until meeting minutes are submitted to TDOT. Note that on some occasions more frequent meetings may be warranted for special conditions. No additional costs will be allowed for these additional meetings.

18.3 EQUIPMENT TO BE MAINTAINED

All equipment installed by the Design-Builder as part of this project shall be subject to the preventive and unscheduled maintenance procedures through the burn-in period until Final Acceptance is given. Following Final System Acceptance, the Design-Builder will enter into an Annual Maintenance contract that will be renewable in one year increments at TDOT's discretion. The Design-Builder will continue to be responsible for preventative and unscheduled maintenance during the Annual Maintenance period for all subsystems listed above.

18.4 MAINTENANCE PROCEDURES

For each major equipment type there are defined minimum preventive maintenance procedures. These minimum procedures are defined in Appendix A – Preventive Maintenance Procedures. Each equipment's preventive maintenance procedure has a fixed period between procedures. These are defined in Appendix A. It is also the Design-Builder's responsibility to obtain and submit to TDOT the preventive maintenance procedures recommended by the equipment manufacturers, including, but not limited to, all requirements to meet warranty standards.

Maintenance procedures performed under repair maintenance shall use materials and installation procedures as specified in this SP for new construction. At the sole discretion of the Engineer, certain repairs that are not possible to complete to the same standard as the new construction may be made utilizing materials and procedures as directed by the Engineer.

Should the Design-Builder perform an unscheduled maintenance action and within five (5) days the same fault is reported on the same piece of equipment, it is the Design-Builder's responsibility to make the second and any subsequent same-fault repairs at no cost to TDOT. Should a particular device persist in its failures, upon TDOT's instruction, such device shall be replaced and paid for by TDOT under the unscheduled maintenance procedures.

Upon completion of any maintenance activity, the work shall be subject to a random inspection by the TDOT. Work that is determined to be unacceptable shall be re-performed by the Design-Builder at the Design-Builder's expense.

For damage caused by acts of God, other Design-Builders, or TDOT personnel, the Design-Builder is responsible for photographing all damaged structures and equipment; obtaining crash reports and/or driver information; and for submitting this information to TDOT.

18.5 RECORD KEEPING PROCEDURES

The Design-Builder shall use an existing database that will be provided by TDOT to the Design-Builder to track all preventive, repair, and unscheduled maintenance activities. The required format for each input will be provided to the Design-Builder prior to Conditional System Acceptance. The Design-Builder shall prepare a separate database to track the inventory of current spares. The database files shall be updated and emailed to TDOT weekly. This email shall also include a summary of the next week's planned maintenance activities.

The records for both preventative maintenance and an unscheduled maintenance response report on the database shall at a minimum include the following information. Additional information may also be required as requested by TDOT:

1. Date and time of failure report or date of unscheduled maintenance

2. Person or source of the report

3. Location of device
4. Description of failure or symptom
5. Name of person responding
6. Arrival time at location of reported failure
7. Weather and condition of the site
8. Actions taken
9. Schedule of initiating corrective work and estimated completion of work
10. Date and time of completion of work
11. Spare part details
12. Any consequential events – such as, but not limited to, failure to operate or secondary failure.

The Design-Builder shall maintain accurate and complete records of all work activities, status reports, meeting notes, cost proposals, invoices, inventory records, etc. The project As-Built Documentation, including the System Equipment Inventory, shall be updated if any information contained therein is changed due to scheduled or unscheduled maintenance activity. As-Built Documentation shall consist of, but not be limited to, modifying cabinet drawings, wiring diagrams, or installations. As-Built Documentation during maintenance shall be in accordance to the standards and requirements in this SP. All project records will be the property of TDOT and shall be returned to TDOT prior to final payment of the Contract.

18.6 EQUIPMENT CONTROL

The Design-Builder shall maintain a sufficient inventory of spares to ensure the repair response time specified in the Appendix. The minimum amount of required spare parts by equipment type is defined below. These spares will be purchased by the Design-Builder and owned by TDOT. As equipment is used from the spare parts inventory during burn-in and device warrantee period, the Design-Builder shall replace at his own expense.

However, if the need to use spare parts equipment is due to acts of God, other special requests by TDOT, or repairs beyond the device warrantee period during the Annual Maintenance Period, the Design-Builder may invoice TDOT for replacement spares added back to the inventory. However, the cost of the replacement spares shall be submitted to TDOT for approval prior to ordering. A 15% markup will be allowed on direct material costs of the replacement spares needed due to acts of God or other special requests by TDOT. Shipping, insurance, and purchase costs should be paid directly by the Design-Builder and billed to TDOT. TDOT must give prior written approval for each monthly order made by the Design-

Builder. The Design-Builder shall maintain a spares record and make readily available to TDOT. Spares records are to include as a minimum:

1. Manufacturer
2. Model number
3. Descriptive title
4. Serial number
5. Location
6. Purchase date
7. Date installed – when applicable
8. Location of installation – when applicable

The Design-Builder is fully responsible for these spares. The Design-Builder shall ensure the inventory of spares against all hazards or loss and name TDOT as the beneficiary in the case of loss. A copy of the insurance documents must be provided to TDOT. TDOT has the right to audit the inventory at any time by providing the Design-Builder with a five day notice. When items from the Spare Parts inventory are used, the Design-Builder shall replenish the inventory within 30 days of use. Contract payments will be held if this is not done within 30 days.

In addition to maintaining the spare parts inventory, the Design-Builder shall also ensure the availability and access to all vehicular equipment (trucks, bucket trucks, backhoes, front end loaders, and diagnostic equipment, etc.) and engineering/technical equipment needed to respond to and repair equipment failures and malfunctions. All equipment that is typically needed for an ITS maintenance contract shall be available and on-site within the required response time frame requirement outlined. If typical maintenance equipment is not available within this timeframe, the Design-Builder shall be considered to have missed the required response requirement. If specialty equipment is needed that is not typical, the Design-Builder shall notify TDOT of this need and TDOT will determine if an exception can be made in that situation.

18.7 SPARE PARTS

The Design-Builder shall have available and maintain the listed quantity of spare parts and modules to provide the required maintenance. Spares will be replenished as used, so that the following quantities in working orders are available at all times and will be delivered to TDOT at the conclusion of the maintenance contract. Note that only the major items are listed below, but each item listed below includes all equipment that was included in the original pay item for that particular item. All supporting, incidental, ancillary, and peripheral items necessary for a fully populated and complete installation shall also be maintained in the inventory. Prior to conditional system acceptance, the Design-Builder shall submit a full spare parts inventory list including the incidental items:

1. Two (2) Radar Detection Units
2. One (1) 35’ Light Standard Poles
3. One (1) CCTV Camera Assembly
4. Two (2) LED face sign modules for DMS Sign
5. One (1) set of DMS fans sufficient to replace all fans in a single DMS housing.
6. One (1) DMS cable assembly from controller cabinet to sign case
7. Two (2) Network Switch (Type A)
8. Five (5) ITS Cable Markers
9. One (1) Cabinet (Type B)
10. One (1) CCTV Pole with Lowering Device (80’)

Only replacement parts provided by or functionally equivalent to those provided by the original manufacturer shall be allowed. Functional equivalency shall be approved at the sole discretion of the Engineer. The Design-Builder shall provide conveniently located secure premises to store all spare parts inventory.

18.8 Bar Code System

TDOT has an existing bar code system. The Design-Builder shall ensure that all new and replacement equipment has bar code labels attached using this existing equipment supplied by TDOT. The purpose of the bar code system is to track the equipment inventory and to be able to determine the various maintenance activities that have occurred with that piece of equipment. The Design-Builder shall initially install bar code labels on all equipment prior to installation during the construction phase. The cost of installing the initial bar code labels shall be included in the cost of other items. Data corresponding to each equipment item must be recorded in the barcode system at TDOT. The implementation of the bar code system must be completed by the Design-Builder prior to the installation of any electronic equipment. The Design-Builder shall follow TDOT’s existing bar code system structure, but shall provide the bar code labels needed for the equipment.

18.9 Staffing / Management Plan

The Design-Builder must provide a minimum of one technician for the duration of maintenance related contract periods to ensure satisfactory completion of all maintenance and repair activities. Before the start of Burn-in Period, the Design-Builder shall submit a Staffing/Management Plan defining the key staff for

ITS Maintenance and the Project Management Team for approval by the Engineer. Resumes for the key staff must be provided. Changes to the key staff and Project Management Team shall require approval of the TDOT or the Department's authorized designee prior to use of the staff on the project. The TDOT shall have the right to reject any proposed replacement staff and request another replacement.

The staffing/management plan should include:

1. Proposed plan for communication and coordination among the Team and key staff.

2. Qualifications of all personnel. All staff must be qualified for the various types of devices and equipment they will be working on. Qualifications must include at least one year of installing and/or maintaining the types of ITS devices in this contract, or equivalent experience as approved by the Engineer. If qualified personnel are not available on Design-Builder's staff, work must be performed by a factory trained manufacturer representative.

18.10 STAFFING QUALIFICATIONS

All staffing associated with this project must be qualified for the work that is to be performed. Specifically, technicians that are responsible for the electronic components, must have a minimum of a two year associate degree plus two years relevant work experience or equivalent. An equivalent to this qualification would be more than three years of relevant experience. Any proposed equivalent must be approved by TDOT. The Design-Builder will furnish staff that is familiar with the equipment that is installed in this project.

18.11 SAFETY PLAN

The Design-Builder is required to follow all applicable safety laws, regulations, and TDOT standard safety procedures. This includes compliance to the requirements of the Manual on Uniform Traffic Control Devices (MUTCD), OSHA, and others as appropriate. Appropriate safety attire for personnel in the field, clear markings, and functional yellow lights on vehicles must be part of the safety plan.

18.12 DESIGN-BUILDER'S RESPONSIBILITY FOR UTILITY, PROPERTY AND SERVICE

At points where the Design-Builder's operations are adjacent to the properties of any utility, including railroads, and damage to which might result in considerable expense, loss, or inconvenience, work shall not commence until arrangements necessary for the protection thereof have been completed.

The Design-Builder shall cooperate with owners of utility lines so that removal and adjustment operations may progress in a reasonable manner, duplication of adjustment work may be reduced to a minimum, and services rendered by those parties will not be unnecessarily interrupted.

Should the Design-Builder cause a cut in any communications media it is the Design-Builder's responsibility to repair that cut within one hour of the cut occurring.

If any utility service is interrupted as a result of accidental breakage or of being exposed or unsupported, the Design-Builder shall promptly notify the proper authority and shall cooperate with the authority in the restoration of service. If utility service is interrupted, repair work shall be continuous until service is restored. No work shall be undertaken around fire hydrants until the local fire authority has approved provisions for continued service.

18.13 PERFORMANCE OF THE DESIGN-BUILDER

Throughout this Contract, TDOT will conduct a review of the various works performed by the Design-Builder. These reviews shall be to determine the compliance of the Design-Builder's operations with the maintenance requirements, the terms of the Contract, and the policies and procedures of TDOT. The Design-Builder shall fully cooperate with these reviews. If deficiencies are found, TDOT shall inform the Design-Builder of this in writing. The Design-Builder shall take immediate remedial action to cure any deficiencies. No additional compensation will be due to the Design-Builder associated with such remedial actions. Payments may be withheld, or the burn-in period may be extended, if the Design-Builder fails to take immediate remedial action to cure any deficiencies.

The Design-Builder is required to maintain the devices uniformly and consistently throughout the Burn-in and Annual Maintenance periods, meeting both TDOT and, as appropriate, the manufacturer's performance specifications, as well as respond to failures identified by TDOT. Continued poor performance of work or failure to perform shall cause the Design-Builder to be declared in default of the Contract. Failure to meet the maintenance requirements specified in this Contract shall result in a written notice from TDOT. This information shall inform the Design-Builder of non-compliance, as well as the withholding of progress payments that will occur, or an extension of the burn-in period if non-compliance continues. Progress payments will be withheld under the following conditions.

1. Regarding Preventive Maintenance: If any devices are found to be behind schedule for the regularly scheduled maintenance procedures, all progress payments will be withheld until all devices are verified back on schedule.

2. Regarding Repair Maintenance: All repair maintenance requests should be responded to within the timeframes outlined. A response is defined as being on site and beginning to diagnose the problem. When the response times exceed the requirements on more than two requests during any given month, the current monthly progress payment will be withheld until the following month. Items where the failure to respond is beyond the control of the Design-Builder, will not be included in this calculation.

3. Regarding Access Maintenance Database: If database is not updated weekly and is more than one week behind schedule, all progress payment will be withheld until database is current.

It is not the intent of TDOT to unfairly penalize the Design-Builder for events beyond his control such as acts of God, vehicle hits, severe weather conditions, major power failure, etc. Failure to perform either repair maintenance or preventive maintenance during such periods will not be used to penalize the Design-Builder, provided the Contactor returns to standard operations after such periods have ended.

The Design-Builder must ensure that all warranties remain valid. To achieve this, the Design-Builder shall perform all the preventive work specified by the manufacturer within the periods specified by the

manufacturer for all equipment. If these tasks are covered by the standard preventive maintenance, then both conditions apply.

The Design-Builder shall provide vehicular equipment such as, but not limited to, bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work. An approved vendor as per the equipment specification requirements shall calibrate all electronic maintenance and measurement equipment.

The Design-Builder shall provide conveniently located secure premises to store all test equipment. The Design-Builder shall provide workbench facilities to enable diagnostic testing and remedial work.

18.14 MEASUREMENT

18.14.1 Burn-In Period

The burn-in period item shall be a lump sum item and shall include all labor, materials, tools, equipment, and engineering necessary to maintain the system as specified in Section 1.5.8. The burn-in period item also includes all labor, materials, tools, equipment, and engineering necessary for all maintenance work as described in accordance with this SP. The bid price for the Burn-in Period shall also include the labor and bar code labels for the bar code system described in Section 18.8. The burn-in period pay item is the only payment that will be made during the burn-in period with the exception of items described below.

Preventive Maintenance shall not be measured separately and shall be included in the price bid for the Burn-in Period. This shall include all labor, tools, vehicles, equipment, and engineering necessary to perform preventive maintenance on the System in accordance with the provisions of the Contract.

Repair Maintenance shall not be measured separately and shall be included in the price bid for the Burn-in Period. This shall include, but is not limited to, all labor, overhead, bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work in accordance with the provisions of the Contract.

For work items resulting from acts of God or other special requests from TDOT, the Design-Builder shall be compensated his hourly labor costs for such operations at the hourly rate bid for Unscheduled Maintenance Labor. This hourly rate includes but is not limited to, all labor, overhead, bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work. Hours shall be based on actual time on task plus a maximum of two hours travel time, or actual travel time if less than two hours. No further labor costs will be allowed. The price bid shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work. The price bid per hour includes all labor charges regardless of the number of people at the site.

18.14.2 Preventative Maintenance for System

Preventative Maintenance shall not be measured separately and shall be included in the price bid for the Burn-in Period (725-24.41). This shall include all labor, tools, vehicles, equipment, and engineering necessary to perform preventative maintenance on the System in accordance with the provisions of the Contract.

18.14.3 Unscheduled Maintenance Labor

During Burn-in, the Design-Builder shall be compensated his hourly labor costs for such operations at the hourly rate bid for Unscheduled Maintenance Labor only for work items resulting from acts of God or other special requests from TDOT. This hourly rate includes but is not limited to, all labor, overhead, bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work. Hours shall be based on actual time on task plus a maximum of two hours travel time, or actual travel time if less than two hours. No further labor costs will be allowed. The price bid shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work. The price bid per hour includes all labor charges regardless of the number of people at the site.

After a successful Burn-in Period and Final Acceptance of the system by TDOT, if unscheduled maintenance operations or modifications are required to repair, modify, or replace system components due to no fault of the Design-Builder and wholly outside his control, the Design-Builder will be compensated his hourly labor costs for such operations at the hourly rate bid for Unscheduled Maintenance Labor. This hourly rate includes but is not limited to, all labor, overhead, bucket trucks, inspection trucks, field engineering equipment, tools, materials, cellular phones, and other equipment necessary to perform the work. Hours shall be based on actual time on task plus a maximum of two hours travel time, or actual travel time if less than two hours. No further labor costs will be allowed. The price bid shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work. The price bid per hour includes all labor charges regardless of the number of people at the site.

18.14.4 Spare Parts and Equipment Replacement

Spare Parts will be paid at the lump sum price bid for Spare Parts. The price bid shall include the furnishing of the specified parts only. Any install costs are covered elsewhere at a later time. The price bid shall be full compensation for all labor, tools, materials equipment, and incidentals to furnish the spare parts. The cost of storing and maintaining the inventory of spare parts and equipment should also be included in the lump sum cost of the spare parts.

Prior to the conditional system acceptance of the project, the Design-Builder shall submit to TDOT an itemized breakdown of the lump sum cost indicating the amount for each item in the spare parts inventory. Should changes during construction require a change in the number or type of spare parts needed, this breakdown of the initial bid price will be used to determine the appropriate change in the lump sum bid price. As spare parts are used, replacements to the inventory will be at the Design-Builder's expenses unless the additional equipment is needed due to an act of God or other special request from TDOT. In these cases, the replacements will be reimbursed at invoice price plus 15%.

Compensation for materials requested by TDOT, in addition to the spare parts listed, will also be at the rate of actual invoice cost including tax plus 15 percent for procurement expenses. Any extraordinary costs to the Design-Builder will not be paid unless approved in advance by the TDOT.

Equipment Replacement is a pay item that will be used to reimburse the Design-Builder invoice cost plus 15% for replacement parts needed throughout this Contract. The bid price shall be $25,000.00 which will establish a base amount that will be used as needed as replacement parts are ordered and invoiced by the Design-Builder. The required bid amount of $25,000.00 is meant only to establish a base amount and does not guarantee that the entire amount will be needed or used. Any unused funds in this pay item at the end of the contract will remain the property of TDOT.

18.15 PAYMENT

The contract unit price shall be full compensation for all work specified in this section

Payment will be made under:

Item No.	Description	Unit
725-24.21	PREVENTATIVE MAINTENANCE FOR SYSTEM	LS
725-24.25	UNSCHEDULED MAINTENANCE LABOR	HOUR
725-24.31	SPARE PARTS	LS
725-24.32	EQUIPMENT REPLACEMENT	LS
725-24.41	BURN-IN PERIOD	LS

1. Unscheduled Maintenance Labor (where requested by TDOT) will be paid at the hourly rate upon completion and acceptance of a repair or modification.

2. Spare Parts and As-Built Plans will be paid at the lump sum price upon complete delivery to TDOT.

3. Burn-in Period will be paid on a lump sum basis as follows:

    a. 50% of the contract unit price upon successful completion of 3 months of the burn-in period.
    b. Final 50% of the contract unit price upon Final System Acceptance

4. Annual Maintenance Labor (for quarters authorized by TDOT) will be paid on a lump sum basis of 1/3rd of the contract unit price upon successful completion of a month of the preventative maintenance activity.

5. Equipment Replacement will be paid at invoice cost plus 15% as replacement parts are ordered and invoiced by the Design-Builder.

19 ITS COMMUNICATIONS HUBS

19.1 DESCRIPTION

This Item shall consist of the Design-Builder furnishing and installing an ITS communications hub building as shown on the Plans. This work includes site preparation, procurement, transportation, and installation of an ITS communications hub building with conduit connections as specified in the Plans. Major elements of the ITS communications hub include the building components, building foundation, heating, ventilation and air conditioning (HVAC) system, interior electrical distribution system, lighting, fire extinguisher, hub camera, lightning protection system, interior and exterior grounding, equipment racks, cable management trays, electrical utility/service connections, standby generator power system, site preparation and driveways, and paving and fencing around the hub building. The work shall be in accordance with plan details, ACI 318-19, IBC and ASCE-7-22.

19.2 MATERIALS

19.2.1 General

1. Furnish only new equipment and materials.

2. Furnish, configure and install ITS communications hubs at locations as shown in the Plans. Furnish, configure, and install all equipment and materials for each specific site as shown in the Plans.

3. Provide an ITS communications hub designed, manufactured and installed for use in an exposed outside plant environment and for housing electronic equipment, fiber optics equipment, and other related system components in a weatherproof and environmentally-controlled interior space.

4. Provide an ITS communications hub, complete building with all systems, that meets all local building codes for a non-habitable equipment shelter.

5. Provide a hub building, complete with all systems, that meets the IBC, SBC, BOCA, UBC, NEC, and NESC national codes.

6. Provide submittal documentation signed and sealed by an architect and/or engineer licensed in the state of Tennessee that each hub building, installed complete with all systems and site work, meets all applicable codes for the final installation location.

19.2.2 Hub Building

1. General

    a. Furnish a hub building manufactured and pre-assembled inside an enclosed plant building in a controlled environment.

b. Provide a hub building, complete with foundation and door, in compliance with the following:

i. UBC Seismic Zone rating of 4.

ii. UL 752 Ballistic Standards rating of Level 4.

iii. 2-hour fire rating of the aforementioned local and national building codes.

iv. All visible components of the building exterior shall have a medium brown color except for the roof covering and incidental materials such as electrical service components.

v. All concrete components manufactured from 5,000 psi @ 28 days design mix unless otherwise specified.

vi. Minimum finished interior dimensions shall be 8'-6" high by 8'-6" wide by 10'-8" long.

c. Configure the building as shown in the Plans.

2. Wall

a. Hub building wall construction shall meet the following:

b. Core construction of monolithic solid concrete slab with minimum 4-inch thickness.

c. Exterior finished surface of exposed stone aggregate of medium brown or tan color.

d. Interior finished surface, on all walls, of minimum ¾-inch plywood paneling with white-colored vinyl, melamine or fiberglass reinforced plastic facing. Alternately, provide two layers of minimum ½-inch plywood with interior facing equivalent to above.

e. Fire-rated gypsum board as required.

f. Minimum 1-1/2 inch expanded polystyrene insulation board or equivalent with continuous vapor barrier or insulated building wrap.

g. Wall studs as required.

h. Minimum R-11 insulation value provided by completed wall section.

i. All interior joints and seams finished out with matching white vinyl or PVC trim or black rubber floor base trim.

j. 3/4-inch PVC ground wire sleeve slanting downward to the exterior below the MGB position.

k. Two 4-inch PVC sleeves, capped and sealed, for telecom cable entrance approximately 12 inches below and to the side of the MGB position. Separate pull box.

l. Four 4-inch PVC sleeves, capped and sealed, for fiber optic cable entrance approximately 12 inches below and to the side of the MGB position. Separate pull box.

3. Ceiling/Roof

Hub building ceiling/roof construction shall meet the following:

a. Core construction of monolithic solid concrete slab with minimum 4-inch thickness.

b. Interior finished surface of minimum ¾ inch plywood paneling with white- colored vinyl, melamine or fiberglass reinforced plastic facing.

Alternately, provide two layers of minimum ½ inch plywood with interior facing equivalent to above.

a. Fire-rated gypsum board as required.

b. Minimum 1-1/2 inch expanded polystyrene insulation board or equivalent with continuous vapor barrier or insulated building wrap.

c. Peaked roof design with drainage slope and minimum 1-inch overhang.

d. UV resistant membrane roof surface material.

e. Minimum R-19 insulation value provided by completed ceiling/roof section.

f. All interior joints and seams finished out with matching white vinyl or PVC trim.

4. Floor

Hub building floor construction shall meet the following:

a. Core construction of monolithic solid concrete slab with minimum 4-inch thickness.

b. Interior finished surface of minimum 1/8-inch vinyl sheet or tile flooring with anti-static coating.

c. Minimum 1-1/2 inch expanded polystyrene insulation board or equivalent with continuous vapor barrier or insulated building wrap.

d. No wood or other organic materials as any component of the floor section.

e. Communications conduit entrance block-outs as shown in the Plans, trimmed with vinyl or PVC molding.

f. Minimum 200 psf rating by completed floor section.

5. Foundation

Hub building foundation wall construction shall meet the following:

a. Construction of monolithic solid concrete slab with minimum concrete design strength of 3,000 psi @ 28 days.

b. Foundation perimeter footer shall be minimum 24 inches deep by 12 inches wide and shall be steel bar and wire mesh reinforced.

c. Foundation thickness within perimeter footer shall be minimum 4 inches thick and shall be wire mesh reinforced.

d. Exterior edge of the foundation slab shall be sloped or chamfered to prevent water coming down the building wall from running on the top of the foundation to under the building.

e. Hub building shall be anchored to the foundation with exterior steel plates and concrete anchors.

6. Door

Hub building door shall meet the following:

a. Minimum 18 gauge galvanized steel door and frame

b. Minimum trade size of 36 inches by 84 inches

c. Includes door check/stop, magnetic weather-stripping, hydraulic door closer, peep hole, mortise lockset with deadbolt, stainless steel hinges with non-removable pins, and door open sensor with dry contact terminals.

d. Exterior canopy of 16 gauge galvanized steel with minimum size of 5 feet by 3 feet.

e. Includes minimum 12 inch by 18 inch sign on door with legend "TENN DEPT OF TRANSPORTATION ITS COMMUNICATIONS HUB "X" – FOR EMERGENCY CALL 000-000-0000" where X is the hub ID. The Engineer shall provide the phone number. Sign shall be minimum #20 AWG aluminum blank with reflective sign sheeting meeting the minimum requirements of AASHTO M268 Type 1.

19.2.3 Electrical System

1. Provide electrical system and components with UL-listings.

2. The electrical system materials and installation given in this SP are a minimum. Design and install the electrical system, including but not limited to the electrical demarcation, transformer, main service entrance, load center, generator connector and transfer switch to provide an electrical system to support the worst case/highest demand combination of the on/active condition of the following scenarios:

    a. All installed equipment under this project (e.g., Network Switch Type B, UPS)

    b. 5000 watts of additional future equipment of the same power factor rating of the Network Switch

    c. One additional UPS of the same load and power factor rating as the UPS specified in this project

    d. HVAC system in maximum load condition commanded/allowed by the HVAC controller (e.g., simultaneous startup load of both systems in cooling, heating and/or dehumidification modes)

    e. All hub building lighting and electrical ancillary and accessories equipment (e.g., hub monitoring system, smoke alarm, etc.)

    f. 1750 watts of usage of general use/technician equipment outlets

    g. 20% uprating of sum of above

    h. Load center after final configuration of above shall have minimum 8 spare breaker positions which will accommodate a minimum of three 2-pole breakers

3. All electrical wiring raceway and enclosure materials shall be metallic. All joints on raceways (conduit) and enclosures shall be bonded across the joint by a #6 AWG green-insulated stranded bonding jumper.

4. Provide a transformer in compliance with all requirements for a Transformer Type B except that the transformer shall be sized in accordance with the Design-Builder's electrical system design as required in Subsection 6.2.3.2.

5. Provide a minimum 200A 120/240V UL-listed main service entrance with exterior main disconnect and 32-position load center, to be fed from the hub electrical power service demarcation. The load center shall be located inside the hub building. Provide over-current disconnect breakers for all branch circuits.

6. Provide a main disconnect enclosure that is UL-listed, rated for outdoor use, does not have external handles or switches, and includes a hinged door on the enclosure that has provisions for locking by means of a padlock. Mount the disconnect on the exterior hub building wall directly opposite of the load center.

7. Provide a lightning/surge arrestor at the load center for 120/240V, single phase, 3 wire plus ground that meets the following minimum requirements:

    a. Mounted in a metal enclosure with LED module status indicators on the enclosure cover

    b. Connected in parallel

    c. Rated for a service entrance or distribution panel

    d. Permanently connected

    e. Internal over-current protection 200 kAIC

    f. Protection modes L-N, L-G, N-G

    g. Suppression voltage, L-N, L-G, N-G 400 V

    h. Surge energy capability, 10/1000 µs, total 5000 joules

    i. Component response time 1 nanosecond (ns)

    j. Operating temperature -25°F to 170°F (-32°C to +77°C)

    k. Dry contact status output, connected to a contact closure input on the UPS.

8. Provide a generator connection and transfer switch for external power generation connection to service the load center, enabling the servicing of the entire hub installation including all housed equipment. The generator connection shall be externally mounted with locking connector that mates with the generator cord-set. The transfer switch shall be mounted internally, adjacent to the load center, and shall be manually controlled.

9. Install an equipment power distribution system that provides one 120 VAC 20A dedicated circuits for the vertical power strip on each of the equipment racks. Add a minimum of one additional 120VAC 20A dedicated circuit for each additional four (4) adjacent equipment racks. Mount one twist-lock receptacle per circuit/per rack in boxes on the ceiling directly above the equipment racks. Mount receptacles for additional circuits in the same manner, positioned approximately in the middle of the group of adjacent racks.

10. Provide one or more dedicated circuits for the HVAC systems as required.

11. Furnish a dedicated 20A circuit with a ground fault circuit interrupter (GFCI) breaker with grounded quad receptacles on each hub building interior wall, one quad receptacle on each short wall and two quad receptacles on each long wall.

12. Furnish one dedicated 20A circuit with grounded duplex outlet with a GFCI breaker that is rated for outdoor use on the exterior hub building wall, adjacent to the door.

13. Furnish four 6 foot fluorescent lights (two bulb fixtures) with protective ulb covers, permanently mounted with one inside switch adjacent to the door that is labeled for the interior lights. Locate the fixtures to provide illumination to the front and rear of the equipment racks and throughout the hub building. Locate fixtures such that overhead cables, cable runways, or equipment racks do not block the light. Provide a dedicated circuit for the hub interior lighting.

14. Provide an exterior floodlight with long life fluorescent bulb for the exterior doorway entrance area, with photocell switch for automatic continuous nighttime operation on the same building wall as the door, with one inside switch adjacent to the door that is labeled for the exterior light. Provide a dedicated circuit for the hub exterior floodlight.

15. Provide a smoke alarm, line-powered with a dedicated circuit, with battery backup and dry contact output. Locate the smoke alarm in the building near the center of the ceiling. Connect the contact output to a contact closure input on the UPS.

16. Provide an interior illuminated exit light over the doorway with integral battery backup and emergency floodlights positioned to light the interior of the hub, without blinding the Hub Monitoring System, in power outage events.

19.2.4 Uninterruptible Power Supply (UPS)

Provide a hub UPS meeting the following minimum requirements:

1. 19” rack mounted, maximum height of 6 rack units
2. 120 VAC single phase 60 HZ output
3. Input line cord with locking plug and mating ceiling-mounted receptacle with dedicated circuit
4. 8 output receptacles type NEMA5-15R
5. Pure sine wave output at 115 VAC ± 5%
6. Transfer time of 4 ms or less
7. Load factor range of 0.5 to 1.0
8. Software adjustable high and low voltage buck/boost function
9. SNMP manageable hardware and software with 10Base-T network interface (RJ-45 connection)
10. SNMP addressable with physical IP address configuration (e.g., dip switch, thumb wheel)
11. Addressable SNMP command set shall minimally include: UPS state, battery condition (capacity, age, internal temperature); current AC input conditions (voltage, phase, frequency, failure condition); current AC output conditions (voltage, frequency, load); and diagnostic/self-test control and status.
12. Remote environmental sensing hardware and software integrated with SNMP minimally capable of temperature and humidity monitoring and 4 dry contact closures
13. SNMP management user interface and MIB software package, fully licensed to TDOT
14. Sealed maintenance-free lead-acid batteries
15. Maximum audible noise of <53 dBA at 3 feet
16. Load and reserve capacity to support the Network Switch with all ancillary equipment and the Hub Monitoring System for a minimum continuous operating period of 6 hours without electrical power service.

19.2.5 Grounding System

1. General Requirements

    a. Provide a complete hub building interior and exterior grounding and bonding system.

    b. The grounding and bonding system materials and installation given in this SPSP are a minimum. Design and install the grounding and bonding system to provide a maximum ground impedance of 2 ohms from the MGB with electrical service not connected.

19.2.6 Heating, Ventilation and Air Conditioning (HVAC) System

1. Provide a wall-mounted HVAC system with 2 equivalent units, each unit with a minimum 3 ton cooling and 3 kW heating capacity.

2. Include a single HVAC controller system operating thermostat and humidistat sensors providing with automatic change over between heating, cooling, dehumidification, and temperature stabilization during dehumidification. The HVAC controller shall balance the operating wear of the two units.

3. Provide integral air filtration with the HVAC system.

4. Ensure that all components of the complete HVAC system including interior and exterior frames are internally bonded and grounded through the branch circuit to the load panel.

19.2.7 Equipment Racks

1. Provide three equipment racks meeting the following requirements:

    a. Overall dimensions of approximately 78 inches high by 20.25 inches wide and meeting EIA standards for mounting 19-inch equipment.

    b. Equipment rack upright channels fabricated from 6061-T6 aluminum extrusions with minimum depth of 5.75 inches, flange thickness of 0.19 inches and web thickness of 0.16 inches.

    c. Equipment rack upright channels manufactured with threaded #12-24 mounting holes of entire channel length front and rear with standard EIA spacing. Do not use non-threaded clearance holes with separate “clip nuts”.

    d. Provide front and rear mounting base angles fabricated from 6061-T6 aluminum extrusions with minimum 6 inch footing extension. Secure base angles to floor in accordance with hub building and rack manufacturers’ recommendations.

    e. Provide front and rear top angles fabricated from 6061-T6 aluminum extrusions with minimum 1.5 inches by 2.0 inches web.

f. Provide a front-mounted lower guardrail fabricated from minimum 0.25 inch by 2.0 inch bar stock with 6 to 7 inch standoff from the upright channel.

g. Provide vertical cable management ducts in between all equipment racks and at each end of a row of equipment racks that meets the following minimum requirements:

    i. Use vertical cable management ducts that reach from the bottom of the equipment frame fully to the top of the rack.

    ii. Use ducts that are double-sided, opening to the front and rear of the equipment rack, with each side having the minimum inside dimensions of 3.5 inches wide by 6.25 inches deep.

    iii. Provide plastic or rubber grommeted openings, between the two sides of the duct, with a minimum opening of 2 inches and a maximum spacing of 12 inches.

    iv. On the opening of each side of the duct, provide positive cable restraint through opening latches or removable covers.

h. For all assembly or fastening hardware use zinc-plated steel, nickel-plated brass, or stainless steel unless otherwise specified.

i. Use a black color finish on upright channels, top and base angles, and lower guardrails.

j. With each equipment rack provide a minimum of 50 #12-24 x 0.75 inch (minimum) cuphead philslot mounting screws with pilot points and nylon washers. Use zinc-plated steel, nickel-plated brass, or stainless steel screws. Provide more screws if necessary to properly mount all equipment as shown in the Plans.

k. With each equipment rack provide one rear-mounted, 20 amp, power strip with a minimum of 8 receptacles and secured with a minimum of four rigid standoff brackets. Do not use threaded bolts or rods as standoff brackets. Power strip cord shall be SJ or equal and shall be equipped with a twist- lock plug to match the equipment rack receptacle.

19.2.8 Hub Monitoring System

1. Provide a self-contained interior hub monitoring system device connected to the hub network switch with the following minimum requirements:

    a. Environmental monitoring including temperature and humidity

    b. IP-video camera with minimum 640x480 resolution at 15fps

    c. 19” rack mounted, maximum height of 6 rack units

d. Motion detection with automatic notification and alarm loging

e. SNMP manageable hardware and software with 10Base-T network interface (RJ-45 connection) that includes all required functions

f. SNMP management user interface and MIB software package, fully licensed to TDOT

g. Power management sensor

h. Door open notification

19.2.9 Fire Extinguisher

Provide a wall mounted CO2 fire extinguisher rated for electrical fires. Locate the fire extinguisher inside the hub building adjacent to the hub door opening.

19.2.10 Project Submittal Program Requirements

1. General Requirements

    a. The Design-Builder shall provide project submittals for all Communications Hubs as required in Section 1.8 of this SP. The project submittals for the Communications Hubs shall also include but not be limited to the additional requirements in this subsection.

2. Hub Building:

    The Design-Builder's submittals shall include but not be limited to the following:

    a. Shop drawings for hub building design, plan and elevation views, cross- sections and all internal components with installation and wiring.

3. Hub Electrical System: Include for each hub site an electrical system design that meets the minimum materials, installation and performance requirements of this SP. The electrical system design submittal shall include but is not limited to the following:

    a. Detailed electrical system design with load calculations and schedules showing the minimum materials and installation required in this SP and all supplementary materials and installation necessary to achieve the minimum performance requirements.

    b. Load center panel circuit schedule

    c. Power riser/service entrance block diagram

d. Materials list including but not limited to the electrical demarcation, transformer, main service entrance, load center, generator connector and transfer switch.

4. Hub Grounding System: Include for each hub site a grounding and bonding system design that meets the minimum materials, installation and performance requirements of this SP. The grounding system design submittal shall include but is not limited to the following:

    a. Pre-installation Soil Resistivity Test results

    b. Detailed grounding system design showing the minimum materials and installation required in this SP and all supplementary materials and installation necessary to achieve the minimum performance requirements.

    c. Plan views with locations of all materials to be installed

    d. Materials list

19.3 INSTALLATION REQUIREMENTS

19.3.1 General

1. Install all materials and materials for each specific site as shown in the Plans.

2. Provide three (3) sets of hub building door keys for each hub to the Project Engineer no more than 24 hours after hub building installation. Doors for all ITS communications hubs shall be keyed the same but shall be keyed differently than the wireless communications hubs.

3. All electrical supply or data/network connections shall be made by direct cabling. No extension or coupling cables or cords are permitted.

19.3.2 Site Preparation

1. Prepare the hub area as shown in the Plans. Grade, level and compact the area of the hub site from within the fenced area to an area a minimum of 8 feet outside the fence, and transitioning into the paved parking area. The lowest point of the grade of the area inside the fence should be 1 foot higher than any other adjacent area so that water does not drain into the fenced building area.

2. Within the limits of the fenced area, place and compact 6 inches of graded aggregate and place asphaltic concrete pavement of the depth and type specified in the Plans, and in accordance with TDOT Standard Specifications. Slope the final surface of the pavement away from the hub building foundation at a minimum ½ inch per foot.

3. Maintaining the requirements of 6.3.2.1 above, outside the fenced area for a minimum of 8 feet, grade and slope the final surface at no more than a 4:1 slope. At more than 8 feet from the fenced

area, transition into surrounding grade at a maximum 2:1 slope. Reseed or sod all areas that are to remain unpaved in accordance with TDOT Standard Specifications.

4. Construct the driveway and associated drainage structures between the hub location and the interstate shoulder as shown in the Plans. Do not deviate from the driveway alignment as shown in the Plans, and do not place any communications or electrical conduit under the driveway paving. Paving will be placed in accordance with the Plans and TDOT Standard Specifications.

19.3.3 Hub Building

1. Place a portland cement concrete foundation in accordance with the hub manufacturer's recommendations and this SP. All aspects of the final site- specific foundation design are the Design-Builder's responsibility, including but not limited to soil analysis and determination of allowable soil bearing strength, all footing and slab dimensions, requirement and design for inner footings, and steel reinforcing members. Design the concrete foundation and hub building installation to prevent water entry between the foundation upper surface and the building lower surface.

2. Securely anchor the building in accordance with the manufacturer's specifications and this SP.

3. Bond all reinforcing steel materials within the foundation slab together, including but not limited to wire mesh and reinforcing bar to form a Ufer ground. At each corner of the foundation, connect a #2 BSC wire to the interconnected reinforcing steel by silver soldering/brazing, and bond each #2 BSC directly to the hub ground ring system at the ground rod closest to the foundation corner.

4. Provide a minimum 20 mil PVC or polyethylene sheet vapor barrier under the slab and under all footing side and bottom surfaces.

19.3.4 Electrical System

1. Electrical service shall be single-phase 120/240VAC and shall enter the hub site in underground conduit for a minimum of 30 feet horizontal distance from any building edge.

2. Electrical service shall enter the building on the same wall as the MGB and all associated equipment (load panel, auxiliary disconnect, surge suppressor, etc.) shall be mounted on the interior or exterior of that same wall.

3. From the Type C pull box outside the hub fence to the auxiliary disconnect, install 2-inch rigid PVC conduit.

4. Install the electrical service PVC conduit inside a 10 foot length of 2-1/2 inch or 3 inch galvanized rigid steel conduit to serve as a lightning surge choke. Locate one end of the steel conduit 5 feet from the edge of the building.

19.3.5 Uninterruptible Power Supply

1. Mount the UPS at the bottom of the equipment rack containing the network switch.

2. Connect the network switch input and any ancillary equipment power supplies to the UPS.

3. Connect the UPS network interface to the network switch.

4. Connect the door open sensor output to a contact closure input on the UPS.

19.3.6 Cable Runway

1. Install cable runways of the size and orientation as shown in the Plans.

2. Install cable runways that are electroplated gold chromate. Cap bare ends of each cable runway with a rubber or plastic cap provided by the cable runway manufacturer.

3. Install cable runways to serve as a main interior equipment ground bus for rack-mounted equipment.

4. Bond all horizontal and vertical cable runways together at each rigid connection point with #2 AWG BSC bonding wires.

5. Bond each rail of the cable runway system to the MGB with #2 AWG BSC bonding wire where the runway attaches to the hub wall above MGB.

6. Install horizontal cable runways directly above the equipment racks at approximately 7 feet 3 inches above finished floor. Rigidly mount horizontal cable runways directly from the ceiling using mounting hardware capable of supporting the weight of the horizontal cable runways and cables on the runways.

7. Include with the horizontal cable runways over the equipment racks a system of 2-inch ducts designed specifically for the management and protection of fiber optic jumpers. Fiber optic jumper ducts shall have radius fixtures to transition between the horizontal duct and the equipment rack vertical cable management ducts.

8. Install vertical cable runways 10-14 inches above finished floor at the fiber optic cable/conduit entry point to the height of the horizontal cable runways and as shown in the Plans. Do not install vertical cable runways directly above the conduits. Rigidly fasten vertical cable runway(s) to the wall and to the horizontal cable runway. Rigidly mount vertical cable runways directly from the ceiling using mounting hardware capable of supporting the weight of the vertical cable runways and fiber optic cables. Do not attach vertical cable runways to the floor.

19.3.7 Grounding System

1. General Requirements

    a. Install all grounding and bonding materials according to the manufacturer's recommended procedures and specifications.

b. All metallic materials interior or exterior to the hub building shall be bonded to the grounding system directly.

c. All electrical and electronic equipment shall be bonded to the grounding system through the electrical service feed to the equipment, or shall be bonded directly if the electrical service feed is not grounded unless otherwise recommended by the equipment manufacturer.

d. Grounding and bonding wire shall be bare solid copper (BSC) unless otherwise specified.

e. Grounding strap shall be BSC unless otherwise specified.

f. Do not splice any grounding or bonding wire or strap.

g. All below ground or exterior connections between wire, ground rod, and metallic structures and posts shall be made only by exothermic welding. All exothermic welding shall be performed in the presence of the Engineer.

h. All connections to ground strap shall be made by silver soldering/brazing, except when impractical due to size and/or quantity of straps, where approved mechanical strap connectors shall be used with the Engineer's approval.

i. Interior connections for bonding jumpers shall be by mechanical fasteners with silver soldered lugs. Copper conductive paste shall be used with mechanical fasteners.

j. Minimum bending radius of any exterior grounding wire or strap shall be 24 inches.

k. Minimum bending radius of any interior grounding wire #6 or smaller shall be 8 inches.

l. Minimum bending radius of any interior grounding wire #2 or larger or any grounding strap shall be 12 inches.

m. Do not splice any grounding or bonding wire or strap.

n. All metallic communications facilities entering the hub building shall be isolated from remote facility ground through isolation or neutralizing transformer technology per IEEE Std. 487-2000.

2. Interior Grounding System

a. The MGB shall be minimum 0.25 in. x 4 in. x 12 in. buss bar fabricated from solid copper alloy and shall include insulated mounting standoffs.

b. The MGB down conductor shall be #2 BSC that is exothermically welded to the bottom of the bar.

c. Install the MGB with standoffs in the lower center of the hub wall as shown in the Plans.

d. Connect the MGB down conductor through the PVC ground wire sleeve directly to the chemically-enhanced ground rod in the grounding ring immediately outside of the building.

e. Seal around the ground wire in the sleeve entry hole with waterproof outdoor-rated silicone caulk. Do not use expanding foam or caulk products.

f. Bond the electrical panel load center and the generator supply transfer switch to the MGB with #2 AWG BSC.

g. Bond each individual equipment rack directly to the cable runway with a #2 AWG BSC.

h. Inside the hub building, bond the hub door to the door frame 6 in. from the top of the door frame with a #2 AWG flexible copper wire or braid jumper of sufficient length to not hinder door movement. Bond the door frame directly to the MGB with a #6 AWG BSC.

i. Unless otherwise specified, bond all any other metallic materials in the hub interior to the MGB with minimum #10 AWG stranded copper wire. Do not daisy-chain or splice bonding wires.

3. Exterior Grounding System

a. Ground rods shall be copper-clad 5/8-inch diameter 8 foot long steel electrical ground rods.

b. Ground ring shall be formed with 3-inch wide #20 AWG BSC strap.

c. Ground rod inspection handholes shall be plastic or polymer round enclosures minimum 12 inches in diameter and 18 inches deep.

d. Chemically-enhanced ground rods shall be 10 foot long hollow copper tubes chemically-charged grounding electrode with an access handlhole, and shall include ground enhancement backfill material.

e. Sacrificial anodes for corrosion protection of the exterior grounding system shall be a minimum of 32 lb. magnesium material.

f. Install the hub ring ground rods and ground strap at a depth of 18 inches. Install the ground strap in one continuous length; do not splice.

g. Install ground ring inspection handholes at the four ground rods outside the corners of the building. Ensure the top of the ground rod is exposed for inspection.

h. Install chemically-enhanced ground rods at the Hub Single Point Ground (HPSG) immediately outside of the hub building below the MGB position.

i. Install a ground ring with a minimum of seven ground rods and one chemically-enhanced ground rod at the HSPG.

j. Provide ground enhancement material as required to comply with the maximum ground impedance requirements. As a minimum, provide ground enhancement material for the complete length of the hub grounding ring strap. Provide ground enhancement material to meet the grounding impedance requirements SP.

k. Install corrosion protection sacrificial anodes in accordance with the manufacturer's recommendations. Install a minimum of one for each ground ring.

l. Install a #6 AWG BSC wire along the entire length of the fence, ending at the gate support posts, by weaving the wire through the chain links. Bond the wire to each fence support post.

m. Weave a #6 AWG BSC wire through the chain links of both gates of the double gate. Bond the wires at the gate ends.

n. Bond each of the four fence corner posts and the two gate support posts to the nearest ground rod of the hub ground ring with separate exothermic welds. Use #2 AWG BSC wire that is installed underground at a depth of 18 inches.

o. Bond each gate panel to a gate support post with a #2 AWG flexible copper braid of sufficient length to not hinder gate movement. Install braid at a height 6 in. above ground.

19.3.8 Fencing

1. Furnish and install fencing in accordance with TDOT Standard Specifications and the Plans.

2. The chain link fence shall be 6' in height and include all end and corner posts.

3. Install double 6-foot wide gates. Install 3-strand barbed wire with extension arms on the fence and gates.

4. Secure the double gates with a padlock at the time of fence installation. Provide three (3) sets of padlock keys for each hub to the Engineer no more than 24 hours after padlock installation. Padlocks for all hubs shall be keyed the same.

19.3.9 Hub Monitoring System

1. Locate the hub monitoring system device so that the integral camera has a clear view of the doorway without being blinded by the emergency floodlights.

2. Connect the hub monitoring system power supply through the UPS.

3. Connect the hub monitoring system network interface to the hub network switch.

19.3.10 Project Testing

1. General Requirements

    a. The Design-Builder shall conduct a project testing program for all wireless equipment as required in Section 1.5 of this SP. The project testing program for the Communications Hubs shall include but is not limited to the additional specific requirements in this subsection.

2. Pre-installation Soil Resistivity Test

    a. Perform a four-probe soil resistivity test at each hub site to determine the required grounding design, materials and installation to meet the requirements of this SP.

    b. The Engineer shall have the option to witness all tests.

3. Grounding System Impedance Test

    a. Perform a total impedance test on the grounding system after installation of all interior and exterior grounding but prior to the placement of compacted base or pavement within the fenced area.

    b. Testing shall be a three-probe impedance test conducted from the MGB.

    c. The Engineer shall have the option to witness all Grounding System Impedance Tests.

19.4 MEASUREMENT

The ITS communications hub will be paid for on a per each basis per site wherein no measurement will be made. The price bid shall include furnishing and installing the communications hubs, all material and equipment specified in Plans and Specifications, and all labor, equipment and miscellaneous materials necessary for a complete and accepted installation. The price bid shall include all system integration, testing, fiber optic drop panels and 144 FDC, system documentation, site preparation, grading and paving for parking area and driveway, grading for drainage and all drainage structures, clearing and grubbing, excavation, fill material and installation/compaction required to level and/or elevate the site, signing, electrical system including service entrance and transformer, uninterruptible power supply, grounding system, HVAC system, equipment racks, hub monitoring system, fire extinguisher, cable runway, fencing and all site restoration, grassing and sodding. The price bid shall include all grounding system testing, materials and installation necessary to comply with the maximum ground impedance requirements. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

19.5 PAYMENT

The contract unit price shall be full compensation for all work specified in this Section.

Payment will be made under:

Item No.	Description	Unit
725-24.12	ITS COMMUNICATIONS HUB (BUILDING)	EACH

ITS Communications Hub will be paid for on a lump sum basis as follows:

1. 35% of the contract unit price upon delivery of the Hub building

2. Additional 30% of the contract unit price for complete installation of hub building, electrical system and service feed, HVAC system, interior grounding, exterior grounding, ground testing, and all interior equipment and materials.

3. Additional 25% of the contract unit price for completion of all site preparation, driveways, and fencing.

4. Final 10% of the contract unit price upon Final System Acceptance.

20 OVERHEIGHT VEHICLE DETECTION SYSTEMS

20.1 DESCRIPTION

Furnish and install Overheight Vehicle Detection Systems (OVDS) as shown on the plans or as directed by the Engineer.

The system will detect any overheight components of the vehicle and any load hauled by the vehicle. Overheight components of the vehicle or hauled load must be detected despite material type, density, size, or shape. The system shall include warning devices that direct the operators of overheight vehicles to take appropriate action to avoid a collision with any conflicting structures. Any necessary connections with the system must be integrated as part of this Item. The system must communicate operational information with a communication network as specified by the engineer.

Ensure the system is comprised of all items of hardware, software, interconnect cabling, and cabinets and enclosures required to provide an operational system to detect and warn overheight vehicles upstream of a potential clearance violation. The to ensure the function of the system, equipment furnished and installed under this section must include the following:

a. Infrared transmitters and receivers, or approved equal,
b. Local controller,
c. Wireless I/O, where specified,
d. Controller enclosure and ancillary equipment,
e. Mounting hardware, and
f. Cabling as required.

Furnish, assemble, fabricate, or install materials referenced under this Specification are new, corrosion resistant, and in strict accordance with the details shown on the plans or as directed.

20.2 MATERIALS

All materials furnished, assembled, fabricated or installed shall be new, corrosion resistant and in strict accordance with all of the details described in this SP.

The OVDS shall comply with the following minimum materials specifications:

20.2.1 Overheight Detection

To support the installation of a fully functional system, the Design-Builder shall:

1. Provide a complete system that will detect objects that dynamically cross a user-created horizontal elevated plane at a user-determined height above the roadway surface. The detection system will be positioned so that it only detects objects moving in one travel direction. The detection system will utilize infra-red or red source technology or approved equal and spectrally matching detectors mounted on poles positioned on opposite sides of the approach at locations shown on the plans. Alternate detection technology may be used with the approval of the Engineer. Furnish units with an effective detection range of 10 ft. to 200 ft. with a reaction speed range of 1 mph to 75 mph for a 2.5 in. diameter object that extends 1 in. above the height of the detectors. Provide detection system that negates the effect of ambient light and an internal environmental control that reduces operational failure from fog condensation and insects.

2. Furnish units that are solid state with printed circuit boards and regulated power. Furnish units that do not exceed a maximum overall size of 18 in. Width x 19 in. Length x 10 in. Depth, or as approved by the Engineer. Provide a communication system as shown on the plans that meets the OVDS manufactures recommendations and specifications that provides the interface needed between the two detection units.

3. Provide medium duty anodized aluminum, fiberglass, or equivalent housing not less than 1/8 in. thick, rated National Electrical Manufacturer's Association (NEMA) 3R or better.

4. Provide transmitter, remote, receiver, and master units required to operate the equipment. The enclosure will maintain its structural integrity for the operational life of the equipment and allow access for control adjustment and electrical interconnection without the use of any special tools.

5. Provide a local controller unit that controls the system at the design location shown on the plans. The local controller unit will continuously monitor detector inputs for a positive overheight detection reading. When the detectors sense an overheight vehicle, the controller will activate the warning components of the system. Circuit breaker protection must be incorporated into the controller. Provide user-configurable settings on the controller for adjusting the duration of the activation of the warning components to accommodate anticipated travel conditions. The controller unit may be in the detection unit housing or in a separate enclosure.

6. New OVDS shall be equipped with a monitoring system accessible to local Regional Transportation Management Center (TMC) personnel via TDOT's fiber network. The system shall be able to communicate the following information to the Regional TMC:

    a. When the system is activated
    b. When a Fault Condition is detected in the system

20.2.2 Mounting Poles

1. Furnish mounting hardware that will securely attach the detection equipment to a vertical cylindrical pole that does not require any machining operation. The attachment will not stress or deform the unit and will prevent the movement of the unit in any direction by the force of developed wind. Furnish mounting hardware that has the capability of adjustment to the angular orientation of the optical axis in both the horizontal and vertical plane over an angular range of ± 5°.

2. Provide structural member that supports the dead weight of the equipment, resists dynamic external forces and that allows for detectors to be adjustable in the vertical plane.

3. Install all poles and foundations outside of the clear zone or behind barrier protection as shown on the plans.

20.2.3 Warning Components

1. Integrate (a) static sign(s) as shown on the plans that directs detected overheight vehicles to take appropriate action. Provide four flashing beacons with each static sign, as shown in the plans. Flashing beacons will conform to Roadside Flashing Beacon Assembly. The static sign assembly will conform all essential elements of the sign to MUTCD standards.

2. Provide a communication system between the OVDS controller and the flashing beacons, as shown on the plans, and is supported by the OVDS system.

20.2.4 Environmental Requirements

1. Provide equipment that operates and meets all of the requirements of this specification under the following atmospheric conditions:

    a. Temperature: -40°F to 135°F (-40°C to 57°C),
    b. Relative Humidity: 0 to 100%,
    c. Rain: 2 in. per hour rate,
    d. Snow: 5 in. per hour rate,
    e. Fog: 200 ft. visibility, and
    f. Wind Velocity: AASHTO 2013 LTS Design Spec, “Wind Velocity and Ice Zones.”

2. Furnish equipment that operates properly when the sun is outside 10° axis of the receiver/master unit in its installed configuration. If the above requirements cannot be met, the equipment will be deemed satisfactory if explicit installation information is provided by the manufacturer such that the rays of the sun will not interfere with the proper operation of the equipment. This provision includes reflections from vehicles.

    Shadow Effect. Furnish equipment that ensures that light intensity caused by the shadow of passing clouds will not interfere with the proper operation of the equipment.

20.2.5 System Communication Requirements

1. Where shown on the plans, provide an Industrial grade wireless I/O radio communications link between the OVDS controller and flashing beacon assembly. The wireless I/O radio unit must meet the following:
    a. Outdoor rating of IP 67, or better,
    b. Utilize the 900 MHz or 2.4 GHz frequency,

c. Support Type C outputs (normally open and normally closed),
d. Support 3 terminals per relay (common, NO, NC),
e. Support multiple user-programmable channels,
f. Support High Gain antenna, and
g. Require a maximum of 7W power supply.

2. The wireless I/O device must be compatible with the manufacture of the OVDS system.

3. Where shown on the plans, the Department will provide for Design-Builder installation a cellular telephone connection to communicate with the unit remotely.

4. Where shown on the plans, provide hard-wired communication using twisted-wire pair to communicate with the OVDS unit. This configuration is typically utilized for long-term equipment deployment and supplies both power and communications.

5. Alternative communication mediums may be approved by the Engineer.

20.2.6 Interface with Third Party Software

1. The Department utilizes specialized software called SmartWay Central Software for traffic management purposes. In addition, there are state operated programs within the state of Tennessee that manage vehicle permits. These systems are collecting data for overheight vehicle detections.

2. The Department will utilize third-party software to collect and analyze this data. All events, including alarms, faults, and status, will be transmitted from the OVDS controller to the Department via the cellular wireless modem.

20.3 CONSTRUCTION

1. Allow for directional adjustment and aiming after initial installation. Perform basic alignment of the detectors either manually or electronically. Perform this step on both the transmitter/remote and receiver/master unit locations as per the manufacturer's guidelines and recommendations.

2. Construct all foundations for detecting units, and other system support structures.

3. Mount the transmitter/remote and receiver/master unit to detect the presence of vehicles that exceed the specified vertical height.

20.4 INSTALLATION

It is the Design-Builder's responsibility to furnish, program, install, and integrate the OVDS devices in the field and at the TMC. The cost of coordination and integration efforts shall be the sole responsibility of the Design-Builder and no payment will be made directly or indirectly by TDOT.

All equipment shall be installed according to the manufacturer's recommendations and as follows:

1. Design-Builder to coordinate with the Regional Traffic Engineer and Regional TMC to ensure that proposed equipment will be compatible with the existing equipment to be relocated. If the existing equipment does not meet these specifications, at the direction of the Regional Traffic Engineer, the existing equipment should be replaced with new equipment meeting the specification, at the contract unit bid price.

2. Install OVDS system in accordance with the manufacturer's specifications to achieve specified accuracy and reliability.

3. Install OVDS system so that proper operation of the equipment will commence within 15 seconds after restoration of power.

4. Install all system components at the locations shown on the plans or as directed by the Engineer.

5. Install pole, breakaway base, local control cabinet, connectors, wiring, signal beacons, sign, and foundation as shown on the plans, or as directed by the Engineer.

6. Install the flasher controller assembly in the ITS cabinet.

7. Install watertight breakaway electrical fuse holders in all line and neutral conductors at the breakaway base.

8. Install foundations, poles, and associated cabinets outside of the clear zone or behind barrier protection.

9. Use established industry and utility safety practices to erect assemblies near overhead or underground utilities. Design-Builder to coordinate with local utility companies. Consult with the appropriate utility company before beginning such work. If such a system is shown on the plans, install solar power system in accordance with Special Specification "Intelligent Transportation Systems (ITS) Solar Power System."

20.5 MEASUREMENT

The Overheight Vehicle Detection System will be measured in units of each and paid for at the contract price per each for each system furnished, installed, made fully operational, and tested in accordance with this specification and as directed. The price bid shall include furnishing, installing, system integration, training, documentation, and testing of a complete OVDS, including the cost of relocating the existing

equipment. If the existing equipment does not meet these specifications, the existing equipment should be replaced, at the direction of the Regional Traffic Engineer, with new equipment meeting the specification, at the contract unit bid price. The price bid shall also include all local configuration and control manufacturer software, system documentation including: shop drawings, operations and maintenance manuals, wiring diagrams, block diagrams and other materials necessary to document the operation of the OVDS. This price shall be full compensation for all labor, tools, materials, equipment and incidentals necessary to complete the work.

20.6 PAYMENT

The contract unit price shall be full compensation for all work specified in this section.

Payment will be made under:

Item No.	Description	Unit
725-04.20	OVERHEIGHT VEHICLE DETECTION SYSTEM	EA

The OVDS will be paid per each as follows:

1. 50% of the contract unit price upon approval of Bench Test Component, Bench Test System and Pre-Installation test results.

2. Additional 20% of the contract unit price upon approval of Stand-Alone Site Test results.

3. Additional 20% of the contract unit price upon approval of Conditional System

4. Final 10% of the contract unit price upon Final System Acceptance.

Appendix A. PREVENTATIVE MAINTENANCE PROCEDURES

All supplies and parts used in the maintenance of equipment shall meet the manufacturer's recommendations for the unit being serviced. The procedures listed in this Appendix are minimum standards for this Contract. In addition to these requirements, the Design-Builder shall submit to the Department and shall meet the preventive maintenance procedures recommended by the equipment manufacturers, including, but not limited to, all requirements to meet warranty standards.

For location where the Design-Builder is responsible for performing work on actively functioning equipment, the Design-Builder shall support the continuous function of the devices and system. Such work shall be coordinated with the TMC, the Engineer, and the maintenance Design-Builder working on the system.

CLOSED CIRCUIT TELEVISION CAMERA PREVENTIVE MAINTENANCE

1. Camera PM at Pole Level

   Perform the following tests once every three months:

   a. Check camera housing pressure (this should be 5 PSI Â± 1 PSI). Re-pressurize with dry nitrogen if not within limits and document readings on sheet provided.

   b. Visually inspect camera housing.

   c. Clean glass with suitable glass cleaning agent.

   d. Inspect pan and tilt mechanism and adjust limit switches where applicable.

   e. Inspect housing mounting for corrosion.

   f. Remove any bird nest, insects, or other miscellaneous debris from the camera housing or movement mechanism.

   g. Check and inspect the integrity of all cable harnesses and connectors. (Replace defective item where applicable).

   h. Check integrity of surge protector (replace where applicable).

   i. Replace filter in camera housing.

   j. Check operation of thermostat inside camera housing.

k. Check for corrosion of terminal inside housing.

2. Camera PM at Cabinet Level

Perform the following tests once each three months:

a. Check integrity of all cables and connectors.

b. Check raw video from the camera with a waveform monitor (raw video shall measure 1.00Vp/p) and adjust per specification in specialty camera manual.

c. Check all local functions (Pan, Tilt, Zoom in, Zoom out, Focus Far, Focus near).

d. Check integrity of surge protectors.

e. Check operation of auto-iris and adjust for correct operation per operational and maintenance manual.

f. Check circuit box at the base of the camera pole to ensure that the terminal strips are corrosion free.

g. Check proper function of thermostat.

h. Check fan and replace where applicable.

i. Clean and vacuum inside of cabinet.

j. Inspect and change filter where applicable.

k. Check light bulb and replace where applicable.

l. Check incoming power for proper voltage and correct if not within tolerances.

m. Check cabinet door(s) for proper closure.

n. Visually inspect pole for damage.

o. Visually inspect pole grounding system.

p. Inspect pole anchor bolts and nuts to ensure they are tight.

DYNAMIC MESSAGE SIGNS PREVENTIVE MAINTENANCE

Preventive Maintenance (Minimum requirements):

UNIT ITEM	ACTION REQUIRED	PM FREQUENCY
Photo Cell	Clean photo cell aperture	3 Months
Ventilation	Clean Filters	3 Months
Lexan Cleaning	Clean front surface with approveddetergent	Yearly
Cabinet Filter	Clean or change filters	3 Months
Fans	Check fan condition and thermostatsettings	3 Months
Vacuum (cabinet)	Vacuum and clean	3 Months
Test	Row and column check	Monthly
Test	All "ON" and All "OFF"	Monthly
Test	Check alpha numeric characters	Monthly

DEMARCATION POINT PREVENTIVE MAINTENANCE

The demarcation points play a very important role by acting as collection point for the power service that is fed to the devices. It is therefore imperative that unit be maintained at the highest level of performance. Design-Builder shall ensure that periodic maintenance on the essential sub units are done as stipulated.

Perform the following tests once each three months:

1. Check integrity of all cables and connectors.
2. Check incoming power for proper voltage and correct if not within tolerances.
3. Check integrity of circuit breakers and TVSS.

OPTIC CABLE PREVENTIVE MAINTENANCE

Use an OTDR to test all fibers prior to Final Acceptance and after any repair work. Follow test requirements of Sections 1 and 4 of this SP.

Compare and document reading with that from original installation tests and the previous

tests. Tests should document the total, cumulative dB loss since the previous test.

RDS PREVENTIVE MAINTENANCE

The unit shall be cleaned and the security of the pole mounting shall be checked once each three months.

S T A T E **O F** **T E N N E S S E E**

May 27, 2022

Contract: DB2101
County: Hamilton

SPECIAL PROVISION

REGARDING

PORTABLE SMART WORK ZONE SYSTEM

DESCRIPTION

This section specifies the minimum equipment requirements for a Portable Smart Work Zone System (PSWZS) furnished and installed on this project. It is anticipated that traffic conditions in the area may deteriorate during the project, due to queuing caused by high traffic volumes, work zone vehicle interference, weather, roadway geometry changes, as well as many other events involved with the area. To help remediate the expected construction interference, this project will require the Design-Builder to supply the necessary PSWZS equipment to monitor traffic and disseminate the information to the motorists based on queuing and delay.

This work shall consist of furnishing, installing, relocating, and maintaining an automated, real-time PSWZS, meeting the requirements noted herein, and providing the maintenance and operations assistance of the complete system for the duration of the project. Included in the operational responsibilities are all communication costs such as FCC licensing, cellular telephone, wireless data networks, satellite and Internet subscription charges, solar system support, and battery charging and maintenance as applicable. In addition to these requirements, the Design-Builder shall assume all responsibility for any damaged equipment included in the system (due to crashes, vandalism, adverse weather, etc.) that may occur during the systems deployment.

The PSWZS equipment shall be operated and maintained by the Design-Builder for the duration of the construction. The PSWZS shall be coordinated with the overall traffic control plan and shall supplement all other temporary traffic control components.

A PSWZS is comprised of several devices linked together to perform as one unit or system on the project, with one web client software operations interface. The components include portable traffic sensors (PRDS), portable changeable message signs (PCMS), Portable Closed-Circuit Television cameras (PCCTV), and control software with user settable parameters to collect and analyze data and automatically trigger new messages on the PCMS and/or warnings to the

appropriate personnel, including but not limited to the Project Engineer, the TDOT Traffic Management Center (TMC) staff, or Local Agencies.

The PSWZS will be used to detect real time vehicle speed and volume, provide travel times and queue detection in the work zone and disseminate that information via automatic updates on the PCMS to advise motorists of changing conditions. The PSWZS shall also alert TDOT TMC operations personnel to traffic issues and conditions, as well as gather data on work zone traffic control performance. The PSWZS devices shall be placed in advance of the work zone so that drivers are advised of slow-downs or stops prior to entering the work zone for enhanced safety. The PSWZS can also be used to divert the traffic prior to entering the work zone based on travel time through the work zone. The Department shall be able to direct the Design-Builder to move devices to increase or decrease the coverage area at any time throughout the project life, as seen fit. All manual and automated messaging to be posted on the PCMS shall be coordinated with TDOT TMC Personnel.

MATERIALS

All PSWZS materials installed on the project shall be provided by the Design-Builder in excellent quality condition, shall be corrosion resistant and in strict accordance with all of the details shown in the Plans and described in this SP. All components provided under the PSWZS shall be in excellent working order and tested prior to deployment in the work zone. All operations software interfaces shall be directly connected through the Web client software and shall not be through a separate software.

The PSWZS shall comply with the following minimum materials specifications:

GENERAL CAPABILITIES AND PERFORMANCE REQUIREMENTS

1. Overall PSWZS capabilities and performance requirements include the following:
    a. PSWZS components shall be placed at proposed approximate locations, as described in Book Three (3) of this RFP, to provide full extent of coverage within the project limits including the mainline travel lanes and shoulders. The Department shall be able to request that the Design-Builder relocate devices throughout project life.
    b. The PSWZS field devices shall be compatible with each other and with the software system provided by the Design-Builder, be of rugged design and suitable for reliable operation when mounted in the configuration as specified in this SP and the Plans.
    c. The Design-Builder shall ensure that the installed equipment provides unobstructed realtime data from the roadway, and other current conditions around a field site; that it responds to control signals from an operator of the system; and that the data and video image can be transmitted to remote operator locations interfaced to the system.

d. Communications of the PSWZS equipment in the field shall be at the discretion of the Design-Builder and the PSWZS manufacturer. Communications shall be fully integrated with the PSWZS devices and software. The communications shall be part of the system. No separate payment shall be allowed for communications or communications provider costs.
e. The devices shall be capable of being remotely controlled and programmed by the Design-Builder provided PSWZS software at the TDOT Region 2 TMC as required by the Department.

PCCTV CAPABILITIES AND PERFORMANCE REQUIREMENTS

1. The Portable Closed Circuit Television camera (PCCTV) device shall be fully integrated with the PSWZS software. PTZ function shall be through the web client software and shall not be through a separate piece of control software or separate link. The PCCTV shall adhere to the following minimum criteria:
    a. The PCCTV shall deliver high quality color images, and be fully compliant with all aspects of the National Television Standards Committee (NTSC) specification, and produce NTSC compatible video.
    b. The PCCTV shall operate over wide dynamic light conditions ranging from low light/dusk to full sunlight having day (color)/night (monochrome) switchover and iris control, with user-selectable manual and automatic control capabilities.
    c. The PCCTV shall be able to deliver multiple streams simultaneously. The streams shall be H.264 and Motion JPEG video at up to 30 fps in all resolutions. Placement of the camera and local communications options on the jobsite shall determine best video frame rate at which to provide video. Design-Builder shall strive for best frame rate and shall place the camera in an area with the best possible cellular coverage while keeping within the relative area shown in the plans.
    d. The PCCTV shall be of dome type, 360 degree PTZ. It shall be IP66 environmentally rated.
    e. Iris capability shall include a provision for manual override via software.
    f. The camera shall be capable of auto-focus during zoom-in or zoom-out, with provisions for override via software.
    g. The PCCTV shall be an all weather installation, integrated into an industrial grade mobile trailer-type mount. The mount shall be adjustable for camera height and solar array. The trailer shall be able to power the camera via solar panels and charger. The PCCTV shall not rely on any outside power source. The trailer shall be painted orange and PCCTV extendable mast shall be able to achieve a 32 foot height measured from the roadway.
    h. Battery bank shall be sized for 30-day autonomy, charged from the solar array.

PORTABLE RADAR DETECTION SYTEM (PRDS) CAPABILITIES AND PERFORMANCE REQUIREMENTS

The Portable Radar Detection System (PRDS) device, or queue detector device, shall be fully integrated with the PSWZS software. The device shall be auto-configurable, trailer mounted, battery-powered, solar charged, and provide high definition microwave-based lane count, occupancy and speed data to the PSWZS software. The PRDS must operate in all weather conditions, including rain, snow, freezing rain, wind, dust and fog.

All of the PRDS data must be passed in real-time to the PSWZS processing server and disseminated to the operator and automated message generator to produce a message on the

PCMS a maximum of 60 seconds after the PRDS detects the data.

General PRDS requirements include:

1. The microwave radar detector shall be dual-zone radar, transmitting on a frequency band of 24 GHz ±25 MHz or another approved spectral band. It shall comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules or the appropriate Spectrum Management Authority. The PRDS shall not interfere with any known equipment. Transmitter power shall not exceed 10 milliwatts.

2. The minimum number of detection zones defined shall be no less than ten (10) at a maximum distance of 250 feet from the detector. Minimum separation between detected vehicles shall be no more than 6 feet. Detection over barriers shall be supported. Data shall include:
    a. Volume
    b. Travel Times
    c. Lane occupancy
    d. Average speed
    e. Vehicle classification by length in a minimum of 3 user defined classes.

3. The microwave radar detector shall be enclosed in a rugged weatherproof box and sealed to protect the unit from wind up to 90 mph, dust and airborne particles, and exposure to moisture (NEMA Type 3R or 4x enclosure).

4. The PRDS unit shall be operable from 12 24 VDC. It shall be powered via a battery bank and charged via an adjustable solar array on an industrial grade trailer platform.

5. Communications connections and equipment to be determined by the manufacturer and PSWZS vendor for fastest and most reliable data communications to the software and automated message generator.

PORTABLE CHANGEABLE MESSAGE SIGNS (PCMS) CAPABILITIES AND PERFORMANCE REQUIREMENTS

The PSWZS shall include PCMS at key locations to provide information to motorists regarding congestion levels, detour information and possible incidents or stopped traffic ahead. The signs are mostly designated to relay automated congestion levels, travel times, routings and queue information, and cautions along the project limits and associated work zone. Message override shall be available to the TDOT TMC operations personnel, should a more important message need to be relayed to the area, such as an Amber Alert or accident.

The minimum requirements include:

1. The signs shall be trailer mounted on an industrial-grade trailer, painted highway orange.
2. The signs shall be either standard mono color or full color matrix displays applicable to roadway applications. Sign case minimum dimensions for full matrix display between 4.5’ H X 8.5’W to 6’ H X 11’ W. Individual line matrix signs of individual characters shall not be allowed.
3. The message panel shall be at least 7 feet above the pavement, present a level appearance, and be capable of displaying a minimum of eight characters in each of three lines of the full matrix display, at an eighteen inch (18”) character height. Other fonts available for use shall be based on real-time speed of the traffic, and are to be used at the discretion of the TDOT TMC operations personnel.
4. Under full 18” character height, the message panel shall be visible from ¼ mile under both day and night conditions. Other font sizes and options for the full matrix display shall be documented and submitted to TDOT TMC operations personnel.
5. It is intended that the full matrix display be able to give TDOT TMC operations personnel the ability to reduce font size based on travel speed to give additional, useful information to the traveling public upon override conditions.
6. The sign shall have a minimum of 5 high-intensity, solid-state LEDs per 2-inch pixel.
7. The sign shall be able to provide 250 text, 60 graphics and 20 arrow board display messages preprogrammed in the controller. Additionally, 100 user-created messages shall be able to be stored in the controller.
8. Computer software shall provide the tools necessary for creating custom messages for the full matrix color PCMS. It shall be able to create messages from scratch using text, graphics or a combination of both; or edit previously created messages. Import graphic images, such as logos and digital photos
9. The sign shall be NTCIP compliant.
10. The sign shall include automatic dimming for nighttime operations.
11. The message board shall utilize a hydraulic lift to raise the unit to display height
12. The sign shall be powered via a battery bank and charged via adjustable solar panel array. Solar panels shall be sized to replace the power used in typical daily operation with less than four (4) hours of sun.
13. The battery bank shall have adequate amp-hr capacity to operate the message board

continuously in the absence solar recharge for a minimum of 21 days.

PSWZS COMMUNICATION REQUIREMENTS

The following are the minimum requirements for the PSWZS communications configuration and devices:

1. The communication devices shall be of ruggedized design and support machine-to-machine applications. The communications device shall be able to report GPS coordinates of the PSWZS device.
2. The communications devices shall utilize appropriate security measures to prevent outside sources from connecting to and controlling the PSWZS devices. These security measures at a minimum include onboard IPsec SSL VPN, MAC address filtering, IP filtering, port filtering, SSH and HTTPS.
3. It shall be at the Design-Builder's discretion which communication provider and technology to use with the PSWZS communications device, in order to achieve the requirements of this special provision. Cellular communications (if available), and satellite communications are all acceptable forms of communicating field data back to the PSWZS server for dissemination. The communications form selected must provide the highest level of connectivity at the required data rates for the PSWZS devices, at their respective locations shown on the plans.
4. The Design-Builder shall perform the required configuration and connection of the Portable Smart Work Zone's communications system during system initialization at the beginning of the project. The system shall be fully functional prior to beginning roadway work.
5. Communications between the server and any individual PCMS, PCCTV and PRDS sensor are independent through the full range of deployed locations and do not rely upon communication, with any other PCMS, PCCTV or PRDS sensor.
6. The Smart Work Zone's communications system shall incorporate an error detection/correction mechanism to insure the integrity of all traffic condition data and motorist information messages, such as blanking signs on loss of communication, sending alerts to the TMC operator for action, etc.

The wireless communications system(s) used for this project must be reliable, dependable, and capable of functioning at all times regardless of weather and location on the project. Slight adjustments to device locations for cellular coverage shall be allowed. These adjustments in location shall not affect the intended operation of the PSWZS, and shall be approved by the Engineer.

The Design-Builder shall be responsible for all communications cost, utilities, and satellite or cellular phone services needed to provide dependable communications to the PSWZS components.

SOFTWARE REQUIREMENTS

1. The PSWZS software shall provide an intuitive web based (web-client) graphical user interface for data verification, overall monitoring, and control of the system components by the Region 3 TMC operators. The web-client shall be accessible on all operator workstations in the Region 3 TMC. The software servers, or core collection system, will collect the data from the portable traffic sensors and automatically update the portable changeable message signs in real-time and as required by the defined automated message rules, as described below. TDOT operations personnel shall be given access to the hosted website with administrative rights, via a username and password, for device control, including the ability to override automated messages and upload of data. TDOT personnel shall also be able to access all historical and current data for download and use by the Department. The software shall provide for public web access as well as an administrative web access for TDOT personnel or other stakeholders as designated.
2. The website and web client interface shall be user friendly, and show a real-time color coded map displaying current roadway conditions in the project area with colors Red (stopped), Yellow (Slowed) and Green (Flowing). The messaging on the PCMS shall be able to be viewed by anyone that accesses the website. TDOT TMC operations personnel shall be given administrative log in rights to access command and control of the devices through the web client process.
3. The software shall provide automatic email updates to designated personnel when speeds drop below certain thresholds, as well as the ability to download device data for performance monitoring or later evaluation. Upon device error or malfunction, a message shall appear that alerts the TDOT operator that communications has been lost, or that a device may be malfunctioning, or power or battery levels are low. All status and monitoring capabilities of the software shall be available to the TDOT personnel.

SOFTWARE OPERATIONAL REQUIREMENTS

In addition to meeting these specifications, the Design-Builder shall program the Portable Smart Work Zone System to ensure that the following General Operational requirements are met:

1. The PSWZS shall operate continuously (24 hours, 7 days a week) when deployed on the project. It shall always be collecting and storing data, and providing real time data feed to the TDOT Region 2 TMC.
2. The PSWZS shall be capable of providing current operational status (i.e. current traffic data and messages, communications system, signs and sensors, video feeds) via the dedicated project website.
3. To provide for remote sign operation, the Website shall allow password-protected TDOT operators to manually override the automated messaging in order to display a manual message at any time. The operator shall be able to send a pre-programmed or custom message to one sign or multiple signs simultaneously without sending the identical message to all PCMS individually. To do this, the PSWZS vendor shall provide a group send feature. The operator shall be able to cancel this manual override and reinitiate all of the systems automated messaging features at any time.

4. The system shall autonomously restart in case of power failure in any part of the system.
5. To support incident management or construction traffic control needs, the Portable Smart Work Zone System shall allow project field staff with password privileges to manually override motorist's information messages for a user-specified duration, after which automatic operation will resume with display of messages appropriate to the prevailing traffic conditions.

The purpose of this PSWZS automated messaging is to alert or warn motorists of congestion delays and queues provided by the sensors. The messages will require a minimum of a two-phased message. The first message will describe the problem such as, "slow traffic ahead", or "stopped traffic ahead" as seen fit by the Department. The second message phase will provide the motorist with a warning, delay estimate or instruction such as, "expect delays", "be prepared to stop", or estimated delay durations. The messages will be invoked on the basis of vehicle speeds, and at the Department's discretion.

PCMS AUTOMATED MESSAGING REQUIREMENTS

The following are minimum messaging requirements for the automated PCMS. The Department reserves the right to edit these automated messages as seen fit to give the motorist the most information available from the PSWZS. The Design-Builder shall coordinate and verify these messages with the TDOT Region 2 TMC operations manager prior to setting up the automated messages, and based on location of the PCMS and sensors. TDOT may choose to include mileage, speed, estimated delay time or edit average speed triggers in the automated message, based on PRDS and PCMS location. Also, it is expected that the PCMS prior to the upstream and downstream intersections may provide different automated messaging than the PCMS's that are closest to the project.

The anticipated automated messaging shall be determined by the Department and in conjunction with the technology options presented by the PSWZS vendor. The delay data shall be relayed to the PCMS real time from the sensors.

INSTALLATION REQUIREMENTS

All locations shall be staked and approved by the Engineer prior to placing and configuring the PSWZS devices. Ensure that the PSWZS is furnished, installed and maintained by personnel who are experienced in this type of work. Deploying vendor personnel must have a minimum of five similar deployments.

Installation shall also include the following requirements:

1. Materials and associated accessories/adapters shall not be applied contrary to the device manufacturer's recommendations and standard practices. All materials for a complete, turn-key system shall be included with the items in the PSWZS
2. The PSWZS shall include power, video, and data cables, and any and all ancillary equipment required to provide a complete and fully operational PSWZS site. No

separate payment will be made for additional cabling and equipment needed to make the PSWZS function as intended in these special provisions

3. All necessary mounting and leveling equipment needed for the portable devices shall be approved by the PSWZS vendor and included in the cost.

The devices shall be located near the proposed positions located on the layout. At the Engineer's or Department's request, the Design-Builder shall relocate the devices so as to improve the data collection area (PRDS), the location of the messaging devices (PCMS), and the camera coverage (PCCTV), as required for optimal use and benefit of the traveling public and TMC operations personnel. The Department may request that these components be moved throughout the life of the project, based on queue information gathered during deployment.

To ensure a prompt response to incidents involving the integrity of the Portable Smart Work Zone System devices and changeable message signs, the Design-Builder shall be required to make all necessary corrections to the components of the system within 6 hours of notification by the Department. If a device is found to not be working or reporting more than 6 hours after notification from the Department or Engineer, payment will not be made for the System for each day the device is not working. This means that if only one PRDS or PCMS is not functioning, the entire system shall not be paid after the notification.

TRAINING AND SUPPORT

The Design-Builder shall train up to ten (10) TDOT designated individuals to operate the PSWZS software. Training shall be provided on a live system, once all devices have been deployed and tested in the field, and all communications are established with the PSWZS server software and web-client. Training shall provide TDOT operations personnel with general knowledge of the field devices and advanced user knowledge of the PSWZS webclient interface. Training shall encompass all areas of the web-client software, including:

1. Login and credentials
2. Navigation of the site, including description of menu tabs and help tabs
3. Description of the map
4. General monitoring of the PSWZS through the web-client
5. General operation of the automated function and procedures for changing automated messages or intervals/speeds related to displaying those messages
6. Operational override of the PCMS and procedure for posting manual messages on the PCMS, along with return to automated function.
7. Retrieval of PRDS detector data
8. Monitoring and PTZ of the PCCTV camera

S T A T E **O F** **T E N N E S S E E**
(Rev. 10-7-19) January 1, 2021
(Rev. 3-30-20) City of Chattanooga
(Rev. 12-16-21) Hamilton County

SPECIAL PROVISION

REGARDING

SECTION 730 – TRAFFIC SIGNALS

DESCRIPTION

730.01 Description of Work

This work consists of furnishing and installing all necessary materials and equipment to complete in-place traffic signal systems, modify existing systems, or both, all as shown on the Plans or the Standard or Special Details, and as specified in these Specifications. Unless otherwise shown on the Plans or specified in the Special Provisions, all materials shall be new.

Where existing systems are to be modified, incorporate the existing material into the revised system, salvage it, or abandon it as specified or as directed by the Engineer.

Furnish and install all incidental parts that are not shown on the Plans or specified herein, but that are necessary to complete the traffic signal or other electrical systems, or that are required for modifying existing systems, as though such parts were shown on the Plans or specified herein. Include the costs of such incidentals in bid price for other items. All systems shall be complete and in operation to the Engineer's satisfaction at the time of completion of the work.

GENERAL REQUIREMENTS

730.02 Regulations and Code

Ensure that all equipment provided conforms to NEMA Standards Publication, Traffic Control Systems, latest revision, or the Radio Manufacturers Association, whichever is applicable. In addition to the requirements of these Specifications, the Plans, and the Special Provisions, all material and work shall conform to the requirements of the NEC and the NESC; the Standards of ASTM, ANSI, ITE, and IMSA; the MUTCD; and other applicable local ordinances.

Wherever reference is made to the NEC, or the Standards mentioned above, consider the reference to mean the code or standard that is in effect on the date of advertising the bids or authorization for force account.

730.03 Submittal Data Requirements

Within 30 days after the issuance of the work order, submit to the Engineer, the Traffic Operations Division, and the City of Chattanooga Traffic Signal Systems Engineer, one collated set of the manufacturer's descriptive literature and technical data that fully describes the types of signal equipment proposed for use. In the descriptive literature, identify the manufacturer and models and include sufficient information for the Engineer to determine if the

equipment or material meets the requirements of the Plans and these Specifications. Include with these sets of submittal data a list of the materials submitted along with descriptive material for, but not limited to, the following items:

1. Controller
2. Cabinet and Exhaust Fan
3. Detectors
4. Signal Heads including Lamp Information and Mounting Hardware
5. Loop Wire and Loop Sealant
6. Shielded Detector Cable
7. Signal Cable
8. Cable for Span Wire, Guys, and similar features
9. Pull Boxes
10. Conduit
11. Coordination Equipment
12. Periphery Equipment (DSRC, Preemption, etc.)

Also include in the submittal sets detailed scale drawings of all non-standard or special equipment and of all proposed deviations from the Plans. Upon request, submit for approval sample articles of materials proposed for use. The Department will not be liable for any materials purchased; labor performed, or delay to the Work prior to such approval.

In addition to the above, submit to the Engineer a notarized letter certifying that all traffic signal materials listed in the submittal conform to the Plans and Specifications along with a copy of a statement from the maintaining agency that the system is acceptable to the agency. Any material substitutions requested by the maintaining agency shall meet minimum Department standards and shall be approved by the Department in writing prior to purchase or installation. The Department will not be liable for any materials purchased; labor performed, or delay to the Work regarding such approval.

Submit an electronic copy in PDF format of "Design" or "Shop" drawings, indicating the proposed dimensions and material specification for each of the supports and mast arms involved, to the Division of Structures for approval purposes within 30 days after the work order is issued. The Department will review these drawings at the earliest possible date and will return the electronic copy marked "Approved for Fabrication," or "Returned for Revisions as Noted." Respond by taking appropriate action to ensure the earliest possible correction of these items so as not to delay the installation.

Provide a complete documentation package with the control equipment. Provide a manual on the operation and maintenance of the equipment. This manual shall contain detailed instructions for the proper operation and maintenance of the equipment.

730.04 Mill Test Reports and Certification

Provide Mill Test Reports (MTR) or Certifications of Conformance to the Specifications for Materials and Design for all materials incorporated into the Work. Supply the following prior to acceptance of the structures:

1. MTRs for MAJOR structural items only, as identified in Table 730.04-1, shall include both physical and chemical descriptions of the material as supplied to the fabricator. When physical properties are altered during the fabrication, supplement the MTR covering chemical composition with certified test reports indicating the physical properties of this material after fabrication.

2. Certifications of Conformance to the Specifications for all remaining material not covered by MTR as identified in Table 730.04-1.

3. Certification that all welding was performed by operators qualified as follows: Steel welders to AWS and aluminum welders to ASME.

4. Certification of Conformance to the Specification for the Design of all components not completely dimensioned and detailed on the Standard Drawing.

Table 730.04-1: Required Mill Test Reports and Certifications

Component Materials	MTR	Certification
Tubes for arms and poles	X	
Base Castings	X	
Anchor Bolts	X	
Pole tops, misc. fittings, and hardware		X
Fabricated or cast-type arm connections		X
Galvanizing		X

730.05 Working Drawings

Provide within the controller cabinet and to the local maintaining agency an electrical schematic diagram of the cabinet and system wiring. A digital copy of the drawing shall also be provided in .pdf format. Circuit designations on the schematic logic diagrams shall correspond to the circuit designation of components on the circuit boards. Circuit board component designations shall be permanently affixed to the circuit board by a permanent process such as silk-screening. Typical drawings will not be accepted. Drawings will be assigned a specific drawing number, which shall relate to the City order as well as the equipment supplied. The controller manufacturer shall retain the original copy of the cabinet drawing for file reference for the future.

Submit manufacturer's instructions for installation, maintenance, and operation of all equipment to the local maintaining agency and also place a copy within the controller cabinet. Place all such materials inside a plastic envelope mounted in the cabinet.

730.06 Guarantee

Guarantee the Traffic Signal System(s) installed under these Specifications, including all equipment, parts, and appurtenances in connection therewith, to the City or County and State against defective workmanship and materials for a period of not less than 1 year following the date the signal system is installed and made operational, except in no case shall this guarantee expire prior to 3 months after the final acceptance of the Project. Upon completion of the Project, turn over to the government agency responsible for maintaining the signal installation all warranties or guarantees on equipment and materials that are offered by the manufacturers as normal trade practice.

730.07 Training

Provide to the maintaining agency and/or the Department a training session on the controller and associated cabinet equipment to be supplied on the Project. Train the user in the complete operation and programming features of all controllers. Provide this training prior to the acceptance of the Project at a facility agreed upon by the maintaining agency. Such training shall be provided by the vendor and/or manufacturer not more than 90 days after request for training by the City. Such training shall be of a highly technical nature and shall be conducted by the vendor and/or manufacturer. The training shall include as a minimum, the following requirements:

1. The training shall be available for 10 persons to be named by the City.

2. The vendor and/or manufacturer shall provide a complete set of documentation materials for each person in attendance.

3. The training shall involve up to three class sessions (8 hours each), as determined by the City and/or the Department.

After the required training, certify to the Engineer that training has been completed.

This training requirement shall not apply if a training program meeting these criteria has been provided to the maintaining agency by this vendor and/or manufacturer on the equipment being bid within 18 months prior to the date of the invitation to bid. This requirement shall apply if the bidder is proposing new, upgraded, or modified equipment not covered in the previous training program.

MATERIALS AND INSTALLATION

730.08 Excavating and Backfilling

Perform excavation needed to install conduit, foundations, and other equipment, so as to cause the least possible damage to the streets, sidewalks, and other improvements. Excavate trenches no wider than necessary to properly install the electrical equipment and foundations. Do not begin excavating until immediately before installing conduit and other equipment. Place the material from the excavation where it will cause the least disruption and obstruction to vehicular and pedestrian traffic and the least interference with the surface drainage.

Backfill the excavations and compact to at least the density of the surrounding material. Remove all surplus excavation material and dispose of outside the highway right-of-way, in accordance with **203.07**, or as directed by the Engineer.

After backfilling, keep excavations well-filled, and maintain in a smooth and well-drained condition until permanent repairs can be made.

At the end of each day's work, and at all other times when construction operations are suspended, remove all equipment and other obstructions from that portion of the roadway used by public traffic, and park a minimum of 30 feet from the edge of pavement unless otherwise protected by guardrail, bridge rail, or barriers installed for other purposes.

Perform excavation in the street or highway so as to restrict no more than one traffic lane in either direction at any time. Do not obstruct traffic during hours of peak flow unless otherwise approved by the Engineer. Incorporate construction signing in accordance with the MUTCD.

730.09 Removing and Replacing Improvements

Replace or reconstruct, with the same kind of materials as found on the Work, improvements, such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, bituminous surfacing, base material, and all other improvements removed, broken, or damaged by the Contractor.

Before removing the sidewalk and pavement material, use an abrasive type saw to cut, to a minimum depth of 2 inches, the outline of all areas to be removed in Portland cement concrete sidewalks and in all pavements. Use any method satisfactory to the Engineer to cut the remainder of the required depth. Make cuts neat and true with no shatter outside the removal area.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, remove the entire square or slab and reconstruct the concrete as specified above.

Perform all work in accordance with these Specifications, or the applicable local ordinance, whichever is of a higher standard. Consider this removal and replacement work to be incidental to other items.

730.10 Foundations

Construct foundations for posts, standards, and cabinets of Class A Portland cement concrete.

Pour foundations for posts, standards, and pedestals after the post, standard, pedestal, or anchor bolts or reinforcing steel is in proper position. Form the exposed portions to present a neat appearance. Rest the bottom of concrete foundations on firm undisturbed ground.

Construct forms to be true to line and grade. Finish tops of footings for posts and standards, except special foundations, to curb or sidewalk grade or as ordered by the Engineer. Use rigid forms, securely braced in place. Place conduit ends and anchor bolts by means of a template until the concrete sets. Moisten both the forms and the ground that will be in contact with the concrete before placing concrete. Do not remove forms until the concrete has cured for at least 12 hours and hardened sufficiently to allow form removal without causing damage to the concrete.

Apply an ordinary surface finish to exposed surfaces of concrete. Wherever the edge of a concrete foundation or sidewalk section is within 18 inches of any existing concrete improvement, extend the sidewalk section to meet the existing improvement.

Where a pole is to have pedestrian pushbuttons attached, extend the sidewalk to neatly encompass the improvement, to allow a smooth and natural path to easily access the pushbutton in a wheelchair. The top of new foundations are not to be poured above the sidewalk grade when the sidewalk is to be extended to it or encompass it.

Where obstructions prevent the construction of planned foundations, construct a foundation satisfactory to the Engineer.

730.11 Anchor Rods

Furnish, with anchor-base type rods, anchor bolts meeting the requirements of ASTM F1554, grade as required by design. Fit each anchor bolt with two heavy hex nuts. Hot-dip galvanize all nuts and not less than 10 inches of the threaded ends of anchor bolts according to ASTM A153. The anchor bolts shall be capable of resisting at yield strength stress the bending moment of the shaft at its yield strength stress.

Set standards, posts, and pedestals plumb by adjusting the nuts before the foundation is finished to final grade. Do not use shims or similar devices for plumbing or raking. After plumbing or raking has been completed, cut off anchor bolts 1/4 inch above the top nut, and paint the exposed surface with rust protective paint.

Furnish all anchor bolts and nuts required for relocating existing standards and posts.

730.12 Pull Boxes

Construct and install pull boxes as shown on the Plans and the Standard Drawings or as directed by the Engineer. Additional pull boxes may be required where conduit runs are more than 150 feet long. The maximum spacing between pull boxes shall be 150 feet, unless otherwise directed by the Engineer. Install pull boxes wherever practicable out of the line of traffic. Set covers level with the pavement, or with the curb or sidewalk grade, or with the surrounding ground as required.

Where possible install pull boxes either completely inside or outside of the sidewalk with no less than a 6” section of concrete around all sides of the pull box located within the sidewalk. If the pull box is to be only partially within the sidewalk, add a 12” section around all sides of the portion of the pull box not within the sidewalk.

Place electrical conductors within pull boxes so as to be clear of the metal frame and cover.

Rest the bottom of the pull box firmly on a bed of crushed stone with a minimum depth of 12 inches below the bottom, and extending 6 inches beyond the outside edge of the pull box, unless otherwise directed by the Engineer.

A. Concrete Pull Boxes

Construct concrete pull boxes of a mixture of one part cement, two parts sand, and four parts gravel or 1-inch crushed stone with reinforcement placed as shown on the Standard Drawings. Reinforcement shall consist of

welded wire reinforcement, 4 x 4 inches - No. 4/4 at 85 pounds per 100 square feet, meeting the requirements of **907.03**. Pull boxes may be poured in place or precast. The color of the pull box concrete material shall match the surrounding concrete color.

Install a cast iron frame and cover of the dimensions shown on the Drawings in each pull box. Provide castings of Class 30, meeting the requirements of **908.07**. The covers shall have a roughened top surface of 1/8 inch in relief. Provide notches for removing the cover. Inscribe the words "TRAFFIC SIGNALS" on top of the covers with letters 1-1/2 inches high and 1/8 inch in relief as shown on the Drawings.

The frame shall have a minimum weight of 42 pounds. The cover shall be of the "Extra Heavy" type with a minimum weight of 54 pounds.

B. Reinforced Plastic or Epoxy Mortar Pull Boxes

Ensure that pull boxes composed of reinforced plastic or epoxy mortar are designed and tested to temperatures of -50 °F and meet the requirements of the following: ASTM D543, ASTM D570, ASTM D790, and ASTM D635, and are based on a 30,000-pound single axle load over a 10 x 20 inch area. The top of the pull box shall consist of a concrete frame (ring) and cover. The color of the pull box concrete material shall match the surrounding concrete color. Inscribe the words "TRAFFIC SIGNALS" on top of the covers.

730.13 Transformer Base

Fabricate the transformer base from steel plate and sheet, and design it to harmonize with the shaft. Provide each transformer base with:

1. One 7-1/2 x 9 inch minimum handhole, with a cover secured with stainless steel fastening screws;
2. Four galvanized steel bearing plates to fasten the base to the anchor bolts;
3. Four galvanized steel bolts, nuts, and washers to fasten base and standard; and
4. One 1/2-inch, 13 UNC grounding nut welded to the inside of the base opposite the handhole opening.

Ensure that the strength of the transformer base is comparable with that of the shaft.

When a transformer base is required, no handhole will be required in the shaft.

730.14 Conduit

Furnish and install plastic and steel conduit in accordance with these Specifications and close conformity with the lines shown on the Plans or as established by the Engineer.

Threads shall be clean cut, straight, and true and of sufficient length to allow proper coupling. Do not use long running threads on any part of the Work. Protect threads in transit and during installation, and provide conduit with proper supports and protection during construction to prevent damage. Properly thread, ream, and cap all ends of pipe installed for future connections to prevent water and foreign matter from entering the conduit system. Provide threaded ends with approved conduit bushings.

Signal conduit shall be two 2" diameter conduits from the cabinet to the signal pull boxes near each pole; one of the conduits shall contain signal wires, while the other one will remain as an empty spare. Conduit for fiber shall be two 2" in diameter with one containing the fiber and the other remaining empty. Fiber conduit 90's shall be 24" or greater sweeps. HDPE conduit may be used in the Plans; if it is to be used it will be SDR 13.5 of greater wall thickness. All conduit with fiber optic cable or one of a pair of empty "future fiber" conduits installed in the project shall have a 14 AWG stranded, conforming to IMSA 51-3 specification, installed with the fiber or one of the "future fiber" conduits with sufficient length in each pull box to allow for attaching locating devices to it and accurately locate the buried conduit. A 1" conduit is to be provided for power and one 1" conduit is to be provided for a

ground to the nearest signal pull box. Conduit shall not go from pole to pole or cabinet to pole; it shall go from cabinet to pull box or pole to pull box.

A. Materials

Provide conduits and fittings of the type as shown in the construction plans or as directed by the Engineer and as follows:

1. **Steel Conduit**

    a. Rigid conduit and fittings shall be heavy-wall, hot dipped galvanized steel conforming to Federal Specification WW-C-581-d(3) and ANSI C80.1. It shall be galvanized inside and out and shall meet the requirements of ASTM A53. Each length shall bear the label of Underwriters Laboratories, Inc.

    b. Flexible conduit shall be galvanized flexible steel meeting Federal Specification WW-C-581-d(3), ANSI C80.1 and UL Standard 6 with a minimum 40-mil thickness of polyvinyl chloride (PVC) coating conforming to ASTM D746.

2. **Plastic Conduit.** For plastic conduit, provide high impact PVC, Schedule 40 or Schedule 80.

3. **High-Density Polyethylene (HDPE).** Materials used for the manufacture of HDPE conduit and fittings shall be per ASTM F2160 and consist of a Standard Dimension Ratio (SDR) 9-11. No other substitutions shall be allowed unless directed by the Engineer. HDPE conduit can be used with preassembled cable and rope-in-conduit.

B. Installation

All bends shall be in strict compliance with the NEC.

Lay conduits to a minimum depth of 12 inches below subgrade but not less than 24 inches below pavement grade except when approved by the Engineer; conduit may be laid at a depth of not less than 24 inches below top of curb when placed in back of the curb. Place conduit runs for detectors parallel to existing or proposed curbs and not more than 18 inches behind the curb face unless other specified. Place steel conduit or Schedule 80 PVC conduit under existing pavements by approved jacking or drilling methods. Do not disturb pavements without the Engineer's approval. Where trenching is allowed in a traffic bearing area, use PVC conduit (Schedule 40) encased in concrete.

Conduits shall be continuous and extend from end point (i.e. pull box, foundation signal pole, pedestal pole, etc.) to another end point, or as directed by the Engineer. Conduit splicing shall not be permitted between end points.

After completing the installation of the conduit, test all conduits installed under the Contract with a mandrel having a diameter 1/4-inch smaller than the conduit and a length of 2 inches. Repair, to the Engineer's satisfaction, all conduits that will not allow passage of the mandrel; if repairs cannot be accomplished, remove and replace the conduit at no additional cost to the Department. After the mandrel test, scour all conduits with a stiff wire brush slightly larger in diameter than the conduit. Clear all conduits in the Engineer's presence.

Extend conduits terminating in anchor base standards and pedestals approximately 2 inches above the foundation and slope them toward the hand-hole opening. Conduits shall enter concrete pull boxes from the bottom and shall terminate not less than 2 inches or more than 4 inches above the bottom of the box and near the box walls to leave the major portion of the box clear.

Clean existing underground conduit to be incorporated into a new system by blowing with compressed air, or by other means approved by the Engineer.

730.15 Conductors

Furnish and install conductors in accordance with these Specifications and close conformity as shown on the Plans, or as directed by the Engineer.

Traffic Control Conductors shall be rated at 600 volts. Run all conductors, except loop conductors and cables run along messengers, in conduit, except where run inside poles. Where signal conductors are run in lighting standards containing high voltage street lighting conductors, encase the signal conductors in flexible or rigid metal conduit. Where telephone circuits are introduced into controller foundations, encase the telephone conductors in flexible metal conduit and in conformance with the NEC.

Traffic loop wire shall be IMSA Specification 51-3, stranded, AWG 14. It shall be spliced to shielded detector cable in a pull box placed near the edge of the roadway. Detector cable shall be two conductor twisted pair shielded AWG No. 14 stranded meeting IMSA Specification No. 50-2.

730.16 Cable

All signal cable shall conform to applicable IMSA Specification No. 19-1 or 20-1. Use stranded cable color coded AWG No. 14 for all signal and accessory circuits. Retain the same color identification for the entire length of a circuit run. Use 5-conductor or 9-conductor stranded signal conductor wire (AWG #14) for all signal and accessory circuits. Shielded detector cable shall conform to IMSA Specification 50-2, stranded, AWG 14.

The video cables and priority control cables shall meet the video and priority control manufacturers' specifications.

Fiber optic drop cable shall be 12 pair single mode, loose tube, gel-free, dry water-blocking, outdoor, rated suitable for aerial & duct installation, no splices except as allowed on the plans or approved by the Engineer. A fiber "fan-out" kit and splice enclosure shall be included for each location where a splice occurs. Only the fibers necessary for connection shall be cut, all other fibers shall remain connected within the originating trunk line.

Splicing shall be done by a core alignment fusion splicer, and splices shall be sealed in a re-enterable watertight enclosure within splice trays and each individual splice shall be protected with a heat shrink splice sleeve designed to protect fiber splices. All splices shall be tested by Optical Time-Domain Reflectometer (OTDR) from both directions and be 0.02 dB loss or less. If the splice is tested to be greater than a 0.02 dB loss, the fiber will have to be broken at the splice and re-spliced. Test results shall be provided in a report both on paper and electronically. Payment for splicing shall not be made until the splice reports are approved. If fiber is damaged during installation, the fiber will replaced or repaired using the above method, if approved by the Engineer, at no cost the Department or the City. The total dB loss for any fiber from end to end shall not exceed 1 dB, or for continuous fiber, per mile. If the dB loss exceeds that amount, propose a remedy and have it approved by the Engineer. Following the remedy, it shall be retested and achieve a satisfactory result. Fiber drop cable shall meet the same specification as the trunk cable. The drop cable and the pigtails with LC fiber connectors shall be core-alignment**.**

730.17 Wiring

1. Terminate all wiring to screw terminals using lugs.
2. Traffic signal cables, video cables, and priority control cables shall not be spliced between the cabinet and the first signal head / push button, camera, or priority control detector respectively.
3. Attach cables to messenger with non-corrosive lashing rods or stainless steel wire lashings.
4. All wiring within enclosed cabinets shall be neatly formed and harnessed and shall have sufficient length for access and servicing.

730.18 Service Connection

Coordinate service connection details and metering with the local utility as directed by the Engineer and in conformance with the City and County requirements. Obtain the necessary service for each installation.

730.19 Sealant

Provide sealant material selected from the Qualified Products List maintained by the Department's Material and Test Division for sealing saw-cuts. The sealant material shall resist the upward movement of loop and lead-in and shall exhibit stable dielectric characteristics, including a low permittivity and high dielectric strength. It shall bond to the roadway paving material, preventing entry of moisture, and shall remain flexible without melting through the anticipated temperature and weather conditions.

730.20 Strand Cable

Span cable for suspending signal heads between pole supports shall be 7-strand, Class A, copper-covered steel wire strand or greater, meeting the requirements of ASTM A460, with a minimum breaking strength as noted on the Plans. An acceptable alternate is 7-strand steel wire with a Class A zinc coating meeting the requirements of ASTM A475, with a minimum breaking strength as shown on the Plans.

Strand cable for messenger wire (other than span wire as specified above) and pole guy cable use shall be of the diameter(s) shown on the Plans and shall meet the requirements of ASTM A475 for zinc-coated steel wire strand, 7-strand Siemens-Martin Grade with a Class A zinc coating or greater. If not otherwise specified in the plans, all overhead guy wire is to have a minimum diameter of 3/8", and all down guys are to have a minimum diameter of 5/16".
A Figure 8 cable combining the messenger cable and conductor cable in an insulated jacket is an acceptable alternate to conductor cable lashed to a messenger cable.

730.21 Bonding and Grounding

Make metallic cable sheaths, conduit, transformer bases, anchor bolts, and metal poles and pedestals mechanically and electrically secure to form a continuous system, and ensure they are effectively grounded. Bonding and grounding jumpers shall be copper wire or copper strap of not less than the same cross-sectional area as No. 6 AWG.

Furnish and install a ground electrode at each service point. Ground electrodes shall be one-piece lengths of copperweld ground rod not less than 8 feet in length and 1/2 inch in diameter, installed in accordance with the NEC. Ground the conduit and neutral as required under the NEC, except that grounding conductors shall be No. 6 AWG or approved equal, as a minimum. Enclose exposed ground conductors in 1/2-inch diameter conduit, and bond to the electrode with a copperweld ground clamp.

The ground conductor shall pass from the device through the 1" conduit provided for grounding to the pull box where the ground rod shall be driven in the ground and the grounding conductor attached to the ground rod in that box.

730.22 Field Test

Prior to completing the work, conduct the following tests on all traffic signal and lighting circuits in the Engineer's presence:

1. Test for ground in circuit.
2. Conduct a megger test on each circuit between the circuit and ground. The insulation resistance shall be not less than the values specified in Section 119 of the NEC.

3. Conduct a functional test to demonstrate that each part of the system functions as specified or intended herein.
4. Test all detector loops and leads before and after they are sealed in the pavement to ensure there are no shorts to ground in the system and to ensure that the loop plus lead-in inductance is within the operating range of the detector.

Replace or repair, in a manner approved by the Engineer, all faults in material or in the installation revealed by these tests. Repeat the applicable testing until no fault appears.

730.23 Inspection

After completion of the installation and before final acceptance of the Project, conduct a full operational check of the system under actual traffic conditions in the presence of the Engineer. The operational check shall cover a minimum time period of 30 calendar days. During this period, perform all necessary adjustments and replace all malfunctioning parts of the equipment required to place the system in an acceptable operational condition at no additional cost to the Department. Perform all work and furnish all materials required under these Specifications subject to the direct supervision, inspection, and approval of the Engineer. Provide the Engineer and authorized representatives free access to the work, and to all plants, yards, shops, mills, and factories where, or in which, articles or materials to be used or furnished in connection with such work are being prepared, fabricated, or manufactured. Provide full and sufficient information to determine that the performance of the work, the character of materials, and the quality of workmanship and materials meets the intent of these Specifications.

Only perform work in the presence of the Engineer or the Inspector appointed by the Engineer, unless permission to do otherwise has first been obtained. The Engineer may reject any work that is performed or constructed in the absence of the Engineer or Inspector, without such permission having been granted, either expressly or by implication.

The inspection of the work shall not relieve the obligation to properly fulfill the Contract as specified. If the Engineer finds a part of the work, or the materials used in the work, to be defective or unsuitable at any time prior to final acceptance, repair or replace such defective or unsuitable work or material.

Request the presence of an Engineer or Inspector in connection with the work under these Specifications at least 24 hours before such services will be required.

SIGNAL HEADS

730.24 Signal Heads

Signal heads shall meet the latest requirements published in the Equipment and Materials Standards of the Institute of Transportation Engineers (ITE) for Adjustable Face Vehicle Traffic Control Signal Heads" and the National Electrical Code. The arrangement of traffic signal heads shall be mounted as shown on the Plans or as specified by the Engineer and be in accordance with the latest versions of the MUTCD and the TDOT Traffic Design Manual.

All circular indications shall use 12-inch lenses unless otherwise shown on the Plans. All arrow indications shall use 12-inch lenses. All new vehicle signal heads installed at any one intersection shall be of the same style and from the same manufacturer. All signal head doors and visors shall be black in color. Signal bodies shall be yellow. Visors shall be tunnel visors. All exposed metal signal housings, doors, visors, backplates and framework parts shall be painted with a powder coated finish and be in accordance to the MUTCD specifications. Signal head mountings shall have one or more coats of primer followed by two coats of high quality resin enamel of Traffic Signal Yellow and shall meet or exceed Federal Specifications TTC-595 Gloss Yellow. Suspensions for span wire mounting of multi-faced signal heads and signal head clusters (such as a 5-section signal head) shall include an approved swivel type balance adjuster for proper vertical alignment.

Signal head housings shall be polycarbonate and all associated parts/hardware shall be of non-corrosive material. In addition to these requirements, comply with the following:

A. Optical Units

Traffic signal indications shall be LED type, Intertek Certified and meet the Institute for Transportation Engineers (ITE) latest LED specifications. All LED indications shall have a five year warranty.

B. Signal Head Mounting and Mounting Brackets

Furnish signal heads that either have integral serrations or are equipped with positive lock rings and fittings designed to prevent heads from turning due to external forces. Lock ring and connecting fittings shall have serrated contacts. Provide signals with water-tight fittings.

Support bracket-mounted signal heads, as shown on the Plans, by mounting brackets consisting of assemblies of 1-1/2 inch standard pipe size. Ensure that all members are both plumb or level, symmetrically arranged, and securely assembled. Conceal all conductors within poles and mounting assembly. Secure each slip fitter to the pole.

Signals mounted on mast arms shall be mounted by a bracket secured by cables to the mast arm, so that the signal head is rigidly mounted but adjustable in height, horizontal direction, and vertical direction.

C. Directional Louvers

Where shown on the Plans, furnish and install louvers in the hoods of the signal head sections designated.

Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder and vanes shall be constructed of a non-ferrous metal, galvanized sheet steel, or polycarbonate. Metal louvers shall be painted with two coats of black enamel as specified in these specifications.

D. Back Plates

Where shown on the Plans, back plates shall be furnished and attached to the signal heads. All back plates shall be polycarbonate. They shall be constructed so as to permit installation after signal heads are in place. Back plates shall have a dull black appearance, and shall provide a 5” wide border around the signal head. The front of the back plate shall have a fluorescent yellow retroreflective border.

E. Wiring

Signal head leads shall be No. 18 AWG stranded with 221 °F thermoplastic insulation. Wire a separate white (common) lead to each socket shell; and wire a colored lead, corresponding to the color code shown on the Plans, to each socket terminal. Provide leads of sufficient length to allow connection to the terminal block specified. Provide each complete signal head with a minimum 6-point terminal block, properly mounted in a signal section. Stud type terminal blocks shall have not less than 1/4-inch edge clearance to any portion of the stud. Exterior wiring shall have a 360-degree drip loop in advance of entering the head.

F. Pedestrian Signals

Pedestrian signal heads shall meet the latest requirements published in the Equipment and Materials Standards of the Institute of Transportation Engineers (ITE) for Adjustable Face Pedestrian Signal Heads”, the National Electrical Code and be compatible with NEMA standards. The arrangement of pedestrian signal heads shall be mounted as shown on the Plans or as specified by the Engineer and be in accordance with the latest versions of the MUTCD and the TDOT Traffic Design Manual. The pedestrian indications shall be LED symbols and in

conformance with the Institute for Transportation Engineers (ITE) latest LED specifications Intertek certified. All LED indications shall have a five year warranty.

In addition, where pedestrian signal heads are provided, they shall:

1. Include a pedestrian change interval countdown display where the calculated pedestrian change interval is more than 7 seconds;
2. Include Accessible Pedestrian Signals and pedestrian pushbuttons complying with MUTCD Accessible Pedestrian Signals section;
3. Incorporate a locator tone meeting the requirements of the MUTCD Accessible Pedestrian Signals;
4. Include a pedestrian pushbutton with tactile vibrating arrow button and audible sound.
5. Pedestrian indications should attract the attention of and be readable to the pedestrian both day and night and at all distances from 10 feet to the full width of the area to be crossed.
6. When illuminated, the "Upraised Hand" shall be Portland orange meeting the standards of the Institute of Transportation Engineers, with all except the symbol and the countdown legend (when the hand is flashing) being black.
7. When not illuminated, the "Walking Figure", "Upraised Hand" and countdown legend shall not be distinguishable by pedestrians at the far end of the crosswalk they control.
8. The countdown legend shall be capable of displaying a two digit number from "00" to "99".
9. The pedestrian module shall monitor the clearance timing for pedestrians to "learn" the clearance time and display the countdown of the clearance interval accurately by the third clearance interval. If the clearance interval changes by more than .05 seconds, the module shall "relearn" and display the new clearance interval by the third clearance interval following the change.
10. The symbols shall be at least 11 inches high and the digits shall be at least 9 inches high. The approximate dimensions for the LED pedestrian module shall be 18 inches wide and 16 inches tall.
11. Each section shall be covered by an egg crate style shield.
12. The pedestrian indications shall be solid LED symbols and legend, providing an incandescent look. Outline or pixelated symbols or legend will not be acceptable.
13. The housing shall be aluminum, clamshell style, Traffic Signal Yellow, with black faces and visors, unless otherwise specified in the plans.
14. The housing door, door latch, and hinges shall be aluminum. Hinge pins shall be stainless steel. Provide the door with a neoprene gasket capable of making a weather resistant, dust-proof seal when closed.
15. All pedestrian signal heads, mountings, outside of hoods, and pedestrian push button housings shall have a powder coated finish in accordance with MUTCD specifications.

The pedestrian countdown display shall conform to the latest FCC regulation on Emission of Electronic Noise.

The manufacturer must supply certification, which includes a copy of the test report by an independent technical laboratory as to the compliance with ITE specifications (where it applies). The report shall also indicate that the tests were performed only after the modules received a thirty (30) minute operational warm-up period immediately preceding the tests.

G. Signal Head Installation

Install signal heads and pedestrian signal heads with the faces completely covered until the entire installation is ready for operation.

CONTROLLERS – GENERAL

730.25 Controllers

The manufacture and model of the controller unit must be:

1. NEMA Siemens EPAC of the latest model ATC controller with backward compatibility with TS-1 and TS-2 with a Linux operating system with open architecture platform which must meet the following minimal requirements:

    a. Controller equipment shall be permanently marked with the manufacturer's name or trademark, part number, and serial number.
    b. Controllers must meet the following applicable industry standards and amendments:

        1) NEMA TS2 Controller ..... NEMA TS-2-2016
        2) ATC Controller ..... AASHTO/ITE/NEMA ATC 5.2b
        3) All NEMA TS2 and ATC controllers must provide functionality that meets or exceeds operational characteristics, including NTCIP support, as described in NEMA TS-2-2016.
        4) NEMA TS2 Type 2 controllers shall be used when downward compatibility to existing TS1 cabinets.

2. The 2070 Controller must adhere to the ATC 5202 v03.04 Model 2070 Controller Standard Version 03 (as amended) and the controller version/operating system indicated by the Traffic Signal Systems Engineer at the time of procurement.

All Controllers NEMA/2070 must be capable of capturing high resolution event-based data elements to provide the automated traffic signal performance measures.

In addition to the above requirements, all controllers shall:

1. Have all timing values entered via a front panel mounted keyboard. This keyboard shall be an integral part of the controller unit or fixed to the controller with screw(s).
2. Have an English language menu for programming or reading all controller features.
3. Continue to operate the intersection as values are inspected or altered.
4. Include the ability to upload and/or download the controller software operating system and user programmed database to or from external media (datakey, usb, sd card etc) and across a closed network.
5. Support Flashing Yellow Arrow for Permissive Left-turn Movements applications.

A. Controller Timer

The controller unit shall be a self-enclosed fully actuated controller unit with operational, programming and diagnostic capabilities. The controller shall be made of injection molded, high impact polycarbonate and designed for easy access to the boards without disassembly. A molded handle for ease of carrying is desired. It shall be compact and able to fit easily on a shelf in the cabinet. Each controller shall have a unique serial number that is permanently and neatly displayed, along with the model, either on the face or on the top.

Controller units shall contain the necessary communications ports to provide the communications called for in the Plans or in any Special Provisions. All controller units shall be capable of interconnection by twisted pair cable, spread spectrum radio, Ethernet, or fiber optic cable as required on the Plans or in any Special Provisions.

The controller shall have a removable, hand-held LCD alphanumeric backlit display unit, with 8-line, 40 characters per line display capability. The display shall connect to the controller via a dedicated C60 port.

The controller unit shall be completely solid-state and digitally timed. Timing of the controller shall be derived from the 60 hertz /120 volt power line. The electronics shall be modular and shall consist of vertical circuit boards designed to plug in and out of a motherboard or harness within the unit.

The controller unit shall have a minimum of 16 phases with 4 timing rings, 16 overlaps, and 80 detectors. Each controller shall be capable of operating as a Master controller via software. Each controller shall have all operating timing parameters as specified in NEMA on a per phase basis, including all Volume/Density features. Each phase shall have a defeatable Last Car Passage feature wherein the last vehicle receiving the Phase Green shall receive at least one full Passage Time increment.

The controller shall include a front mounted 10/100Mbps Ethernet Port that can be configured with specific network parameters such as an IP address. The controller shall also include an available serial port for connection to the conflict monitor so that its information can be uploaded through the controller. The controller shall have a Data key option to carry data from controller to controller.

In accordance with NEMA, the following are minimum standard features of controller units:

1. Actuated control
2. Volume density timing
3. Conditional service
4. Additional detectors
5. Delay/extension/switching detectors
6. Dual entry
7. Alternate phase sequences
8. Start-up flash
9. Automatic flash
10. Dimming
11. Coordination
12. Preemption (six inputs; six sequences)
13. Time base including daylight savings and leap year adjustments
14. Internal diagnostics (memory diagnostics; processor monitoring; conflict monitoring checking; detector diagnostics)

The controller unit shall have a built-in alphanumeric backlit liquid crystal display for each ring of the controller to provide an English language menu for programming with displays for programming or reading all controller features. The unit shall display all menus and fields required by NEMA.

It shall be possible to inspect and alter any currently programmed value while the controller is in operation without affecting the field operation. The controller shall continue to operate the intersection as values are inspected or altered.

The display screen shall provide both programming area identification and editing prompts.

An RS-232C interface and connector shall be provided for interconnecting to a printer, another like controller unit, a local personal computer, or a remote personal computer through an external modem.

B. Programming

User programming of timing intervals shall be via a single front panel mounted keypad. All of the features listed below shall be user programmable via the keypad:

1. All controller-timing values specified in the above section.

2. Controller start-on sequence. The start-on sequence shall include the phase and overlap display.

3. Phase detector status, on a per phase basis, including Lock Detector Call, Non-Lock Detector Call, Minimum Recall, Maximum Recall, Pedestrian Recall and Non-Actuated Phase.

4. RED START time and RED REVERT time.

5. The phase(s) to be designated as the Non-Actuated Phase for NEMA function CALL NON-ACTUATED I & II.

6. On a per phase basis, FLASHING WALK output shall be selectable.

There shall be a data entry security code with the following features:

1. User entered values shall not be altered without first entering the security code.

2. The security code shall be user changeable via the keypad.

3. The security code requirement shall not preclude the inspection of controller data.

C. Front Panel Displays

The controller shall be provided with a removable front panel LCD alphanumeric backlit display with a minimum of 8-lines, 40 characters per line, English language menus. The display system shall display the following information.

The display shall indicate the following information for each ring of the controller. (Dual ring controllers shall have dual indications to display both rings simultaneously).

1. Phase in Service

2. Phase Next in Service

3. Interval currently timing.

4. Detector/Recall status of phase currently timing.

5. Cause for termination of phase.

6. Maximum Green II in effect.

7. HOLD input applied to phase.

8. Phase in REST mode.

The display system shall indicate the following time values:

1. Maximum Green time remaining

2. Time before Reduction Remaining

3. Walk time remaining

The following coordination data shall be displayed:

1. Cycle, Offset and Split in effect.

2. Time remaining in the local cycle length.

3. Time Remaining in the programmed split for a phase.

4. Active offset and programmed offset.

D. Preemption / Priority

Each controller shall include:

1. 6 Preempt Routines providing complete signal control

2. 6 Priority Routines providing complete phase control and in-sync return to coordination.

Preempt activity can be monitored on a Preempt Status display which denotes:

1. Preempt In Control, Interval Timing, and Interval Countdown

2. Individual Preempt Status and Timing

3. Individual Priority Status and Timing

E. System Controlled Coordination.

All controllers supplied shall include a coordinating device as specified herein. The coordination unit shall be an internal component of the controller. All controllers shall be supplied with a Time Based Coordination (TBC) unit. Also, the Time Based Coordination unit shall be an internal component of the controller. Additionally, when required by the bid documents, hard-wire coordination functions and cabinet wiring facilities shall be supplied. Controllers for central control or closed loop systems shall have an internal connectivity Ethernet port to enable it to communicate with an on-street master or the central office.

Modes of Coordination:

1. Permissive Mode

2. Yield Mode

3. Permissive Yield Mode

4. Permissive Omit Mode

5. Sequential Omit Mode

6. Full Actuated Mode

Coordination – Coordination via the controller shall provide the following functions:

1. Sixteen independent coord plans, programmable over the range of 10-255 seconds, in one second increments.

2. Three independent offsets per plan, programmable over the range of 0-255 seconds, in one second increments.

3. FREE (Non-coordinated) operation.

The controller coordination shall be user programmable via the keypad for all of the following:

1. Values required by the functions of 1 and 2 listed above.

2. At a minimum the following offset correction methods shall be available:
   a. Shortway
   b. Dwell with Maximum dwell time.
   c. Shortway Plus

3. Standby operation with selection of Cycle, Offset, Split and Sequence for the condition of loss of interconnect.

4. Manual operation of the controller.

The coordinator shall compute and generate the necessary Force Off, Hold(s) and Omit(s) based upon the controller time settings and the maximum split times programmed in the coordinator for each phase.

Loss of Interconnect - In such cases, the user shall be able to pre-select which of the following will prevail:

FREE (Non-Coordinated) operation.

Pre-selected Cycle, Offset and Split.

Operation (Coordination) by TBC on a Time-of-Day basis.

F. Time Based Coordination.

Time Based Coordination shall emulate the function of interconnect cable on a time-of-day, day-of-week, week-of-year basis in the following manner.

The following user programmable functions shall be provided:

1. 99 year calendar

2. Defeatable daylight savings time correction, the date for which shall be user programmable.

3. Capacitor back-up for user programmed data, with 100-hour operation and timing accuracy of 0.0015%. The capacitor shall also maintain the real time clock.

4. User programmable resynch method for compatibility with currently available systems.

5. Timing programs shall be selected via a combination of the following user programmable functions:

   a. A minimum of 250 events which may be used to select timing patterns for any combination of 10 different weeks or 99 different days or special days.
   b. Time-of-day resynch via external input as a resynch line when TBC is used in hard-wire system (This function to be an output when the plans or specifications require a TBC MASTER).

c. Four user selectable hard-wire outputs for use for such things as Max II select, flash, etc.

G. Adaptive Traffic Control

Controller shall be capable of performing the following routines:

Adaptive Maximum Routines which are enabled via Time Base, offer three separate Step values to cause the running maximum to increase or decrease smoothly based on current traffic conditions. Separate Dynamic Maximum parameters are available for each Step value.

Adaptive Protected/Permissive Routines measure the volume of Left Turn vehicle traffic and available gap windows in the conflicting Through-Vehicle traffic to determine whether the Left Turn should operate protected or permissive.

Coordination Virtual Split Routine provides for actuated coord phase vehicle and pedestrian modes. This control provides for a period of time of each cycle which is distributed to the Coord phase(s) or non-coord phases, based on Coord Phase vehicle traffic activity.

Coordination Adaptive Split Routines which are enabled via Time Base adjust split times smoothly based on current traffic conditions.

H. External Adaptive Control Option

The controller shall be compatible with the overall centrally controlled adaptive solution should this be required in the future. Modification to the firmware or hardware of the controller shall not be necessary.

Surge Protection Devices

The cabinet shall have Surge Protective Devices (SPDs) for the main AC power input, all signal head field wiring terminals, interconnect cable terminals and loop lead-in cable terminals which are located in the cabinet. Furnish SPDs to provide effective defense against high transient voltages caused by lightning discharges or other sources. SPDs must be unobstructed and accessible from the front side of any panel used in the cabinet. The SPD for the main AC power input of the cabinet must be connected on the load side of the cabinet circuit breaker. SPDs must meet the following minimum requirements:

1. AC power SPD:
    a. Must be UL 1449 4th Edition Listed
    b. Parallel connected device
    c. UL Nominal Surge Rating (In): 20kA
    d. UL Short Circuit Current Rating (SCCR): 150kA minimum
    e. Surge current rating: 50kA per phase minimum
    f. Visual status indication
    g. Remote signalization contacts for monitoring purposes
    h. 10 year manufacturer’s warranty minimum

2. DC power SPD:
    a. Must be UL 1449 4th Edition recognized
    b. Parallel connected device
    c. UL Nominal Surge Rating (In): 10kA minimum
    d. Must provide protection between all +/-/Gnd connections
    e. Surge current rating: 20kA per phase minimum
    f. Visual status indication
    g. Remote signalization contacts for monitoring purposes
    h. 10 year manufacturer’s warranty minimum

3. Data and communication SPD:

    a. Must be UL 497B listed
    b. 10 year manufacturer's warranty minimum

4. Signal and interconnect cable field wiring terminal SPD:

    a. Clamp the surge voltage to a level no greater than twice the peak operating voltage of the circuit being protected.
    b. Withstand a surge current of 1000A with an 8 by 20 μs waveform six times (at 1 second intervals between surges) without damage to the suppressor.
    c. 10 year manufacturer's warranty minimum

5. Loop lead-in cable field wiring terminal SPD:

    a. Protect the detector unit loop inputs against differential (between the loop lead) surges, and against common mode (between loop leads and ground) surges
    b. Clamp the surge voltage to 25 V or less when subjected to repetitive 300A surges
    c. Withstand repetitive 400A surges with an 8 by 20 μs waveform without damage
    d. 10 year manufacturer's warranty minimum

All SPDs must be installed according to the SPD manufacturer's instructions and not affect the operation of equipment. SPD leads must be kept as short and straight as possible.

CABINETS – GENERAL

730.26 Cabinets

Cabinets must be permanently marked with a label including the manufacturer's name or trademark, model/part number, and the year and month of manufacture. The label should be placed on the inside of the main door using a water resistant method. The label must be visible after installation.

Cabinets shall be provided as a complete unit and have all terminals and facilities necessary for traffic signal control as shown on the plans and shall meet at a minimum, the following requirements:

NEMA TS2 Controller Cabinet ..... NEMA TS 2 2016 (III, IV or V as indicated by the plans)
NYDOT/Caltrans/FHWA/TEES..... 33xL ITS (2 or as indicated by the plans)

The manufacturer must supply certification of the conformance to the above requirements at the time of the bid. Cabinets shall also be in accordance with the latest version of the TDOT Traffic Design Manual.

Two paper copies of the cabinet wiring diagram shall be provided with each cabinet. The nomenclature of signal heads, vehicular movements and pedestrian movements on the wiring diagram must be in accordance with the signal operating plan. Documentation must include a list identifying the termination points of cables used for vehicular and pedestrian signal heads, detector loop lead-ins, and pedestrian pushbutton wires. A heavy duty, resalable plastic bag must be mounted on the backside of main cabinet door for storing cabinet documentation.

A. NEMA TS-2

House the controller in a rigid, weatherproof cabinet, constructed, finished, and equipped as follows, and as shown on the Standard Details for NEMA cabinets only:

1. **Material.** Provide weather-tight cabinets fabricated from aluminum sheet or cast aluminum alloy with a minimum 0.125-inch thickness. All welds on fabricated cabinets shall be internal and continuous; spot welding is not acceptable. Painting of cabinets is only required if the final finish presents an unsightly appearance.

   Cabinets shall be fabricated from aluminum or copper bearing 14 gauge sheet steel. Aluminum cabinets shall have a minimum wall thickness of 0.125 inches. All welds shall be neat, smooth and free of blowholes. Where practical, welds shall be internal to present a neat appearance. Non-aluminum cabinets shall be painted aluminum in color.

2. **Doors.** Type III, IV, and V cabinets shall have a righthinged front opening door that shall include substantially the full area of the front of the cabinet. Equip the door with a positive hold fast device to secure the door in at least two open positions: one position at approximately 90 degrees and the other at 120 degrees or more. The holdfast device shall be easily secured and released without the use of tools. Equip doors for Type II, III, IV, and V cabinets with a switch compartment, and provide the manual switches, specified in **730.26.6.k**, with a hinged front opening auxiliary door. Each door shall have a neoprene rubber gasket to provide a weatherproof seal when closed. The main cabinet door shall employ a heavy gauge aluminum or stainless steel continuous hinge utilizing a non-removable 3/16" diameter stainless steel hinge pin for door support, carriage bolted in place, for ease of door removal. The auxiliary door shall employ a 14-gauge stainless steel continuous hinge with a 3/32" diameter hinge pin. The switch compartment is to be mounted flush to the main cabinet door.

   Provide the main door with a No. 2 pin-tumbler cylinder lock, and the auxiliary door with a standard police sub-treasury lock. Provide four keys for each lock.

   Provide a door jamb switch which is to be tied to the cabinet light so that cabinet light will be on when the door is open and off when the door is closed.

3. **Cabinet Mounting.** Mount cabinets as shown on the Plans or Standard Details. Cabinet foundations shall have a minimum of 1" extending beyond the outside of the cabinet on all sides. A concrete pad extension shall extend 36" outward in front of the main door and the UPS door the full with of the concrete base for standing on while working in the main portion of the cabinet or the UPS portion of the cabinet. The extension may be omitted if there is a paved area or sidewalk area adjacent to the pad where the door is located, and the sidewalk is not blocked by the door opening over it.

4. **Ventilation.** Unless otherwise specified, provide ventilation as follows:

   a. On all cabinets housing ventilation shall be provided.

   b. Provide screened or filtered inlet ventilation openings in the door of ITS cabinets and cabinets with controllers. Flasher cabinets may have ventilation openings in the door or sides.

   c. Construct the vents so as to project within the cabinet no more than necessary to provide for lock nuts and gaskets to retain the vent.

   d. Locate vents so as to not interfere with the mounting of controller or other equipment.

5. **Cabinets with Exhaust Fans.** Exhaust fans shall consist of an electric fan with permanently lubricated ball or roller bearings and a capacity of at least 130 cubic feet per minute with the filter installed. The filter shall be a replaceable furnace type. Mount the fan in a rain-tight housing attached to the top of the controller cabinet.

   The fan shall be controlled by a thermostat having a temperature differential between turn-on and turn-off of 15 °F (-0, +5 °F), adjustable for turn-on through a minimum calibrated range of from70 °F to 150 °F.

Whenever a fan is to be installed, provide the air inlet filter and filter holder shown in the Standard Details, or approved equal. Internally seal other air inlets. Provide exhaust fans in all cabinets that house controllers, with the exception of flasher controllers.

6. **Auxiliary Equipment.** With the exception of cabinets used in special applications (Type I and II), provide all cabinets with the following:

   a. Substantial shelves or brackets to support controller and auxiliary equipment.

   b. Panel for terminals arranged for adequate electrical clearance. Panels should be located in the cabinet as described below:

- Detectors	Lower left wall
- AC power	Lower right wall
- Auxiliary/police switches	Door
- Load switch bay	Back wall

   c. The cabinet shall include an LED light, a standard duplex receptable, and GFI duplex receptacle which can be used when the main circuit breaker is off.

   d. Control panel assembly consisting of:

      1. Power supply connections made to a 30-ampere circuit breaker mounted on the cabinet separate from the signal terminal panel. The circuit breaker shall be a magnetic trip type, having an interrupting capacity of at least 2,000 amperes at 125 volts AC. The circuit shall trip between 101% and 125% of rated load, with an inverse time delay characteristic provided. Instantaneous tripping shall occur at ten times the nominal rating. All controllers shall be internally fused.

         Noise/transient suppression shall be provided to minimize the noise levels in the cabinet and to protect equipment in the cabinet in accordance with NEMA. The supplier shall take care to provide suppression where noise generation may occur. Suppression devices shall be provided that meet or exceed both NEMA and the following requirements:

         (a) All lightning arrestors and surge protectors shall be easily accessible from the front of the panel.
         (b) The transient voltage surge suppressor shall have a peak surge current rating of 100 kA per phase. The peak clamping voltage shall be 395 VAC. Normal operating current is 15 Amps with an operating temperature of -40C to +85C. All relay devices shall have resistor/capacitor network across the coil terminals of the relay.
         (c) The fan and thermostat control shall have adequate noise suppression.
         (d) Interconnect lines, when required, shall be protected by a unit capable of withstanding a 10 KA, 8 x 20 nanosecond surge five times without damage. The response time of the unit shall be less than 50 nanoseconds. The maximum clamping voltage shall be no greater than 400 volts at one MA. The units must be individually packaged for interconnect line protection and in a package of three for the signal loads.
         (e) Signal loads (Load Switch Outputs) shall be protected by a three circuit protective device capable of withstanding a 10ka (8x20 microsecond) waveform. Occurrences should be >100 at 200 amps with a maximum clamp voltage of 475 volts per

occurrence. Resistor Loads shall be provided for any unused Load Switch Output. Load switches should be mounted on the rear panel near the field outputs.

(f) Each detector input line from a remote detector or pedestrian push-button shall be protected by a two-stage hybrid device capable of withstanding a minimum of 30 surges of at least 5,000 amperes each applied to the input. The device shall have one input lead, one output lead, and a ground lug in order for the signal wire to "pass through" the protector. The voltage across the output must be held to 30 volts when the input is subject to a 2,000 ampere, 10:20 microsecond surge. The unit must not interfere with the normal operation of the signal equipment, and must respond in less than 20 nanoseconds.

(g) The manufacturer shall provide cabinet noise suppression as required by the particular controller.

(h) If external data communications pair (twisted pair FSK cable) is required, it shall be protected at the cabinet entry point by a two stage series of hybrid device capable of withstanding a peak surge of 4,000 amps, 8 x 20 microsecond waveform. The device shall have a minimum life of 50 surges at 4000 amps with a response time of less than 20 nanoseconds. The maximum clamping voltages shall be 200V on the incoming telephone line and 15V on the incoming multi-pair voice grade interconnect line.

(i) Video detection and/or surveillance cameras panel, when used, shall have surge suppression using EDCO model CX06-M, ASCO Model 160, or approved equal.

2. Service line surge protection.
3. Electrical service termination point sized to accept No. 4 AWG copper wire.
4. Ground fault receptacle.
5. If LED lenses are utilized, they shall be dimmable and switchable to reduce glare at night time.
6. Circuit breakers in accordance to the National Electric Code for:
   (a) Main power input to provide all power associated with normal operation.
   (b) Flasher power input to provide all power associated with flash operation.
   (c) Service power to provide power for the lamp and duplex receptacle and cabinet light.
7. Copper ground bus (minimum of 24 positions).

e. Flasher mechanism independent of controller. The cabinet shall be wired for and include a NEMA flasher mounted on the back panel. All cabinets shall have a two-circuit flasher. The flasher shall have output indicators mounted on the front of the flasher case and shall be rated at a minimum of 15 amperes.

f. General purpose relays, where required to perform specified functions. All relays external to the controller or appurtenances shall meet NEMA standards. In addition:

1. Flash transfer relays shall be of heavy-duty type and have a minimum contact rating of 10 amperes. Contacts shall be of silver material to reduce contact pitting.
2. Unless otherwise specified, each cabinet shall include six (6) flash transfer relays.
3. Flash transfer relays shall support Flashing Yellow Arrow for Permissive Left-turn movement applications.

g. Type II, III, IV, and V cabinets, when specified as housing for traffic actuated controllers, with two or more insulated terminal blocks mounted within the housing, one or more for terminating each field wire.

h. A minimum of 12 available bare ground positions tied to AC Common Return.

i. Earth (driven) ground tie point to terminate a single No. 4 AWG copper ground.

j. A tie point to tie all ground systems within the cabinet to a single reference point. All grounds (AC - return, Chassis, and Logic Ground) must be referenced to a single ground point at the electric service.

k. A panel (police subpanel) shall contain the following:

1. A main power switch, which shall be wired to remove all cabinet power when in the Off position.
2. An Automatic Flash switch, which shall be wired as follows:
   (a) The Flash position shall cause the cabinet to provide Flash Operation. The controller shall continue to operate, and Stop Time shall be applied to the controller.

   (b) Upon return from Flashing to Automatic, the controller shall initialize in the Start-Up Display condition as programmed in the controller, typically major road phases.
3. A panel mounted inside the main door shall contain the following switches:
   (a) A technician Stop-Time switch to apply Stop Time to each controller ring.
   (b) An Interval Advance switch, enabled only by the Stop Time switch, to be momentary pushbutton switch to apply Interval advance to the timer.
   (c) A Signal On-Off switch, which shall remove the AC power applied to the signal heads for normal operation while the controller continues to operate.
   (d) Individual phase vehicle and pedestrian detector test switches to be miniature toggle of the On-Off Momentary type to place:
      i. No Call - Call provided by detectors
      ii. Locked detector call
      iii. Momentary detector call

   Insulate or shield switch terminals on back of main cabinet door so that no live parts are exposed.

   Leads from the terminal block to the auxiliary door switches shall be no less than No. 18 AWG stranded, with TW plasticized polyvinyl chloride or nylon insulation enclosed in an insulating loom, and shall be of sufficient length to allow full opening of the main cabinet door.

l. The cabinet shall be wired with the appropriate number of load switches to accommodate vehicular and pedestrian phasing according to plans. At a minimum, cabinets shall include 16 load switch bases. The load switch wiring shall support Flashing Yellow Arrow for Permissive Left-turn Movement applications. NEMA Signal load switch base plates shall be wired in the cabinet according to the following:

Vehicle Phase	8
Overlap	4
Pedestrian Phase	4

m. All cabinet wiring shall be neatly routed and labeled, laced and permanently secured. All cable shall be secured to the panel, where practical. There shall be no holes drilled through the cabinet walls to mount panels or secure cables.

n. All terminals in the cabinet shall be of the barrier type. The following field connector terminals shall be provided:

1. Four (4) signal output positions per load switch bay (R-Y-G-FL).

2. Ten (10) positions per phase for vehicle loop detector harness.
3. One position per phase for pedestrian detector inputs.

o. Cabinets shall have SDLC communication between the controller, MMU, Detector Rack, Radar Detector (if applicable) and Video Detection (if applicable).

p. Cabinets shall have an electrical outlet (Non GFI) that has 120 VAC from the OUTPUT side of the Main Power Surge unit.

q. Cabinets shall support Flashing Yellow Arrow for Permissive Left-turn Movements applications.

r. The cabinet wiring shall be such that it shall be possible to program each phase output to flash Red, Yellow, or No Flash. Flash programming shall employ simple measures using color-coded jumper wire(s) to indicate flash output.

s. Signal circuits which are designated as flash shall be routed through mechanical flash transfer relays. Flash transfer relays shall be in the energized position for non-flash operation and shall fail-safe to flash operation. Flash transfer relays shall operate from 115 VAC, and shall be heavy-duty type. Contact rating shall be ten (10) amperes minimum. Relays shall be of the male plug type, and shall have a minimum plug length of 18 millimeters (0.70 inches). Contacts shall be of a silver bearing material to reduce contact pitting.

t. When specified on the plans, or the bid document, loop vehicle detector card rack assembly shall be wired in place. The card rack assembly shall have slots spaced at 2.25" to facilitate the use of 2" or 2.25" detectors, either video or inductive loop. Unless otherwise specified, each position to be wired as follows:

Slot	Function
1	Rack Power Supply
2	Ch1=Ø1, Ch2-4=Ø6
3	Ch1=Ø5, Ch2-4=Ø2
4	Ch1=Ø3, Ch2-4=Ø8
5	Ch1=Ø7, Ch2-4=Ø4
6	Preemption

u. Positions not used for standard phasing shall be wired for future or system detection, as specified in the plans. Additional positions may be required in the plans; such positions shall be provided to the right in a larger rack that maintains proper slot spacing.

This configuration shall be considered "STANDARD" unless otherwise specified. The call wires shall be hooked to a terminal strip on the detector panel. The wires shall be movable to actuate a different phase if so desired. The detectors and rack must meet NEMA specifications.

v. An optical preemption detection rack shall be separate and be wired for confirmation lights.

A confirmation light panel shall be supplied that will receive 24V (Logic) outputs from the "D" Panel or AIP panel and convert them to 120V outputs. These outputs will in turn activate the confirmation lights to notify the emergency vehicle that the vehicle its emergency signal has been detected. The Confirmation Light Panel shall have a 12 position terminal block to terminate wiring from (5) solid state relays, (5) metal oxide varistors and associated wiring from the Detector Panel.

B. 33xL ITS NYDOT/Caltrans/FHWA/TEES

The 33xL traffic signal cabinet shall meet current Caltrans/TEES specifications. All cabinets shall be supplied with a Malfunction Management Unit (MMU) and shall meet at a minimum, the following requirements:

NEMA TS2 Malfunction Management Unit ..... NEMA TS 2 2016
Caltrans/TEES specification …… Model 2010 conflict monitor (w/Ethernet and USB)

The manufacturer must supply certification of the conformance to the above requirements at the time of the bid.

According to NEMA TS2 the MMU shall be able to detect the presence of voltage on conflicting on conflicting field connection terminals, the absence of proper voltages on all the signal field connection terminals of a channel and shall be capable of monitoring for the presence of satisfactory operating voltages within the Controller Unit (CU) and the MMU itself. The MMU shall be able to operate as a Type 16 with sixteen channels or as a Type 12 with twelve channels (compatible with NEMA TS1 cabinets.

The MMU should have an Ethernet port.

The MMU monitoring functions shall meet those required by the NEMA Standard Section 4 and shall provide the following.

1. Dual Indication Monitor
   Dual Indication monitoring shall detect simultaneous input combinations of active Green (Walk), Yellow, or Red (Don't Walk) field signal inputs on the same channel. In Type 12 mode this monitoring function detects simultaneous input combinations of active Green and Yellow, Green and Red, Yellow and Red, Walk and Yellow, or Walk and Red field signal inputs on the same channel.

   When voltages on two inputs of a vehicle channel are sensed as active for more than 450 msec, the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the DUAL INDICATION fault. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. When voltages on two inputs of a vehicle channel are sensed as active for less than 200 msec, the MMU shall not transfer the OUTPUT relay contacts to the Fault position.

   When operating with Port 1 communications enabled, Bit #68 (Spare Bit #2) of the Type #129 response frame shall be set to indicate a Dual Indication fault has been detected.

   Dual Indication Monitoring shall be disabled when the RED ENABLE input is not active.
   Dual Indication Programming

   Programming shall be provided to enable the Dual Indication monitoring function for the Green and Red, Green and Yellow, and Yellow and Red combinations for each individual channel. In the Type 12 mode, the Walk inputs shall be logically OR'ed with the Green inputs for purposes of Dual Indication programming.

2. Field Check Monitoring
   The Field Check Monitor function shall provide two modes of operation, Field Check Fault and Field Check Status. Field Check Monitoring shall be disabled when the RED ENABLE input is not active.
   (a) Field Check Monitor
   In the Field Check Fault mode, when the field signal input states sensed by the MMU do not correspond with the data provided by the Controller Unit in the Type #0

message for 10 consecutive messages, the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the FIELD CHECK FAIL fault. Bit #67 (Spare Bit #1) of the Type #129 response frame shall be set to indicate a Field Check fault has been detected. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input.

(b) Field Check Status

The Field Check Status mode shall work in combination with the other fault monitoring functions of the MMU. When a Conflict, Red Fail, Clearance Fail, or Dual Indication Fail triggers the MMU, the Channel Status Display and Fault Status Display shall correspond to that detected fault. If Field Check errors were detected while the fault was being timed, the inputs on which the Field Check errors were detected shall be reported on the Channel Status display. Bit #67 (Spare Bit #1) of the Type #129 response frame shall also be set to indicate Field Check errors have been detected.

(c) Field Check Programming

Programming shall be provided to enable the Field Check monitoring function for each Green, Yellow, and Red input individually. Programming shall be provided to enable the Field Check monitoring function for channel 2, 4, 6, and 8 Walk input individually when operating in the Type 12 with SDLC mode.

3. Recurrent Pulse Monitoring

The Signal Monitor shall detect Conflict, Red Fail, and Dual Indication faults that result from intermittent or flickering field signal inputs. These recurring pulses shall result in a latching fault with the RECURRENT PULSE STATUS indicated along with the resulting Conflict, Red Fail, or Dual Indication status. An option shall be provided to disable the RP detect function for testing purposes.

When operating with Port 1 communications enabled, Bit #69 (Spare Bit #3) of the Type #129 response frame shall be set to indicate a Recurrent Pulse status has been detected.

4. External Watchdog Monitoring

The MMU shall provide the capability to monitor an optional external logic level output from a Controller Unit or other external cabinet circuitry. If the MMU does not receive a change in state on the EXTERNAL WATCHDOG input for 1500 msec ($\pm$100 msec), the MMU shall enter the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the WATCHDOG fault. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure shall reset the WATCHDOG fault state of the monitor. The EXTERNAL WATCHDOG input shall be wired to connector MSB-S.

When operating with Port 1 communications enabled, Bit #70 (Spare Bit #4) of the Type #129 response frame shall be set to indicate an External Watchdog fault has been detected.

5. Type Fault Monitor

The MMU shall verify at power-up that the Type 12 or Type 16 operating mode as determined by the TYPE SELECT input is consistent with the mode set by the last external reset.

Detection of a Type Fault shall place the MMU into the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the TYPE 12/16 fault. The MMU shall remain in the fault mode until the unit is reset by the RESET button or the EXTERNAL RESET input. An MMU Power Failure shall reset the Type Fault state of the monitor.

6. Flashing Yellow Arrow PPLT Support

The MMU shall be designed to monitor an intersection with up to four approaches using the four section Flashing Yellow Arrow (FYA) movement outlined by the NCHRP Research Project 3-54 on Protected/Permissive signal displays with Flashing Yellow Arrows. Two

cabinet configurations shall be supported for both the MMU Type 16 and Type 12 modes depending on the number of load switches provided and the capabilities of the Controller Unit. In both modes the MMU shall be designed to provide the same fault coverage for the FYA approaches as it does for conventional protected left turn phases including Conflict, Red Fail, Dual Indication, and both Minimum Yellow and Minimum Yellow Plus Red Clearance monitoring.

The MMU shall have Configuration Options that provide the following:

1. RYG ONLY Red Fail Option
   The MMU shall provide the capability to exclude the Walk inputs from the Red Fail fault detection algorithm when operating in the Type 12 mode. When the option is selected, the absence of signals on the Green, Yellow, and Red field outputs of a channel will place the MMU unit into the fault mode, transfer the OUTPUT relay contacts to the Fault position, and indicate the RED FAIL fault.

2. LED Signal Threshold Adjust
   The MMU shall provide the capability to sense field inputs signals with the following thresholds:
   (a) Conflict, Dual Indication Low Threshold Signal Inputs (Green, Yellow, and Red)
   No Detect less than 15 Vrms
   Detect greater than 25 Vrms
   (b) Red Fail High Threshold Signal Inputs (Green, Yellow, and Red)
   No Detect less than 50 Vrms
   Detect greater than 70 Vrms

3. CVM LOG Disable Option
   The MMU shall provide a means to disable the logging of CVM fault events.

The MMU Display Functions shall meet those required by the NEMA TS-2 Standard Section 4 and shall provide the following:
A PC shall not be required to display the following parameters.

1. Field Signal Voltages Display
   A mode shall be provided to display the RMS voltage of each field signal input. If the MMU is not in the fault mode, the displayed voltage will be the currently applied RMS voltage. If the MMU is in the fault mode, the displayed voltage will be the applied RMS voltage at the time of the fault.

2. Cabinet Control Signal Voltages Display
   A mode shall be provided to display the RMS voltage of the AC Line and Red Enable, the frequency of the AC Line, and the ambient temperature measured at the MMU. If the MMU is not in the fault mode, the displayed values will be the currently applied values. If the MMU is in the fault mode, the displayed values will be the applied values at the time of the fault.

3. Field Check Status Display
   When the MMU is in the fault mode, a display screen for the front panel display shall be provided to identify all field signal inputs with Field Check status.

4. Recurrent Pulse Status Display
   When the MMU is in the fault mode, a display screen for the front panel display shall be provided to identify all field signal inputs with Recurrent Pulse status.

5. Configuration Display

A display mode for the front panel display shall be provided that allows the setting and viewing of all MMU configuration parameters. The configuration parameters provided on the program card shall be viewable only. A PC shall not be required to completely program or view the MMU configuration parameters.

6. Event Logs Display
   A display mode for the front panel display shall be provided to review all details of the Previous Fail log, AC Line log, and the Monitor Reset log.

7. Clock Set Display
   A display mode for the front panel display shall be provided to view and set the time and date of the MMU real time clock.

The MMU shall operate in both the Type 12 mode and Type 16 mode as required by the NEMA Standard.

1. Help System
   A context sensitive Help system shall be provided that is activated by a separate Help button. The Main Status display shall respond with text messages relevant to the position in the menu navigation level. When the MMU is in the fault mode the Help system shall respond with the Diagnostic mode.

2. Setup Wizard
   A built-in setup mode shall be provided that automatically configures the Dual Indication enable, Field Check enable, Red Fail enable, and Minimum Yellow Plus Red Clearance enable parameters from user input consisting only of channel assignment and class (vehicle, ped, pp-turn, etc) responses.

3. Diagnostic Wizard
   A built-in Diagnostic Wizard shall be provided that displays detailed diagnostic information regarding the fault being analyzed. This mode shall provide a concise view of the signal states involved in the fault, pinpoint faulty signal inputs, and provide guidance on how the technician should isolate the cause of the malfunction. The Diagnostic Wizard shall be automatically invoked when the MMU is in the fault mode and the HELP button is pressed. It shall also be automatically invoked when the MMU is in the Previous Fail (PF) event log display and the HELP button is pressed.

4. TS-1 Type 12 With SDLC Mode
   The MMU shall be capable of operating in the Type 12 mode with SDLC communications enabled on Port 1. The Channel Status display shall operate in the Type 12 configuration and provide the field check function for up to four pedestrian Walk inputs.

The MMU Enclosure shall meet the following:

1. Size
   The MMU shall be compact so as to fit in limited cabinet space. It shall be possible to install on a shelf that is at least 7" deep. Overall dimensions, including mating connectors and harness, shall not exceed 10.5" x 4.5" x 11" (H x W x D).

2. Material
   The enclosure shall be constructed of sheet aluminum with a minimum thickness of 0.062" and shall be finished with an attractive and durable protective coating. Model, serial number, and program information shall be permanently displayed on the top surface.

3. Electronics

(a) Microprocesor Monitor
A microprocessor shall be used for all timing and control functions. Continuing operation of the microprocessor shall be verified by an independent monitor circuit, which shall force the OUTPUT RELAY to the de-energized "fault" state and illuminate the DIAGNOSTIC indicator if a pulse is not received from the microprocessor within a defined period not to exceed 500 ms. Only an MMU Power Failure shall reset the DIAGNOSTIC fault state of the monitor.

(b) RMS Voltage Measurement
High speed sampling techniques shall be used to determine the true RMS value of the AC field inputs. Each AC input shall be sampled at least 32 times per line cycle. The RMS voltage measurement shall be insensitive to phase, frequency, and waveform distortion.

(c) Sockets
In the interest of reliability, no IC sockets shall be used.

(d) Battery
All user programmed configuration settings shall be stored in an electrically erasable programmable read-only memory (EEPROM). Designs using a battery to maintain configuration data shall not be acceptable. If a battery is used, it shall provide power only to the real time clock.

(e) Field Input Terminals
All 120 VAC field terminal inputs shall provide an input impedance of at least 150K ohms and be terminated with a discrete resistor having a power dissipation rating of 0.5 Watts or greater.

(f) Component Temperature Range
All electrical components used in the MMU except the front panel Status LCD shall be rated by the component manufacturer to operate over the full NEMA temperature range of -34ºC to +74ºC.

(g) Printed Circuit Boards
All printed circuit boards shall meet the requirements of the NEMA Standard plus the following requirements to enhance reliability:

i. All plated-through holes and exposed circuit traces shall be plated with solder.
ii. Both sides of the printed circuit board shall be covered with a solder mask material.
iii. The circuit reference designation for all components and the polarity of all capacitors and diodes shall be clearly marked adjacent to the component. Pin #1 for all integrated circuit packages shall be designated on both sides of all printed circuit boards.
iv. All printed circuit board assemblies shall be coated on both sides with a clear moisture-proof and fungus-proof sealant.

4. Front Panel and Connectors

(a) MMU Status Display
A four line by 20 character alpha-numeric LCD display shall be provided to report MMU status, time and date, menu navigation, etc. This display shall be separate from the full intersection channel status display.

(b) Full Intersection Channel Status Display
A separate Red, Yellow, and Green indicator shall be provided for the channel status LCD display for each channel to show full intersection status simultaneously. For Type 12 mode operation a separate Red, Yellow, Green and Walk indicator shall be provided for each channel to show full intersection status simultaneously. Individual icons shall also be provided to indicate channels involved in a fault.

(c) LED Display Indicators
The following LED display indicators shall be provided:

i. Power Indicator
The green POWER indicator shall flash at a rate of 2Hz when the AC LINE voltage is below the drop-out level. It shall illuminate steadily when the AC LINE voltage

returns above the restore level. It shall extinguish when the AC Line voltage is less than 75 Vrms.

ii. Fault Indicator
The red FAULT indicator shall illuminate when the MMU is in the fault mode and the OUTPUT relay has transferred to the Fault position.

iii. Port 1 Receive Indicator
The yellow RECEIVE indicator shall illuminate for a 40 msec pulse each time a Port 1 message is correctly received from the Controller Unit.

iv. Port 1 Transmit Indicator
The yellow TRANSMIT indicator shall illuminate for a 40 msec pulse each time a Port 1 message is transmitted from the MMU.

v. COMM Receive Indicator
The yellow COMM indicator shall illuminate for a 40 msec pulse each time a message is correctly received on the Ethernet port.

vi. Diagnostic Indicator
The red DIAGNOSTIC indicator shall illuminate when the MMU has detected an internal diagnostic failure.

(d) Controls
All displays, controls, and connectors shall be mounted on the front panel of the MMU.
Help Button
A momentary contact button shall be provided that initiates the context sensitive help system. MS Connectors
The MS connectors on the MMU shall have a metallic shell and be attached to the chassis internally. The connectors shall be mounted on the front of the unit in accordance with the following: Connector A shall intermate with a MS 3116 22-55 SZ, and Connector B shall intermate with a MS 3116 16-26 S.

In the interest of reliability and repair ability, printed circuit board mounted MS connectors shall not be acceptable. Internal MS harness wire shall be a minimum of AWG #22, 19 strands.

(e) Ethernet Port
An Ethernet port capable of both 10 and 100 Mbps operation shall be provided on the front panel. The Ethernet port shall be electrically isolated from the MMU electronics using optical couplers and shall provide a minimum of 2500 Vrms isolation. The connector shall be an RJ-45 eight pin connector.

5. Monitor Configuration Parameters
All NEMA standard configuration parameters shall be provided by a program card meeting the requirements of clause 4.3.6 of Nema TS-2. All configuration parameters for functions and options beyond the requirements of the standard shall be stored in non-volatile memory within the MMU. This memory shall be programmable from the front panel menu driven interface, data downloaded via the Ethernet port, or loaded from shadow memory located on the program card.

6. Program Card Memory
The program card supplied with the MMU shall provide non-volatile memory that contains the configuration parameters for the enhanced features of the MMU, such that transferring the program card to a different MMU completely configures that MMU. The non-volatile memory device used on the program card shall not utilize any I/O pins designated as “Reserved” by NEMA TS-2.

7. Event Logging
The MMU shall be capable of storing in non-volatile memory a minimum of 100 events. Each event shall be marked with the time and date of the event. These events shall consist of fault events, AC Line events, reset events, and configuration change events. The capability to

assign a four digit identification number and 30 character description to the unit shall be provided. The event logs shall be uploaded to a PC using the serial port of the MMU and Windows based software provided by the manufacturer.

Each event log report shall contain the following information:

(a) Monitor ID#: a four digit (0000-9999) ID number and 30 character description assigned to the monitor.
(b) Time and Date: time and date of occurrence.
(c) Event Number: identifies the record number in the log. Event #1 is the most recent event.

8. WAN Network Discovery
   The communications software running on the PC shall be able to search the network and display a list of IP addresses and Monitor IDs of MMUs responding on the network. The communications software shall also be capable of making changes to the MMU network parameters such as IP address and subnet mask.

9. ETHERNET Port HTML Interface
   An HTML based capability shall be provided in the MMU to configure the network parameters of the MMU Ethernet port using a standard HTML browser.

10. Reports
    (a) Monitor Status Report (CS)
        The Current Status report shall contain the following information:
        i. Fault Type: the fault type description.
        ii. Field Status: the current GYR(W) field status and field RMS voltages if the monitor is not in the fault state, or the latched field status and field RMS voltages and fault channel status at the time of the fault.
        iii. Cabinet Temperature: the current temperature if the monitor is not in the fault state, or the latched temperature at the time of the fault.
        iv. AC Line Voltage: the current AC Line voltage and frequency if the monitor is not in the fault state, or the AC Line voltage and frequency at the time of the fault.
        v. Control Input Status: the current state and RMS voltages of the Red Enable input & Load Switch Flash bit input if the monitor is not in the fault state, or the status latched at the time of the fault.
    (b) Previous Fault Log (PF)
        The Previous Fault log shall contain the following information:
        i. Fault Type: the fault type description.
        ii. Field Status: the latched field status with RMS voltages, fault channel status, RP Detect status and Field Check status at the time of the fault.
        iii. Cabinet Temperature: the latched temperature at the time of the fault.
        iv. AC Line Voltage: the AC Line voltage & frequency at the time of the fault.
        v. Control Input Status: the latched state of the Red Enable input at the time of the fault.
    (c) AC Line Event Log (AC)
        The AC Line log shall contain the following information:
        i. Event Type: describes the type of AC Line event that occurred.
        Power-up - AC on, monitor performed a cold start
        Interrupt - AC Line < Brownout level
        Restore - AC restored from AC brown-out or AC interruption (AC Off), no cold start
        ii. AC Line Voltage: the AC Line voltage & frequency at the time of the event.
    (d) Monitor Reset Log (MR)
        The Monitor Reset log shall contain the following information:
        The monitor was reset from a fault by the front panel Reset button, or External Reset input, or a non-latched event clear.

11. Configuration Change Log (CF)
    The Configuration Change log shall contain the following information:
    (a) The status of all configuration programming including the contents of the Program Card.

(b) Any configuration programming inputs such as 24V Inhibit, Port 1 Disable, Type Select.
(c) Configuration Check Value: A unique check value that is based on the configuration of items #a and #b above.

The log shall also indicate which items have been changed since the last log entry.

12. Signal Sequence Log (SSQ)
A minimum of five logs shall be provided that graphically display all field signal states and Red Enable for up to 30 seconds prior to the current fault trigger event. The resolution of the display shall be at least 50 milliseconds.

13. Remote Monitor Configuration
(a) Setup Wizard
A setup mode shall be provided by the Windows based software that automatically configures the Dual Indication enable, Field Check enable, Red Fail enable, and Minimum Yellow Plus Red Clearance enable parameters from user input consisting only of channel assignment and class (vehicle, ped, pp-turn, etc) responses.
(b) Upload From File
All configuration parameters for functions and options beyond the requirements of the standard shall be programmable by transferring a file from a PC to the MMU via the front panel Ethernet port. These parameters shall be stored in nonvolatile memory in the MMU.
(c) Download to File
All configuration parameters for functions and options beyond the requirements of the standard shall be downloadable to a PC by transferring a file from the MMU to a PC via the front panel Ethernet port.

730.27 Auxiliary Equipment for Traffic Signal Controllers

Furnish and install the following auxiliary equipment in each cabinet for traffic actuated controllers.

A. Load Switches

Provide each cabinet complete, with the necessary number of NEMA load switches and Flash Transfer relays necessary to affect the specified signal sequence and phasing. Load switches shall:

1. Meet NEMA traffic control system standards, latest revision.
2. Have front-face mounted LED indicators to indicate the "On" condition of both the Input and Output circuits.
3. Use replaceable "cube" type circuitry or encapsulated discrete component construction. No unencapsulated discrete component constructions are acceptable.
4. Units shall be rated at 10 amperes per circuit.
5. Shall be compatible with all "Energy Star" LED signal lamps including arrow indications.

B. Time Clock Switches

Where shown on the Plans, provide time clock switches of solid state circuitry, continuous duty, with a 7-day cycle clock operating from the 120-volt AC service line. Provide switching for a minimum of six independent outputs and ensure the time of day selection is adjustable to within 1 minute of the desired time. Provide a battery or capacitor backup system that can maintain time keeping and memory a minimum of 24 hours after power interruption. Furnish an omitting device as an integral part of the time switch to allow the switching operation to be skipped for any preselected day or days of the week. The time clock shall automatically compensate for daylight savings time changes. When the time clock is supplied as an internal component of the controller, supply the clock feature to provide for the selection of Maximum Green II on

time of day, day of week, week of year basis. Time clocks shall meet NEMA environmental specifications. The timer shall be capable of programming and storing an entire year of preprogrammed plans. The unit shall have a serial or Ethernet port that can be accessed by laptop or over a closed or wireless network.

When required in the traffic signal plans, the auxiliary equipment listed below shall meet the following requirements:

A. Uninterruptable Power Supply (UPS)

The UPS shall power the traffic signal cabinet in the event of a power failure for a minimum of 3 hours.

UPS assemblies should include off-the-shelf deepcycle AGM batteries. Loss of utility power, transfer from utility power to battery power, and transfer back to utility power must not interfere with normal operation of connected equipment. In the event of UPS failure or battery depletion, connected equipment must be energized automatically upon restoration of utility power. Removal and replacement of the UPS must not disrupt the operation of the equipment being protected.

All harnesses necessary to connect and operate the system must be included. All connectors must be keyed to prevent improper connection.

UPS assemblies shall be installed in accordance with the manufacturer's recommendations.

An UPS operation and maintenance manual shall be provided in the cabinet where the UPS is installed with cabinet wiring schematics, electrical interconnection drawings, parts layout and parts lists.

The UPS shall include a manufacturer's warranty covering defects for a minimum of three years (5 years for the external batteries) from the date of final equipment acceptance. The warranty must include provisions for providing a replacement UPS within 10 calendar days of notification for any UPS found to be defective during the warranty period at no cost to the maintaining agency.

B. Communications

1. Wireless

Wireless shall consist of installing a Wireless Network Communications Link with all necessary hardware in accordance with the plans and standard drawings to provide a data link between field devices (i.e. Traffic Signal Controllers).

Each link shall consist of Master ODU (Out Door Unit, Antenna) connected to a data switch within one of the signal cabinets and a Slave ODU connected to a data switch within the other signal cabinet. Each ODU is aligned to face the opposing ODU. The cable length between the ODU and its associated data switch may not exceed 300 feet.

The Wireless Network Communications Link components at each of the linked traffic signal cabinets shall include an ODU, a LPU (Lightning Protection Unit), power supply mounting hardware, and CAT 5e cabling. The ODU is pole mounted per manufacturer's specifications. The LPU and power supply are mounted within the traffic signal cabinet. CAT 5e cable is installed between the ODU and LPU.

For the applicable frequency spectrum of the radios being deployed, perform a spectrum analysis to ensure no competing equipment in the area. Ensure the radio path site survey test is performed using the supplied brand of radio equipment to be deployed. Typically, if the ODUs can be mounted with clear line of sight between them, this is sufficient to ensure proper operation. If this is not possible, it may be determined that a repeater station is necessary to complete the intended link. Provide the test results to the ENGINEER for review and approval. Submit copies of the test results and colored copies of the frequency spectrum scan along with an electronic copy of this information. The ENGINEER will approve final locations of the ODUs and any necessary repeater stations.

Install each ODU in such a manner that avoids conflicts with other utilities (separation distances in accordance with the guidelines of the NESC) and as specified in the ODU manufacturer's recommendations. Secure the ODU mounting hardware to the pole and route the CAT 5E cable such that no strain is placed on the RJ-45 connectors. Align each antenna/radio to be perpendicular to the ground (using bubble level) and to face the opposing radio.

2. Ethernet Access Device

   Where Ethernet is available in the cabinet, an Ethernet access device (EAD) shall be included with the cabinet assembly. The EAD shall be a Ethernet network switch of the latest model compatible with the existing EAD's.

3. Network Switches and Terminal Servers

   The minimum requirements for network switches and terminal servers shall meet the following requirements:

   a. Minimum of eight (8) 10/100 Base-TX ports. Each port shall connect via RJ-45 connector.

   b. Minimum of two (2) 1000 Base Long Reach SFP ports with the following optical requirements:
      1) The minimum optical budget between transmit and received ports shall be 23dB.
      2) SFP shall include SX, LX, and ZX 1000Base Options. Size and provide the appropriate optics with each switch for each field site.
      3) Optical receiver maximum input power level shall not be exceeded. Optical attenuators shall be added as needed. Determine where attenuators are needed and shall be included in the cost of the switch.
      4) Each port shall connect via duplex small form-factor pluggable connectors.

   c. Rack, shelf or DIN rail mountable. If shelf mounted, furnish and install the shelf. The shelf shall be ventilated as per the Network Switch manufacturer recommendation.

   d. Operate between -40to +85 degree Celsius, including power supply.

   e. Operate from 100 VAC to 200 VAC.

   f. Operate from 5% to 97% non-condensing humidity

   g. Meet the IEEE 802.3 (10Mbps Ethernet) standard.

   h. Meet the IEEE 802.3u (Fast Ethernet 100 Mbps) standard.

   i. Meet the IEEE 802.3x (Full Duplex with Flow Control) standard.

   j. Meet the IEEE 802.1p (Priority Queuing) standard.

   k. Meet the IEEE 802.1Q (VLAN) standard per port for up to four (4) VLAN's.

   l. The switch shall meet the IEEE 802.1D (Spanning Tree Protocol) and IEEE 802.1w (Rapid Spanning Tree Protocol) standards.

   m. Meet the IEEE 802.3ad (Port Trunking) standard for a minimum of two (2) groups of four (4) ports.

   n. Capable of mirroring any port to any other port within the switch.

   o. Password manageable through:
      1) SNMPv3 Encrypted Authentication and Access Security
      2) Telnet/CLI
      3) HTTPS/ SSH Enhanced Network Security

   p. Full implementation of SNMPv1 and SNMPv2c.

   q. Full implementation of GVRP (Generic VLAN Registration Protocol).

r. Full implementation of IGMP and IGMP snooping.

s. Minimum MTBF of 100,000 hrs. using Bellcore TS-332 standard.

t. Full implementation of RF 783 (TFTP) to allow remote firmware upgrades.

u. UL approved

v. All power transformers provided shall be "fastening mechanism" type. No plug-in types shall be permitted. All corded transformers shall be mountable with the ability to neatly secure power cords.

w. The field switch shall provide status indicators as follows: 1) power on and off, 2) network status per port (transmit, receive, link, speed), and 3) status indicators shall be LED.

x. Unused ports (copper and optical) shall be covered with rubber or plastic dust caps/cover.

C. Fiber optic cables

Multi-mode type fiber optic cable shall be 50 µm core diameter, with at least 12 fibers per cable unless otherwise specified in the plans. Single-mode type cable shall be between 8-9 µm core diameter, with at least 12 fibers per cable unless otherwise specified. A fiber optic drop cable shall be a minimum of 6 fibers (each type) and be spliced into the trunkline in a splice enclosure either aerially or in a pull box. 50ft. of slack shall be provided, either lashed to a span aerially, or coiled in a pull box for underground installations. Termination panels shall be provided with sufficient size to provide for a neat installation, and enough panel space to accommodate the specified number of fibers for termination. ST connectors shall be used unless otherwise specified. Any necessary jumpers shall be provided for installed equipment.

MISCELLANEOUS TRAFFIC SIGNALS

730.28A Flashing School Signals

When shown on the Plans, provide flashing school signals that conform to the following:

1. The signal shall produce two alternate flashing lights within the marginal limits of a school speed limit sign. Details of the sign construction shall be as shown on the Plans. Sign colors shall conform to the MUTCD and be constructed of materials complying with these specifications.

2. The two LED lenses shall be yellow in color and a minimum of 8 inches in diameter. The LED lenses shall be part of a weather-proof and water-tight optical unit. The LED lenses shall meet the same requirements for vehicular signal head LED lenses. Mount the lenses in the sign using a molded endless rubber gasket with the sign being mounted to the signal case.

3. Provide a two circuit type flasher unit to provide alternating equal on-off operation. The flashing mechanism shall produce between 50 and 60 flashes per minute through two 120-volt, 60-cycle AC, 15-ampere circuits. The flasher shall be of solid state construction.

4. Wire the unit for external circuits.

5. The signal shall be actuated by time switch meeting **730.27**. Locate the timing device in a remote mounted control cabinet.

6. Where an illuminated speed limit indication is shown on the Plans, the numeral message shall be illuminated in Portland Orange in a rectangular lens and illuminated only during the period when the signal produces two alternately flashing amber lights.

In addition, the Time Clock Unit/Switch used for Flashing School Signals shall be a programmable module that allows a user to define the time and day that the school speed zone flasher assembly will initiate and terminate flashing operation. The module shall be installed within the pole-mounted signal cabinet provided as part of project. The time clock shall be compatible with the cabinet's wiring relays and termination panels and the battery power supply system. The time clock switch provided shall also have the following features/capabilities outlined below:

1. Daylight Savings Time shall be a user-programmable setting, in addition to having automated compensation per TDOT specifications.

2. The unit shall provide a minimum 12-character, multi-line alpha-numeric LCD back-lit display capable of displaying all programming parameters.

3. The unit shall be capable of being programmed manually (using an integral keyboard pad) or programmed externally using an optional software program via a laptop computer and cable connection (compatible software program is a separate and distinct item from the time switch unit, and if required, will be separately specified and noted in list of estimated project quantities).

4. Unit shall provide automatic Leap Year compensation.

5. The time clock switch shall be capable of up to minimum 24-hours of capacitive back-up operation, 48 hours desirable, in the event of power interruption.

6. Unit shall be compatible with the supplied solar powered power system / battery unit

7. Time clock switch shall be capable of being programmed for one (1) Normal / Main program, and an additional minimum of 12 Exception periods /programs allowing holiday, vacation and custom skip plans. The exception programs will allow for the Normal / Main program to be skipped or allow for flasher operation on alternative schedules (i.e. early release days, summer school, etc).

8. Unit shall conform to TDOT standard specification subsection 730.27 – Auxiliary Equipment for Traffic Actuated Controller – Time Clock Switches except as superseded herein.

9. Unit shall have non-volatile program memory to allow retention during power loss.

730.28B Solar Power Flashers

When required, the solar power flasher equipment listed below shall meet the following requirements:

1. Solar panel and mounting equipment shall be installed on cantilever pole shaft as illustrated on layout detail sheet and as directed by manufacturer instructions.

2. Solar power unit assembly shall include all required mounting equipment, wiring/cables, battery supply, battery charging unit and other ancillary equipment necessary to operate the solar panel and properly charge the battery. The photovoltaic array shall include mounting bracket assembly to permit adjustment of the array to optimal sun exposure. The photovoltaic module shall be mounted and aligned per manufacturer recommendations to maximize solar exposure.

3. Battery unit shall meet manufacturer specifications required to operate and power L.E.D. signal displays and continuous time clock switch operation. Battery shall be compatible with cabinet equipment, including the time clock switch and the flasher signal displays. Battery unit shall meet minimum environmental and performance specifications required for system operation as recommended by solar panel and time clock switch manufacturers.

4. Solar panel and battery supply shall be of a size and power rating necessary to provide required power to time switch clock and flasher signal displays. Obtain the power load requirements from the solar

power equipment manufacturer and provide as required. On a typical school day, it should be expected that the flasher system will operate up to four (4) hours per day with the time clock continuously operating to maintain its clock timer. Provide a solar system sizing report from the manufacturer indicating the power supply requirements of the proposed system required to meet the expected power demand.

5. The photovoltaic modules shall be warranted for a minimum of five (5) years from date of installation.

6. The battery system shall be a gelled-electrolyte type battery with capacity to provide a minimum of five (5) days continuous operation of the flasher assembly without charging. Batteries shall be field replaceable. Batteries shall have prorated warranty of a minimum of five (5) years from date of installation.

730.28C Portable Traffic Signals

Portable Traffic Signals (PTS) consists of furnishing, installing and configuring a complete PTS system that may be used in construction zones or in other temporary signal locations. The work will be at various sites throughout the state of Tennessee and will consist of providing all labor, materials, equipment and incidentals necessary to make functional the PTS in accordance with these specifications.

The PTS shall be trailer or cart mounted units that provide for easy transportation and quick setup and deployment. There shall be 2 unit options and each unit shall be self-contained.

1. Type 1 units are typically used for long term projects (i.e. projects 5 days or longer in duration) and shall include 2 signal heads per trailer with an upper signal head mounted on an overhead mast arm that can be extended over the travel lane, and a lower signal head mounted on the vertical upright of the trailer.

2. Type 2 units are typically used for short term projects (i.e. projects 4 days or shorter in duration) and shall include 1 signal head that is mounted on the vertical upright of the trailer or cart. Cart-mounted units shall meet the requirements of and be listed on the Department's QPL or Standard Drawings. If the project duration is extended beyond 4 days, then Type 1 units should be substituted in lieu of the Type 2 units for all PTS within the signal system.

The PTS shall be MUTCD Compliant and utilize standard ITE signal heads, and adhere to the ITE Specifications and Standards for Vehicle Traffic Control Signal Heads, Light Emitting Diode (LED) Circular Signal Supplement. The unit shall be solar powered and communicate via a wireless or hardwire connection. The unit shall include all the major components listed below or be able to perform the functions of these components. The major components of the unit shall include but are not limited to the trailer or cart, telescoping mast arm (on Type 1 units only), signal head(s) and back plates, traffic signal controller with operating software, solar charging system with batteries, input and output devices, flasher units, conflict monitor, relays, communications system and other equipment required for the safe operation and installation of the unit.

The PTS signal heads and all applicable components of the PTS shall meet the physical display and operational requirements of conventional traffic signals as specific in the MUTCD.

1. For Type 1 units, each unit shall contain 2 signal heads with an upper signal head mounted on an overhead mast arm that can be extended over the travel lane with a minimum clearance of 17 feet measured from the bottom of the signal head unit to the road surface. The lower signal head shall be mounted to the vertical upright of the trailer at a minimum height of 8 feet from the bottom of the signal head unit to the road surface. The signal heads shall also include black back plates that can be easily removed. The signal heads shall have the ability to be rotated 180 degrees to face in the opposite direction and shall have the ability to rotate and lock in approximately 10 degree increments to position the signal head for the optimum visibility to motorists.

2. For Type 2 units, the signal head of the unit shall be mounted to the vertical upright at a minimum height of

8 feet from the bottom of the signal head unit to the road surface. The signal head shall also include black back plate that can be easily removed. The PTS shall be easily rotated to position the signal head for optimum visibility to motorists.

The PTS shall include a solid-state controller with operating temperature range of -40ºF to +180ºF and compliance with NEMA TS-5 Performance Standard. The controller or programming module shall have an easy to read front panel indicator display. The display shall be backlit and have the capability to facilitate programming and display the currently operating program for each vehicular approach. The controller shall be capable of operating the PTS system in a fixed time, traffic actuated, or manual control mode. Each PTS in a connected system shall have the capability to serve as either the master or slave signal. Each PTS shall include a Conflict Monitor Unit (CMU), or Malfunction Management System (MMS) to ensure phase conflicts do not exist during operation.

1. A minimum of 5 automatic time-of-day timing plans within a 24-hour period should be available in fixed time mode. The operating system should have the ability to control a minimum of 4 traffic phases with programmable cycle time adjustments and user adjustable red, amber, minimum green and maximum green times. The operating system shall also have the capability of facilitating standby modes of red, red flash and yellow flash.

2. The system shall also have the ability to operate in vehicle actuation mode when vehicle detection detectors are used. The operating system shall have the capability to allow the PTS to be connected to and controlled by a standard NEMA controller.

3. The system shall have the capability to be configured and controlled remotely using a handheld wireless remote control with the capability of being operated at a distance up to ¼ mile from the master.

4. The system shall have the capability of remote monitoring for reporting, at a minimum, signal location and status, battery voltage and system defaults. The remote monitoring shall have capability to alert designated individuals if a fault condition occurs.

5. The operating system shall include password protection to prevent unauthorized programming.

The PTS shall communicate with all other PTS within the signal system via license-free wireless 900 MHZ radio link communications. The radio units shall maintain communications at a minimum distance of 1 mile. The radio system shall conform to the applicable Federal Communications Commission (FCC) requirements, including FCC 90.17, and all applicable state and local requirements. The PTS shall be in direct communication at all times either by wireless or hardwire connection to provide for the required conflict monitor.

The system shall also have the ability to operate in vehicle actuation mode when vehicle detection detectors are used. For Type 1 units, the PTS detector shall be a high-definition, multi-beam, microwave radar stop bar detector for each vehicular approach. The Type 1 radar detector shall have a minimum range of 140 feet and shall be mounted at a minimum height of 17 feet measured from the top of the road surface. For Type 2 units, the PTS detector shall be a radar detector for each vehicular approach. The Type 2 radar detector shall have a minimum range of 140 feet and shall be mounted and have complete radar detection functionality at a minimum height of 8 feet measured from the top of the road surface.

The PTS shall be equipped with a solar power array, charging unit and battery system. For Type 1 units, the number and size of batteries shall be sufficient to operate the signal for a minimum of 21 days at 70 degrees without additional charging or assist from the solar array. An on-board battery charger shall be compatible with both the solar array and with a 120V AC power source. The solar panel array shall provide for a minimum of 440 watts of solar collection capability. For Type 2 units, the PTS shall have batteries sufficient to operate the signal for a minimum of 5 days at 70 degrees without additional charging or assist from a solar array. All instrumentation for the electrical system and battery compartment shall be mounted in a lockable weatherproof enclosure. Solar panels shall be secured to the mounting brackets for theft prevention. All wiring for the unit shall be protected against weather and damage.

The trailer or cart, and all mounted components, shall conform to the wind loading requirements (90 mph minimum) as described in the AASHTO Standard Specifications for Highway Signs, Luminaries and Traffic Signals. The wind load calculations shall be completed by an independent third-party, and stamped by a U.S. Registered Professional Engineer. The trailer or cart shall be made of structural steel and shall include 4 leveling/stabilizer jacks capable of lifting the trailer or cart a minimum of 6 inches. The trailer or cart shall be equipped with a hydraulic or electric lift system sufficient for 1 person to be able to raise and lower the vertical upright and/or horizontal mast arm to and from the operating position. For Type 1 or 2 units, the trailer or cart shall be equipped to provide legal and safe transport on the public highway system at speeds up to 55 mph. All exterior metal surfaces, except signal heads and back plates, shall be powder-coat painted highway safety orange.

The PTS work shall meet the following general requirements:

1. Be responsible for locating the PTS in the appropriate location based on MUTCD and ITE standards for visibility to motorists and for safe operation.

2. Be responsible for providing all hardware, software, communications equipment and licenses to operate a complete PTS system.

3. Be responsible that all PTS equipment is installed according to the manufacturer's recommendations including wireless or hardwire connections.

4. Be responsible for transport, setup, configuration, operation and monitoring of the PTS throughout the entire project. The Engineer shall approve all timing and settings that are used for operation of the signal.

5. As directed by the Engineer, it may be necessary to relocate the PTS during the project. The cost of the relocation shall be included in the PTS price bid.

DETECTORS

730.29 Detectors

Provide detectors, of the type shown on the Plans, to actuate signal phases of traffic actuated controllers. Provide ample lightning protection to provide effective defense against high transient voltages caused by lightning discharges or from other sources. The lightning protection unit must withstand repeated 400-ampere surges on a 9 x 20 microsecond waveform. Also, the unit must be a two-stage device capable of clamping a minimum of one hundred 300-ampere surges to 25 volts within 40 nanoseconds for surge applied across the two detector leads.

A. Inductive Loop Detection System

Inductive loop detector units (loop amplifiers) shall meet at a minimum, the following requirement:

1. Must be 4 channel, inductive loop vehicle detectors utilizing a Liquid Crystal Display (LCD) to indicate the operational, setup, and loop diagnostic parameters of the detector/loop system.

2. Detectors supplied to this specification shall have a manufacturer’s warranty to be free of defects in materials and workmanship for a period of not less than 2 years.

3. The Detector shall meet, as a minimum, all applicable sections of the *NEMA Standards Publication No. TS2-2016*. Where differences occur, this specification shall govern.

4. Detector units shall be in full compliance with the environmental, transient and size requirements of NEMA Standards TS1-1994 Section 15, TS2-2016 Section 6.5, and California/New York Type

170/179 specifications, and shall meet the design, operation, electrical and functional performance requirements of these specifications.

5. The detector unit shall have four operationally independent channels that scan sequentially.

6. The detector unit shall be microprocessor controlled, fully digital, and self-tuning. The detector unit shall be configured as a rack mounted printed circuit board for insertion into a NEMA TS-1 / TS-2 rack or Caltrans 170 type detector input file.

7. Detector units shall be designed to operate over a voltage range of 10.8 to 28 VDC.

8. The detector shall include optically isolated, solid state outputs designed to provide a continuous "fail-safe" (Fail-call) output in the event of power loss to the unit.

9. The detector shall utilize two spring loaded toggle switches per channel to navigate the menu driven user interface.

10. The detector unit shall display and record the occurrence of an open loop, shorted loop, or excess inductance change (> 25%). The type of error shall be displayed both by the LCD and a yellow fault LED. The LCD shall display "shorted loop", "open loop" or "25% DL/L" and shall log the 25 most recent events. All information shall be stored in non-volatile memory.

11. Each channel shall provide a continuous (fail-safe) output and indication in response to an open or shorted loop.

12. Each channel shall include two, wide angle, high visibility LED indicators.

    a. Each channel shall have a red LED to display channel detect output status, output state and also the status of the delay and extension timers plus a yellow LED to display loop fault monitor diagnostics (open loop, shorted loop, >25% inductance change.
    b. The red channel detect LED indicator shall flash at a rate of 2 Hz during delay timing.
    c. The red channel detect LED shall flash at a rate of 4 Hz during extension timing.
    d. The yellow fault LED shall flash once to indicate an open loop.
    e. The yellow fault LED shall flash twice to indicate a shorted loop.
    f. The yellow fault LED shall flash three times to indicate an excessive change in inductance.
    g. During fault indication, the red channel detect LED shall flash at the same rate as the fault LED to indicate a current fault. If the fault self-heals, the red led will return to normal operation (indicating calls) while the yellow fault LED continues to flash indicating a prior fault.

13. Graphic Liquid Crystal Display

    a. The unit shall be capable of displaying ALL 4 channels simultaneously.
    b. The unit shall be capable of setting up and resetting all channels individually.
    c. The unit shall be capable of changing setup parameters (sensitivity, frequency) dynamically while detecting vehicles.
    d. The unit shall be capable of setting up all channels simultaneously.
    e. The unit shall utilize a white back light for the LCD. (No electro-luminescence allowed)

14. LCD Full Prompting Menu System

    a. The LCD shall prompt the user utilizing word prompts for easy setup, operation, diagnostic and information gathering operations. All prompting from the display shall be in clear English. There shall be no need to memorize any special switch setting combinations to setup or change the operational parameters of the detector. As long as the user understands the operations of standard

loop detectors, there will be no need for a user manual or prior knowledge to setup and use the detector.

b. The menu system shall prompt the end user for the following input during setup and operation.
   1) Channel Output Control: Each channel's output shall be user selected as "On" for normal operations, "Call" to output a constant call for diagnostic purposes, and "Off" for when a channel is not in use.
   2) Sensitivity: A value between 1 and 20 may be selected. A pie graph shall be displayed to assist in determining the correct sensitivity by showing the deflection caused by vehicles on the loop. Also, an XY Graph showing Deflectometer values and vehicle calls over time shall be displayed.
   3) Frequency: One of Eight frequency values may be selected depending on the frequencies of the adjacent loops. The actual frequency is displayed and can be compared to adjacent detectors so that the maximum separation can be achieved between loops adjacent to one another. The unit shall be capable of graphically displaying noise or crosstalk on the display.
   4) Operational Mode: One of two modes may be selected, Pulse or Presence. If Presence is selected then the user shall be prompted for Short, Long, or User defined presence.
   5) Timing: Delay and Extension timing shall prompt for a yes or no response. If yes, it shall then prompt for the amount of delay and extension timing desired.
   6) Count: Shall control the secondary count outputs and prompt for a yes or no response. If yes is selected the user shall be prompted for the loop configuration the counts are to be taken from and also whether the secondary count outputs shall be active. The counts (1 thru 999,999) shall be displayed.
   7) Paired Channels: Pairs channels 1 & 2 and 3 & 4 to perform one of the following functions:
      (a) 3rd Car Mode: Is used for determining the number of cars in a left turn lane. When 2 loops, usually 6' x 20', are in a left turn lane and both have detection, a call is output.
      (b) Directional Logic Mode: Uses two loops to determine the direction of a vehicle.
   8) Approach ID: The user is prompted to select up to 5 alpha numeric characters to identify the approach that channel is related to, e.g. SBLT4 (South Bound Left Turn Phase 4).
   9) Display: This selection determines the display that shall be shown during normal operation. Channel ID, Sensitivity setting, Countdown timers, and the Deflectometer are shown on all with the option of Frequency (Freq), Inductance (Induct), or Count (Count).
   10) Event Logs: Selecting Logs shall allow the user to view the last 25 events with the most recent being first on a per channel basis. The log shall include the type of fault (open loop, shorted loop, >25% inductance change). It shall also include power up, power loss and reset events. The time elapsed after each event will also be displayed.

15. Mechanical

Height	4.50	inches
Width	2.30	inches
Depth (excluding handle)	6.875	inches

16. Electrical Specifications
    a. Power Supply: 10.8 to 28.8 Vdc, max 200 mA.
    b. Tuning Range: 20 to 2500 uH Loop plus lead-in (approx 15 to 60 kHz)
    c. Q factor: 5 min.
    d. Inputs: Low (true) less than 8 volts, High (false) greater than 16 volts.
    e. Call Output: Solid State optically isolated. "On" voltage shall be less than 1.5 volts at 50mA collector current.
    f. Status and Count Outputs: 50 volts max collector voltage, "On" voltage less than 1.5 volts with 50mA collector current.

17. Environmental: -34^{o}C to + 74^{o}C. humidity 95% max (non-condensing)

NEMA TS2 Inductive Loop Detector Units ..... NEMA TS 2 2016

Loop amplifiers may be single or multi-channel and shall be of the totally self-contained type.

All loop amplifiers shall be of the type to provide both "Extended" and "Delayed" outputs.

The loop detector amplifier shall be full automatic, requiring no adjustments to effect operational ability other than setting of the operating frequency and sensitivity. The amplifier shall:

1. Sense any legal motor vehicle traveling at speeds up to 65 miles per hour.
2. Have both a “Pulse” and “Presence” Output:
   a. Pulse output shall generate an output of 125 ±25 millisecond output for each vehicle entry.
   b. Presence output shall provide a continuous output for up to 60 minutes as long as a vehicle is within the detection zone.
3. Provide at least four user selectable sensitivity ranges.
4. Be supplied with at least three frequency ranges for crosstalk minimization.
5. Have a front-face mounted indicator to indicate active output of the internal relay. This indicator shall indicate the presence of:
   a. Normal Output
   b. Delayed Output
   c. Extended Output
6. Have a front-panel mounted “Reset” switch that when pressed shall cause the unit to completely re-tune itself.
7. Have Delayed or Extended timing features with the following ranges:
   a. Delayed output of 0 to 30 seconds in 1-second increments.
   b. Extended output of 0 to 10 seconds in 1/4-second increments.
8. Have internal diagnostics to determine the operational ability of the loop. These diagnostics shall determine if a loop is opened or shorted, and shall provide a visible indication of such condition. Additionally, if such a condition occurs, the amplifier unit shall default to a “constant” output.
9. Provide output by a mechanical relay, which shall be “off” to provide an output.
10. Have all delay functions wired to the associated plan phase green to inhibit that function during controller phase green.
11. Be able to operate with loop lead-in lengths of at least 2,000 feet.

Comply with the details of the detector loop installation as shown on the Plans or Standard Drawings.

B. Video Detection Video Image Vehicle Tracking and Detection System (VIVTDS)

Included are the minimum requirements for a system that views, captures, and derives data based on the vehicles that pass within the sensor field of view along a highway, road, ramp, or other commonly used transit pathway via processing video images. The detection of vehicles by a VIVTDS can be accessed and used by and for a large number of applications, including:

1. Vehicle detection and actuation at intersections.
2. Highway flow monitoring.
3. Ramp metering.
4. Advanced detection.
5. PED crossing extensions.
6. Temporary construction zone detection.

7. Situational awareness of location area, including an intersection center.
8. Automated alerts and reports of potentially unsafe conditions, incidents, malfunctions, or signal timing inefficiencies.
9. Collecting and archiving traffic data for future analysis to improve performance by optimizing timing plans at intersections.

The system shall have a modular electrical design and use Ethernet to connect and network with the different system components. Streaming video images, alerts, and data shall be transmitted from the field back to a Traffic Operations Center (TOC) via the systems client software and to the VIVTDS's cloud by using any or combination of the following:

1. Fiber optic
2. Microwave
3. WAN
4. TCP/IP
5. Internal modem
6. Any other means of commonly used communication practices and standards for digital content and information.

The VIVTDS client software shall provide graphical user interfaces between the administrator(s) and permissioned users of the system and the VIVTDS sensor(s) itself. The software shall allow the user to configure sites, conduct maintenance, monitor information relayed from the sensor(s), and provide access to real-time data, system and user defined alerts, and access to historical data collected by the sensor(s). The client software should be installed on a single personal computer or across a network of computers. One or more users will be able to access VIVTDS simultaneously.

1. System Hardware

The required hardware shall include the following:

a. One VIVTDS processor capable of connecting with 1 to 8 sensors.
b. One or more VIVTDS sensors, with at least one sensor having a fisheye lens for omnidirectional viewing of the roadway or intersection.
c. One surge protector junction unit, per each advanced/stopline sensor.
d. One mounting pole and bracket (90° pole per each fisheye sensor; or straight, vertical pole per each advanced/stopline sensor). Pole should be assembled in 2 pieces (3' x 3' plus 7' straight, vertical base).
e. One ball-swivel, bracket, and surge protector junction unit, per each fisheye sensor.
f. One Ethernet Protection Module (surge protector located in the traffic cabinet), per each VIVTDS sensor.
g. VIVTDS interface cables to the traffic signal controller based on model/type.
h. Optional portable field computer to configure and monitor system operations.
i. Optional computer to configure and monitor system operations at the TOC or other remote location.
j. Optional Ethernet Repeater to extend VIVTDS sensors beyond 300 feet.
k. Optional POE Powered Switch for use with more than two sensors.

2. Sensor Hardware

a. 360 Degree (Fisheye) Camera Sensor

The VIVTDS should have at least one downward-facing fisheye sensor capable of seeing the center of the intersection and have an omnidirectional line of site to track vehicles entering and exiting the intersection. Other required features shall include the following:

1) Color images outputted into digital format as MJPEG images.
2) Camera lens shall not require adjustment and is always in focus.
3) A thermostatically controlled heater residing inside the enclosure to reduce the effects of ice and condensation.
4) Any plastics used in the enclosure shall have ultraviolet inhibitors.
5) A waterproof and dust tight aluminum enclosure.

The sensor dimensions excluding connectors shall not exceed 9.9" x 7.9" (height x diameter). The weight of the sensor including the enclosure shall not exceed eight pounds. The VIVTDS sensor manufacturer shall provide a lifetime "always in focus" guarantee on the iconic bell-shaped fisheye camera. The sensor's mounting bracket shall utilize a 2 piece, 10 foot 90º mounting pole. The sensor junction box should mount at the base of the vertical pole and allow for the installer to adjust the sensor's horizontal position with one hand and tighten the bracket without having to support the sensor simultaneously.

b. Optional VIVTDS Sensors

Certain projects will have special requirements or needs, such as advanced detection beyond 300 feet and/or stopline detection. In these instances, an additional VIVTDS sensor with a field of view of either 30º - 50º for stopline detection or a field of view of 9º - 18º for advanced detection should be used. The sensor dimensions excluding connectors and mounting bracket shall not exceed 8" x 15" x 3.5" and the weight should not exceed eight pounds. Other required features are the following:

1) Color images outputted into digital format as MJPEG images.
2) A 5 – 50 mm varifocal lens set for the specific application.
3) A thermostatically controlled heater residing inside the enclosure to reduce the effects of ice and condensation.
4) A sun shield to minimize lens exposure to the sun.
5) A waterproof and dust tight powdered coated aluminum housing.

The VIVTDS should support thermal imaging sensors for use in specific situations.

3. Processor Hardware

The VIVTDS processor shall support 1 or 2 fisheye sensors, or if equipped with 1 fisheye sensor the VIVTDS processor should, at a minimum, be capable of simultaneously supporting up to4 additional VIVTDS sensors for special requirements such as advance detection or underpass detection.

The VIVTDS processor shall comply with NEMA standards, TS1, TS2 Type 1 and Type 2; 170/2070; and ITS. The VIVTDS processor shall provide inputs and outputs shown in Table 730.29-01:

Table 730.29-01: VIVTDS Processor Inputs and Outputs

Type	Inputs	Outputs
TS1	24	24
TS2	16	64
170/2070	8	24
ITS	16	64

The VIVTDS processor will have at a minimum four (4) USB 3.0 ports for expansion flexibility and have a built-in modem.

The VIVTDS processor shall be no more than 1U high with dimensions, excluding connectors, not to exceed 8.5" x 11.5" x 1.75" and weigh no more than 5.2 lbs. The unit shall have flexible mounting options including the ability to lie flat on a cabinet shelf, be mounted in a standard traffic cabinet rack with optional mounting ears or be installed vertically with optional base. The outer enclosure shall be a powdered coated aluminum.

a. Electrical

The VIVTDS sensor(s) will use 5 watts nominally and a maximum of 50 watts with active heaters. The sensor(s) will be Power Over Ethernet (POE) and will only require a single shielded, burial grade, gel-filled CAT5e cable for both power and data.

Each VIVTDS sensor shall have its own surge protector junction unit and EPM surge protection unit in the traffic cabinet.

The VIVTDS processor shall operate within a range of 89 to 240 VAC, 60Hz single phase. Power to the VIVTDS processor is from the transient protected side of the AC power distribution system in the traffic control cabinet where the VIVTDS processor is installed.

b. Cabling and Surge Protection Units

CAT5e cabling shall be a high performance shielded direct burial data cable capable of 350MHz bandwidth for data applications. The cabling shall consist of a 24 AWG solid core copper wire with 8 conductors in a gel-filled jacket. The jacket shall consist of linear low-density polyethylene (LLDPE) that is UV resistant and have a cable diameter of no more than 6.5 mm. The cable shall have easily identifiable striped pairs as follows:

1) Orange-White, Orange
2) Green-White, Green
3) Blue-White, Blue
4) Brown-White, Brown

The cable shall be rated at a minimum for 60 V.

The surge protector junction unit for the VIVTDS sensor shall provide protection against a transient pulse with a pulse shape of 8/20µs and a max current of 75A. The unit shall weigh no more than two (2) lbs.

The EPM, surge protection unit for the VIVTDS sensor, shall have at most a max impulse discharge current of 40 KA and an impedance of at least 100 ohms. The unit should have at least Line-Line and Line-Ground protection options, and the POE current should not exceed 1.8A.

c. Environmental

The VIVTDS processor will meet or exceed the NEMA standard of -29º F up to 149º F and meet or exceed a 5-30Hz vibration test as well as a 10G shock test.

The VIVTDS processor shall operate properly in an environment with 0% to 95% relative humidity, non-condensing. The VIVTDS sensor(s) shall operate properly in an environment with 0% to 100% relative humidity.

4. System Software

Each VIVTDS system will include client software for up to 8 sensors for detecting and counting the vehicle's entrance and exit of the intersection. The VIVTDS system will also include software for communicating with the traffic controllers and other electronic devices.

The client software shall be included with each VIVTDS system and should be downloaded and run on any personal computer with a Windows 7 or newer operating system. The client software at minimum should include management tools to perform the following:

a. View, diagnose, configure, and reset individual sensor outputs.
b. View the status of inputs to enable setup and troubleshooting in the field.
c. Configure and view calls and phases.
d. The ability to create and define, as well as edit, vehicle zones, road masks, object masks, and pedestrian zones by drawing arbitrary shaped polygons using a computer.
e. The ability to detect and track vehicles, motorcycles, bicycles, and pedestrians through the entire 360 degree field of view.
f. Provide system calls based on zone occupancy.
g. Provide RTSP streaming capability.
h. View the site's configuration history.
i. Publish and revert back to previous configuration.
j. View video and images from the sensor within the software's interface.
k. Optionally access and use an API that is documented online and that uses HTTP.
l. Provide System Alerts for diagnostic and administrative events.

The VIVTDS system will need to have optional data packages for purchase that provide count data, access to real time data, and system and user defined alerts. The count data shall be accessible directly from the processor or from a remote computer with a network connection. The count data will include at least the following type of reports:

a. Turning movement counts, including U-turns.
b. Length based vehicle classifications.
c. Incidents reporting.
d. Volume
e. 7 Day Volume
f. Occupancy on Green.
g. Occupancy on Red.
h. Percentage of Arrivals on Green.
i. Percentage of Arrivals on Red.

All reports should be exportable and downloadable in any of the following formats:

a. PDF
b. Excel
c. Rich Text Format
d. TIFF Image
e. Web Archive

The alerts/notifications package for purchase should include at a minimum the following types of alerts:

a. Wrong way vehicle detection.
b. Loss of visibility event.
c. Volume Exceeded.

5. Vehicle Detection

VIVTDS system shall provide real time vehicle detection (within 500 milliseconds (ms) of vehicle arrival). The system should detect the presence of vehicles for up to 64 detection zones per VIVTDS sensor. The detection zones shall be sensitive to the direction a vehicle travels and the direction to be detected by each detection zone shall be programmable by a client software user.

a. Detection Zone Placement
The VIVTDS system should provide a flexible detection zone placement anywhere within 150 feet of the VIVTDS sensors. Preferred presence detector configurations shall be arbitrarily shaped polygons, including simple boxes, drawn across lanes of traffic or placed in line with lanes of traffic. A single VIVTDS sensor should replace one or more conventional detectors. Advanced detection zones may be placed up to 300 feet from a Fisheye sensor when mounted at least 40 feet high.

b. Detection Zone Programming
Placement of detection zones will be done by means of a graphical interface using the MJPEG image of the roadway. The client software displays images of the detection zones overlaid on the video image of traffic while the VIVTDS processor is running. The detection zones, when operating, shall display outlined or filled, with a visible change indicating activation.

A laptop should be used to draw detection zones. Alternatively, a mouse, keyboard, and monitor may be connected directly to the processor to configure a site. The detection zones should be capable of being sized and shaped to provide optimal road coverage and detection. It should be possible to upload detector configurations to the VIVTDS processor and to retrieve the sensor configuration that is currently running in the VIVTDS processor through the client software. The configuration should also be retrievable from the VIVTDS system's cloud if properly backed up.

The user will be able to edit previously defined detector configurations in order to fine tune the detection zone placement size and shape. Once a detection configuration has been created, the system will provide a graphic display of the new configuration on its monitor. While this fine-tuning is being done, the sensor will be required to continue to operate from the sensor configuration, currently in place. A user should be able to use a system command to revert to previous configurations stored in the client software or on the VIVTDS system's cloud if properly backed up.

When a vehicle occupies a detection zone, the detection zone on the live video will indicate the presence of a vehicle, thereby verifying proper operation of the system.

The presence of the vehicle as well as the signal states will be indicated via colored LED lights on the front panel of VIVTDS processor. With the absence of images, the VIVTDS processor's display shall indicate proper operation of the detection zones.

Detection zones shall be sensitive to the direction of vehicle travel. The direction will be capable of being detected by each detection zone and will be programmable by the user. The vehicle detection zones will not activate if a vehicle is traveling in any direction other than the one specified for detection in the zone. Cross-street and wrong way traffic shall not cause a false detection.

Detection zones will be capable of an optional user defined call to detect a side entrance (90° or less angled entrance).

c. Design Field of View

The VIVTDS system will be able to reliably detect vehicle presence in the design field of view. The design field of view shall be defined as the sensor view when the image sensor is mounted 30 feet or higher above the roadway, when the sensor is in front of all stop lines, no more than 75 feet from the intersection center, and the beginning of the detection area is not greater than one hundred and 150 feet from the image sensor. Within this design field of view, the VIVTDS processor should be capable of setting up detection zones for point detection (equivalent to the operation of a 6' x 6' inductive loop). A VIVTDS sensor, placed at the proper mounting height, is able to monitor up to and including 5 traffic lanes per approach simultaneously. A single fisheye sensor, placed at the proper mounting height, should be able to monitor detection zones in an intersection of 5 approaches, at a minimum. Fisheye sensors mounted no less than 40 feet should be capable of advanced vehicle detection of up to 300 feet.

d. Detection Performance

Detection accuracy of the VIVTDS system shall be comparable to properly operating inductive loops. Detection accuracy should include the presence of any vehicle in the defined detection zone regardless of the lane the vehicle is occupying. Occlusion produced by vehicles in the same or adjacent lanes shall not be considered a failure of the VIVTDS processor, but a limitation of the VIVTDS sensor placement.

Detection shall be 98% accurate with slight degradation possible under adverse weather or road conditions (i.e. rain, snow, fog). Detection will be expected for the entire design field of view on a lane by lane or by approach basis.

Equipment failure, either sensor or VIVTDS processor, shall result in constant vehicle detection on affected detection zones. The VIVTDS system will be required to have the ability to place a constant call to a specific zone, if said zone loses visibility, while simultaneously making calls in the traditional manner in the remaining zones.

6. System Software Operation

The VIVTDS must transmit and receive all information needed for sensor setup, to monitor vehicle detection, to view vehicle traffic flow, and to interpret stored data. The remote communications link

between the VIVTDS processor shall not interfere with the on-street detection of the VIVTDS processor.

The user should be able to view the detection area in a horizon to horizon fisheye view or in a configurable 4 pane flattened view on the same screen. Each view should be able to be customized by the user, with the ability to digitally pan-tilt-zoom.

7. Installation and Training

   The supplier of the VIVTDS system shall supervise the installation and testing of the sensors, processor, and other sensor components.

   System installers will be required to be certified by the system manufacturer. A manufacturer's instructional guide will not be considered an adequate substitute for practical, classroom training and formal certification by an approved agency.

   However, the manufacturer shall provide an online user guide and an electronic copy of the user guide within the client software and on board the VIVTDS processor for reference.

   Formal levels of factory authorized training are required for installers, contractors and system operators. All training must be certified by the VIVTDS system manufacturer.

8. Warranty, Maintenance and Support

   The video detection system must be warranted to be free of defects in material and workmanship for a period of 3 years from date of shipment from the manufacturer's facility. During the warranty period, the system manufacturer will be required to repair with new or refurbished materials, or replace at no charge, any product containing a warranty defect provided the product is returned FOB to the supplier's factory or authorized repair site. Return product, product for repair, or product to be replaced under warranty by the supplier shall have prepaid transportation. This warranty does not apply to any products damaged by accident, improperly operated, abused, serviced by unauthorized personnel or unauthorized modification.

   Ongoing software support by the manufacturer includes updates of the VIVTDS processor's engine and updates to the client software shall be provided free of charge for the life of the system.

C. Radar Vehicle Detection System (RVDS)

When specified in the plans, the equipment shall consist of all items necessary to provide a complete functional RVDS that process high-definition, multi-beam radar electromagnetic waves and provide detection outputs to the traffic signal controller.

RVDS shall be capable of NEMA TS2 operation.

The RVDS shall consist of the following components:

1. Radar sensor (1)
2. Detector rack interface module (1)
3. Power and surge protection panel or module (1) (cabinet interface devices that combine one or more of the above components shall be acceptable as well).

4. All associated equipment required to setup and operate in a field environment including software, serial and ethernet communication ports, cabling, electrical connectors and mounting hardware.

The RVDS shall be capable of the following:

1. The RVDS shall be able to operate in all types of weather conditions including: rain, snow, sleet, ice, fog and windblown dust.
2. Lightning and surge protection will be provided for power connections and communications links to the radar RVDS.
3. Provide a "fail safe" operation that triggers when communication between the radar vehicle sensor and the interface module is broken. Contact closure from the interface module will occur on all programmed detector channels associated with the affected radar sensor when the failsafe is triggered and will remain in this state until communication is re-established between the interface module and the radar vehicle sensor.
4. Comply with all applicable Federal Communications Commission (FCC) requirements. The manufacturer will provide documentation of compliance with FCC specifications.
5. Shall maintain frequency stability without the use of manual tuning elements by the user.
6. Shall provide a minimum of 4 separate RF channels selectable by the user to avoid interference with other devices working on the same frequency.
7. The communication port(s) shall support a communication speed that will not introduce excessive latency between when a vehicle is detected and the contact closure in the traffic signal cabinet.
8. The interface modules that utilize the detector rack must operate at 12V or 24V DC. Shelf mounted interface modules must operate within a range of 89V to 135V AC, 60 Hz single phase. Power to the RVDS radar sensor must be from the transient protected side of the AC power distribution system in the traffic control cabinet in which the RVDS is installed.
9. RVDS documentation shall include a comprehensive user guide as well as quick reference guide(s).
10. Shall have the ability to configure presence, pulse, extend and delay outputs.

D. Wireless Magnetometer Detection System (WMDS)

When specified in the plans, the equipment shall consist of all items necessary to provide a complete functional wireless magnetometer detection system that process changes to earth magnetic field and provide detection outputs to the traffic signal controller.

WMDS shall be capable of NEMA TS2 operation.

The WMDS shall consist of the following components:

1. In-pavement sensors
2. All wireless communication equipment needed to establish communication links to the controller cabinet.
3. Interface modules compatible with NEMA TS-2 V2.06b cabinet detector rack.
4. Surge protection for the WMDS and system software for set-up and monitoring of the WMDS.

The WMDS shall be capable of the following:

1. Detecting a variety of vehicle types including motorcycles, automobiles and large trucks. The system must allow the user to select sensitivity levels that adjust the amount of hysteresis to the magnetic field needed to achieve contact closure to the assigned detector channel. Magnetometer sensitivity level adjustments must allow for different levels of vehicle detection.
2. The ability to configure presence, pulse, extend and delay outputs.

3. WMDS equipment failure such as: the sensor, communications link, access point radio, repeater radio (if used) or interface module, shall result in constant vehicle call "fault state" on the affected detector channel to the traffic controller.
4. Detection accuracy must be comparable to properly operating inductive loops.
5. Provide real-time vehicle detection (within 150 milliseconds (ms) of vehicle arrival). Once detection is achieved by the sensor, the traffic controller must receive contact closure to the assigned detector channel within the 150 ms time frame.
6. The in-pavement sensor must operate on batteries without the need for underground power or communication cable connections to the unit.
7. The average operating life span of the sensor under battery power must be a minimum of 10 years.
8. The interface module must provide 2 or 4 detector channels. Sensors must be assignable to the available detector channels on the interface module using software provided with the WMDS.
9. The front face of the module shall identify detector channel 1 and detector channel 2. Each must use an LED to indicate contact closure on the channel. When vehicle detection is achieved, the LED will be on and contact closure applied to the detector channel. During periods of no vehicle detection the LEDs will be in an off state and no contact closure will be applied to the detector channel.
10. The interface module will use an LED indication to indicate a "fault state" with the WMDS. When the fault state is active contact closure will be applied to the appropriate detector channel.

E. Pedestrian Push Buttons

Where shown on the Plans, furnish and install pedestrian push buttons of substantial tamper-proof construction. They shall consist of a direct push type button and single momentary contact switch in a cast metal housing. Operating voltage for pedestrian push buttons shall not exceed 24 volts.

Provide a weatherproof assembly, constructed to prevent electrical shocks under any weather condition.

Where a pedestrian push button is attached to a pole, the housing shall be shaped to fit the curvature of the standard or post to which it is attached to provide a rigid installation.

Unless otherwise specified, install the push button and sign on the crosswalk side of the pole.

Pedestrian push buttons shall have a transient protection that meets NEMA specifications.

F. Accessible Pedestrian Signals (APS) and Pushbuttons

Where specified in the plans, the APS system shall consist of all items necessary to provide a complete functional audible pedestrian pushbutton system conforming to the current MUTCD and PROWAG, and meeting these specifications:

1. Placement

    a. Pushbuttons shall be placed facing the pedestrian with a left or right arrow that points in the direction of the crossing for which it is intended. The face of the pushbutton shall be parallel to the crosswalk for which it is intended.
    b. Pushbuttons shall not be blocked from access by any obstacle.
    c. Pushbuttons shall not be placed more than 10" behind any sidewalk obstruction or extension of a pole base. The maximum reach over any obstacle from the pedestrian path to the pole is 10". Pushbuttons shall not extend any more than 4" into the pedestrian path.
    d. Pushbuttons shall be mounted 42" above the pedestrian path to the center of the button.

e. Pushbuttons shall be located between 1.5’ and 6’ from the edge of curb, shoulder or pavement. Where physical constraints make this placement impractical, it should not be further than 10’ from the edge of curb, shoulder, or pavement.
f. Pushbuttons shall be located between the edge of the crosswalk line (extended) farthest from the center of the intersection and the side of a curb ramp (if present), but not greater than 5’ from said crosswalk line.
g. Where two pushbuttons are provided on the same corner, the pushbuttons should be separated by a distance of at least 10’. Where physical constraints make it impractical to have 10’ of separation between the pushbuttons, the pushbuttons may be placed closer together or on the same pole. Where the pushbuttons are placed closer than 10’ or on the same pole, the APS pushbuttons shall have all of these features:
    i. A pushbutton locater tone,
    ii. A tactile arrow,
    iii. A speech walk message for the walk indication,
    iv. A speech pushbutton information message.

2. Physical Design

    a. The base shall accommodate an R10-3e sign.
    b. The button shall have a raised arrow that points in the direction of the crossing.
    c. The button, speaker and sign support shall be a single unit.

3. Visual

    a. The base shall be federal yellow.
    b. The arrow on the button shall be of a contrasting color to the remainder of the button.
    c. An R10-3e sign shall be positioned above the button.
    d. An LED indication, visible in sunlight, shall indicate that the button has been pushed.

4. Audible

    a. All audible locator and messages shall be capable of increasing or decreasing volume based on traffic and other background noise.
    b. A locator tone / chirp shall be selectable.
    c. Programmable clear voice messages shall inform pedestrians of the walk and clearance indications and what road is to be crossed.
    d. Audible features shall fully comply with the MUTCD.

5. Tactile

    a. The button shall vibrate in pulses as confirmation that the button has been pushed.
    b. The button shall vibrate when in walk.
    c. Tactile features shall fully comply with the MUTCD.

6. Control

    a. A control unit shall be placed in the control cabinet to communicate with the buttons and the controller.

b. The control unit shall be able to push programming to the buttons, including updates in firmware.
c. By means of the control unit, data shall be retrievable on pushbutton pushes and extended pushes.
d. Remote programming and monitoring shall be provided by means of an Ethernet connection.
e. Direct programming shall be possible by wireless or Bluetooth capable devices.

7. Cabling

a. A cable shall be provided to either communicate directly to the controller through the SDLC port, using a Y-cable or hook up to the cabinet wiring to give inputs in the controller as standard pushbuttons do.
b. An Ethernet cable shall be provided for communication with the devices from a remote location.
c. Wiring to each pushbutton shall be through a 2-wire cable.

730.30 (Reserved)

730.31 (Reserved)

TRAFFIC SIGNAL SUPPORTS

730.32 Cantilever Signal Supports

This Subsection applies to the manufacture of steel poles and mast arms for the support of traffic signals. The height of poles, shaft dimensions and wall thickness shall meet the design requirements and mounting height of traffic signals as set forth in these Specifications and shown on the Plans. The Plans indicate bracket arm lengths.

Furnish poles consisting of a straight or uniformly tapered shaft, cylindrical or octagonal in cross-section, having a base welded to the lower end and complete with anchor bolts. All castings shall be clean and smooth with all details well defined and true to pattern. Steel castings shall conform to ASTM A27, Grade 65-35. Gray iron castings shall conform to ASTM A126, Class A.

All mast arms shall be compatible with the poles in material, strength, shape, and size.

A. Anchor Base

Secure an anchor base of one-piece cast steel or steel plate of adequate strength, shape, and size to the lower end of the shaft. Place the base so as to telescope the shaft, and weld at the top and bottom faces with continuous fillet welds so that the welded connection develops the full strength of the adjacent shaft section to resist bending action. Provide each base with a minimum of four holes to receive the anchor bolts. Provide cast steel bases with removable cast iron covers for anchor bolts and tapped holes for attaching covers with hex head cap screws.

Provide a welded frame handhole, 5 x 8 inches minimum and located with a clear distance above the base of no less than the pole diameter, “D”. Weld a 1/2-inch 13 UNC grounding nut to the inside of the pole at a point readily accessible for wiring.

B. Shaft

Fabricate shafts from the best, hot-rolled basic open hearth steel. The shaft shall have only one longitudinal electrically welded joint and may have electrically welded intermediate transverse full penetration circumferential joints, at intervals of not less than 10 feet. The shaft shall be longitudinally cold-rolled to flatten the weld and increase the physical characteristics so that the metal will have minimum yield strength of 48,000 pounds per square inch. Where transverse full penetration circumferential welds are used, the shaft fabricator shall furnish to the Engineer certification that: (1) all such welds have been radiographed and ultrasonically tested by an independent testing laboratory using a qualified Nondestructive Testing (NDT) technician and (2) the NDT equipment has been calibrated annually.

Fit the shaft with a removable pole cap, a J-hook wire support welded inside near the top, and a flange plate assembly to match that welded to the butt end of the mast arm.

C. Mast Arms

Provide mast arms fabricated and certified in the same manner as the upright shafts and that have the same physical characteristics.

The mast arms shall meet the design requirements necessary to support rigidly mounted traffic signals as shown on the Plans. All arms shall include a removable cap at the tip, grommeted wire outlets, and signal hanger assemblies of the type and number shown on the Plans, and a flange plate welded to the butt end to provide a rigid connection to the mast. The assembly shall be constructed so that all wiring can be concealed internally.

Connect mast arms to the upright pole at a height necessary to provide a minimum clearance of 16 feet 6 inches and a maximum clearance of 19 feet under the traffic signal heads. Install separate signal heads to provide the same clearance.

D. Finish

Galvanize steel poles, mast arms, and hardware in accordance with ASTM A123 or, if specified on the plans, painted pole green

Galvanize all steel and cast iron components, hardware, and threaded fasteners, except anchor bolts, after fabrication in accordance with ASTM A123, or A153 or A385, as applicable.

730.33 Steel Strain Poles

Provide steel strain poles consisting of a uniformly tapered or equivalent upright shaft fitted with a removable pole top, J-hook wire support and 45-degree wire inlet near the top, a span wire clamp, a 5 x 8 inch handhole with reinforced frame and cover, bent anchor bolts, and all other accessories needed to make a complete installation. The pole and all of its component parts shall be designed to support tethered traffic signals of the type and number shown on the Plans, suspended from a span wire assembly. Fabricate and certify the poles as specified for the upright shafts in **730.32**.

Determine the shaft length required to meet field conditions and vertical clearances of signal heads over the roadway. The signal head clearance shall be a minimum of 16 feet 6 inches and a maximum of 19 feet. Fasten the span wire no closer than 1 foot 6 inches from the top of the pole.

Unless otherwise specified, provide all strain pole traffic signal supports with a one-piece anchor type base, fabricated from drop forged or cast steel of sufficient cross-section to fully develop the ultimate strength of the poles. Fasten the base to the pole with a welded connection that develops the full strength of the pole. Provide the base with a minimum of four holes of sufficient size to accommodate the proper size anchor bolts that are capable of resisting at yield strength stress, the bending moment of the shaft at its yield strength stress. Provide removable cast iron covers for the anchor bolts.

The shaft shall be fabricated from material providing minimum yield strength of 48,000 pounds per square inch after fabrication.

Galvanize the steel poles and hardware in accordance with ASTM A123 or, if specified in the plans, painted pole green.

Galvanize all steel and cast iron components, hardware, and threaded fasteners, except anchor bolts, after fabrication in accordance with ASTM A123, or A153 or A385, as applicable.

730.34 Pedestal Support Signal Poles

Provide pedestal poles consisting of one upright pole with suitable base and other accessories or hardware as required making a complete installation.

All poles shall be made of one continuous piece from top of base connection for the entire height of the pole. The cross-section shall be either cylindrical or octagonal and may or may not be uniformly tapered from butt to tip.

The cross-section at the tip shall have a 4-1/2 inch outside diameter.

A. Type "A" Pedestal (Aluminum)

Pedestals shall be of uniform octagonal or cylindrical cross-section of the tubular tapered type fabricated of one full length sheet.

Bases shall be octagonal or square in shape, of the ornamental type fabricated of cast material. Provide a handhole in each base.

Caps shall be of the nipple or tenon type mounting fabricated of cast material.

Furnish bases with four steel anchor bolts of sufficient size and length to securely anchor the base to the concrete footing. Weld the shaft to the cast metal base. Refer to the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (current edition).

Type A pedestal shaft shall be fabricated from aluminum tubing 6063-T4 heat treated to T-6 temper after fabrication, and meeting ASTM B221.

Type A anchor base shall be made of sand-cast aluminum alloy 356-T6 meeting ASTM B26 - SF 70A-T5 specifications.

B. Type "B" Pedestal (Steel)

Pedestals shall be fabricated from a 4-1/2 inch (outside diameter) seamless steel pipe.

Bases shall be octagonal in shape of the ornamental type fabricated of cast or malleable iron and shall have minimum height of 12 inches. The top opening of the base shall be threaded to receive the shaft. Provide a handhole in each base.

Furnish bases with four steel anchor bolts of sufficient length to securely anchor the base to the concrete footing.

730.35 Wooden Pole Signal Supports

A. General

Provide wooden poles of the class and length shown on the Plans and that meet **917.11**. Set poles to the depth shown on the Plans, and fit them with all the necessary hardware to make the installation complete.

The signal head clearance shall be 16 feet 6 inches minimum and 19 feet maximum. Fasten the span wire at least 2 feet below the top of the pole.

B. Guying Components

Guy clamps shall be steel, 3-bolt type, 6 inches in length, and of the proper strand size to fit the wire used. The clamp bolts shall have upset shoulders fitting into the clamp plate. Substitution of the cable grip is subject to the Engineer's approval.

Attach guy wire to the pole with a 5/8-inch diameter x 12-inch length single strand angle-type eye bolt with 2 x 2 inch square cut washers; lock washer, and square nut.

Instead of the eye bolt specified above, an angle single strand eye of drop forged steel may be used, fastened on threaded end of span wire eye bolt.

Sidewalk guy fittings shall consist of 2-inch inside diameter standard galvanized steel pipe of required length with malleable iron pole plate and guy clamp. Fasten the pole plate to the pole with a 3/8-inch thru bolt and 1/2-inch lag screws.

All guying components and hardware shall be galvanized in accordance with ASTM A123 or A153.

Anchors for guys shall be of the pressed steel four-way expanding fluke type or of the steel or malleable iron sliding plate type. The minimum unexpanded diameter shall be 8 inches, and the minimum expanded area shall be 110 square feet. Coat anchors with a black asphaltic paint.

Guy anchor rods shall be drop-forged steel, 3/4-inch diameter and 7-foot minimum length, threaded, of the single thimble eye type, with a square anchor bolt nut.

730.36 Pole Location

Install all signal support poles at the locations shown on the Plans or where directed by the Engineer.

COMPENSATION

730.37 Method of Measurement

Measurement for traffic signals will be on a per item basis for each item to be furnished and installed, as specified herein and shown on the Plans.

With regard to items for signal head assemblies, each item to be furnished, installed, or both furnished and installed shall be distinguished with a code number as follows:

1. The first digit is the number of faces per assembly.

2. The second digit will indicate the number of 12-inch lenses per assembly (including arrow lenses).

3. The third digit is the quantity of 8-inch lenses per assembly.

4. The letter "A" indicates an arrow lens and the digit following the "A" indicates the number of 12-inch arrow lenses per assembly.

5. The letter "H" or "V" indicates the arrangement of arrow signal lenses to be horizontal or vertical with respect to solid ball indications.
   EXAMPLE:
   1 5 0 A 2 H
   Digits indicate the following:
   1 = one face
   5 = five 12-inch lenses
   0 = zero 8-inch lenses
   A2 = two 12-inch arrow lenses
   H = Arrow lenses placed horizontally with respect to circular indications

A. Removal of Signal Equipment

The Department will measure items of equipment or material designated or required for removal on a per each intersection basis. Removal and salvage of all signal heads, poles, control equipment, cabinets, span wire, cable, and similar features to be performed at an intersection shall be included as a unit cost per each intersection. This includes the cost of stockpiling salvable equipment for pick-up by the appropriate agency, as noted in the Plans.

Signal Head Assembly (includes Pedestrian Signal Heads)

The Department will measure signal heads of the type shown on the Plans by the individual assembly complete in place, per each. This item shall include the signal heads, terminals, lamps, attachment hardware, cable connection, and testing.

Pull Box

The Department will measure each pull box of the type required as one complete unit, installed, per each. This item includes the pull box, excavation, backfilling, crushed stone base, and other incidental items as called for in the Plans or Standard Drawings.

Electrical Service Connection

The Department will measure Electrical Service Connections on a per each signal installation basis. This item includes the electrical service supplied to the weatherhead by the local utility, all necessary materials and labor for connection of the electrical service from the controller to the weatherhead, the wiring of the controller and detectors, and all incidentals necessary to render a complete and operable system.

Signal Cable

The Department will measure the length of Signal Cable of each size (number of conductors) installed in linear feet to the nearest foot from point to point along the routing for each cable.

The Department will make horizontal measurements by center to center measurement from:

1. Pole to pole
2. Pole to signal head (when terminating in a signal head)
3. Pull box to pull box
4. Pull box to pole
5. Pull box to pole-mounted or base-mounted controller

For cable inside mastarms, the Department will measure from center of vertical support to signal head where cable terminates.

The Department will make vertical measurement by one of the following:

1. For cable inside poles or conduit risers, the distance from ground level to the point of attachment of the span wire.
2. For cable inside mast arm supports, the distance from ground level to the mast arm connection.
3. For cable to pole-mounted controller,
   a. From ground level to bottom of controller.
   b. From bottom of controller to point of attachment of span wire.
4. For cable to pole-mounted signal head or pushbutton,
   a. From ground level to bottom of signal head or pushbutton
   b. From bottom of signal head or pushbutton to point of attachment of span wire.

The Department will make no additional allowance for slack length, length inside equipment or supports (except as noted), length for the required 360-degree drip loop, and similar instances requiring additional length of cable.

Span Wire

The Department will measure Span Wire Assembly, Tether Wire Assembly, and Messenger Cable by type in linear feet to the nearest foot. The measurement will be made from center to center of poles. These items include attachment hardware, strain insulators, and other hardware shown in the Plans as part of the assembly. The Department will make no additional allowance for slack length and other instances requiring additional length of wire.

Steel Conduit Riser Assembly

The Department will measure conduit riser assemblies per each for each size conduit riser installed on the outside of a pole, as shown on the Plans. This item includes conduit, weatherhead, condulet, fittings, nuts, washers, banding, clamps, grounding, and other items necessary for installation.

Conduit

The Department will measure conduit in linear feet to the nearest foot for each size and type of conduit installed.

The Department will measure underground conduit along the conduit by one of the following:

1. From the face of curb to the center of a pull box, pole or controller foundation,
2. From center to center of pull boxes,
3. From center to center of a pull box and a pole or controller foundation, or
4. From center to center of pole foundations or pole foundation and controller foundation.

The Department will add:

1. 1 foot to the above measurements for each entry to a pull box or pole foundation and each exit of a pull box or pole foundation.
2. 3 feet to the measurement for each capped extra entry (conduit stub) or exit to a pull box or pole foundation installed, as shown on the Plans.

3. 3 feet to the measurement for each connection between underground conduit and above ground riser.

4. 3 feet to the measurement for each entry or exit to a foundation for a base-mounted controller.

This item includes trenching, backfilling, sealing, capping, fittings, bushings, banding, grounding, and other accessories and hardware required for installation of the conduit system.

Vehicle Loop Detector (Amplifier)

The Department will measure vehicle detector loop amplifier per each unit, including the cable and associated hardware necessary to electrically connect the amplifier to the controller and loop lead in.

The Department will measure two and four channel card rack type amplifiers per each unit, including the cable, card rack(s), and associated hardware necessary to electrically connect the amplifiers to the controller and loop lead-ins.

Shielded Detector Cable

The Department will measure the two-conductor shielded detector cable installed between the controller cabinet and the loop detector wires in linear feet to the nearest foot.

The Department will make horizontal measurements (overhead and underground) by one of the following:

1. From center to center of pull boxes,
2. From center to center of pull box and pole,
3. From center to center of poles, or
4. From center to center of pull box or pole and controller foundation.

The Department will make vertical measurements by one of the following:

1. From ground level to the point of attachment of span wire, inside pole or conduit riser,
2. From the bottom of controller cabinet to the point of attachment of span wire, or
3. From ground level to the bottom of controller.

The Department will make no additional allowance for slack length, length inside equipment or supports (except as noted), splices, and similar instances requiring additional length of cable.

Saw Slot

The Department will measure the length of saw slot for installation of detection loop and lead wiring in linear feet to the nearest foot. Measurement for detection loops in the traffic lanes will be made based on the loop size shown on the Plans (the nominal length plus the nominal width) times 2. The Department will make no additional allowance for saw overruns to obtain full depth of saw slot or diagonal cuts to prevent sharp bends in the loop wire. The Department will measure saw slot for detection loop leads from the conduit entry at the face of curb or edge of pavement and along the route of the lead-in to the detection loop.

This item includes backing rods, or polyethylene foam sealant, loop sealant, and all other incidentals necessary to render a complete and operable system.

Loop Wire

The Department will measure the length of loop wire for installation of detection loops and lead-ins in linear feet to the nearest foot. Measurement will be made from the pull box or pole to the detection loop, around the loop the required number of turns and back to the pull box, pole, or point of splice. The Department will make

no additional allowance for slack length, length inside equipment or supports, splices, and similar instances requiring additional length of wire.

This item includes electrical connections, testing, and all other incidentals necessary to render a complete and operable system.

Controller

The Department will measure controllers as one complete unit, installed, per each. This item includes all auxiliary equipment shown the Plans to provide signalization control as shown on the Plans, and all hardware, including the cabinet (and cabinet foundation, if base-mounted), necessary for installation.

Wood Pole

The Department will measure Wood Poles, of the type and size shown on the Plans, per each, installed.

Guying Device

The Department will measure Guying Devices, of the type shown on the Plans, per each, installed. This item includes the guy wire, anchor, clamps, and all other components shown on the Plans necessary for installation.

Steel Strain Pole

The Department will measure Steel Strain Poles of the type and size shown on the Plans, per each, installed. This item includes the pole, foundation, anchor bolts, grounding, and all other hardware shown on the Plans necessary for a complete installation.

Cantilever Signal Support

The Department will measure Cantilever Signal Supports, of the type and size shown on the Plans, per each, installed. This item includes the vertical pole shaft, mast arm, foundation, anchor bolts, grounding, and all other hardware shown on the Plans necessary for a complete installation.

Service Cable

The Department will measure two conductor power service cables, of the type and size shown on the Plans, in linear feet to the nearest foot, installed. Horizontal runs will be measured center to center of poles. Vertical runs will be measured from the ground to the weatherhead inside a pole or conduit riser, or from the ground to the bottom of the controller, or from the bottom of the controller to the weatherhead. This item includes all necessary attachment hardware. The Department will make no additional allowance for slack length or other instances requiring additional length of cable.

Pedestrian Pushbutton with Sign

The Department will measure Pedestrian Pushbutton with Sign as one complete unit, in place, per each. This item includes the pushbutton, sign, mounting hardware, wiring of pushbutton, testing, and all other incidentals necessary for a complete installation.

Pedestrian Signal Display with Pushbutton and Sign

The Department will measure Pedestrian Signal Display with Pushbutton and Sign as one complete unit, in place, per each. This item includes the signal heads, terminals, lamps, cable connections, pushbutton, sign, all attachment hardware, testing, and other incidentals necessary for a complete installation.

Portable Traffic Signal

The Department will measure Portable Traffic Signal, of the type shown on the Plans or as directed by the Engineer, per each, installed. This item includes the all of the software and hardware necessary for a complete installation.

730.38 Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item	*Pay Unit*
Traffic Signal	Lump Sum
Removal of Signal Equipment	Each
Signal Head Assembly (Description)	Each
Install Pull Box (Description)	Each
Electrical Service Connection	Each
Signal Cable – (Description)	Linear Feet
Span Wire Assembly (___ pounds min. break strength)	Linear Feet
Tether Wire Assembly – __" Diameter	Linear Feet
Messenger Cable – __" Diameter	Linear Feet
Riser Assembly (Description)	Each
Conduit __" Diameter (Type)	Linear Feet
Vehicle Detector (Description)	Each
Shielded Detector Cable	Linear Feet
Saw Slot	Linear Feet
Loop Wire	Linear Feet
Controller (Description)	Each
Wood Pole (Description)	Each
Guying Device (Description)	Each
Steel Strain Pole (Description)	Each
Cantilever Signal Support (Description)	Each
Service Cable	Linear Feet
Pedestrian Pushbutton with Sign	Each
Pedestrian Signal Display with Pushbutton and Sign	Each
Portable Traffic Signal (Type)	Each

The unit price to be paid includes the cost of furnishing and installing, complete in place, each of the various types of equipment required by the Summary of Quantities shown on the Plans. Total payment is full compensation for all materials, labor, equipment, and incidentals necessary to produce a completely operative and finished installation of a traffic signal or traffic signal system as shown on the Plans and as specified herein, including restoration of pavements, sidewalks, and appurtenances damaged or destroyed during construction and tests. All additional materials and labor not specifically shown or called for, which are necessary to complete the traffic signal installation or traffic signal system described, will be considered incidental to the system and no additional allowance will be made.

S T A T E **O F** **T E N N E S S E E**

(Rev. 01-08-2015) January 1, 2021
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(Rev. 10-09-2020)
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SPECIAL PROVISION

REGARDING

RIGHTS-OF-WAY MOWING

Description. This work shall consist of mowing of the rights-of-way for vegetation control in accordance with the Plans, Specifications and as directed by the Engineer. A mowing cycle shall be one complete mowing of the areas along state highways and interstates designated within this contract and shall be completed within twenty (20) working days that are suitable for mowing.

Definitions.

Continuous Mowing Operation. A Continuous Mowing Operation is an operation conducted for a minimum of five (5) hours per day over a twenty (20) working day cycle which consists of one or more mechanical mowers working independently or in coordination to cut vegetation on state rights-of-way deemed Mowable Acres by the Engineer.

Working Day. A calendar day, exclusive of State recognized holidays, which weather or other conditions not under the control of the Contractor, will permit a continuous mowing operation with the normal working force engaged in performing the controlling item or items of work which are normal to progress at the time, as determined by the Engineer.

Mowable Acres. All areas within rights-of-way where mechanical mowers and finish mowers can cut vegetation and safely traverse slopes without significant damage to existing ground.

Mowing. The work associated with cutting or trimming vegetation primarily consisting of, but not limited to, grasses and invasive weeds to provide a consistent and aesthetically pleasing standing vegetation height of four (4) inches.

Swath Mowing. The work associated with cutting one fifteen (15) foot wide swath of vegetation parallel to the edge of pavement on each shoulder and one fifteen (15) foot wide swath of vegetation parallel to the edge of pavement in each direction within the median. For medians less than sixty (60) feet, the entire median will be mowed (see sheet 7 for Typical Mowing Diagram).

Mechanical Mower. A commercial quality piece of equipment which is capable of mowing vegetation in excess of two (2) acres per hour at least five (5) hours per day.

Finish Mower. A commercial quality piece of equipment specifically designed to address mowing of vegetation around roadside obstacles or areas not accessible to conventional mowers in an attempt to prevent damage and provide a consistent vegetation height by means other than a mechanical mower. The cost associated with this work shall be included in the unit price bid for mowing 806-01,swath mowing 806-02.13 or sidewalk finish mowing 806-02.14. Finish mowers do not meet the requirements for mechanical mowers as described in this special provision and cannot be utilized for continuous mowing operations on state highways or interstates.

Hand Trimming. The work associated with cutting or trimming vegetation in proximity to roadside obstacles or in areas not accessible to mechanical mowers in an attempt to prevent damage and provide a consistent vegetation height by means other than a mechanical mower.

Roadside Obstacles. Items located within the right of way, both natural and man-made which may include but are not limited to trees, signposts, delineator posts, light posts, steel beam guardrail, and associated posts, cable barrier rail, barrier walls, retaining walls, utility poles, catch basins, fallen rock, bridge end abutments, mailboxes, established/planted trees and shrubs, landscaped beds, and wildflower areas.

General. All mowing operations shall be performed to the satisfaction of the Engineer. Standing vegetation shall be cut to a height of four (4) inches while maintaining a consistent vegetation profile within all mowing limits adjacent to the roadway. The Contractor shall mow only those areas that are designated as mowable acres, including, if present, a minimum of five (5) feet up the back slope from the bottom of the ditch, and five (5) feet behind all guardrails as shown in The Typical Mowing Diagram on sheet 7. The actual dimensions and mowing limits shall be discussed at the pre-construction conference. Vegetation including small trees, shrubs, and bushes with a stem diameter of up to two (2) inches which are inside of and encroaching upon the established mowing limits shall be cut by the Contractor using a mower or hand trimming methods as directed by the Engineer. Areas that were recently cleared or chipped will be included in mowable acres. Extreme care shall be taken not to damage the trees, plants, and shrubs, which are designated by the Engineer to remain. Hand trimming may be required as directed by the Engineer for areas of vegetation inside the designated mowable acres which are not accessible to mechanical mowers. As work progresses, mowing and trimming shall be conducted in such a manner to provide a consistent standing vegetation height in all mowing limits adjacent to the roadway (see sheet 7 for Typical Mowing Diagram). The Contractor shall mow as close as practicable to all roadside obstacles. Hand trimming is required atop earth berms, within all rip rap areas, and around all roadside obstacles.

Guardrail and cable barrier rail located on interstates will be sprayed by TDOT personnel except for those located in the following counties: Davidson, Hamilton, Knox, and Shelby. Spraying by TDOT does not relieve the Contractor from hand trimming if needed. The Contractor shall not apply herbicides on state rights-of-way.
The Department reserves the right to perform spot mowing with its own forces on all State right-of-way as necessary. Minor quantity adjustments may be made due to the Tennessee Department of Transportation's Wildflower Program, Adopt a Plot Program, designated research areas, environmental no-mow areas, and Adopt A Highway Program.

Time and Frequency Mowing. A notice to begin work will be issued to the Contractor at least five (5) working days prior to the date the mowing cycle is to begin. Work shall begin on the date specified in the notice. Mowing operations shall proceed in the same route sequence as performed during litter operations. The contractor shall submit a planned mowing sequence, hand trimming sequence and schedule to the Engineer for approval before each mowing cycle begins. Any deviations from the approved mowing sequence or schedule may be allowed at the discretion of the Engineer. A failure to begin mowing operations on the date specified in the notice will result in the assessment of liquidated damages (see SP108B). The mowing cycle shall be twenty (20) working days suitable for mowing unless otherwise documented in the Special Notes.

The number of mowing cycles will be indicated in the Special Notes, but may be increased or decreased by one mowing cycle to coincide with extreme weather conditions. Also, the Engineer may require a partial mowing cycle at certain locations.

Mowing shall be performed during daylight hours Monday through Friday. Work may be allowed on Saturday at the discretion of the Engineer. If the approved mowing schedule is not maintained, the Engineer may require work to be performed on Saturday and/or Sunday. If work is performed on Saturday and/or Sunday, the Contractor will be charged a Working Day.

Mowing Operations. Work shall begin for each mowing cycle on the date specified in the notice to begin work. Once a mowing cycle begins, the Contractor shall maintain a Continuous Mowing Operation until the mowing is complete. A mowing cycle will be considered complete when all mowing and hand trimming is completed to the satisfaction of the Engineer. Hand trimming shall be performed in the same sequence as mowing operations.

Hand trimming is to be completed within the twenty (20) working day cycle. Failure to complete hand trimming within five (5) working days of the termination of mechanical mowing represents a failure to maintain a continuous mowing operation.

When mowing within twelve (12) feet of the edge of pavement or shoulder, mechanical mowers shall not discharge vegetation and debris toward the roadway. When mowing is required in proximity to the roadway, any vegetation or debris deposited on the roadway as a result of the mowing operation will be removed immediately from edge of pavement to edge of pavement, or between curb and gutter, whichever applies, Any cost associated with the removal of vegetation clippings, foreign objects, or gravel that is deposited on the roadway, the shoulder, or in a curb and gutter section as a result of the mowing operation shall be included in the unit price bid for mowing (item no. 806-01) swath mowing (item no. 806-02.13) or sidewalk finish mowing (item no. 806-02.14).

Swath mowing shall follow as closely as practical to the boundary between the shoulder of the roadway and the point at which vegetation begins. In cases where a continuous swath cannot be maintained on ramps, at bridges, and when encountering assets of the state, the swath shall deviate away from the edge of pavement then terminate, or the swath shall deviate away from, then back to the edge of pavement in as tight a space as practical. Any vegetation that cannot be cut by the mower between the edge of pavement and the edge of the swath shall be cut using hand trimming, and the cost shall be included in the unit price bid for swath mowing (item no. 806-02.13). All interchanges and ramps will be mowed completely during a Swath mowing operation.

The Contractor shall mow in the direction of traffic when less than thirty (30) feet from the paved surface.

Equipment. Prior to beginning work, the Contractor shall provide the Engineer with a schedule of equipment which will be used to accomplish work under the terms of the contract. The Contractor shall certify to the Engineer that the equipment to be used on this project is suitable for mowing along public highways. All equipment used for mowing operations shall be utilized as described by the manufacturer's recommendations and maintained in safe operating conditions. Mowing on slopes that exceed the equipment manufacturers specifications shall not be allowed. Any equipment that the Engineer determines to be unsuitable for use or hazardous to highway users shall not be used. The Contractor shall provide sufficient equipment and accessory items necessary for efficient operation and the completion of the mowing cycle in the designated time. Any special equipment requirements will be noted in the Special Notes. Zero-turn mowers are considered finish mowers and can be utilized for mowing around roadside obstacles but do not meet the requirements for continuous mowing operations under the terms of this special provision. The cost associated with this work shall be included in the unit price bid for mowing (item no. 806-01, swath mowing (item no. 806-02.13), or sidewalk finish mowing (item no. 806-02.14)

All rotary mowers must be equipped with safety chains to prevent damage to property caused by flying debris propelled out from under the mower. No disc type mowers will be allowed. Chains shall be a minimum of 5/16 inch in size, and links spaced side by side around the mower's front, sides, and rear. Chains shall be spaced at no less than twelve (12) strands of chain per foot and shall be laced horizontally one row from the bottom with 1/4" steel cable secured by cable clamps on each end. When sitting on level ground, at a level deck height of seven (7) inches, the chains shall be long enough to drag the ground. Flaps or semi-rigid guards will not be allowed as a substitute for chains. Maximum cutting widths for rigid frame rotary mowers shall be l20 inches (10 ft.). Maximum cutting widths for all other mower types shall not exceed 180 inches (15 ft.) without the approval of the Engineer.

Safety Requirements. Mechanical mowers and finish mowers shall be equipped so as to conform to prevailing Occupational Safety Health Act (OSHA) Standards, including flashing amber lights and slow-moving equipment emblems.

The Contractor shall comply with OSHA standards, including the use of Class 3 reflective shirts or vests at all times.

Notification to the Engineer shall be made immediately of any personal injury, accidents involving contractor's equipment, or accidents involving the motoring public.

While equipment is not in use, it shall be parked or stored off the pavement or shoulder of the highway in an inconspicuous place more than thirty (30) feet from edge of pavement or as directed by the Engineer. Under no circumstances shall mechanical mowers or finish mowers be parked or stored in medians. When batwing mowers are being moved from one site to another under their own power with the mowers raised, the mower shall be disengaged.

Handheld, pushed, or riding trimmers using string or blades are not considered mechanical mowers and cannot be considered as part of a continuous mowing operation under the terms of this special provision.

The Contractor shall be required to have a mechanical leaf blower on site to address any vegetation or debris deposited on state routes. The cost associated with this work shall be included in the unit price bid for mowing 806-01 or swath mowing 806-02.13.

The Contractor shall be required to have the company name and phone number on all tractors and work zone support vehicles on the left and right sides in a location that is visible to the public. The lettering for the company name and phone number shall consist of a reflectorized material with a minimum height of three inches (3") or five inches (5") in height if non- reflectorized.

Equipment Cleaning. The Contractor will be required to clean any piece of equipment moved into Tennessee if the equipment is moving from an area infested with invasive species of concern listed below:

- Cogon Grass

Prior to moving equipment into Tennessee, the Contractor shall notify the Engineer of the location of the equipment's most recent operation. The Contractor shall not move a n y equipment that last operated in an area infested with an invasive species of concern into Tennessee without having cleaned such equipment of seeds, soil, vegetative matter, and other debris that could contain or hold seeds. If the Contractor cannot verify the location of its most recent operation, then the Contractor shall assume that the location is infested with invasive species of concern.

Prior to moving from an area identified as infested with invasive species of concern to, or through Tennessee, the Contractor shall clean such equipment of seeds, soil, vegetative matter, and other debris that could contain or hold seeds, and shall notify TDOT prior to moving any equipment subject to the cleaning requirements set forth above. The Contractor shall advise TDOT of its cleaning measures and make the equipment available for inspection. TDOT shall have two (2) days, excluding weekends and state holidays, to inspect and approve for use equipment after it has been made available. After satisfactory inspection, the Contractor may move the equipment as planned. Equipment shall be considered clean when a visual inspection does not disclose seeds, soil, vegetative matter, and other debris that could contain or hold seeds. The Contractor shall not be required to disassemble equipment.

Traffic Control. The Contractor shall maintain traffic and all traffic control devices for mobile mowing operations according to the requirements contained herein, the State of Tennessee's currently adopted edition of the Manual on Uniform Traffic Control Devices (MUTCD) defined under the Rules of Tennessee Department of Transportation Chapter 1680-3-1, and the Standard Specifications. Although Traffic Control may be included in the cost of other items, the Contractor will be responsible for submitting certifications per Materials & Tests Division Standard Operating Procedures. Under no circumstances shall a mower cross the pavement edge line without complying with Mobile Operations requirements found in the MUTCD.

Warning Signs. The Contractor shall furnish portable signs in accordance with the "Manual on Uniform Traffic Control Devices" to notify the traveling public of the operations of mowing equipment. The Contractor shall place these signs on the highway during the operation of mowers and remove them immediately after the operation ceases. Signs at the beginning point shall be 48" by 48" in size; diamond-shaped with black letters on an orange background with a black border with eight- inch high letters. These signs shall be dual mounted, one on each shoulder, for both directions of travel.

Damage to Property. The Contractor shall carry on the operation in such a manner that does not damage the existing ground areas, trees, shrubs, guardrail, utilities, delineators, or other structures. The Contractor shall not mow during wet conditions where turf damage or ruts would occur. In the event damage occurs to the right-of-way because of mowing operations, the Contractor shall replace or repair same, at own expense, in like kind, and as directed by the Engineer. Notify the Engineer immediately when any property damage occurs. If damaged property resulting from the Contractor's operations has to be repaired or replaced by the Department, the cost of such work shall be deducted from monies due to the Contractor.

The Contractor shall take all necessary precautions to prevent damage to passing vehicles and to both public and private property. This shall include roadside obstacles, vehicles and any other property which may be damaged by the mowing operation. Payment for work may be withheld until the damaged property has been repaired or replaced.

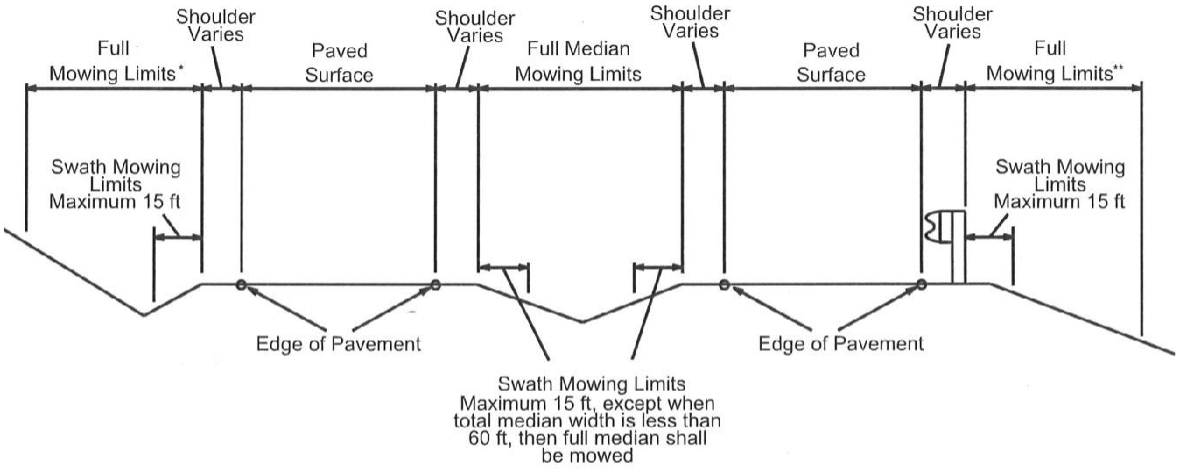
The Contractor shall respond to all claims of damage from the public within seventy-two (72) hours after notification of damage. Failure to settle claims for damages in a timely manner may result in actions by the Department to preclude the Contractor from performing work on future projects.

Additional Work. The Contractor may be required to mow in areas not specifically detailed in the Special Notes under the direction of the Engineer. Additional work shall be limited to the counties and systems which are designated in the Special Notes. Payment for additional work will be made at the contract unit price for mowing (item no. 806-01), swath mowing (806-02.13), or sidewalk finish mowing (item no. 806-02.14).

Method of Measurement. Mowing shall be measured by the acre based on the quantities shown in the Special Notes for each mowable area. Each mowing cycle or partial cycle will be measured separately. A mowing cycle includes the mowing of all tabulated areas shown in the Special Notes one time.

Basis of Payment. The accepted quantities of mowing will be paid for at the contract unit price per acre. All costs for traffic control as defined above shall be included in the unit bid price for mowing Item No. 806-01, swath mowing Item No. 806-02.13, or sidewalk finish mowing (item no. 806-02.14).

TYPICAL MOWING DIAGRAM
(NOT TO SCALE)



NOTES:

* Cut a minimum of 5 ft up the back slope from the bottom of the ditch, or as directed by the engineer.

** Cut a minimum of 5 ft behind all guardrail, or as directed by the engineer.

S T A T E **OF** **T E N N E S S E E**

(Rev.12-20-19) January 1, 2021
(Rev.4-11-22)

SPECIAL PROVISION

REGARDING

DYNAMIC PILE TESTING

General

A. Scope of Work

This work consists of assisting the Consultant Testing Engineer (CTE) with the dynamic testing of driven piles as specified.

The Department will select a qualified CTE that will be utilized to perform the testing.

B. Performance and Design Requirements

Performance and design conditions for dynamic testing of driven piles shall be in accordance with subsection High-Strain Dynamic Pile Testing Specification.

C. Approved Manufacturers

The following hardware and software components are recognized to provide the level of quality required. Substitutes may be accepted at the discretion of the Department Engineer.

Component	Product	Manufacturer
Pile Driving Modeling - Wave Equation Software	GRLWEAP	Pile Dynamics, Inc.
Pile Driving Monitoring - Hardware & Software	Pile Driving Analyzer - Model PAX or PDA 8	Pile Dynamics, Inc.
Pile Driving Analysis – Signal Matching Software	CAPWAP	Pile Dynamics, Inc.

D. Test Requirements

Dynamic pile testing shall be conducted in accordance with the standard test method indicated below.

Standard Test Method	Designation	Conducted By
High-Strain Dynamic Testing of Piles	ASTM D 4945	CTE

E. Qualifications Of Department's CTE

The CTE that performs the pile driving dynamic monitoring shall have a minimum of 3 years dynamic pile testing and analysis experience and shall have achieve a basic or better rank on the Dynamic Measurement and Analysis Proficiency Test offered by the Pile Driving Contractors Association. The CTE who performs the driving modeling and signal matching shall have a minimum of 5 years dynamic pile testing and analysis experience or who has and shall have achieved an advanced or better rank on the Dynamic Measurement and Analysis Proficiency Test offered by the Pile Driving Contractors Association.

Execution

A. Pile Driving Modeling

Submit to the Engineer the hammer specifications that will be used in driving the piles. The CTE shall perform preconstruction wave equation analyses and prepare a summary report of the results. The wave equation analyses shall be used to assess the ability of all proposed pile driving systems to install piles to the required nominal axial resistance and the desired penetration depth within allowable driving stresses. The report shall include a drivability graph relating pile capacity, blow count and driving stresses to depth. The report shall include a bearing graph relating the nominal axial resistance to the pile driving resistance. The bearing graph shall indicate blow count versus capacity and stroke. The report shall also contain a constant capacity analysis or inspector's chart to assist the engineer in determining the required driving resistance at other field observed strokes. The CTE shall perform wave equation analyses in accordance with subsection High-Strain Dynamic Pile Testing Specification. Acceptability of the wave equation report and the adequacy of analyses will be determined by the Engineer.

1. Approval by the Engineer of the proposed pile driving system will be based upon the wave equation analyses indicating that the proposed system can develop the required nominal axial resistance at a pile driving rate of 2 to 10 blows per inch at the end of driving, and within allowable driving stresses per *the current addition of the AASHTO LRFD Bridge Design Specifications*, subsection 10.7.8 using a resistance factor of 1.0. The CTE shall provide preliminary pile driving criteria based on wave equation analyses and any anticipated capacity changes after driving, set-up or relaxation, subject to revision based upon dynamic pile testing field measurements

2. If any changes or modifications are made to the approved pile driving system, additional wave equation analyses in accordance with subsection A shall be required.

B. High-Strain Dynamic Pile Testing

1. Assist the Department's selected CTE with dynamic pile testing at the locations and frequency required in accordance with subsection High-Strain Dynamic Pile Testing.

2. Dynamic pile testing involves monitoring the response of a pile subjected to heavy impact applied by the pile hammer at the pile head. The testing shall provide information on the driving stresses, nominal axial resistance, structural integrity, and hammer efficiency.

3. All field testing and measurements shall be made in the presence of the Engineer.

C. Field Testing

1. Equipment. Dynamic pile testing field measurements shall be carried out using approved equipment, software and recording equipment. The data collected at the end of initial driving and the beginning of re-strike shall be analyzed using approved signal matching techniques and software.

2. Monitoring during driving. During pile driving, piles shall be instrumented and monitored with testing equipment satisfying the requirements of the subsection C. Approved Manufacturers.

a. At the direction of the Engineer, assist with installing two sets of strain transducers and accelerometers near the top of each pile to be tested, and shall use a compatible measuring and recording system to record the blow count data during driving.

b. The equipment required to be attached to the pile shall be appropriately positioned and fixed to the approval of the Engineer.

c. The hammer and all site equipment used shall be capable of delivering an impact force sufficient to mobilize the specified nominal axial resistance indicated in subsection High-Strain Dynamic Pile Testing Specification without damaging the pile.

d. The testing equipment shall monitor pile stresses during driving to prevent pile damage and ensure pile integrity and capacity. If the testing equipment indicates overstressing or damage to the pile, immediately discontinue driving.

e. If the testing equipment determines that pile stresses during driving exceed acceptable levels, a new pile driving system, modifications to existing system or new pile installation procedures shall be proposed by the Contractor. Approval by the Engineer of any proposed changes to the pile driving system or pile installation procedures will be based upon the results of additional wave equation analyses in accordance with subsection A.2, Pile Driving Modeling.

3. **Preparation of the Pile Head**. The preparation of the pile head for the application of dynamic test load shall involve, where appropriate, trimming the head, cleaning, and building up the pile using materials that shall, at the time of testing, safely withstand the impact stresses. The impact surface shall be flat and at perpendicular to the pile axis.

4. **Dynamic Measurement and Analysis.** Monitoring of pile driving shall begin when pile driving begins, unless otherwise approved by the Engineer. The data shall be recorded and processed immediately in the field by the pile driving monitoring equipment and software. Unless monitoring indicates that additional driving will damage the pile, pile driving, and monitoring shall continue until both the specified pile tip elevation and the required nominal axial resistance are reached. For each pile tested, pile driving analysis using signal matching techniques shall be performed for a selected blow at the end of driving to determine the relative resistance from end bearing and skin friction along the pile.

   a. Re-strike tests shall be performed at the frequency indicated in subsection High-Strain Dynamic Pile Testing Specification. The time interval between end of initial driving and beginning of re-strike shall be in accordance with subsection High-Strain Dynamic Pile Testing Specification. During re-strike, the pile shall be instrumented and monitored similar to during initial driving. For each re-strike test, pile driving analysis using signal matching techniques shall be performed for a selected blow from the beginning of re-strike to determine the relative resistance from end bearing and skin friction along the pile.

   b. The re-strike test shall be performed with a warmed-up hammer and shall consist of striking the pile for 20 blows or until the pile penetrates an additional 3 inches whichever occurs first unless testing equipment indicates overstressing or damage to the pile. If such overstressing or damage to the pile is indicated, immediately discontinue driving. In the event initial re-strike testing indicates a nominal axial resistance below the required nominal axial resistance additional driving may be required as directed by the Engineer.

   c. The Engineer may request use of pile driving monitoring equipment and software on additional piles if inconclusive results are obtained or unusual driving conditions are encountered.

   d. Pile nominal axial resistance and integrity shall be evaluated based on the standard procedure used in practice.

5. Results

Reports. The CTE shall prepare a report for each pile tested. Each report shall contain tabular and detailed graphical results for the dynamic test versus depth, blow analyzed using signal matching techniques and software, and indicate the pile driving criteria for the additional piles to be installed at the substructure unit of the pile tested. Each report shall include the information required by ASTM D4945 Section 7 and the following:

1) The maximum force applied to the pile head.
2) The maximum pile head velocity.
3) The maximum energy imparted to the pile.
4) The assumed soil damping factor and wave speed.
5) Nominal axial resistance estimate.
6) The maximum compressive and tensile forces in the pile.
7) Pile integrity.
8) Blows per inch.
9) Stroke.
10) Blow selected for signal matching analysis.
11) Temporary compression.
12) Force/velocity versus time trace.
13) Force/velocity match curve.
14) Resistance distribution along the pile.

Schedule of Contract Submittals

Item Number	Submittal Item	Type	Calendar Days	Event/Date	Liquidated Damages Apply
1	Details of the components, method of testing, pile driving equipment and materials to be used.	DOCS	15 Before	Start of Pile Driving Monitoring	No
2	Report as defined in subsection C.5.a	DOCS	3 After	Completion of Each Field Test	No

High-Strain Dynamic Pile Testing Specification

Item	Requirement
Wave Equation Analysis	Minimum of 1 and sufficient additional analyses as needed to define performance for all combinations of piles, driving systems and subsurface conditions anticipated.
Dynamic Testing Pile Capacity	Nominal Axial Pile Compressive Resistance
End of Initial Driving Test Frequency	Minimum of 1 production pile for substructure or as required by the Engineer.
Re-strike Test Frequency	The greater number of piles: 1 production pile for substructure, or 2% of production piles at each substructure, or Quantity required by the Engineer.
Time Interval between End of Initial Driving and Re-strike	Minimum of 3 days or as required by the Engineer.
Pile Driving Analysis using Signal Matching Techniques	For each End of Initial Driving Test and each Re-strike Test

Method of Measurement

The Department will measure Dynamic Pile Testing (PDA) and Dynamic Pile Re-strike Testing, performed, and accepted per each.

Basis of Payment

The Department will pay for accepted quantities, complete in place, at the contract prices as follows:

Item	Description	Pay Unit
930-01.01	PDA TESTING	EACH
930-01.02	PDA RE-STRIKE	EACH

Such payment is full compensation for all described work, including all material, equipment, tools, labor, and any other incidentals necessary to complete the work

STATE OF TENNESSEE

Rev. 4-15-18 January 1, 2021

SPECIAL PROVISION

REGARDING

GEOFOAM BACKFILL

1.0 General.

1.1 **Description.** This work shall consist of site preparation and installation of Expanded PolyStyrene (EPS) blocks, Gasoline Resistant Geomembrane (GRG), Cushion Geotextile (CG), and permeable material, for the lightweight fill (EPS blocks backfill in accordance with these specifications, the Standard Specifications, the contract plans, the approved shop drawings or as directed by the Engineer.

1.2 **References.**

A. NCHRP Report 529: Guideline and Recommended Standard for Geofoam Applications in Highway Embankments
B. ASTM C 203: Breaking Load and Flexural Properties of Block-Type Thermal Insulation
C. ASTM C 272: Water Absorption of Core Materials for Structural Sandwich Construction
D. ASTM C 578: Rigid Cellular Polystyrene EPS Thermal Insulation
E. ASTM D 732: Strength of Plastics by Punch Tool
F. ASTM D 751: Standard Test Methods for Coated Fabrics
G. ASTM D 814: Standard Test Method for Rubber Property
H. ASTM D 1621: Compressive Properties of Rigid Cellular Plastics
I. ASTM D 1622: Apparent Density of Rigid Cellular Plastics
J. ASTM D 1623: Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
K. ASTM D 2136: Standard Test Method for Coated Fabrics–Low-Temperature Bend Test
L. ASTM D 6817: Standard Specification for Rigid Cellular Polystyrene Geofoam
M. ASTM D 7180: Standard Guide for Use of Expanded Polystyrene (EPS) Geofoam in Geotechnical Projects

2.0 Manufacturing Quality Control.

2.1 Manufacturing quality control (MQC) of the EPS block geofoam product is the primary responsibility of the molder or primary molder. The purpose of this section is

to define the parameters for use by a molder or primary molder in developing an MQC plan. These parameters will also be those measured as part of the manufacturing quality assurance (MQA) to be conducted by the Engineer.

2.2 EPS blocks must be entirely made of Expanded Polystyrene consisting of 100% virgin raw material. Blocks shall have a height of at least 24 inches, a width of at least 48 inches, and length of at least 96 inches. All blocks shall be shop-trimmed as necessary so that all surfaces are smooth and flat, and are within tolerances of 0.5% from respective height, width, and length dimensions. Geometry of the fill being constructed may require additional field and/or shop-trimming and cutting.

2.3 All EPS-block geofoam shall be adequately seasoned prior to shipment to the project site. For the purposes of this standard, seasoning is defined as storage in an area suitable for the intended purpose as subsequently defined herein for a minimum of 72 hours at normal ambient room temperature after an EPS block is released from the mold. Seasoning shall be done within a building or other structure that protects the EPS blocks from moisture as well as ultraviolet (UV) radiation. The area in which EPS blocks are stored for seasoning shall also be such that adequate space is allowed between blocks and such that positive air circulation and venting of the structure are provided so as to foster the out-gassing of blowing agent and trapped condensate from within the blocks. The Engineer shall be allowed to inspect the structure(s) to be used for seasoning upon request and during normal business days and hours. The molder or primary molder may request a shortened seasoning period if the EPS blocks are seasoned within an appropriate heated storage space and the molder or primary molder demonstrates to the satisfaction of the Engineer that the alternative seasoning treatment produces blocks that equal or exceed the quality of blocks subjected to the normal 72-hour seasoning period.

2.4 Geofoam shall contain a flame-retardant additive and shall have Underwriters Laboratories, Inc. (UL) Certification of Classification as to External Fire Exposure and Surface Burning Characteristics. Geofoam should be considered combustible and/or subject to damage from extreme heat; and should not be exposed to open flame or any source of ignition. Geofoam shall be treated to prevent insect attack and shall be protected from vector intrusion.

2.5 Table 1 indicates the ASTM D6817 material type designations used for the different densities/unit weights of EPS blocks that are covered by this standard. Only these material type designations shall be used in any correspondence or other communication related to this project. For a given material type, the dry unit weight of each EPS block (as measured for the overall block as a whole) after the period of seasoning shall equal or exceed that shown in Table 1. The dry unit weight shall be determined by measuring the weight of the entire block by weighing the block on a scale and dividing the mass by the volume of the block. The volume shall be determined by obtaining dimensional measurements of the block in accordance with ASTM test method C 303.

Table 1 ASTM D6817 material type designations for EPS-block geofoam

	Minimum Properties					
Type	Density (pcf)	Compressive Resistance @ 1% (psi)	Compressive Resistance @ 5% (psi)	Compressive Resistance @ 10% (psi)	Flexural Strength (psi)	Oxygen Index (volume %)
EPS12	0.70	2.2	5.1	5.8	10.0	24.0
EPS15	0.90	3.6	8.0	10.2	25.0	24.0
EPS19	1.15	5.8	13.1	16.0	30.0	24.0
EPS22	1.35	7.3	16.7	19.6	40.0	24.0
EPS29	1.80	10.9	24.7	29.0	50.0	24.0
EPS39	2.40	15.0	35.0	40.0	60.0	24.0
EPS46	2.85	18.6	43.5	50.0	75.0	24.0

2.6 Table 1 gives the minimum allowable values of various material parameters corresponding to each ASTM D6817 material type. It is imperative to note that there is no guarantee, expressed, implied or suggested, that the minimum required block density for a given type of EPS will result in EPS that will meet the required minimum values of material properties as stated in Table 1. For the purposes of this special provision, the minimum material property values specified in Table 1 are to be assumed to be independent of each other. A molder, primary molder, or supplier must make their own independent assessment of block density required to meet or exceed all material property values specific in Table 1 for a given type of EPS. These material parameters are to be obtained by testing specimens prepared from samples taken from actual blocks produced for the project. The actual blocks should be covered by this standard for either MQC by the molder or MQA by the Engineer. All test specimens shall be seasoned as specified in ASTM C 578. Dry unit weight, compressive resistance, and flexural strength shall be measured as specified in ASTM C 578. The specimens used for compressive testing shall be cubic in shape with a 2-in. face width. A strain rate of 10 percent per minute shall be used for the compressive strength tests. The compressive resistances at 1%, 5%, and 10% shall be determined in the same test.

2.7 Each EPS block shall meet dimensional tolerances, as determined in three distinct areas:

2.7.1 The thickness, width, and length dimensions of an EPS block are defined herein as the minimum, intermediate, and maximum overall dimensions of the block, respectively, as measured along a block face. These dimensions

of each block shall not deviate from the theoretical dimensions by more than 0.5 percent.

2.7.2 The corner or edge formed by any two faces of an EPS block shall form an angle of 90 degrees. The deviation of any face of the block from a theoretical perpendicular plane shall not exceed 1/8 inch over a distance of 20 inches.

2.7.3 Any one face of a block shall not deviate from planarity by more than 1/4 inch when measured using a straightedge within a length of 10 ft.

3.0 Manufacturing Quality Assurance.

3.1 Manufacturing quality assurance (MQA) of the EPS-block geofoam product will be conducted to verify the molder's MQC procedures. The Engineer will have primary responsibility for all MQA. The Engineer will communicate directly only with the Contractor in matters and questions of MQA unless all parties agree otherwise.

3.2 MQA of the EPS-block geofoam will consist of two phases. Phase I MQA consists of pre-certification of the molder and shall be conducted prior to shipment of any EPS blocks to the project site. Phase II MQA shall be conducted as the EPS blocks are delivered to the project site. Table 2 provides a summary of the MQA procedures.

3.3 No EPS blocks shall be shipped to the project site until such time as all parts of Phase I MQA have been completed in the order listed and as specified in this section.

3.3.1 The Contractor shall first indicate in writing to the Engineer whether the molder has a third-party certification program in force. When there are multiple molders, each molder must have a program in order for third-party certification to be indicated, and the primary molder must take responsibility for coordinating the third-party certification of all molders.

3.3.2 If third-party certification is offered, this notification shall be accompanied by documentation that identifies the business entity providing the third-party certification and describes in detail the steps to be taken by this agency to verify the molder's compliance with the specific requirements of this specification. Acceptance of the molder's third-party certification by the Engineer will waive the need for preconstruction product submittal and testing. When there are multiple molders, third-party certification must be acceptable for each and every molder; otherwise, it will be denied for each and every molder.

3.3.3 If the molder does not have third-party certification or the certification is deemed unacceptable by the Engineer, the Contractor shall deliver a minimum of three full-size EPS blocks for each ASTM D6817 EPS-block

geofoam type to be used on the project to a location specified by the Engineer. When there are multiple molders, there shall be three blocks from each molder. These blocks shall in all respects be the same as blocks to be supplied to the project, including required seasoning. The Engineer will weigh, measure, sample, and test a random number of blocks to evaluate the ability of the molder(s) to produce EPS-block geofoam of quality as specified herein. The sampling and testing protocol will be the same as for Phase II MQA.

3.3.4 The Contractor shall submit shop drawings indicating the proposed location and layout of all EPS blocks to be placed during the project. When there are multiple molders, the areas to be covered by each molder shall be clearly identified. These drawings shall be reviewed by the Engineer.

3.3.5 As part of the Phase I Manufacturing Quality Assurance (MQA) Supplier Pre-certification requirements, the Contractor shall submit its proposed shipping procedure for the EPS block to the Engineer for review. The procedure shall include protective measures during shipping to avoid any damage to the blocks including crushing to the edges, sides and corners. Timber cribbing with straps, tarps attached to the truck or other effective means may be proposed to secure the blocks to the transporting vehicle. Alternatively, closed container trucks may be used to transport the blocks to the Project site.

3.3.6 Prior to delivery of any EPS-block geofoam to the project site, a meeting shall be held between, at a minimum, the Engineer and Contractor. The supplier and/or molder/primary molder of the EPS-block geofoam may also attend at the Contractor’s discretion to answer any questions. The purpose of this meeting shall be to review the Phase I MQA results and discuss the Phase II MQA as well as other aspects of construction to ensure that all parties are familiar with the requirements of this standard. At the satisfactory conclusion of this meeting, the Contractor shall be allowed to begin onsite receipt, storage, and placement of the EPS block geofoam.

Table 2 MQA Procedures

Phase	Sub-phase	Start of Phase	Description	Requirements	Possible Actions
I	None	Prior to shipment to the project site	Pre-certification of the molder	Approved third-party certification: Molder will • Identify the organization providing this service. • Provide detailed information as to the procedure and tests used by this organization to verify the molder's compliance with the specific requirements of this specification. • Provide written certification that all EPS blocks supplied to the project will meet the requirements specified in the project specifications. • Contractor shall provide shipping plan. No approved third-party certification: • Contractor shall deliver a minimum of three full-size EPS blocks for each ASTM D6817 EPS block geofoam type to be used on the project to a location specified by the Engineer. • The Engineer will weigh, measure, sample, and test a random number of blocks. Sampling and testing protocol will be the same as for Phase IIc MQA. • Molder should submit a letter stating that all EPS blocks supplied for the project are warranted to meet specification requirements and identifying what MQC measures the molder employs. • Contractor shall provide shipping plan.	• Acceptance of the molder's third-party certification by the Engineer will waive the need for pre-construction product submittal and testing. • No EPS blocks shall be shipped to the project until such time as all parts of Phase I MQA have been completed.

Phase	Sub-phase	Start of Phase	Description	Requirements	Possible Actions
II	IIa	As the EPS blocks are delivered to the project site	On-site visual inspection of each block delivered to the project site to check for damage as well as visually verify the labeled information on each block	For each truckload, the Engineer shall inventory each and every block.	Any blocks with physical damage or not meeting specifications will be: • Rejected on the spot and placed in an area separate from those blocks that are accepted, or • Marked "unacceptable" and returned to the supplier.
II	IIb	As the EPS blocks are delivered to the project site	On-site verification that the minimum block dry density, as well as the physical tolerances, meet specifications	Approved third-party certification: • For each truckload, initially, only one block per load should be tested to ensure that the minimum block dry density, as well as the physical tolerances, meets specifications. No approved third-party certification: • For each truckload, each block for the first load and at least one block per load for subsequent truckloads should be tested to ensure that the minimum block dry density, as well as the physical tolerances, meets specifications.	• If the selected block meets specifications with respect to its size and shape, and the mass agrees with the mass marked on the block, no further checking of the load for these parameters is required and the shipment is approved conditionally until the Phase IIc test results verify that the block meets specifications. • If the selected block does not meet specifications, then other blocks in the truckload should be checked and none used until the additional checking has determined which blocks are unsatisfactory. • At the completion of this sub-phase, the Contractor should be conditionally (until the Phase IIc test results verify that the blocks meet specifications) allowed to proceed with installing blocks.

Phase	Sub-phase	Start of Phase	Description	Requirements	Possible Actions
II	IIc	As the EPS blocks are delivered to the project site	Confirming the EPS engineering design parameters related to stiffness as well as the quality control strength parameters	Approved third-party certification: • Use the discretion of the Engineer. For example, parameter confirmation can be omitted entirely on a small project, can be performed only at the beginning of a project, or can be done on an ongoing basis. No approved third-party certification: • Parameter confirmation should be performed on all projects throughout the entire duration of the project. • For each ASTM D6817 EPS-block geofoam type, at least one block will be selected for: o Sampling from the first truckload. o Additional blocks may be selected at a rate of sampling not exceeding one sample for every 325 CY. o Sampling is to be performed per the locations indicated in Figure 1. o Laboratory tests should be performed to check for compliance with the parameters shown in Table 1 to include the compressive resistances at 1%, 5%, 10%strength and flexural strength.	• Portions of sampled blocks that are not damaged or otherwise compromised by the sampling can be used as desired by the Contractor. • If unsatisfactory test results are obtained, the Contractor may be directed to remove potentially defective EPS blocks and replace them with blocks of acceptable quality at no additional expense to TDOT.

Phase	Sub-phase	Start of Phase	Description	Requirements	Possible Actions
II	IId	As the EPS blocks are placed	As-built drawing(s)	The Engineer, with the cooperation of the Contractor, will prepare as-built drawing(s) as well as perform additional record keeping to document the location of all EPS blocks placed for the project.	

4.0 Manufacturing Quality Assurance: Phase II.

4.1 Phase II MQA will be performed by the Engineer as the EPS blocks are delivered to the project site. Phase II MQA will consist of four sub-phases (IIa through IId). The Contractor shall cooperate with and assist the Engineer in implementing Phase II MQA.

4.2 Phase IIa MQA will consist of on-site visual inspection of each block delivered to the project site to check for damage and to visually verify the labeled information on each block. Any blocks with damage or not meeting specifications will be (a) rejected on the spot and placed in an area separate from those blocks that are accepted or (b) marked "unacceptable" and returned to the supplier.

4.3 Phase IIb MQA will consist of on-site verification that the minimum block dry unit weight, as well as the physical tolerances, meets specifications. At least one truckload will be checked, and additional blocks will be checked if initial measurements indicate lack of compliance. A truckload of EPS blocks is defined as either a full-length box-trailer or a flat-bed trailer of typical dimensions, i.e., approximately 40 ft or more in length, fully loaded with EPS blocks. The volume of EPS in such a truckload would typically be on the order of 65 to 130 CY. The Contractor shall supply a scale on site with sufficient capacity and precision for weighing of EPS blocks. This scale shall be calibrated prior to use on the project, and certification of such calibration shall be made available to the Engineer. The scale shall be recalibrated per manufacturers recommendations throughout its use on the project.

4.4 Phase IIc MQA will consist of sampling the EPS blocks and laboratory testing specimens prepared from these samples. Sampling will be at the locations shown in Figure 1. The laboratory tests will check for compliance with the parameters shown in Table 1. The Contractor shall cooperate with and assist the Engineer with obtaining the necessary samples. Testing will be by or under the direction of the Engineer. For each density/unit weight of EPS used on a project, at least one block will be selected for sampling from the first truckload of EPS blocks of that density delivered to the job site. Additional blocks may be selected for sampling during the course of the project at the discretion of the Engineer on a lot basis not to exceed one sample for

every lot (325 CY) of EPS delivered. Portions of sampled blocks that are otherwise acceptable can be used as desired by the Contractor. The Engineer will make every reasonable effort to conduct the laboratory testing expeditiously. However, if unsatisfactory test results are obtained, the Contractor may be directed to remove potentially defective EPS blocks and replace them with blocks of acceptable quality at no additional expense to TDOT.

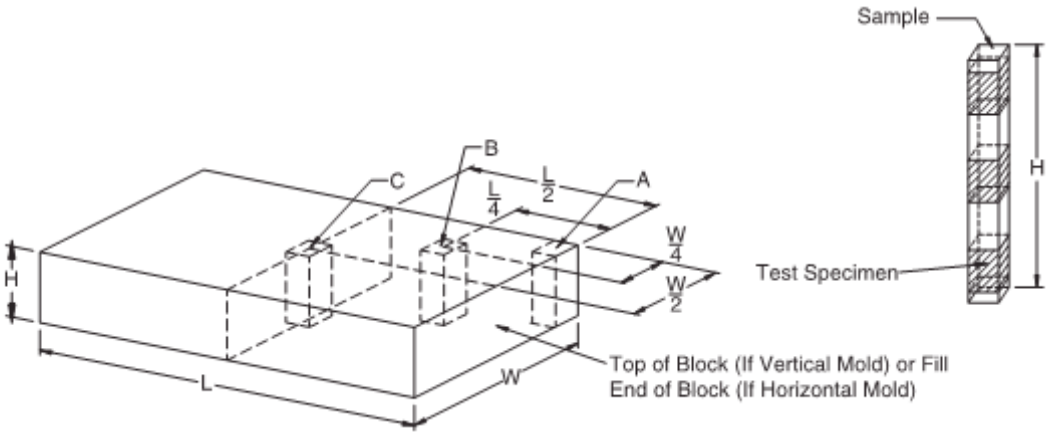


Figure 1 Recommended block sampling and test specimens.

4.5 Phase IId MQA will consist of preparation of an as-built drawing or drawings, as well as additional record keeping to document the location of all EPS blocks placed for the project. The Contractor shall cooperate with and assist the Engineer with this phase.

5.0 Product Storage and Shipment.

5.1 Each EPS block shall be labeled to indicate the name of the molder (if there is more than one supplying a given project), the date the block was molded, the weight of the entire block in pounds as measured after a satisfactory period of seasoning, the dimensions of the block in inches, and the actual dry unit weight in pounds per cubic foot. Additional markings using alphanumeric characters, colors, and/or symbols shall be applied as necessary by the supplier to indicate the location of placement of each block relative to the shop drawing, as well as the density of the block if multiple block densities are to be supplied for a given project.

5.2 At all stages of manufacturing, shipment, and construction, the EPS blocks shall be handled in a manner so as to minimize physical damage to the blocks. No method of lifting or transporting the blocks that creates dents or holes in the block surfaces or losses of portions of the block shall be allowed.

5.3 If the EPS blocks are to be stockpiled at the project site until placement, a secure storage area shall be designated for this purpose. The storage area shall be away from

any heat source or construction activity that produces heat or flame. In addition, personal tobacco smoking shall not be allowed in the storage area. EPS blocks in temporary on-site storage shall be secured with sandbags and similar "soft" weights to prevent their being dislodged by wind or water. The blocks shall not be covered in any manner that might allow the buildup of heat beneath the cover. The blocks shall not be trafficked by any vehicle or equipment. In addition, foot traffic by persons shall be kept to a minimum. The blocks shall not be stored in an area where they will be subjected to extensive periods of sunlight. Discoloration and dusting of EPS blocks caused by extended exposure to sunlight is grounds for rejection.

5.4 EPS is not an inherently dangerous or toxic material, so there are no particular safety issues to be observed other than normal construction safety and protection against heat and flame. However, extra caution is required during wet or cold weather. Surfaces of the EPS blocks tend to be more slippery when wet than when dry. In addition, when air temperatures approach or go below freezing, a thin layer of ice can readily develop on the exposed surfaces of EPS blo-cks if the dew point is sufficiently high. Thus, the surfaces of the EPS blocks can pose particular slip hazards in this condition.

6.0 Construction Quality Requirements.

6.1 The Contractor shall be directly responsible for all construction quality control (CQC). Items covered by CQC include all earthwork and related activities other than manufacturing and shipment of the EPS-block geofoam.

6.2 The Engineer will be responsible for providing construction quality assurance (CQA) of the Contractor's construction activities.

6.3 **Site Preparation.**

6.3.1 At the discretion of the engineer, the natural soil sub-grade shall be cleared of vegetation and any large or sharp-edged soil particles and be reasonably planar prior to placing a geotextile and/or bedding layer. If no bedding layer is used, the natural sub-grade shall be cleared such that there is no vegetation, or particles of soil or rock larger than coarse gravel, exposed at the surface.

6.3.2 Regardless of the sub-grade material (i.e., natural soils or bedding layer), the sub-grade surface on which the EPS blocks will be placed shall be sufficiently planar (i.e., smooth) prior to the placement of the first block layer. The required smoothness is defined as a vertical deviation of no more than 3/8 inch over any distance of 10 ft.

6.3.3 There shall be no debris of any kind on the sub-grade surface when EPS blocks are placed.

6.3.4 Unless directed otherwise by the Engineer, there shall be no standing water or accumulated snow or ice on the sub-grade within the area where EPS blocks are placed at the time of block placement.

6.3.5 EPS blocks shall not be placed on a frozen sub-grade except in the case of construction over continuous or discontinuous permafrost terrain and as directed by the Engineer.

6.3.6 Dewater site as required.

6.4 **Placement of EPS Block Geofoam.**

6.4.1 EPS blocks shall be placed at the locations shown on either the contract drawings or approved shop drawings submitted by the Contractor. Particular care is required if EPS blocks of different density/unit weight are to be used on the project.

6.4.2 EPS blocks shall be placed so that all vertical and horizontal joints between blocks are tight.

6.4.3 The surfaces of the EPS blocks shall not be directly traversed by any vehicle or construction equipment during or after placement of the blocks.

6.4.4 Blocks shall not be placed above blocks in which ice has developed on the surface.

6.4.5 With the exception of sand bags or similar “soft” weights used to temporarily restrain EPS blocks against wind, no construction material other than that shown on the shop drawings shall be placed or stockpiled on the EPS blocks.

6.4.6 At no time shall heat or open flame be used near the EPS blocks so as to cause melting or combustion of the EPS.

6.4.7 The final surface of the EPS blocks shall be covered as shown on the shop drawings. Care shall be exercised during placement of the cover material so as not to cause any damage to the EPS blocks.

6.4.8 **Shop Drawings.**

6.4.8.1 Contractor shall submit shop drawings to scale indicating the grade of the proposed EPS material, location and layout of all EPS blocks, inter-block connectors, and all accessory items to be used.

The submitted drawings shall include, but are not limited to, plans, elevations, cross-sections showing profiles and cross-slopes, location of connectors between EPS blocks, connections and accessory items as necessary. The block layout shall be designed so that the following general design details are taken into account:

6.4.8.1.1 The plane on which a given layer of blocks is placed must be parallel to the longitudinal axis of the road alignment.

6.4.8.1.2 There must be a minimum of two layers of blocks at all locations.

6.4.8.1.3 Within a given layer of blocks, the longitudinal axes of all blocks must be parallel to each other.

6.4.8.1.4 Within a given layer of blocks, the vertical joints between the adjacent ends of blocks within a given row of blocks must be offset to the greatest extent practicable relative to blocks in adjacent rows.

6.4.8.1.5 The longitudinal axes of the uppermost layer of blocks must be perpendicular to the longitudinal axis of the road alignment.

6.4.8.2 The Contractor shall include on the submitted shop drawings a step-by-step description of the installation and construction procedure proposed for the EPS block fill. Installation and construction sequence, of the EPS blocks, pavement system proposed features within backfill zone, and utilities shall all be included. The installation and construction sequence description shall be supplemented by drawings as necessary. EPS block sizes and laying pattern shall be described. Methods of temporarily ballasting and stabilizing EPS blocks to prevent movement during construction, before construction of the roadway pavement, as applicable, shall also be identified.

6.4.8.3 Shop drawings, working drawings, installation and construction procedures and design calculations shall be prepared by the EPS Wall Engineer. Design calculations shall include confirmation of the EPS designation shown on the plans as well as both internal and external stability of the EPS mass. All calculations and detail shop drawings shall be signed and sealed. The EPS Wall Engineer

shall be a Professional Engineer registered in the State of Tennessee and shall seal all submittals.

6.4.8.4 All details different than those depicted on the shop drawings, required in support of the construction procedures, shall be engineered by the Contractor. All Contractor engineered items shall be stamped by a Professional Engineer registered in the State of Tennessee. All such details shall be reviewed and approved by the Engineer prior to construction.

7.0 Products. (If specified within plans)

7.1 Connectors.

7.1.1 Connectors shall consist of galvanized steel multi-barbed connectors. Each connector shall have a lateral holding strength of at least 60 lbs when tested with ASTM C578 Type I Geofoam, with a minimum safety factor of 2.0.

7.1.2 Install a minimum of 3 connectors for each 4.0-ft by 8.0ft section of Geofoam material or as shown on the shop drawings. Press firmly into the rigid foam until the connector is flush with the surface. Position the next foam block as specified and seat firmly before placing subsequent blocks.

7.2 Geomembrane.

7.2.1 Geomembrane (gasoline-resistant) shall consist of a separate, puncture-free geomembrane. The geomembrane shall be flexible and, by its own weight, shall cover and conform closely to 90 degree edges and corners of Geofoam blocks at ambient temperatures above 45 degrees Fahrenheit, without additional heating of the geomembrane.

7.2.2 The geomembrane shall be reinforced or unreinforced geomembrane. It shall be manufactured from a tripolymer consisting of polyvinyl chloride, ethylene interpolymer alloy, and polyurethane or a comparable polymer combination. It shall meet the following physical and chemical requirements (specified as minimum or maximum, not average roll properties):

Physical Property	ASTM Designation	Acceptance Value
Unleaded Gasoline Permeability	D 814	0.4 oz/SF Maximum per 24 hours
Thickness	D 751	30 mils Minimum
Grab Tensile Strength (1” grip, 4”x8” sample)	D751	550 lb Minimum in each direction
Elongation at break	D751	20% Minimum
Toughness (Grab x elongation)	N/A	14,000 Minimum
Bursting / Puncture Resistance (ball tip)	D 751	750 lb Minimum

Physical Property	ASTM Designation	Acceptance Value
Cold Crack Resistance (1" wide, 4 hours)	D 2136	Pass at -30° F
Factory Produced Seams, Bonded Width	D 751	1.25 Minimum
Factory Produced Seams, Shear Strength	D 751 Procedure A	550 lb. Minimum
Field Produced Seams, Vapor Tight Seal	D 5641	Pass

7.2.3 The Contractor shall furnish a Certificate of Compliance stating that the selected geomembrane has been tested, meets the above-mentioned requirements, and is: Free from pinholes, tears, and other defects that would cause leakage of liquids through the geomembrane; Acceptable for spill containment of hydrocarbons, including automobile gasoline, aviation gas, diesel fuel, kerosene, hydraulic fluid, methanol, ethanol, mineral spirits, naphtha, chlorinated hydrocarbons, organic solvents, ketones, ethers, esters, concentrated acids, vegetable oils, paraffin, animal fats and oils.

7.2.4 Geomembrane (gasoline resistant) shall be placed directly on the surface of the lightweight (EPS block) fill, which shall be clean and free of sharp objects. Field seams shall be bonded with an electrically-heated hot-wedge device as recommended by the manufacturer. Hot air extrusion welding devices or solvent bonding chemicals shall not be used. The temperature of the bonded geomembrane shall not exceed 165°F immediately before contacting the EPS blocks. Before installation of geomembrane, the Contractor shall demonstrate to the Engineer that the equipment, techniques, and personnel proposed for the bonding of field seams can produce vapor-tight seams under similar weather and work conditions near the job site. The Contractor shall provide a typical "test panel" as a basis for testing acceptance. Field seams shall be inspected by the Engineer. Construction equipment shall not be operated directly on the geomembrane. Any material damaged by the Contractor's equipment or operations shall be replaced or repaired to the satisfaction of the Engineer.

7.3 **Cushion Geotextile.**

7.3.1 Cushion Geotextile (CG) must be a nonwoven needle-punched fabric of polypropylene, polyester, or a combination of polymer materials including polyethylene. CG must not contain any needle broken-off during manufacturing. CG must not contain biodegradable filler materials.

7.3.2 Cushion Geotextile shall conform to the following properties:

Physical Property	ASTM Designation	Acceptance Value*
Weight	D 5261	10 oz/SY
Grab Tensile Strength (1" grip both directions)	D 4632	230 lb
Elongation at break	D 4632	50%
Trapezoidal Tear Strength	D 4533	95 lb
Puncture (pin) Strength	D 4833	120 lb
UV Resistance	D 4355	70% Minimum
Biodegradable Filler Materials	E 204	0%
* All are minimum average roll value, except UV Resistance		

7.3.3 Cushion Geotextile shall be placed directly on the surface of the geomembrane (gasoline resistant), which shall be clean and free of sharp objects. Joints shall overlap a minimum of 12". Construction equipment shall not be operated directly on the geotextile cushion. The geotextile shall be handled and placed in conformance with the manufacturer's recommendations and shall be aligned and placed in a wrinkle-free manner. Within 72 hours after the filter fabric has been placed, the fabric shall be covered with the planned thickness of overlying material as shown on the shop drawings. Completely encase the Gasoline Resistant Geomembrane with the Cushion Geotextile.

7.4 **Select Granular Material.** Select Granular Material used for leveling a course beneath Geofoam blocks and/or backfill shall be reasonably free (maximum of 0.1%) from organic and otherwise deleterious materials, and it shall be approved by the engineer prior to use. The material shall conform to the following gradation limits and be tested at the established frequencies in the TDOT "Procedures for the Sampling and Testing, and Acceptance of Materials and Products (SOP 1-1)".

7.4.1 The Contractor shall also provide test data from an approved laboratory certifying that the material meets the following:

7.4.1.1 Gradation as determined byAASHTO T 27.

Sieve Size	Percent Passing
4 inches	**100**
3/8 inch	**0-75**
No. 4	**0-25**
No. 8	**0-10**
No. 16	**0-5**

7.4.1.2 Note: Size Nos. 1 through 78 as listed in order of Table 1 Standard Sizes of Processed Aggregate in Section 903.22 of Standard Specifications meet the above gradation requirements.

7.4.1.3 In addition, the backfill must conform to all of the following requirements:

7.4.1.4 Soundness - The material shall be substantially free from shale or other soft, poor durability particles. The material shall have a sodium sulfate loss of less than 12 percent after five (5) cycles determined in accordance with AASHTO T 104.

7.4.1.5 The material shall exhibit an angle of internal friction of not less than 34 degrees as determined by the standard direct shear test AASHTO T 236 on the portion finer than the No. 4 sieve, using a sample of the material compacted to 95 percent of AASHTO T 99. No testing is required for backfills where 80 percent of sizes are greater than 3/8 inch.

7.4.1.6 Electrochemical requirements - The backfill shall meet the following criteria:

Requirements	Test Method
ph = 5-10	AASHTO T 289 – 91
Resistivity> 3000 ohm centimeters	AASHTO T 288 – 91
Chlorides < 100 parts per million	AASHTO T 291 – 91
Sulfates < 200 parts per million	AASHTO T 290 – 91
Organic Content < 1 %;	AASHTO T 267- 86

7.4.1.6.1 If the resistivity is greater or equal to 5000 ohm centimeters the chloride and sulfates requirements may be waived.

7.5 **Sand.** Sand using for leveling a course beneath Geofoam blocks shall consist of friable, natural river or bank aggregate, free of debris, soluble or organic matter, or other detrimental matter; and shall meet the following gradation:

Sieve Size	Percent Passing
3/4 inch	100
No. 4	90—100
No. 50	0—70
No. 200	0—10

8.0 Execution.

8.1 **Protection.**

8.1.1 Prevent damage to the Geofoam during delivery, storage, and construction. Prior to delivery of Geofoam fill to the Project site, review and be thoroughly knowledgeable with the manufacturer's care and handling recommendations. Any Geofoam fill to be exposed to sunlight for more than 90 days shall be covered with opaque material to prevent ultraviolet light degradation.

8.1.2 Placement of backfill will require special procedures and careful selection of appropriate construction equipment to prevent damage to the Geofoam fill. No heavy construction equipment or other vehicles will be allowed directly on the Geofoam. If it is necessary for construction equipment to pass over completed Geofoam areas prior to the placement of the load distribution slab, place an adequately thick layer of compacted fill over the Geofoam to bridge the equipment loads and prevent damage to the Geofoam. Geofoam shall be protected from petroleum-based solvents such as gasoline and diesel fuel, generators shall not be placed on Geofoam unless placed on a tray lined with GRG (gasoline resistant geomembrane).

8.1.3 Damaged Geofoam shall be replaced, or corrected by the Contractor as follows:

1. Slight damage (0.12 CF with no linear dimension > 1 foot) may be left in place as-is.
2. Moderate damage (0.35 CF with no linear dimension > 3.3 ft) shall be filled with sand.

8.1.4 Geofoam blocks with excessive damage (i.e., exceeding the "moderate" category) shall be replaced with Geofoam blocks that meet the damage criteria. Geofoam blocks not meeting the damage criteria may be cut to eliminate the excessive damage and the remaining undamaged portion of the block may be used within the fill, provided the undamaged portion of the block meets all other requirements.

8.1.5 Do not drive construction equipment or other vehicles directly on the geomembrane. Geomembrane damaged as a result of vehicles, equipment, or other operations shall be replaced or repaired with new materials to the satisfaction of the Engineer.

8.2 **Subgrade Preparation.** Place a leveling course of sand material over the prepared surface with a minimum thickness of 8 inches, unless other subgrade preparation is specified within the plans. Compact the sand using at least 3 passes of a vibratory plate compactor, or equivalent. Level and compact the sand to ±3/8 inch over 10 feet horizontal to provide uniform contact for the Geofoam blocks.

8.3 **Placement.**

8.3.1 Place Geofoam backfill to the lines and grades shown in the plans. Construct the surface of a layer of Geofoam block to receive additional Geofoam blocks with a variation in surface tolerance of no more than 0.05 foot (0.60 in) in any 10-foot interval. All blocks shall accurately fit relative to adjacent blocks. No gaps greater than 0.07 foot (0.84 in) will be allowed on vertical joints. Construct the finished surface of the Geofoam fill beneath pavement sections to within the tolerance of zero to minus 0.2 foot (2.4 in) of the indicated grade.

8.3.2 Blocks placed in a row in a particular layer shall be offset to the maximum extent practical relative to blocks placed in adjacent rows of the same layer as shown on the plans. In order to avoid continuous joints, each subsequent layer of blocks shall be rotated on the horizontal plane 90 degrees from the direction of placement of the previous layer placed. Cut the blocks with a saw or hot wire.

8.3.3 Provide temporary weighing and/or guying as necessary until all the blocks are built into a homogeneous mass, and the pavement section as well as any soil cover are in place.

8.3.4 Place geomembrane as shown on approved shop drawings.

8.3.5 Place concrete pavement, load distribution slab or moment slab over the final Geofoam blocks as shown on approved shop drawings.

8.3.6 During placement of concrete pavement, load distribution slab or moment slab over the top surface of the Geofoam, it is permissible to use precast concrete block rebar supports to support the reinforcing steel during concrete placement, in accordance with the Standard Specifications. Do not use chairs.

S T A T E **O F** **T E N N E S S E E**

January 1, 2021

SPECIAL PROVISION

REGARDING

EQUAL EMPLOYMENT OPPORTUNITY

Reference:
Federal-Aid Highway Program Manual
Transmittal 147, June 26, 1975
Replaces FHWA Order Interim 7-2(1)

Specific Equal Employment Opportunity Responsibilities

GENERAL

a) Equal employment opportunity requirements not to discriminate and to take affirmative action to assure equal employment opportunity as required by Executive Order 11246 and Executive Order 11375 are set forth in Required Contract Provisions (Form FHWA-1273 or PR-1316, as appropriate) and these Special Provisions which are imposed pursuant to Section 140 of Title 23, U.S.C., as established by Section 22 of the Federal-Aid Highway Act of 1968. The requirements set forth in these Special Provisions shall constitute the specific affirmative action requirements for project activities under this contract and supplement the equal employment opportunity requirements set forth in the Required Contract Provisions.

b) The contractor will work with the Tennessee Department of Transportation and the Federal Government in carrying out equal employment opportunity obligations and in their review of his/her activities under the contract.

c) The contractor and all his/her subcontractors holding subcontracts not including material suppliers, exceeding $10,000, will comply with the following minimum specific requirement activities of equal employment opportunity: (The equal employment opportunity requirements of Executive Order 11246, as set forth in Volume 6, Chapter 4, Section 1, Subsection 1 of the Federal-Aid Highway Program Manual, are applicable to material suppliers as well as contractors and subcontractors). The contractor will include these requirements in every subcontract exceeding $10,000 with such modification of language as is necessary to make them binding on the subcontractor.

Equal Employment Opportunity Policy

The contractor will accept as his operating policy the following statement which is designed to further the provision of equal employment opportunity to all persons without regard to their age, race, color, religion, sex, national origin or disability and to promote the full realization of equal employment opportunity through a positive continuing program:

> It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment opportunity officer (hereinafter referred to as the EEO Officer) who will have the responsibility for and must be capable of effectively administering and promoting an active contractor program of equal employment opportunity and who must be assigned adequate authority and responsibility to do so.

Equal Employment Opportunity Officer

The contractor will designate and make known to the Tennessee Department of Transportation contracting officers an equal employment opportunity officer (hereinafter referred to as the EEO Officer) who will have the responsibility for and must be capable of effectively administering and promoting an active contractor program of equal employment opportunity and who must be assigned adequate authority and responsibility to do so.

Dissemination of Policy

(a) All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's equal employment opportunity policy and contractual responsibilities to provide equal employment opportunity in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

(1) Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's equal employment opportunity policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer or other knowledgeable company official.

(2) All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer or other knowledgeable company official covering all major aspects of the contractor's equal employment opportunity obligations within thirty days following their reporting for duty with the contractor.

(3) All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer or appropriate company official in the contractor's procedures for locating and hiring minority group employees.

(b) In order to make the contractor's equal employment opportunity policy known to all employees, prospective employees and potential sources of employees, i.e., schools, employment agencies, labor unions (where appropriate), college placement officers, etc., the contractor will take the following actions:

(1) Notices and posters setting forth the contractor's equal employment opportunity policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

(2) The contractor's equal employment opportunity policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

Recruitment

(a) When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be published in newspapers or other publications having a large circulation among minority groups in the area from which the project work force would normally be derived.

(b) The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minority group applicants, including, but not limited to, State employment agencies, schools, colleges and minority group organizations. To meet this requirement, the contractor will, through his EEO Officer, identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority group applicants may be referred to the contractor for employment consideration.

(c) In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, he is expected to observe the provisions of that agreement to the extent that the system permits the contractor's compliance with equal employment opportunity contract provisions. (The U.S. Department of Labor has held that where implementation of such agreements have the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Executive Order 11246, as amended).

(d) The contractor will encourage his present employees to refer minority group applicants for employment by posting appropriate notices or bulletins in areas accessible to all such employees. In addition, information and procedures with regard to referring minority group applicants will be discussed with employees.

Personnel Actions

Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to age, race, color, religion, sex, national origin or disability. The following procedures shall be followed:

(a) The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

(b) The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

(c) The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

(d) The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with his obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of his avenues of appeal.

Training and Promotion

(a) The contractor will assist in locating, qualifying, and increasing the skills of minority group and women employees, and applicants for employment.

(b) Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. In the event the Special Provision Regarding Training Program Requirements is provided under this contract, this subparagraph will be superseded as indicated therein.

(c) The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

(d) The contractor will periodically review the training and promotion potential of minority group and women employees and will encourage eligible employees to apply for such training and promotion.

Unions

If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use his/her best efforts to obtain the cooperation of such unions to increase opportunities for minority groups and women within the unions, and to effect referrals by such unions of minority and female employees. Actions by the contractor either directly or through a contractor's association acting as agent will include the procedures set forth below:

(a) The contractor will use best efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minority group members and women for membership in the unions and increasing the skills of minority group employees and women so that they may qualify for higher paying employment.

(b) The contractor will use best efforts to incorporate an equal employment opportunity clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their age, race, color, religion, sex, national origin or disability .

(c) The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the Tennessee Department of Transportation and shall set forth what efforts have been made to obtain such information.

(d) In the event the union is unable to provide the contractor with a reasonable flow of minority and women referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to age, race, color, religion, sex, national origin or disability, making full efforts to obtain qualified and/or qualifiable minority group persons and women. (The U.S. Department of Labor has held that it shall be no excuse that the union with which the contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority employees). In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the Tennessee Department of Transportation.

Subcontracting

(a) The contractor will use his best efforts to solicit bids from and to utilize minority group subcontractors or subcontractors with meaningful minority group and female representation among their employees. Contractors shall obtain lists of minority-owned construction firms from the Tennessee Department of Transportation.

(b) The contractor will use his best efforts to ensure subcontractor compliance with their equal employment opportunity obligations.

Records and Reports

(a) The contractor will keep such records as are necessary to determine compliance with the contractor's equal employment opportunity obligations. The records kept by the contractor will be designed to indicate:

(1) The number of minority and non-minority group members and women employed in each work classification on the project.

(2) The progress and efforts being made in cooperation with unions to increase employment opportunities for minorities and women. (Applicable only to contractors who rely in whole or in part on unions as a source for their work force).

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minority and female employees.

(4) The progress and efforts being made in securing the services of minority group subcontractors or subcontractors with meaningful minority and female representation among their employees.

(b) All such records must be retained for a period of 3 years following completion of the contract work and shall be available at reasonable times and places for inspection by authorized representatives of the of the Tennessee Department of Transportation and the Federal Highway Administration.

(c) Each contractor and subcontractor shall submit to the Tennessee Department of Transportation an annual report for every July during which work is performed indicating the number of minority, women and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form PR 1391 and is to be received by the Department not later than the 20th of the month following the reporting period.

(d) The contractor and/or sub-contractor will be required to complete other reports as instructed by the Engineer.

(e) Current estimates may be withheld by the Project Engineer when reports are not received within the above specified time limits.

S T A T E **O F** **T E N N E S S E E**

January 1, 2021

SPECIAL PROVISION

REGARDING

STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY

CONSTRUCTION CONTRACT SPECIFICATIONS (EXECUTIVE ORDER 11246)

1) As used in these specifications:

   a. "Covered area" means the geographical area described in the solicitation from which this contract resulted;

   b. "Director" means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;

   c. "Employer identification number" means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941

   d. "Minority" includes:

      I. Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);

      II. Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish or Portuguese Culture or origin, regardless of race);

      III. Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and

      IV. American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining indentifiable tribal affiliations through membership and participation or community identification).

2) Whenever the Contractor, or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of $10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation arid which is set forth in the solicitations from which this contract resulted.

3) If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals (including goals and time tables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

4) The Contractor shall implement the specific affirmative action standards provided in paragraphs 7a though p of these specifications. The goal set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. The Contractor is expected to make substantially uniform progress toward its goals in each craft during the period specified.

5) Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specification, Executive Order 11246, or the regulations promulgated pursuant thereto.

6) In order for the nonworking training hours of apprentices and the trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

7) The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

   (a) Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the

Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

(b) Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available and maintain a record of the organization's responses.

(c) Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefor, along with whatever additional actions the Contractor may have taken.

(d) Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

(e) Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The contractor shall provide notice of these programs to the sources complied under 7b above.

(f) Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

(g) Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions including specific review of these items with on-site supervisory personnel such as Superintendents, General Foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

(h) Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.

(i) Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screenings procedures, and tests to be used in the selection process.

(j) Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's workforce.

(k) Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

(l) Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriation training, etc., such opportunities.

(m) Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.

(n) Ensure that all facilities and company activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.

(o) Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

(p) Conduct a review, at least annually, of all supervisor's adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

8) Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (7a through p). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under 7a through p of these Specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

9) A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women, generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

10) The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of age, race, color, religion, sex, national origin or disability.

11) The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

12) The Contractor shall carry out such sanctions and penalties for violations of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.

13) The Contractor, in fulfilling its obligations under these specifications, shall implement' specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

14) The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15) Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

S T A T E **O F** **T E N N E S S E E**

(Rev. 10-19-12) January 1, 2021

SPECIAL PROVISION

REGARDING

NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION

TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY (EXECUTIVE ORDER 11246)

1. The Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.

2. The goals for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work are as follows:

County	Goals for Female Participation in each Trade
All Counties	6.9

County	Goals for Minority Participation for each Trade
Lincoln	11.2
Hamilton, Marion, Sequatchie	12.5
Bledsoe, Bradley, Grundy, McMinn, Meigs, Monroe, Polk, Rhea	8.6
Carter, Hawkins, Sullivan, Unicoi, Washington	2.6
Greene, Hancock, Johnson	3.2
Anderson, Blount, Knox, Union	6.6
Campbell, Claiborne, Cocke, Cumberland, Fentress, Grainger, Hamblen, Jefferson, Loudon, Morgan, Roane, Scott, Sevier	4.5

County	Goals for Minority Participation for each Trade
Montgomery	18.2
Davidson, Cheatham, Dickson, Robertson, Sumner, Williamson, Wilson, Rutherford	15.8
Bedford, Cannon, Clay, Coffee, Dekalb, Franklin, Giles, Hickman, Houston, Humphreys, Jackson, Lawrence, Lewis, Macon, Marshall, Maury, Moore, Overton, Perry, Pickett, Putnam, Smith, Stewart, Trousdale, Van Buren, Warren, Wayne, White	12.0
Shelby, Tipton	32.3
Benton, Carroll, Chester, Crockett, Decatur, Dyer, Fayette, Gibson, Hardeman, Hardin, Haywood, Henderson, Henry, Lake, Lauderdale, McNairy, Madison, Obion, Weakley	26.5

These goals are applicable to all the Contractor's construction work whether or not it is Federal or federally assisted.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in CFR Part 60-4.3(a), and its efforts to meet the goals established for the geographical area where the contract resulting from this solicitation is to be performed. The hours of minority and female employment and training must be substantially uniform through- out the length of the contract, and in each trade, and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from Project to Project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The Contractor shall provide written notification to the Office of Federal Contract Compliance Programs at the following address within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation:

U.S. Department of Labor – Regional Office
Office of Federal Contract Compliance Program
61 Forsyth Street, Room 7B75
Atlanta, GA 30303

The notification shall list the name, address and telephone number of the subcontractor; employer identification number; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the contract is to be performed.

S T A T E **O F** **T E N N E S S E E**

(Rev. 5-11-09) January 1, 2021

SPECIAL PROVISION

REGARDING

TRAINING PROGRAM REQUIREMENTS

Reference:

Federal-Aid Highway Program
Transmittal 147, June 26, 1975
Replaces FHWA Order Interim 7-2(2)

This Training Special Provision supersedes subparagraph 7b of the Special Provision Regarding Equal Employment Opportunity, and is in implementation of 23 U.S.C. 140(a).

As part of the contractor's equal employment opportunity affirmative action program, training shall be provided as follows:

The contractor shall provide on-the-job training aimed at developing full journeymen in the type of trade or job classification involved.

The number of training hours under this Special Provision will be indicated in the Proposal.
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In the event that a contractor subcontracts a portion of the contract work, he shall determine how many, if any, of the trainees are to be trained by the subcontractor, however, the contractor shall retain the primary responsibility for meeting the training requirements imposed by this special provision. The contractor shall also insure that this training special provision is made applicable to such subcontract. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training.

The number of trainees shall be distributed among the work classifications on the basis of the contractor's needs and the availability of journeymen in the various classifications within a reasonable area of recruitment. Prior to pre-construction conference, the contractor shall submit to the Tennessee Department of Transportation OJT Program Coordinator for approval the number of trainees to be trained in each selected classification and training program to be used. Furthermore, the contractor shall specify the starting time for training in each of the classifications. The contractor will be credited for each trainee employed by him on the contract work who is currently enrolled or becomes enrolled in an approved program and will be reimbursed for such trainees as provided hereinafter.

Training and upgrading of minorities and women toward journeyman status is a primary objective of this Training Special Provision. Accordingly, the contractor shall make every effort to enroll minority trainees and women (e.g., by conducting systematic and direct recruitment

through public and private sources likely to yield minority and women trainees) to the extent that such persons are available within a reasonable area of recruitment. The contractor will be responsible for demonstrating the steps that he has taken in pursuance thereof, prior to a determination as to whether the contractor is in compliance with this Training Special Provision.

This training commitment is not intended, and shall not be used, to discriminate against any applicant for training, whether a member of a minority group or not.

No employee shall be employed as a trainee in any classification in which he has successfully completed a training course leading to journeyman status or in which he has been employed as a journeyman. The contractor should satisfy this requirement by including appropriate questions in the employee application or by other suitable means. Regardless of the method used the contractor's records should document the findings in each case.

The minimum length and type of training for each classification will be as established in the training program selected by the contractor and approved by the Tennessee Department of Transportation and the Federal Highway Administration. The Tennessee Department of Transportation and the Federal Highway Administration shall approve a program if it is reasonably calculated to meet the equal employment opportunity obligations of the contractor and to qualify the average trainee for journeyman status in the classification concerned by the end of the training period. Furthermore, apprenticeship programs registered with the U.S. Department of Labor, Employment and Training Administration, or with a State apprenticeship agency recognized by the Department of Labor and training programs approved but not necessarily sponsored by the U.S. Department of Labor, Office of Apprenticeship, Employment and Training Administration, shall also be considered acceptable provided it is being administered in a manner consistent with the equal employment obligations of Federal-Aid highway construction contracts. Approval or acceptance of a training program shall be obtained from the State prior to commencing work on the classification covered by the program. It is the intention of these provisions that training is to be provided in the construction in lower level management positions such as office engineers, estimators, timekeepers, etc., where the training is oriented toward construction applications. Training in the laborer classification may be permitted provided that significant and meaningful training is provided and approved by the Federal Highway Administration division office. Some offsite training is permissible as long as the training is an integral part of an approved training program and does not comprise a significant part of the overall training.

Except as otherwise noted below, the contractor will be reimbursed 80 cents per hour of training given an employee on this contract in accordance with an approved training program. As approved by Change Order and the AAPO, reimbursement will be made for training persons in excess of the number specified herein.

This reimbursement will be made even though the contractor receives additional training program funds from other sources, provided such other source does not specifically prohibit the contractor from receiving other reimbursement. Reimbursement for offsite training indicated above may only be made to the contractor where he does one or more of the following and the trainees are concurrently employed on a Federal-aid project; contributes to the cost of the training, provides the instruction to the trainee, or pays the trainee's wages during the offsite training period.

No payment shall be made to the contractor if either the failure to provide the required training, or the failure to hire the trainee as a journeyman, is caused by the contractor and evidences a lack of good faith on the part of the contractor in meeting the requirements of this Training Special Provision. It is normally expected that a trainee will begin his training on the project as soon as feasible after start of work utilizing the skill involved and remain on the project as long as training opportunities exist in his work classification or until he has completed his training program. It is not required that all trainees be on board for the entire length of the contract. Failure of the contractor to employ a trainee in the classification he has requested by the time 15 percent of that type work has been performed will be just cause for withholding progress estimates unless the contractor has furnished the AAPO a satisfactory explanation in writing of his failure to do so. A contractor will have fulfilled his responsibilities under this Training Special Provision if he has provided acceptable training to the number of trainees specified. The number trained shall be determined on the basis of the total number enrolled on the contract for a significant period.

Trainees will be paid at least 60 percent of the appropriate minimum journeyman's rate specified in the contract for the first half of the training period, 75 percent for the third quarter of the training period, and 90 percent for the last quarter of the training period, unless apprentices or trainees in an approved existing program are enrolled as trainees on this project. In that case, the appropriate rates approved by the Department of Labor or Transportation in connection with the existing program shall apply to all trainees being trained for the same classification who are covered by this Training Special Provision. However, in no case will the trainee be paid less than the minimum wage shown in the contract for the classification of laborer.

The contractor shall furnish the trainee a copy of the program he will follow in providing the training. The contractor shall provide each trainee with a certification showing the type and length of training satisfactorily completed.

The contractor will provide for the maintenance of records and furnish periodic reports documenting his performance under this Training Special Provision.

Payment is to be made under item 109-10.01, Trainee, at the unit price of $0.80 per hour, for each hour of approved training provided. In any case the number of training hours for which payment is made will not exceed number of hours specified for the approved classification by the approved Training program.

The contractor shall not be permitted to commence construction without an approved training program**.** Failure of the contractor to provide an approved training program shall not be considered "As a condition not under the control of the contractor" in regards to Contract Time.

S T A T E **O F** **T E N N E S S E E**

(Rev. 06-01-03) January 1, 2021
(Rev. 06-23-08)
(Rev. 11-10-08)
(Rev. 02-12-18)
(Rev. 08-20-18)

SPECIAL PROVISION

REGARDING

DISADVANTAGED BUSINESS ENTERPRISE PARTICIPATION

The disadvantaged business enterprise (DBE) requirements of 49 CFR Part 26 apply to this contract. Accordingly, Disadvantaged Business Enterprises (DBEs) as defined in 49 CFR Part 26 shall have the maximum appropriate opportunity to participate in the performance of this contract or in the performance of subcontracts to this contract. In this latter regard, the Contractor shall take all necessary and reasonable steps in accordance with 49 CFR Part 26 to ensure that DBEs have the opportunity to compete for and perform subcontracts. The Contractor shall not discriminate on the basis of age, race, color, religion, national origin, sex, or disability in the award of subcontracts.

The Contractor shall submit to the Civil Rights Division Small Business Development Program (CRD-SBDP) copies of any subcontract agreements with DBEs upon execution. The Contractor shall identify all DBE subcontractors at the Preconstruction Conference and indicate the approximate date for each DBE subcontractor's appearance on the project. Before terminating and/or substituting a DBE subcontractor, the Contractor must give notice in writing to the DBE subcontractor, with a copy to TDOT's CRD-SBDP, of its intent to terminate and/or substitute including the reason for the request.

The Contractor shall provide notification to the Project Supervisor at least 24 hours prior to each DBE beginning work. The project supervisor or Inspector must complete a "Commercially Useful Function Checklist" to document the first date of work, work items, equipment, and forces of each DBE. The Contractor shall take full responsibility for the performance of a commercially useful function (CUF) by all DBE subcontractors, manufacturers, and materials suppliers who work on or provide materials for the project.

The Contractor shall enter monthly prompt payment certification to the Department through external access to AASHTOWare Project Civil Rights & Labor (CRL) The Contractor is responsible for ensuring all subcontractors, any tier, and material suppliers or haulers are registered for access with the Department. The Prompt Payment Certification shall be submitted monthly beginning no later than sixty (60) days after payment of the first estimate. Payments must abide by the conditions set in T.C.A. § 12-4-707.

Prior to receiving final payment, the Contractor shall provide to the project supervisor and CRD-SBDP certification of the dollars paid to each DBE firm, using Form CC3, "Certification of DBE Accomplishment." The certification shall be dated and signed by a responsible officer of the Contractor and by a responsible officer of the DBE. Falsification of this certification may

result in formal enforcement actions, including civil actions for false claims, suspension and debarment proceedings, or other administrative actions affecting bidder qualifications.

The Contractor and all subcontractors shall retain, for a period of not less than three (3) years after final acceptance of a project, copies of canceled checks or other documentation that substantiates payments to DBE firms. These records shall be available at reasonable times and places for inspection by authorized representatives of the Department and various Federal Agencies.

The Contractor is advised that failure to carry out the requirements as set forth above shall constitute a breach of contract, and after notification by the Department, may result in termination of the contract or other remedy deemed appropriate by the Department.

S T A T E O F T E N N E S S E E

(Rev. 04-17-15)
(Rev. 10-19-15)
(Rev. 02-12-18)
(Rev. 07-02-18)

January 1, 2021

SPECIAL PROVISION

REGARDING

DBE CONTRACT GOAL

All contractors shall pursue affirmative action requirements to encourage and increase participation of firms certified as a Disadvantaged Business Enterprise (DBE) as set forth in this special provision and in accordance with 49 CFR Part 26. The bidder shall arrange for the percentage of the work specified on the cover of the Proposal Contract to be performed by Tennessee Uniform Certification Program (TNUCP) Disadvantaged Business Enterprises (DBEs) or otherwise clearly demonstrate adequate good faith efforts as described herein. All payments must follow the conditions set by the most current T.C.A. § 12-4-707.

The Contractor shall take full responsibility for ensuring the performance of a "commercially useful function" (CUF), as defined in 49 CFR Part 26, by all DBE subcontractors, manufacturers, and materials suppliers who work on the project or provide materials for the project.

A. Disadvantaged Business Enterprise Policy

The Contractor shall abide by the following provision and include in all subcontract agreements the following provision, which is designed to promote full participation of DBEs as suppliers and subcontractors through a continuous, positive result-oriented program on contracts let by the Department:

> *The Contractor, sub-recipient or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of U.S. Department of Transportation-assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the Department deems appropriate.*

B. Counting DBE Participation toward Meeting Goals

The Contractor shall count DBE participation toward goals in accordance with 49 CFR Part 26. If the DBE performs a CUF on the contract including those functions as a

subcontractor, expenditures to a DBE contractor count toward DBE goals. A DBE performs a CUF when it is responsible for execution of some portion of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. To perform a CUF, the DBE must also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, installing (where applicable), and paying for the material itself. The work performed by the DBE firm shall be necessary and useful to the completion of the contract, and consistent with normal highway construction industry practices in Tennessee. Work performed by a DBE firm in a particular transaction may be counted toward the goal only if the Department determines that it involves a CUF. The determination is verified by the "Commercially Useful Function Checklist" and the requirements of 49 CFR Part 26.

Note: In accordance with 49 CFR 26.55(c), to determine whether a DBE is performing a CUF, the Department must evaluate the amount of work subcontracted, industry practices, whether the amount the firm is to be paid under the contract is commensurate with the work it is actually performing and the DBE credit claimed for its performance of the work, and other relevant factors. A DBE does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed in order to obtain the appearance of DBE participation. In determining whether a DBE is such an extra participant, the Department must examine similar transactions, particularly those in which DBEs do not participate.

When a DBE is presumed not to be performing a commercially useful function, the DBE may present evidence to rebut this presumption. The Department may determine that the firm is performing a commercially useful function given the type of work involved and normal industry practices.

The bidder may count the following DBE expenditures involving a CUF towards the DBE goal:

1. **Projects where the DBE is the Prime Contractor** – The entire portion(s) of the contract to be completed by certified DBE firm's own forces will be counted toward meeting the goal. This will also include the cost of supplies and materials obtained by the DBE for the work of the contract, including supplies purchased or equipment leased by the DBE. Items of the contract subcontracted to non-DBE firms will not be counted toward the goal.

Note: If a DBE does not perform or exercise responsibility for at least 30 percent of the total cost of its contract with its own work force, or the DBE subcontracts a greater portion of the work of a contract than would be expected on the basis of normal industry practice for the type of work involved, the Department must presume that it is not performing a commercially useful function.

2. **Portions of a Bid from a Joint Venture** – When a DBE performs as a participant in a joint venture, only the total dollar value of the contract equal to the distinct, clearly defined portion of the work of the contract that the DBE performs with its own forces will count toward DBE goals. A bid from a joint venture between a DBE and a non-DBE Contractor shall include an explanation of DBE commitments on DBE Form 1247A, which must be approved by the Civil Rights Division - Small Business Development Program (CRD-SBDP) prior to the letting. Only the DBE's portion will be counted toward the goal. Joint venture agreements have to be approved separately from the bid documents, prior to the awarding of the contract.

3. **DBE Subcontractors** – The DBE subcontractor shall assume actual and contractual responsibility for provision of materials and supplies, subcontracted work, or other commercially useful functions of the items of work subcontracted to them. When a DBE subcontracts part of the work of its contract to another firm, the value of the subcontracted work may be counted toward the DBE goal only if the DBE's subcontractor is also a DBE. Work that a DBE subcontracts to a non-DBE firm does not count toward the DBE goal. Cost of materials purchased from or the cost of equipment leased from the non-DBE Contractor will not count toward the project DBE commitment. Prior written approval must be obtained from the CRD-SBDP for any DBE use of the Contractor's personnel or equipment.

4. **DBE Manufacturers** – The Contractor may count toward the DBE goal 100% of its expenditures for materials and supplies required under a contract and obtained from a DBE manufacturer only if the DBE operates or maintains a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the contract and of the general character described by the specifications.

5. **DBE Regular Dealers (Material Suppliers)** – The Contractor may count toward the DBE goal 60% of its expenditures for materials and supplies required under a contract and obtained from a DBE regular dealer. For purposes of this section, a regular dealer is a firm that owns, operates, or maintains a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business. To be a regular dealer, the firm must be an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question. A firm may be a regular dealer in such bulk items as petroleum products, steel, cement, gravel, stone, or asphalt without owning, operating, or maintaining a place of business where such products are bought, kept in stock, and regularly sold to the public if the firm owns and operates the distribution equipment for the products. Any supplementing of the regular dealer's own distribution equipment shall be by a long-term lease and not on an ad hoc or contract-by-contract basis. Any lease containing the terms of the agreement shall be made available to and must be approved in writing by CRD-SBDP

6. **Other DBE Suppliers** − With respect to materials or supplies purchased from a DBE which is neither a manufacturer nor a regular dealer, count the entire amount of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees or transportation charges for the delivery of materials or supplies required on a job site, toward DBE goals; provided, the Department finds the fees to be reasonable and not excessive as compared with fees customarily allowed for similar services. The cost of the materials and supplies themselves shall not count toward DBE goals.

7. **Transportation or Hauling of Materials** – The Contractor may count towards the DBE goal hauling in either DBE-owned trucks or in trucks leased to or by DBE firms. The verification of truck drivers employed by DBE firms will continue to be by submission of payrolls independent from any Davis-Bacon regulations. Use the following factors in determining whether a DBE trucking company is performing a CUF:

    a. The DBE must be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting DBE goals.
    b. The DBE must itself own and operate at least one fully licensed, insured, and operational truck used on the contract.
    c. The DBE receives credit for the total value of the transportation services it provides on the contract using trucks it owns, insures, and operates using drivers it employs.
    d. The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services that the lessee DBE provides on the contract.
    e. The DBE may also lease trucks from a non-DBE firm, including an owner-operator. The DBE that leases trucks equipped with drivers from a non-DBE is entitled to credit for the total value of transportation services provided by non-DBE leased trucks equipped with drivers not to exceed the value of transportation services provided by DBE-owned trucks or leased trucks with DBE employee drivers. Additional participation by non-DBE owned trucks equipped with drivers receives credit only for the fee or commission it receives as a result of the lease arrangement. If the DBE chooses this approach, it must obtain written consent from the Department [CRD-SBDP].
    f. The DBE may lease trucks without drivers from a non-DBE truck leasing company. If the DBE leases trucks from a non-DBE truck leasing company and uses its own employees as drivers, it is entitled to credit for the value of these hauling services.
    g. For purposes of this paragraph, a lease must indicate that the DBE has exclusive use of and control over the truck. Leases cannot be Department

contract-specific, must be long term, and must be approved by CRD-SBDP. This does not preclude the leased truck from working for others during the term of the lease with the consent of the DBE, so long as the lease gives the DBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the DBE.

h. Prior to hauling, the Contractor and DBE shall provide the project supervisor a complete list of trucks that will be used on the project for DBE goal participation. The Department will provide a form that shall be used by the Contractor and the DBE to identify the trucks. A revised list will be required any time the trucks used changes. The Contractor and DBE must be able to adequately document the actual amount of hauling eligible for DBE goal participation.

8. **Contracted Labor / Temporary Employment Agencies** – The Department will count the entire amount of fees or commissions charged by a DBE firm for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of the contract; provided, however, the Department must find the fee to be reasonable and not excessive as compared to the fees customarily allowed for similar services.

C. Contract Award Procedures

The established DBE goal will be shown on the proposal as a percent of the total amount bid. If the total proposed DBE work submitted with the bid is less than the percentage participation goal set by the Department, the bidder shall, within three (3) business days from the bid openings, either propose sufficient additional DBE participation to meet the goal or clearly demonstrate by documentation that good faith efforts were made to meet the goal.

1. Bidder's Responsibility

It is the bidder's responsibility to determine the level of professional competence and financial responsibility of any proposed DBE subcontractor. The bidder shall ascertain that the proposed DBE subcontractor has suitable experience and equipment to perform a commercially useful function for work that is common industry practice in the Tennessee highway construction industry.

The Contractor shall develop and maintain records of negotiations with DBEs to reach agreeable prices, quotations and work schedules, including but not limited to a record of dates when the Contractor first contacted each DBE.

2. DBE’s Responsibility

Before bidding and subsequently entering into a contract (as a contractor or subcontractor), the DBE should consider the scope and size of the project, as well as whether it is certified to receive credit for the type of work performed. As with any contract, this is a legally binding document and should be performed to the best of one's ability. However, should a DBE ever have to withdraw from a contract, it shall provide the CRD-SBDP and Contractor with written documentation. A DBE should only withdraw when there is no other option, as non-completion of its duties may result in temporary disqualification of a prequalified bidder or subcontractor by suspending the privilege of bidding on Department contracts or becoming an approved subcontractor, as outlined in Chapter 1680-05-03 of the Rules of the Department.

3. Proposals with Established Project DBE Goals

For proposals with established project goals, the bidder will be required to complete DBE Form 1247A. The bidder shall list the following information on each DBE Form 1247A that is submitted:

a. The names and addresses of all DBE firms being used or being considered for use under the contract as part of the bidder's DBE commitment;
b. The work classification(s) for each DBE on the contract;
c. The "Amount to DBE" which has been committed to each DBE firm for use on the contract;
d. Written documentation of the bidder's commitment to use a DBE subcontractor whose participation it submits to meet a contract goal; and
e. Written confirmation from each listed DBE firm that it is participating in the contract in the kind and amount of work provided in the Contractor's commitment.

The completed DBE Form 1247A shall be submitted within three (3) business days after the Letting. Failure to provide a completed form or documentation clearly evidencing a good faith effort, as detailed in Section 4 below, within three (3) business days after the Letting may cause the bid to be rejected as irregular. Only certified DBE firms may be used. Contractor may access certification information by viewing the TNUCP DBE Directory website.

When DBE goal projects are involved and the Contractor subcontracts to a non-DBE, and the non-DBE subcontractor in turn subcontracts to a DBE as a second tier subcontractor, the Contractor must affirm in writing his/her knowledge and approval of such an arrangement. Recognition of a second tier arrangement with a DBE subcontractor for goal work must be forwarded to the CRD-SBDP Director for verification, in writing, prior to any work being performed by the DBE which is intended to be counted toward the goal.

4. Bidder Selection and Good Faith Efforts

a. Bidders shall submit proposals that meet the DBE goal or shall submit documentation clearly evidencing that they made a good faith effort to meet the DBE goal. Contractors who meet or exceed the contract goal will be assumed to have made good faith efforts to utilize DBE firms. DBE firms who bid as Prime Contractors will be considered to have met the goal.

b. In making a fair and reasonable judgment as to whether the bidder has made adequate good faith efforts, the Department shall consider quality, quantity, and intensity of the different kinds of efforts that the bidder has made. The following list of factors is not intended to be a mandatory checklist, nor is it intended to be exclusive or exhaustive. Other factors or types of efforts may be relevant in appropriate cases. In any event, the Department may consider whether the bidder:

    1) Selected portions of the work likely to attract DBE participation. The total dollar value of the portions selected should meet or exceed the contract DBE goal. If it is necessary, the bidder should break down subcontracts into economically feasible units in order to facilitate participation.

    2) Provided notice to a reasonable number of specific DBEs, including those not regularly used by the bidder, that their participation in the contract is being solicited in sufficient time to allow them to participate effectively.

    3) Provided interested DBEs with adequate information about the plans, specifications and requirements of the contract.

    4) Advertised in trade association publications or minority-focused media concerning participation opportunities.

    5) Effectively used the services of available minority community organizations, minority contractors groups, local, state, or federal minority business assistance offices, or other organizations that provide assistance in the recruitment and placement of DBEs.

    6) Negotiated in good faith with interested DBEs, including not rejecting DBEs as unqualified lacking sound reasons based on a thorough investigation of their capabilities.

    7) Made efforts to assist interested DBEs in obtaining bonding or insurance required by the bidder.

    8) Submitted all quotations received from DBEs, and for those quotations not accepted, an explanation of why the DBE was not accepted including price comparisons. Receipt of a lower quotation

from a non-DBE will not in itself excuse a bidder's failure to meet the contract goal.

9) Has adequate records of its contacts and negotiations with DBEs.

c. If the Contractor has not met the DBE goal or submitted documentation clearly evidencing good faith efforts within three (3) business days after the bid opening, the Contractor's bid will be considered non-responsive and may be cause for the forfeiture of the Proposal Guaranty which shall become the property of the Department, not as penalty, but as liquidated damages. The Department then may consider the next lowest responsive bid for award.

As soon as practical after contract award, the Contractor shall submit copies of all binding subcontracts and purchase orders with DBEs to the respective Project Supervisor and to CRD-SBDP.

No progress estimate shall be processed until copies of all binding subcontracts and purchase orders with DBEs have been received.

5. Joint Checking Allowance for DBE

A DBE must receive pre-approval by the Department before using a joint check. Joint check requests shall be submitted by the DBE to CRD-SBDP prior to the subcontract agreement.

The following are some general conditions that must be met regarding joint check use:

a. The second party (typically the Contractor) acts solely as a guarantor.
b. The DBE must release the check to the supplier.
c. The use of joint checks must be a commonly recognized business practice in the industry.
d. The DBE remains responsible for all other elements of 49 CFR Part 26.55(c)(1)
e. The DBE is not required to use a specific supplier nor the Contractor's negotiated unit price.
f. The DBE shall submit receipt/copy of cancelled checks to CRD-SBDP.

D. Construction Requirements

1. Preconstruction Conference

The Contractor shall identify all DBE subcontractors and indicate the approximate dates for their appearance on the project. The Department will review the contract information to verify the actual work to be performed by the DBE contractors and will review any lease agreements allowed as part of the DBE commitment.

Information submitted shall match Form 1247A.

2. Process for Removal of a DBE

At no time shall a DBE be terminated or substituted without prior written consent from CRD-SBDP. This includes, but is not limited to, instances in which the Contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm. The Contractor shall utilize the specific DBEs listed to perform the work and supply the materials for which each is listed unless the Contractor obtains the CRD-SBDP's written consent as provided herein. Absent such written consent, the Contractor shall not be entitled to any payment for work or material unless it is by the listed DBE. The CRD-SBDP may provide such written consent only if it agrees that the Contractor has good cause to terminate the DBE firm, as further described below.

Before terminating and/or substituting a DBE subcontractor on a project that includes SP1247 in the Contract Proposal, the Contractor must give notice in writing to the DBE subcontractor, with a copy to the CRD-SBDP, of its intent to request to terminate and/or substitute including the reason for the request.

The Contractor must then give the DBE five (5) days to respond to the Contractor's notice. The DBE shall then advise the CRD-SBDP and the Contractor of the reasons, if any, why it objects to the proposed termination of its subcontract and why the CRD-SBDP should not approve the Contractor's action. If required in a particular case as a matter of public necessity (e.g., safety), the CRO-SBDP may provide a response period shorter than five (5) days.

If approval is granted for removal, CRD-SBDP will submit a letter to the Contractor and the DBE. Good faith efforts shall then be directed at finding another DBE to perform at least the same amount of work under the contract as the DBE that was terminated, to the extent needed to meet the contract goal established. The good faith efforts shall be documented by the Contractor. If requested by the CRD-SBDP, the Contractor shall submit the documentation within seven (7) days, which may be extended for an additional seven (7) days if necessary at the request of the Contractor, and the CRD-SBDP shall provide a written determination to the Contractor stating whether or not good faith efforts have been demonstrated.

The Contractor has the responsibility to comply with 49 CFR Part 26.53(f) and all applicable policies and regulations.

Reasons for termination and/or substitution of a DBE subcontractor must meet the reasons for good cause as outlined in the current 49 CFR Part 26.53(f), which include, but are not limited to, circumstances in which the listed DBE subcontractor:

a. Fails or refuses to execute a written contract;
b. Fails or refuses to perform the work of its subcontract in a way consistent with normal industry standards. Provided, however, that good cause does not exist if the failure or refusal of the DBE subcontractor to perform its work on the subcontract results from the bad faith or discriminatory action of the Contractor;
c. Fails or refuses to meet the Contractor's reasonable, nondiscriminatory bond requirements;
d. Becomes bankrupt, insolvent, or exhibits credit unworthiness;
e. Becomes ineligible to work on public works projects because of suspension and debarment proceedings pursuant 2 CFR Parts 180, 215 and 1,200 or applicable state law;
f. Is not a responsible contractor, as determined by the Department;
g. Voluntarily withdraws from the project and provides written notice to the Contractor of its withdrawal;
h. Is ineligible to receive DBE credit for the type of work required;
i. Is unable to complete its work on the contract as a result of death or disability of an owner; and/or
j. For other documented good cause, the Department may elect to compel the termination of the DBE subcontractor; provided that good cause does not exist if the Contractor seeks to terminate a DBE it relied upon to obtain the contract so that the Contractor can self-perform the work for which the DBE was engaged, or so that the Contractor can substitute another DBE or non-DBE contractor after contract award.

3. Brokering of work by DBEs is not allowed and is a material breach of contract. A DBE firm involved in brokering of work may result in removal or suspension of DBE certification and/or formal enforcement actions, including civil actions for false claims, suspension and debarment proceedings, or other administrative actions affecting bidder qualifications Any firm involved in brokering of work that engages in willful falsification distortion, or misrepresentation with respect to any facts related to the project shall be referred to the U. S. Department of Transportation's Office of the Inspector General for prosecution under Title 18, U. S. Code, Section 641. Contractor shall place this provision in all subcontracts with DBEs.

4. The Contractor shall provide notification to the Project Supervisor at least 24 hours prior to each DBE beginning work. A Department Project Supervisor/Inspector must complete a Commercially Useful Function (CUF) Checklist to document the first date of work, work items, equipment, and forces of each DBE.

5. The Contractor shall enter monthly prompt payment certification to the Department through external access to AASHTOWare Project Civil Rights & Labor (CRL) The Contractor is responsible for ensuring all subcontractors, any tier, and material suppliers or haulers are registered for access with the Department. In addition, the

Contractor shall require subcontractors, material suppliers, and haulers to review payment information monthly and respond in CRL when discrepancies or disputes are present.

Prompt Payment data shall be submitted monthly beginning no later than sixty (60) days after payment of the first estimate.

6. The Department will hold estimate payment if previously listed information is not submitted. Reasons for non-payment to a DBE could include the following:

    a) Whether the DBE is performing satisfactorily;
    b) Whether the Contractor has reason to believe the DBE is not performing a commercially useful function, and if so, why and what steps the Contractor is taking to rectify the situation.

In the event the Contractor reports questions in relation to prompt payment regarding whether a DBE is independent and performing a commercially useful function and takes appropriate steps promptly to address the issue, then the Department will take this effort into account when considering Contractor compliance measures as described below. Payments must abide by the conditions set in TCA 12-4-707.

E. Post Construction Requirements

Prior to receiving final payment, the Contractor shall provide to the Project Engineer and CRD-SBDP certification of the dollars paid to each DBE firm, using Form CC3, "Certification of DBE Accomplishment." The certification shall be dated and signed by a responsible officer of the contractor and by a responsible officer of the DBE. Falsification of this certification may result in removal or suspension of DBE certification and/or formal enforcement actions, including civil actions for false claims, suspension and debarment proceedings, or other administrative actions affecting bidder qualifications. The final estimate will not be paid to the Contractor until proper certifications including CC-3 have been made.

F. Required Records

The Contractor and all subcontractors shall retain, for a period of not less than three (3) years after final acceptance of a project, copies of canceled checks or other documentation that substantiates payments to DBE firms. These records shall be available at reasonable times and places for inspection by authorized representatives of the Department and various Federal Agencies. Copies shall be provided to the Department if requested.

G. Contractor Compliance

1. If the Contractor fails to comply with Special Provision 1247 and/or 49 CFR Part 26, resulting in failure to obtain goal where a good faith effort was not accepted, the Department shall take one or a combination of the following steps:

1) The Department may withhold from the Contractor the monetary value of the unattained goal percentage plus an additional 10% for engineering costs, not as penalty but as liquidated damages.

2) Suspend the Contractor from participation in Department bid lettings pursuant to rules promulgated by the Department.

3) For repeated failures to comply, debar the Contractor pursuant to rules promulgated by the Department.

4) Invoke other remedies available by law and/or in the contract.

5) Invoke any other lawful remedy agreed upon by the Commissioner and the Contractor in writing.

REQUIRED CONTRACT PROVISIONS
FEDERAL-AID CONSTRUCTION CONTRACTS

I. General
II. Nondiscrimination
III. Nonsegregated Facilities
IV. Davis-Bacon and Related Act Provisions
V. Contract Work Hours and Safety Standards Act Provisions
VI. Subletting or Assigning the Contract
VII. Safety: Accident Prevention
VIII. False Statements Concerning Highway Projects
IX. Implementation of Clean Air Act and Federal Water Pollution Control Act
X. Compliance with Governmentwide Suspension and Debarment Requirements
XI. Certification Regarding Use of Contract Funds for Lobbying

ATTACHMENTS

A. Employment and Materials Preference for Appalachian Development Highway System or Appalachian Local Access Road Contracts (included in Appalachian contracts only)

I. GENERAL

1. Form FHWA-1273 must be physically incorporated in each construction contract funded under Title 23 (excluding emergency contracts solely intended for debris removal). The contractor (or subcontractor) must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services).

The applicable requirements of Form FHWA-1273 are incorporated by reference for work done under any purchase order, rental agreement or agreement for other services. The prime contractor shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Form FHWA-1273 must be included in all Federal-aid design-build contracts, in all subcontracts and in lower tier subcontracts (excluding subcontracts for design services, purchase orders, rental agreements and other agreements for supplies or services). The design-builder shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Contracting agencies may reference Form FHWA-1273 in bid proposal or request for proposal documents, however, the Form FHWA-1273 must be physically incorporated (not referenced) in all contracts, subcontracts and lower-tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services related to a construction contract).

2. Subject to the applicability criteria noted in the following sections, these contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.

3. A breach of any of the stipulations contained in these Required Contract Provisions may be sufficient grounds for withholding of progress payments, withholding of final payment, termination of the contract, suspension / debarment or any other action determined to be appropriate by the contracting agency and FHWA.

4. Selection of Labor: During the performance of this contract, the contractor shall not use convict labor for any purpose within the limits of a construction project on a Federal-aid highway unless it is labor performed by convicts who are on parole, supervised release, or probation. The term Federal-aid highway does not include roadways functionally classified as local roads or rural minor collectors.

II. NONDISCRIMINATION

The provisions of this section related to 23 CFR Part 230 are applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more. The provisions of 23 CFR Part 230 are not applicable to material supply, engineering, or architectural service contracts.

In addition, the contractor and all subcontractors must comply with the following policies: Executive Order 11246, 41 CFR 60, 29 CFR 1625-1627, Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The contractor and all subcontractors must comply with: the requirements of the Equal Opportunity Clause in 41 CFR 60-1.4(b) and, for all construction contracts exceeding $10,000, the Standard Federal Equal Employment Opportunity Construction Contract Specifications in 41 CFR 60-4.3.

Note: The U.S. Department of Labor has exclusive authority to determine compliance with Executive Order 11246 and the policies of the Secretary of Labor including 41 CFR 60, and 29 CFR 1625-1627. The contracting agency and the FHWA have the authority and the responsibility to ensure compliance with Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), and Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The following provision is adopted from 23 CFR 230, Appendix A, with appropriate revisions to conform to the U.S. Department of Labor (US DOL) and FHWA requirements.

1. Equal Employment Opportunity: Equal employment opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630, 29 CFR 1625-1627, 41 CFR 60 and 49 CFR 27) and orders of the Secretary of Labor as modified by the

provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140 shall constitute the EEO and specific affirmative action standards for the contractor's project activities under this contract. The provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

a. The contractor will work with the contracting agency and the Federal Government to ensure that it has made every good faith effort to provide equal opportunity with respect to all of its terms and conditions of employment and in their review of activities under the contract.

b. The contractor will accept as its operating policy the following statement:

"It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, pre-apprenticeship, and/or on-the-job training."

2. EEO Officer: The contractor will designate and make known to the contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active EEO program and who must be assigned adequate authority and responsibility to do so.

3. Dissemination of Policy: All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.

b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.

c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minorities and women.

d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

4. Recruitment: When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minorities and women in the area from which the project work force would normally be derived.

a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minorities and women. To meet this requirement, the contractor will identify sources of potential minority group employees, and establish with such identified sources procedures whereby minority and women applicants may be referred to the contractor for employment consideration.

b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, the contractor is expected to observe the provisions of that agreement to the extent that the system meets the contractor's compliance with EEO contract provisions. Where implementation of such an agreement has the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Federal nondiscrimination provisions.

c. The contractor will encourage its present employees to refer minorities and women as applicants for employment. Information and procedures with regard to referring such applicants will be discussed with employees.

5. Personnel Actions: Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age or disability. The following procedures shall be followed:

a. The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with its obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of their avenues of appeal.

6. Training and Promotion:

a. The contractor will assist in locating, qualifying, and increasing the skills of minorities and women who are applicants for employment or current employees. Such efforts should be aimed at developing full journey level status employees in the type of trade or job classification involved.

b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision. The contracting agency may reserve training positions for persons who receive welfare assistance in accordance with 23 U.S.C. 140(a).

c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

d. The contractor will periodically review the training and promotion potential of employees who are minorities and women and will encourage eligible employees to apply for such training and promotion.

7. Unions: If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women. Actions by the contractor, either directly or through a contractor's association acting as agent, will include the procedures set forth below:

a. The contractor will use good faith efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minorities and women for membership in the unions and increasing the skills of minorities and women so that they may qualify for higher paying employment.

b. The contractor will use good faith efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age or disability.

c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the contracting agency and shall set forth what efforts have been made to obtain such information.

d. In the event the union is unable to provide the contractor with a reasonable flow of referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age or disability; making full efforts to obtain qualified and/or qualifiable minorities and women. The failure of a union to provide sufficient referrals (even though it is obligated to provide exclusive referrals under the terms of a collective bargaining agreement) does not relieve the contractor from the requirements of this paragraph. In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the contracting agency.

8. Reasonable Accommodation for Applicants / Employees with Disabilities: The contractor must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established there under. Employers must provide reasonable accommodation in all employment activities unless to do so would cause an undue hardship.

9. Selection of Subcontractors, Procurement of Materials and Leasing of Equipment: The contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The contractor shall take all necessary and reasonable steps to ensure nondiscrimination in the administration of this contract.

a. The contractor shall notify all potential subcontractors and suppliers and lessors of their EEO obligations under this contract.

b. The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.

10. Assurance Required by 49 CFR 26.13(b):

a. The requirements of 49 CFR Part 26 and the State DOT's U.S. DOT-approved DBE program are incorporated by reference.

b. The contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the contracting agency deems appropriate.

11. Records and Reports: The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following the date of the final payment to the contractor for all contract work and shall be available at reasonable times and places for inspection by authorized representatives of the contracting agency and the FHWA.

a. The records kept by the contractor shall document the following:

(1) The number and work hours of minority and non-minority group members and women employed in each work classification on the project;

(2) The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women;

b. The contractors and subcontractors will submit an annual report to the contracting agency each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on Form FHWA-1391. The staffing data should

represent the project work force on board in all or any part of the last payroll period preceding the end of July. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data. The employment data should reflect the work force on board during all or any part of the last payroll period preceding the end of July.

III. NONSEGREGATED FACILITIES

This provision is applicable to all Federal-aid construction contracts and to all related construction subcontracts of $10,000 or more.

The contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensure that its employees are not assigned to perform their services at any location, under the contractor's control, where the facilities are segregated. The term "facilities" includes waiting rooms, work areas, restaurants and other eating areas, time clocks, restrooms, washrooms, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees. The contractor shall provide separate or single-user restrooms and necessary dressing or sleeping areas to assure privacy between sexes.

IV. DAVIS-BACON AND RELATED ACT PROVISIONS

This section is applicable to all Federal-aid construction projects exceeding $2,000 and to all related subcontracts and lower-tier subcontracts (regardless of subcontract size). The requirements apply to all projects located within the right-of-way of a roadway that is functionally classified as Federal-aid highway. This excludes roadways functionally classified as local roads or rural minor collectors, which are exempt. Contracting agencies may elect to apply these requirements to other projects.

The following provisions are from the U.S. Department of Labor regulations in 29 CFR 5.5 “Contract provisions and related matters” with minor revisions to conform to the FHWA-1273 format and FHWA program requirements.

1. Minimum wages

a. All laborers and mechanics employed or working upon the site of the work, will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph 1.d. of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph 1.b. of this section) and the Davis-Bacon poster (WH–1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

b.(1) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(i) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(ii) The classification is utilized in the area by the construction industry; and

(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(2) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(3) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Wage and Hour Administrator for

determination. The Wage and Hour Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(4) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs 1.b.(2) or 1.b.(3) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

c. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

d. If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding

The contracting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract, or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the contracting agency may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and basic records

a. Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

b.(1) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the contracting agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g. , the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/esa/whd/forms/wh347instr.htm or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the contracting agency for transmission to the State DOT, the FHWA or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the contracting agency..

(2) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(i) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed,

as specified in the applicable wage determination incorporated into the contract.

(3) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH–347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 3.b.(2) of this section.

(4) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

c. The contractor or subcontractor shall make the records required under paragraph 3.a. of this section available for inspection, copying, or transcription by authorized representatives of the contracting agency, the State DOT, the FHWA, or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the FHWA may, after written notice to the contractor, the contracting agency or the State DOT, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

4. Apprentices and trainees

a. Apprentices (programs of the USDOL).

Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice.

The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

b. Trainees (programs of the USDOL).

Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.

The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration.

Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

c. Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity

requirements of Executive Order 11246, as amended, and 29 CFR part 30.

d. Apprentices and Trainees (programs of the U.S. DOT).

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

5. Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

6. Subcontracts. The contractor or subcontractor shall insert Form FHWA-1273 in any subcontracts and also require the subcontractors to include Form FHWA-1273 in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

7. Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of eligibility.

a. By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

b. No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

c. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

V. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

The following clauses apply to any Federal-aid construction contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 29 CFR 5.5(a) or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in paragraph (1.) of this section, the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1.) of this section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1.) of this section.

3. Withholding for unpaid wages and liquidated damages. The FHWA or the contacting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2.) of this section.

4. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (1.) through (4.) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1.) through (4.) of this section.

VI. SUBLETTING OR ASSIGNING THE CONTRACT

This provision is applicable to all Federal-aid construction contracts on the National Highway System.

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the contracting agency. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635.116).

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

(1) the prime contractor maintains control over the supervision of the day-to-day activities of the leased employees;
(2) the prime contractor remains responsible for the quality of the work of the leased employees;
(3) the prime contractor retains all power to accept or exclude individual employees from work on the project; and
(4) the prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other Federal regulatory requirements.

b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the contract as a whole and in general are to be limited to minor components of the overall contract.

2. The contract amount upon which the requirements set forth in paragraph (1) of Section VI is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the contracting officer determines is necessary to assure the performance of the contract.

4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the contracting agency has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

5. The 30% self-performance requirement of paragraph (1) is not applicable to design-build contracts; however, contracting agencies may establish their own self-performance requirements.

VII. SAFETY: ACCIDENT PREVENTION

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704).

3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.3704).

VIII. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, Form FHWA-1022 shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined under this title or imprisoned not more than 5 years or both."

IX. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

By submission of this bid/proposal or the execution of this contract, or subcontract, as appropriate, the bidder, proposer, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any person who is or will be utilized in the performance of this contract is not prohibited from receiving an award due to a violation of Section 508 of the Clean Water Act or Section 306 of the Clean Air Act.
2. That the contractor agrees to include or cause to be included the requirements of paragraph (1) of this Section X in every subcontract, and further agrees to take such action as the contracting agency may direct as a means of enforcing such requirements.

X. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, consultant contracts or any other covered transaction requiring FHWA approval or that is estimated to cost $25,000 or more – as defined in 2 CFR Parts 180 and 1200.

1**. Instructions for Certification – First Tier Participants:**

a. By signing and submitting this proposal, the prospective first tier participant is providing the certification set out below.

b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective first tier participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective first tier participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.

c. The certification in this clause is a material representation of fact upon which reliance was placed when the contracting agency determined to enter into this transaction. If it is later determined that the prospective participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the contracting agency may terminate this transaction for cause of default.

d. The prospective first tier participant shall provide immediate written notice to the contracting agency to whom this proposal is submitted if any time the prospective first tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

e. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. “First Tier Covered Transactions” refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). “Lower Tier Covered Transactions” refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). “First Tier Participant” refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). “Lower Tier Participant” refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

f. The prospective first tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

g. The prospective first tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions," provided by the department or contracting agency, entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

i. Nothing contained in the foregoing shall be construed to require the establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of the prospective participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

j. Except for transactions authorized under paragraph (f) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

* * * * *

2. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – First Tier Participants:

a. The prospective first tier participant certifies to the best of its knowledge and belief, that it and its principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency;

(2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (a)(2) of this certification; and

(4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

b. Where the prospective participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

2. **Instructions for Certification - Lower Tier Participants:**

(Applicable to all subcontracts, purchase orders and other lower tier transactions requiring prior FHWA approval or estimated to cost $25,000 or more - 2 CFR Parts 180 and 1200)

a. By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.

b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.

d. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations. “First Tier Covered Transactions” refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). “Lower Tier Covered Transactions” refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). “First Tier Participant” refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). “Lower Tier Participant” refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the $25,000 threshold.

g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (https://www.epls.gov/), which is compiled by the General Services Administration.

h. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the

department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

* * * * *

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Participants:

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

* * * * *

XI. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts which exceed $100,000 (49 CFR 20).

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

b. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

2. This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

3. The prospective participant also agrees by submitting its bid or proposal that the participant shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such recipients shall certify and disclose accordingly.

ATTACHMENT A - EMPLOYMENT AND MATERIALS PREFERENCE FOR APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM OR APPALACHIAN LOCAL ACCESS ROAD CONTRACTS

This provision is applicable to all Federal-aid projects funded under the Appalachian Regional Development Act of 1965.

1. During the performance of this contract, the contractor undertaking to do work which is, or reasonably may be, done as on-site work, shall give preference to qualified persons who regularly reside in the labor area as designated by the DOL wherein the contract work is situated, or the subregion, or the Appalachian counties of the State wherein the contract work is situated, except:

a. To the extent that qualified persons regularly residing in the area are not available.

b. For the reasonable needs of the contractor to employ supervisory or specially experienced personnel necessary to assure an efficient execution of the contract work.

c. For the obligation of the contractor to offer employment to present or former employees as the result of a lawful collective bargaining contract, provided that the number of nonresident persons employed under this subparagraph (1c) shall not exceed 20 percent of the total number of employees employed by the contractor on the contract work, except as provided in subparagraph (4) below.

2. The contractor shall place a job order with the State Employment Service indicating (a) the classifications of the laborers, mechanics and other employees required to perform the contract work, (b) the number of employees required in each classification, (c) the date on which the participant estimates such employees will be required, and (d) any other pertinent information required by the State Employment Service to complete the job order form. The job order may be placed with the State Employment Service in writing or by telephone. If during the course of the contract work, the information submitted by the contractor in the original job order is substantially modified, the participant shall promptly notify the State Employment Service.

3. The contractor shall give full consideration to all qualified job applicants referred to him by the State Employment Service. The contractor is not required to grant employment to any job applicants who, in his opinion, are not qualified to perform the classification of work required.

4. If, within one week following the placing of a job order by the contractor with the State Employment Service, the State Employment Service is unable to refer any qualified job applicants to the contractor, or less than the number requested, the State Employment Service will forward a certificate to the contractor indicating the unavailability of applicants. Such certificate shall be made a part of the contractor's permanent project records. Upon receipt of this certificate, the contractor may employ persons who do not normally reside in the labor area to fill positions covered by the certificate, notwithstanding the provisions of subparagraph (1c) above.

5. The provisions of 23 CFR 633.207(e) allow the contracting agency to provide a contractual preference for the use of mineral resource materials native to the Appalachian region.

6. The contractor shall include the provisions of Sections 1 through 4 of this Attachment A in every subcontract for work which is, or reasonably may be, done as on-site work.

S T A T E **O F** **T E N N E S S E E**

(Rev. 01-03-20) January 1, 2021
(Rev. 01-01-21)
(Rev. 01-07-22)

SPECIAL PROVISION

REGARDING

TENNESSEE DEPARTMENT OF TRANSPORTATION

2022 MINIMUM WAGE SCALES FOR FEDERAL-AID CONSTRUCTION

& 2022 MINIMUM WAGE SCALES FOR STATE FUNDED CONSTRUCTION

This Contract contains "Tennessee Department of Transportation 2022 Minimum Wage Scales for State Funded Construction", Tennessee Department of Labor Decision No. T-40288, dated January 1, 2022 and “Tennessee Department of Transportation 2022 Minimum Wage Scales for Federal-Aid Highway Construction”, U. S. Department of Labor Decision No. TN20220147 (dated January 7, 2022).

The Contractor is required to pay the greater of the two (2) rates for each classification.

Note: Minimum Wage Scales for Federal-Aid Heavy Construction are on file with the Department, and will be included in all applicable Contract Proposals

(Rev. 01/07/22)

STATE OF TENNESSEE

TENNESSEE DEPARTMENT OF TRANSPORTATION

MINIMUM WAGE SCALES FOR FEDERAL AID HIGHWAY CONSTRUCTION

General Decision Number: TN20220147 01/07/2022

Superseded General Decision Number: TN20210147

State: Tennessee

Construction Type: Highway

Counties: Tennessee Statewide.

HIGHWAY CONSTRUCTION PROJECTS

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022, Executive Order 14026 generally applies to the contract. The contractor must pay all covered workers at least $15.00 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2022.

If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022, Executive Order 13658 generally applies to the contract. The contractor must pay all covered workers at least $11.25 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2022.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at www.dol.gov/whd/govcontracts.

Modification Number 0 | Publication Date 01/07/2022

SUTN2016-001 07/13/2016

	Rates	Fringes
BRICKLAYER	$ 14.26	
CARPENTER	$ 17.52	
CEMENT MASON/CONCRETE FINISHER	$ 15.55	
ELECTRICIAN	$ 24.08	
IRONWORKER		
Reinforcing	$ 16.29	
Structural	$ 16.89	
LABORER		
Common/Unskilled	$ 13.11	
Skilled		
Air Tool Operator, Asphalt Raker, Chain Saw Operator, Concrete Mixer (less than 1 yd), Concrete Rubber, Edger, Fence Erector, Form Setter (steel), Guard Rail Erector, Mechanic's Tender (tire changer or oiler), Mortar Mixer, Nozzleman or Gun Operator (gunite), Pipelayer, Sign Erector	$ 15.27	
PAINTER (INCLUDES SANDBLASTER)	$ 26.36	
POWER EQUIPMENT OPERATOR:		
GROUP 1		
Backhoe/Hydraulic Excavator (3/4 yd & over), Crane (less than 20 Tons), End Loader (3		

yd & over), Motor Patrol (finish),Piledriver, Dragline.....$ 19.14
GROUP 1A
Drill Operator (Caisson)...$ 25.26
Farm Tractor Operator (Power Broom).....$ 13.50
GROUP 2
Backhoe/Hydraulic Excavator (less than 3/4 yd), Bulldozer or Push Dozer, End Loader (less than 3 yd), Motor Patrol (rough), Tractor (crawler/ utility), Truck Driver (Heavy Duty, Off Road) Scraper, Shovel, or Trenching Machine.....$ 17.08
GROUP 3
Asphalt Paver, Concrete Finishing Machine, Concrete Paver, Scale, Spreader (self-propelled), Concrete Grinder, Asphalt Milling Machine, Boring Machine (horizontal).....$ 17.75
GROUP 4
Bobcat, Central Mining Plant, Concrete Pump, Concrete Saw, Curb Machine (automatic or manual), Dozer or Loader (stockpile), Drill (piling), Mulcher or Seeder, Rock Drill (truck mounted), Roller (asphalt), Roller (compaction self-propelled), Soil Stabilization Machine, Tractor (boom and hoist), Bituminous Distributor Machine, pump, Track Drill, Striping Machine....$ 16.48
Heavy Duty Mechanic.....$ 20.33
Light Duty Mechanic.....$ 19.53
Sweeping Machine (Vacuum) Operator.....$ 15.56
GROUP 5
Crane (over 20 Tons).....$ 20.44

TRUCK DRIVER
2 axles.....$ 15.36

3-4 axles.....$ 14.86
5 or more axles.....$ 16.27

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union, which prevailed in the survey for this classification, which in this example would be Plumbers 0198

indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Division National Office Branch of Wage Surveys. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

S T A T E O F T E N N E S S E E

TENNESSEE DEPARTMENT OF TRANSPORTATION

2022 MINIMUM WAGE SCALES FOR STATE FUNDED CONSTRUCTION

January 1, 2022 **Tenn. DOL Decision No. T-40288**

CLASSIFICATION (ENGLISH)	CLASSIFICATION (SPANISH)	Basic Hourly Rates	Craft No.
Blaster	**Proveedor do Explosivos**	25.01	**1**
Bricklayer	**Ladrillero**	18.03	**2**
Carpenter / Leadsperson	**Carpintero o Lider**	22.16	**3**
Class "A" Operators	**Operador Clase A**	25.44	**4**
Class "B" Operators	**Operador Clase B**	23.07	**5**
Class "C" Operators	**Operador Clase C**	24.04	**6**
Class "D" Operators	**Operador Clase D**	22.67	**7**
Concrete Finisher	**Terminador de Cemento**	21.59	**8**
Drill Operator (Caisson)	**Operador de Perfordora**	37.53	**9**
Electrician	**Electricista**	33.96	**10**
Farm Tractor Operator (Power Broom)	**Operador de Tractor de Rancho**	16.88	**11**
Ironworkers (Reinforcing)	**Herrero**	21.15	**12**
Ironworkers (Structural)	**Herrero de Estructura**	21.36	**13**
Large Crane Operator	**Operador de la Grua**	26.45	**14**
Mechanic (Class I) Heavy Duty	**Mecanico Clase 1**	27.32	**15**
Mechanic (Class II) Light Duty	**Mecanico Clase 2**	25.66	**16**
Painter / Sandblaster	**Pintor o Lajador**	33.35	**17**
Skilled Laborer	**Obrero Diestro**	20.62	**18**
Survey Instrument Operator	**Operador de Agrimensor**	28.00	**19**
Sweeping Machine (Vacuum) Operator	**Operador de Barredora**	20.35	**20**
Truck Driver (2 axles)	**Camionero (2 ejes)**	20.07	**21**
Truck Driver (3/4 axles)	**Camionero (3 o 4 ejes)**	20.42	**22**
Truck Driver (5 or more axles)	**Camionero (5 o más ejes)**	23.89	**23**
Unskilled Laborer	**Obrero no Diestro**	17.71	**24**
Worksite Traffic Coordinator	**Coordinar de Trafico en el Lugar de Trabajo**	23.99	**25**

CLASSIFICATION	CRAFT NO.
SKILLED LABORER:	**18**

Air Tool Operator, Asphalt Raker, Chain Saw Operator, Concrete Mixer Operator (less than 1 yard), Concrete Rubber/Edger, Fence Erector, Form Setter (Steel Road), Guardrail Erector, Mechanic's Helper (Tire Changer or Oiler), Mortar Mixer, Nozzleman or Gun Operator (Gunite), *Pipelayer, Sign Erector

CLASS "A" OPERATORS: **04**

Backhoe/Hydraulic Excavator (3/4 yard and over), Crane (less than 20 tons see Crane Operator below), End Loader (3 yards and over), Motor Patrol (Finish), Pile Driver, Dragline

CLASS "B" OPERATORS: **05**

Backhoe/Hydraulic Excavator (less than 3/4 yard), Bull Dozer or Push Dozer, End Loader (less than 3 yards), Motor Patrol (Rough), Tractor (Crawler/Utility), Scraper, Shovel, Trenching Machine

CLASS "C" OPERATORS: **06**

Asphalt Paver, Concrete Finishing Machine, Concrete Paver, Scale, Spreader (Self-Propelled), Concrete Grinder, Asphalt Milling Machine, Boring Machine Operator (Horizontal)

CLASS "D" OPERATORS: **07**

Bobcat, Central Mixing Plant, Concrete Pump, Concrete Saw, Curb Machine (Automatic or Manual), Dozer or Loader (Stockpile), Drill (Piling), Mulcher or Seeder, Rock Drill (Truck Mounted), Roller (Asphalt), Roller (Compaction Self-Propelled), Soil Stabilization Machine, Tractor (Boom & Hoist), Bituminous Distributor Machine, Pump, Track Drill, Striping Machine Operator, Ditch Paving Machine

CRANE OPERATOR: **14**

Means one who operates boom-type equipment equal to or greater than 20 tons to hoist and move materials, raise and lower heavy weights and perform other related operations; may oil, grease or otherwise service and make necessary adjustments to equipment as needed; and may perform other related duties. (Note: The equipment is used for such work as pouring concrete and setting steel. This work is subject to strict inspection and must conform closely to specifications. The equipment may also be used for other miscellaneous tasks for which crane or stick-type equipment is required which may include hoist operations and pile driving operations.)

***Skilled Laborer - Pipelayer Classification**

For any work where prevailing wage rates apply which is located five feet or more outside the actual building if building construction is involved:

AND

(a) which consists of the building, rebuilding, locating, relocating or repairing any street, highway, bridges, water lines, sewer lines, gas lines, force mains or other relatedutilities

OR

(b) which involves the construction or upgrading of industrial parks or sites and is located outside the five-foot limitation.

The classification of pipelayer shall be applicable and the description of work under this classification shall be as follows:

Lays, connects, inspects and tests water lines, force mains, gas lines, sanitary or storm sewers and drains, underground telephone and electric ducts or other utilities manufactured from clay, concrete, steel, plastic, cast iron pipe or other similar materials.

May smooth bottom of trench to proper elevation by scooping with a shovel; receives pipe lowered from top of trench; inserts spigot end of pipe into bell end of last laid pipe; adjusts pipe to line and grades, caulks and seals joint with cement or other sealing compound; may connect threaded or flanged joint pipe; may assemble and place corrugated metal or plastic pipe and performs other related duties.

Additional Information:

Wage Rates : http://www.tennessee.gov/labor-wfd/prevail.html

Poster Page : http://www.state.tn.us/labor-wfd/poster.htm

Note: Adobe Acrobat Reader is required to download & print. If you do not have this software a link is provided at the bottom of the Poster Page for a free download.

Tenn. Dept. of Labor & Workforce Development (Labor Standards Division) : (615) 741-2858.

APPRENTICESHIP REGULATIONS:

Under T.C.A., §12-449, the Prevailing Wage Commission has promulgated Rule 0800-3-2-.04 which provides that: "Apprentices shall mean those persons registered individually under a bona fide apprenticeship program registered with the Bureau of Apprentiship and Training in the United States Department of Labor. The state agency contracting officer shall require the contractor or sub-contractor using the apprentice to submit evidence of his indenture and/or apprenticeship registration when the apprentice's name first appears on a submitting payroll."

AUTHORITY: T.C.A., §12-449. Administrative History: Original Rule filed June 4, 1976. Effective: July 14, 1976.

APPENDIX C

CONTRACT BOOK 2 (DESIGN-BUILD CONTRACT) FORMS

FORM NAME	FORM DESIGNATION
ATTESTATION RE PERSONNEL USED IN CONTRACT PERFORMANCE	FORM AT
CONFLICT OF INTEREST DISCLOSURE STATEMENT	FORM COI
CONTRACT PAYMENT AND PERFORMANCE BOND	FORM CP&PB
LOBBYING CERTIFICATE	FORM LC
TECHNICAL PROPOSAL SIGNATURE PAGE	FORM TPSP

ATTESTATION RE PERSONNEL USED IN CONTRACT PERFORMANCE
FORM AT

DESIGN-BUILD CONTRACT NUMBER:	**DB2101**
LEGAL ENTITY NAME:	
FEDERAL EMPLOYER IDENTIFICATION NUMBER: (or Social Security Number)	

The Entity, identified above, does hereby attest, certify, warrant, and assure that the Entity shall not knowingly utilize the services of an illegal immigrant in the performance of this Contract and shall not knowingly utilize the services of any subcontractor who will utilize the services of an illegal immigrant in the performance of this Contract.

SIGNATURE & DATE:

NOTICE: This attestation **MUST** be signed by an individual empowered to contractually bind the Design-Builder. If said individual is not the chief executive or president, this document shall attach evidence showing the individual's authority to contractually bind the Design-Builder.

CONFLICT OF INTEREST DISCLOSURE STATEMENT
FORM COI

DB2101

Background

The integrated nature of Design-Build creates the potential for conflicts of interest. Disclosure, evaluation, and management of these conflicts and of the appearance of conflicts, require attention to State and federal Laws in the contracting process. The Tennessee Department of Transportation ("TDOT") has developed *Conflict of Interest Disclose Guidelines* ("COI Disclosure Guidelines"). The COI Disclosure Guidelines are intended to summarize the key governing standards of State and Federal Laws, include definitions of key terms, and describe the COI Disclosure Process.

Federal Standards

Pursuant to 23 USC 112(b)(3), the Federal Highway Administration (FHWA) has promulgated administrative rules that affect federally-funded Design-Build procurements and related procurements. These rules, which are in 23 Code of Federal Regulations (CFR) Parts 635 and 636, are used as the basis for TDOT's guidelines on the subject. The main rule on organizational conflicts of interest in Design-Build transactions is 23 CFR § 636.116. This rule affects not only Design-Build procurements, but also "any contract for engineering services, inspection or technical support in the administration of the Design-Build contract."

These rules specifically regulate both organizational and individual conflicts of interest. The federal rules define "organizational conflict of interest" as follows:

> "*Organizational conflict of interest* means that because of other activities or relationships with other persons, a person is unable or potentially unable to render impartial assistance or advice to the owner, or the person's objectivity in performing the contract work is or might be otherwise impaired, or a person has an unfair competitive advantage." (23 CFR § 636.103)

Organizational Conflict of Interest Policy

TDOT may disqualify the Design-Builder if any of its Major Participants belong to more than one Design-Builder organization. If any Major Participants of different Design-Builder organizations belong to the same parent company, each Design-Builder must describe how the participants have avoided conflicts of interest during the procurement phase of the Project.

The Design-Builder agrees that, if after award, an organizational conflict of interest is discovered, an immediate and full disclosure in writing must be made to TDOT that must include a description of the action that the Design-Builder has taken or proposes to take to avoid or

mitigate such conflicts. If an organizational conflict of interest is determined to exist, TDOT may, at its discretion, cancel the Contract. If the Design-Builder was aware of an organizational conflict of interest prior to the award of the Contract and did not disclose the conflict to TDOT, TDOT may terminate the Contract for default.

Disclosure Pursuant to Section 636.116(2)(v)

In the space provided below, and on supplemental sheets as necessary, identify all relevant facts relating to past, present, or planned interest(s) of Design-Builder which may result, or could be viewed as, an organizational conflict of interest in connection with the RFP.

The Design-Builder shall disclose:

a. any current contractual relationships with TDOT (by identifying TDOT contract number and project manager);

b. present or planned contractual or employment relationships with any current TDOT employee;

c. any current relationships between the Major Participants, Key Personnel. Design Professionals, or Subcontractors of the Design-Builder on other TDOT projects; and

d. any other circumstances that might be considered to create a financial interest in the contract for the Project by any current TDOT employee if the Design-Builder is awarded the contract.

The foregoing is provided by way of example, and shall not constitute a limitation on the disclosure obligations.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

Explanation

In the space provided below, and on supplemental sheets as necessary, identify steps that have been or will be taken to avoid, neutralize, or mitigate any organizational conflicts of interest described herein.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

Certification

The undersigned hereby certifies that, to the best of his or her knowledge and belief, no interest exists that is required to be disclosed in this Conflict of Interest Disclosure Statement, other than as disclosed above.

_____

Signature

_____

Name

_____

Title

_____

Company Name

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
CONTRACT PAYMENT AND PERFORMANCE BOND
FORM CP&PB

DB2101

Be it known that _____, as Design-Builder, and_____, as Surety(ies), all authorized to do business in the State of Tennessee, hereby bind themselves to the State of Tennessee, Department of Transportation, and other potential claimants, for all obligations incurred by the Design-Builder under its contract with the State of Tennessee, Department of Transportation, for the construction of the above identified contract; in the full contract amount of _____ ($_____).

The obligations of the Design-Builder and Surety(ies) under these payment and performance bonds shall continue in full force and effect until all materials, equipment and labor have been provided AND all requirements contained in the Contract Documents, plans and specifications have been completed in a timely, thorough and workmanlike manner. The parties agree that these bonds are statutory in nature and are governed by the provisions contained in Title 12, chapter 4 and Title 54, chapter 5 of the Tennessee Code Annotated relating to bonds required of contractors and that those provisions constitute a part of this bond.

By this instrument, the Design-Builder and Surety(ies) specifically bind themselves, their heirs, successors, and assigns, *in solido*, under the following bonds:

Payment Bond. To the Tennessee Department of Transportation and all "Claimants," as contemplated by T.C.A. Title 54, chapter 5, in the full contract amount of

_____

_____ ($_____), in order to secure the payment in full of all timely claims under the Project.

Performance Bond. To the Tennessee Department of Transportation in the full contract amount of _____

_____ ($_____),

in order to secure the full and faithful performance and timely completion of the project according to its scope, plans and specifications, inclusive of overpayments to the contractor and liquidated damages as assessed.

Upon receipt of notice that the Design-Builder is in default under the contract, the Surety(ies) shall undertake to complete performance, without regard to cost. If the Surety(ies) fail or refuse

to complete performance of the contract, the Department may then proceed with the work in any lawful manner that it may elect until it is finally completed. When the work is thus finally completed, the total cost of the same will be computed. All costs and charges incurred by the Department in completing the work will be deducted from any monies due or which may become due to the Design-Builder. If the total costs of completion exceeds the sum which would have been payable under the Contract, then the Principal and the Surety(ies), *in solido*, shall be liable for and shall pay to the Department the amount of such excess.

In witness whereof we have signed this instrument as dated.

Design-Builder (1) _____

By: _____ Date: _____

_____

Printed Name and Title

Design-Builder (2)* _____

By: _____ Date: _____

_____

Printed Name and Title

Surety 1 _____ Surety 2* _____

By: _____ By: _____

Attorney-in-Fact Attorney-in-Fact

_____ _____

Printed Name and Title Printed Name and Title

_____ _____

Agency Name Agency Name

Street Address	Street Address
City/State/Zip	City/State/Zip
(Seal)	(Seal)

Subsequent correspondence/communication from TDOT with respect to monthly progress reports and/or the contract bonds should be directed to:

Surety 1	Surety 2*
By:	By:
Attorney-in-Fact	Attorney-in-Fact
Printed Name and Title	Printed Name and Title
Agency Name	Agency Name
Street Address	Street Address
City/State/Zip	City/State/Zip

*NOTE: The signature and information for Design-Builder (2) and Surety (2) is to be provided when there is a joint venture.

LOBBYING CERTIFICATE
FORM LC

PROJECT
DESCRIPTION: I-75 Interchange Modification at I-24, Phase 2 (IA)

DB2101

The undersigned certifies, to the best of his or her knowledge and belief, that **CHECK ONE**:

☐ **No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned**, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of **ANY** Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan or cooperative agreement.

☐ **If any funds other than Federal appropriated funds have been paid or will be paid** to any person for making lobbying contacts to an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with **THIS** Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying", in accordance with its instructions [as amended by "Government-wide Guidance for New Restrictions on Lobbying," 61 Federal Regulations 1413 (1/19/96). Note: Language in paragraph (2) herein has been modified in accordance with Section 10 of the Lobbying Disclosure Act of 1995 (P.L. 104-65, to be codified at 2 U.S.C. 1601, et seq.)].

The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code (as amended by the Lobbying Disclosure Act of 1995). Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

[Note: Pursuant to 31 U.S.C. §1352(c)(1)-(2)(A), any person who makes a prohibited expenditure or fails to file or amend a required certification or disclosure form shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each expenditure or failure.]

The Design-Builder, _____, certifies or affirms the truthfulness and accuracy of each statement of its certification and disclosure, if any. In addition, the Design-Builder understands and agrees that the provisions of 31 U.S.C. §3801, et seq., apply to this certification and disclosure, if any.

Date

Company Name

Signature

Name and Title

NOTE: DESIGN-BUILDER IS REQUIRED PURSUANT TO FEDERAL LAW TO INCLUDE THE ABOVE LANGUAGE IN SUBCONTRACTS OVER $100,000 AND TO OBTAIN THIS LOBBYING CERTIFICATE FROM EACH SUBCONTRACTOR BEING PAID $100,000 OR MORE UNDER THIS CONTRACT.

TECHNICAL PROPOSAL SIGNATURE PAGE
FORM TPSP

DESIGN-BUILDER:_____ TELEPHONE No. (___) _____

ADDRESS: _____

CONTRACTOR'S LICENSE No. _____

LICENSE CLASSIFICATION_____

PROJECT: I-75 Interchange Modification at I-24, Phase 2 (IA), Hamilton County (the "Project")

DB CONTRACT No.: DB2101

TO THE TENNESSEE DEPARTMENT OF TRANSPORTATION:

FIRM OFFER; SCOPE OF FIRM OFFER. The Design-Builder hereby submits this its Firm Offer in response to that Request for Proposals (RFP) issued _____,____20___, as amended by Addenda

Addendum No.	_____	Dated	_____
Addendum No.	_____	Dated	_____
Addendum No.	_____	Dated	_____
Addendum No.	_____	Dated	_____
Addendum No.	_____	Dated	_____
Addendum No.	_____	Dated	_____

to execute the Contract, consisting of the Contract Documents, as those terms are defined in the **DB Standard Guidance**, within the time period stipulated in the Contract Documents if awarded the Contract, and upon Contract execution to perform the Contract in accordance with its terms. Such Firm Offer shall remain open for a minimum of 180 Calendar Days from the original Proposal Due Date, or for such longer period to which the Design-Builder may consent. Notwithstanding the foregoing, the Design-Builder's execution of the Contract shall constitute evidence that its Firm Offer was held open to date of Contact execution.

The following portions of the Design-Builder's Technical Proposal and Price Proposal (collectively, its "Proposal") are included in this Firm Offer in accordance with the criteria established in the Design-Build Contract and all associated Contract Documents:

Technical Proposal: Those portions of the Proposal that meet or exceed TDOT's minimum Contract requirements, as determined by TDOT in its sole discretion, shall be incorporated into the resulting Contract as if fully set forth therein, and shall constitute additional minimum Contract requirements. Upon incorporation, such portions of the Proposal shall amend the minimum Contract requirements they exceed. Those portions of the Technical Proposal that do not meet or exceed the minimum Contract requirements established by TDOT shall **not** be incorporated into the Contract.

Price Proposal: The total of prices proposed in the Price Proposal "Schedule of Items" (the "Proposal Price"), shall be incorporated into the resulting Contract as if fully set forth therein.

EQUAL OPPORTUNITY CLAUSE. The Design-Builder, hereby certifies that **(CHECK ONE)** it has [ ] has not [ ], participated in a previous contract or subcontract subject to the equal opportunity clause, as required by Executive Orders 11246, 10925 and 11114 as amended, and that **(CHECK ONE)** it has [ ] has not [ ], filed with the Office of Federal Contract Compliance Program all reports due under the applicable filing requirements.

PROPOSAL SECURITY. By submitting this Proposal, the undersigned Design-Builder hereby agrees to be bound by the award of the Contract and, if awarded the Contract on this Proposal, to execute the required Contract and the required Contract Payment and Performance Bond within ten (10) days after receipt of notice of the award. The undersigned Design-Builder submits herewith the required Proposal guaranty in an amount of not less than five (5%) percent of the total amount of the Price Proposal drawn to the order of the Tennessee Department of Transportation offered and agrees and consents that the Proposal guaranty shall immediately be at the disposal of the Department, not as a penalty, but as an agreed liquidated damage if the required Contract and Contract Payment and Performance Bond are not executed within ten (10) days from receipt of the notice of award.

DBE PROJECT UTILIZATION GOAL is **10%**.

GOOD FAITH EFFORTS. The Design-Builder will either meet the DBE utilization goals identified herein or will make good-faith efforts to meet such goals. **(CHECK ONE)** YES [ ] NO [ ] or N/A [ ].

DESIGN-BUILDER DBE STATUS. The Design-Builder affirms that the Design-Builder is certified as a DBE under Tennessee Law: **(CHECK ONE)** YES [ ] NO [ ] or N/A [ ]. The Design-Builder affirms that one or more joint-venture partners of the Design-Builder is certified as a DBE under Tennessee Law: **(CHECK ONE)** YES [ ] NO [ ] or N/A [ ].

If the Design-Builder or a joint-venture partner of the Design-Builder is a DBE, answer the following:

Indicate both type of work to be performed by the DBE Design-Builder and **percent** of total Proposal Price represented by such work

_____.

Identify by name each joint venture partner certified as a DBE under Tennessee Law and include both type of work to be performed by each such joint venture partner and **percent** of total Proposal Price represented by such work

_____.

DESIGN-BUILDER AFFIRMATIONS.

The undersigned Design-Builder, its authorized representative, acknowledges, represents, attests, warrants and certifies that:

(1) By submitting this Proposal, the Design-Builder represents that it has carefully examined the Contract, which includes **Contract Book 1 (ITBD - Instruction to Design-Builders), Contract Book 2 (Design-Build Contract), Contract Book 3 (Project Specific Information)** and all referenced documents**,** the **DB Standand Guidance,** ;has carefully examined any Plans provided by the Department, the Standard Specifications for Road and Bridge Construction (January 1, 2021) adopted by the State of Tennessee, Department of Transportation, with subsequent revisions which are acknowledged to be a part of this Proposal, the Special Provisions, the Standard Drawings, the Proposal Form, the Form of Contract, All Contract Documents and Addenda; and thoroughly understands their stipulations, requirements, and provisions. The Design-Builder, acting through its authorized representatives, has read and understands, and agrees to be bound by and comply with all RFP instructions, terms and conditions, together with all Addenda, if any, issued.

(2) The Design-Builder, acting through its authorized representatives, has made a proper examination of the Project Site work described herein and all work locations and has become familiar with local conditions and the character and extent of the work.

(3) The Design-Builder, acting through its authorized representatives, has read and understands, and agrees to be bound by and comply with the terms of the Contract identified, included, or incorporated by reference into the RFP before submitting its Proposal.

(4) The Design-Builder has determined the quality and quantity of materials required; has investigated the location and determined the sources of supply of the materials required; has investigated labor conditions; and, has arranged for the continuous prosecution of the work herein described.

(5) By submitting this Proposal, the Design-Builder agrees to provide all necessary equipment, tools, labor, incidentals, and other means of construction, to do all the work, and furnish all the materials of the specified requirements which are necessary to complete the work in accordance with the Plans, the Specifications and all Contract Documents, and agrees to accept as payment in full therefor described in the Contract that are set forth in this Proposal. Compensation for "Extra Work" which may be required by the Department in connection with the construction and completion of the work but which was not reflected in the Proposal scope at the time of bidding, will be made in the following manner: work will be compensated in accordance with the applicable Contract Documents.

(6) The Proposal was prepared independently from all other Design-Builders, and without collusion, fraud, or other dishonesty.

(7) Neither the Design-Builder nor anyone representing the Design-Builder offered or gave any advantage, gratuity, bonus, discount, bribe or loan of any sort to TDOT or its agents, employees, or anyone representing TDOT, or engaged in any other type of anti-competitive conduct at any time during this procurement.

(8) If awarded the Contract, the Design-Builder shall utilize in performance of the Contract all resources indicated in its Proposal, including Major Participants, Key Personnel, and Design Professionals, to the extent within the Design-Builder's control and through application of the Design-Builder's best efforts.

(9) If awarded the Contract, the Design-Builder shall make all Personnel, including Design Professionals, identified in its Proposal available at all times and places required under the terms of the Contract, and shall ensure that such Personnel devote all efforts necessary for all periods of time necessary or required under the terms of the Contract, to timely fulfill all Contract obligations.

(10) The Design-Builder has the power and authority to enter into and perform the Contract to be awarded, and the Contract, when executed and delivered, shall be a valid and binding obligation enforceable according to its terms.

(11) If the Design-Builder is a joint venture or partnership, each joint venturor or partner has signed this Technical Proposal Signature Page on behalf of both itself and the Design-Builder, and each joint venturor or partner and the Design-Builder shall be jointly and severally liable for performing all of the duties and meeting all of the obligations of the Design-Builder under the terms of the RFP, Proposal and Contract to be entered into.

(12) The Design-Builder acknowledges that TDOT has the right to modify the Contract prior to execution to (a) correct typographical errors, (b) reconcile inconsistencies within and among the Contract Documents, (c) conform terminology used throughout the Contract, (d) include omitted terms clearly contemplated by the language in the Contract, (e) add terms required under State or federal law, and (f) incorporate those portions of the Technical Proposal and Price Proposal, as set forth under, if so, as may be authorized under applicable statutes and rules.

(13) The Design-Builder intends its Proposal Price to constitute full compensation for performance of all Contract obligations, including those additional minimum Contract requirements proposed in the Technical Proposal and incorporated in the Design-Build Contract.

(14) The Design-Builder agrees to be bound by and will comply in all respects with the terms of the resulting Contract upon award.

(15) TDOT will not be liable for any expenses incurred by the Design-Builder in preparing and submitting its Proposal or in participating in the Proposal evaluation/selection process.

(16) In the event the Design-Builder has engaged in unlawful anti-competitive conduct or behavior prohibited under the terms of the RFP during this procurement or lacks power or authority or fails for any reason to execute the Contract if awarded to it within the time period specified in the RFP or agreed to by the Parties, the Design-Builder shall forfeit its Proposal Security and be disqualified from further consideration for Contract award and eligibility for receipt of a Proposal stipend.

(17) The Design-Builder certifies that it is not under the control of any person, firm, partnership, or corporation, which has or exercises any control of any other person, firm, partnership, or corporation, which is submitting a Proposal on this Contract.

BEFORE ME APPEARING THE UNDERSIGNED AND BEING BY ME DULY SWORN, UPON HIS/HER OATH INDIVIDUALLY AND IN HIS/HER REPRESENTATIVE CAPACITY ON BEHALF OF THE DESIGN-BUILDER, DEPOSES AND STATES:

I, the undersigned, am a duly-authorized representative of the Design-Builder and have been authorized by the Design-Builder (a) to make in the name of and on behalf of the Design-Builder all acknowledgments, representations, attestations, warranties, and certifications contained herein and elsewhere in the Proposal, (b) to execute this Technical Proposal Signature Page and (c) by my signatures to bind the Design-Builder to the terms of its Proposal.

And further, that (a) the acknowledgments, representations, attestations, warranties, and certifications contained herein and elsewhere in the Proposal are true and correct, and (b) all copies of the Technical Proposal and Price Proposal submitted with the originals are true and correct copies of the originals. This is an official document that is required or authorized by law to be made under oath and is presented in an official proceeding. A person who makes a false statement in this certification is subject to the penalties of perjury.

______________________________ Sworn to and subscribed before me
Design-Builder (1)
this _________ day of ____________, __________

By: __________________________

______________________________ ______________________________
Printed Name and Title Notary Public
My commission expires ________________________

(Seal)

- -

______________________________ Sworn to and subscribed before me
Design-Builder (2)*
this _________ day of ____________, __________

By: ________________________

______________________________ ______________________________
Printed Name and Title Notary Public
My commission expires ________________________

(Seal)

*NOTE: The signature and information for Design-Builder (2) is to be provided when there is a joint venture.

*****THIS TECHNICAL PROPOSAL SIGNATURE PAGE MUST BE SIGNED IN BLUE INK. ANY ALTERATIONS, INTERLINEATIONS, OR ERASURES TO THE PROPOSAL MUST BE INITIALED ON THE ORIGINAL COPY IN INK BY THE SIGNATORY TO THIS TECHNICAL PROPOSAL COVER SHEET AND SIGNATURE PAGE.***

DESIGN-BUILD
RFP CONTRACT BOOK 3
PROJECT SPECIFIC INFORMATION

TENNESSEE DEPARTMENT OF TRANSPORTATION

I-75 Interchange Modification at I-24, Phase 2 (IA)

Hamilton County- TENNESSEE

CONTRACT NUMBER: DB2101

May 27, 2022

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1. GENERAL

This **Contract Book 3 (Project-Specific Information)** contains the requirements and conditions by which the Design-Builder shall design and construct the Project, except for any portions of the Work that may be stipulated within this **Contract Book 3 (Project-Specific Information)** to be performed by the Tennessee Department of Transportation (TDOT, or "the Department").

The order of precedence of **Contract Book 3 (Project-Specific Information)** with the other contract documents as is described in **Contract Book 2 (Design-Build Contract)**.

The Definition of Terms corresponding with this **Contract Book 3 (Project-Specific Information)** can be found in the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction and/or **Design-Build Standard Guidance** (**DB Standard Guidance**):

Design-Build_Standard-Guidance_04-28-22 (tn.gov)

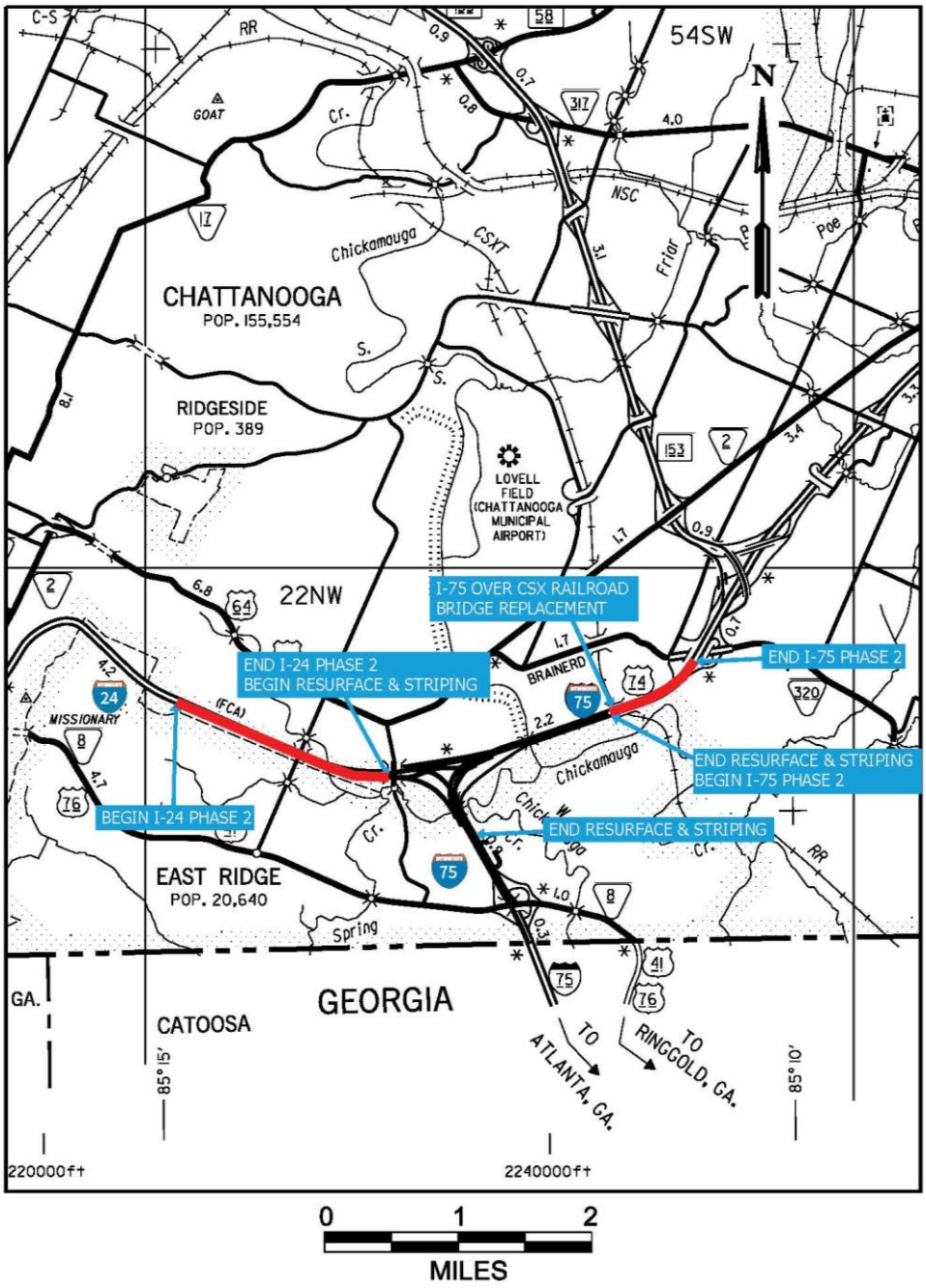
All Work shall be completed in accordance with the most current version of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction at the time of the Proposal Due Date, unless specifically stated herein.

○ *GENERAL PROJECT DESCRIPTION; SCOPE OF WORK*

The Design-Builder shall perform all surveying, design and construction services necessary to construct (roadway and structures) the I-75 Interchange Modification at I-24 Project (Phase 2) (the "Project").

The proposed project for Phase 2 of the modification and reconstruction of the I-24/I-75 Interchange in Hamilton County is generally bound on I-24 by the Germantown Road interchange to the west and the Spring Creek Rd. bridges to the east; and on I-75 from approximately 1,000 feet south of the I-75 bridge over CSX railroad to the south and the East Brainerd Road interchange to the north. The project will include the widening of I-75 and I-24 roadways to include additional lanes in each direction. The existing concrete section of I-24 will be removed and replaced with asphalt pavement. The Work on I-24 will also include interstate ramp modifications, and modifications to the existing drainage and proposed drainage improvements. The existing temporary ramps at I-24 and Germantown Road will be removed. Additionally, the project includes new bridges, new retaining walls and noise walls, concrete and asphalt paving, lighting, ITS relocations and upgrades, signal modifications, slide repair/stabilization, and areas of median barrier replacement. The Work on I-75 will include the bridge replacement on I-75 over CSX railroad to satisfy the minimum vertical clearance required and reconstruction of the roadway where profile changes are required. This project will also include resurfacing, new pavement marking installation, and signing required to satisfy the lane configurations shown in Phase 2 of Alternative 7 of the Interstate Access Request dated June 2012. An overview of the project is shown in the figure below.

PROJECT LOCATION MAP



The Design-Builder's general responsibilities with respect to the Scope of Work for the Project shall include without limitation the following, as more particularly described within this **Contract Book 3 (Project-Specific Information)**:

Segment 1

- Reconstruct all concrete pavement and shoulders on I-24 from S Germantown Road to Spring Creek Road with asphalt pavement;
- Replacing the existing median barrier with a 51-inch single slope concrete median barrier from Germantown Rd. to Spring Creek Rd along I-24;
- Reconstruct the existing interstate access ramps between Germantown Road and Spring Creek Road to the configuration shown on the Functional Plans;
- Replacing the storm sewer system from Germantown Rd. to Spring Creek Rd along I-24 for a complete operational system designed in accordance with TDOT's Drainage Manual. Drainage structures that can be retained and reused are limited to the following: STA 91+98 – 30" RCP, STA 99+52 – 36" RCP, STA 142+44 – 24" RCP, STA 145+02 – 24" RCP, STA 155+34 – DBL 8x7 RCBC, STA 175+78 (westbound roadway) - 48" RCP, and STA 176+52 (eastbound roadway) - 48" RCP;
- Widening to add an additional lane eastbound and westbound from Germantown Rd. to Moore Rd. and two (2) additional lanes eastbound and westbound from Moore Rd. to Spring Creek Rd along I-24 as shown on the Functional Plans;
- Removal of the existing temporary ramps between Germantown Road and Belvoir Avenue from N Terrace and S Terrace to I-24;
- Adding new noise walls along I-24;
- Replacing the S Moore Road and McBrien Road overpass bridges and approaches including new sidewalks, bike lanes, lighting, traffic signals and fencing as shown on the Functional Plans;
- Full depth repairs as required and milling and resurfacing all existing asphalt pavement on N Terrace and S Terrace from Germantown Road to Spring Creek Road;
- Repairing and stabilizing an existing slide on N Terrace located between Belvoir Avenue and S Moore Road;
- Removing and replacing all guardrail. Installing new guardrail in accordance with TDOT's Roadway Design Guidelines;
- Cleaning and placing new texture coat on all existing median barrier to be retained;
- Replacing all roadway lighting on I-24 between Germantown Road and Spring Creek Road. Replace all roadway lighting on N Terrace and S Terrace between Germantown Road and Spring Creek Road. Replace all roadway lighting on S Moore Road between N Terrace and S Terrace. Replace all roadway lighting on McBrien Road between N Terrace and S Terrace;
- Coordinating utility relocations in Segment 1;
- Relocating and improving ITS facilities in Segment 1;

- Installing new overhead signs and sign structures and update existing signs and sign structures to the ultimate build configuration as shown in the roll plots for Segment 1; and
- Replacing control access fence at locations detailed in this RFP for Segment 1.

Segment 2

- Widen I-75 northbound and southbound from approximately 400 ft south of the CSX Railroad bridge to the E Brainerd Road interchange;
- Replace the existing I-75 bridge over the CSX Railroad with a new structure (no modifications to the existing structure allowed) with a minimum vertical clearance of 23'- 6" above top of rail and shall provide a minimum horizontal clearance to provide offsets from the existing track and one future track without requiring crash walls;
- Reconstruct portions of I-75 necessary to achieve a new vertical profile to accommodate the new bridge over the CSX Railroad with new concrete pavement in accordance with the design criteria. All existing overhead structures to be retained in the area of reconstruction shall be modified to maintain the required minimum vertical clearance of 17' 6". The existing retaining wall along the shoulder of I-75 NB approximately between STA 440+50 and 443+50 shall be modified as required to accommodate the new vertical profile;
- Replacing the existing median barrier with a 51-inch single slope concrete median barrier from approx. 750 ft south of the CSX railroad crossing bridge to approximately 500 ft north of the CSX Railroad bridge (areas of profile change) along I-75;
- Rehabilitating the existing concrete pavement from approx. 300 ft north of the CSX Railroad bridge to East Brainerd Road;
- Removing and replacing all guardrail. Installing new guardrail in accordance with TDOT's Roadway Design Guidelines;
- Cleaning and placing new texture coat on all existing median barrier to be retained on I-75 from 400 ft south of the CSX Railroad bridge to the E Brainerd Road bridge;
- Replacing all lighting on I-75 from 400 ft south of the CSX Railroad bridge to the E Brainerd Road bridge;
- Coordinating utility relocations in Segment 2;
- Relocating and improving ITS facilities in Segment 2;
- Installing new overhead signs and sign structures and update existing signs and sign structures to the ultimate build configuration as shown in the roll plots for Segment 2; and
- Replacing control access fence at locations detailed in this RFP for Segment 2.

Segment 3

- Resurface and restripe the I-75 southbound to I-24 westbound interstate-to-interstate ramp, I-24 eastbound from just west of Spring Creek Road to I-75 northbound interstate-to-interstate ramp and I-75 southbound from 400 ft south of the CSX Railroad bridge through the interchange to just west of Spring Creek Road to the ultimate build configuration;
- Resurface and restripe the I-75 northbound to I-24 westbound interstate-to-interstate ramp, the I-24 eastbound from just west of Spring Creek Road to I-75 southbound interstate-to-interstate ramp and I-75 northbound through the interchange to 400 ft south of the CSX Railroad bridge to the ultimate build configuration;
- Update and install new signs on the existing sign structures to the ultimate build configuration as shown in the roll plots for Segment 3; and
- Replacing control access fence at locations detailed in this RFP for Segment 3.

○ *PROJECT GOALS*

The Project's primary purposes are to provide present and future congestion relief, reduce high crash rates and address deficiencies of the existing interchange to meet the intent of the approved Interstate Access Request (IAR). The following goals have been established for the Project (not listed in any specific order):

- Minimize inconvenience to the public during construction;
- Provide a management system or approach that ensures the requirements of the Project will be met or exceeded;
- Provide a high-quality project that minimizes future maintenance;
- Provide a solution consistent with the Department's Roadway Design Standards;
- Adhere to local, state, and federal environmental regulations and/or permits required in executing and/or completing the Project;
- Incorporate Best Management Practices (BMPs) to control sediment, storm water runoff/discharge, or other environmental parameters established for the Project;
- Implement innovative solutions to maximize the return on taxpayer investment by reducing costs, limiting project delivery time, limiting traffic impacts during construction or improving quality of the transportation system;
- Complete construction as quickly as possible and not later than October 30, 2026;
- Incorporate safety into all aspects of design and construction with the goal of zero incidents and accidents; and
- Provide a visually pleasing finished product.

○ *REFERENCE DOCUMENTS*

The Functional Plans and Department-supplied materials are listed in **Appendix B - Reference Documents**. All documents have been published on the Department's Project website:

https://www.tn.gov/content/tn/tdot/tdot-construction-division/transportation-construction-alternative-contracting/design-build-project-i-75-interchange-at-i-24-phase-ii.html

The Design-Builder shall acknowledge that Reference Documents are preliminary and provided solely to assist the Design-Builder in the development of the Project design. The Design-Builder shall be fully responsible for the accuracy and completeness of all Work performed under this Contract. The Design-Builder shall be fully liable and hold the Department harmless for any additional costs and all claims against the Department which may arise due to errors, omissions and negligence of the Design-Builder in performing the Work required by this Contract.

The Design-Builder is responsible for verifying all information provided by the Department.

○ *DBE GOAL*

The assigned Disadvantaged Business Enterprise (DBE) goal for this Project is 10%. The Design- Builder shall exercise all necessary and reasonable steps to ensure that DBEs participate in at least the percent of the total project cost set forth above as the goal. The Design-Builder shall require all Subcontractors to also comply and make good faith efforts in achieving this goal and shall comply with all requirements of 49 Code of Federal Regulations (CFR) part 26.

○ *ON-THE-JOB/APPRENTICESHIP TRAINING*

On-the-Job/Apprentice Training is required on this Project and shall be included in the bid document and special provision. See for further information Section 7.2.11 of the **DB Standard Guidance.**

2. PROJECT MANAGEMENT

The Design-Builder shall prepare and administer a Project Management Plan (PMP) containing the Design-Builder's approach to managing the design and construction activities of the Project in accordance with the **DB Standard Guidance** and the specific requirements defined herein.

The PMP shall contain, at a minimum, the following component parts:

- Organizational Structure and Staffing Plan
- Critical Path Method (CPM) Schedule
- Quality Management Plan
    - Design Quality Management Plan
    - Construction Quality Management Plan
    - Environmental Management Plan
    - Safety and Health Plan
- Public Relations and Public Information Plan
- Records Management Plan

Within 30 Days of Contract Award, the Design-Builder shall meet with the Department at the Post-Award Meeting to discuss development of the components of the PMP for Review and Acceptance by the Department prior to the start of any Work.

The Design-Builder shall use the Project Understanding and Approach, and the Project Management and Approach submitted with the Proposal as a foundation to prepare the PMP component plans. The Design-Builder shall implement all elements of the PMP.

The successful Design-Builder is required to utilize PlanGrid software for the project. All project submittals shall be uploaded to PlanGrid and include an email with the transmittal letter to the Departments to initiate review of the material. The Design- Builder shall contact PlanGrid directly to obtain usage license and service information. Information about PlanGrid and contact information for purchasing licenses at TDOT's special rate can be found at the following link:

https://www.tn.gov/tdot/tdot-construction-division/transportation-construction-division-resources/plangrid.html

○ *ORGANIZATIONAL STRUCTURE AND STAFFING PLAN*

The Design-Builder shall prepare an Organizational Structure and Staffing Plan for the purpose of ensuring that appropriate qualified staff are employed by the Design-Builder to perform the Work and are able to carry out the Work in a manageable and safe manner.

The plan shall identify the Key Personnel and key management staff including Level "1" Personnel and Level "2" Personnel identified in the Statement of Qualifications (SOQ) and on the Response Category II Form.

The Design-Builder shall provide an organizational chart that graphically represents the

hierarchy and functional interaction of the Key Personnel and indicates the functional responsibilities of each. The organizational chart shall be part of the PMP.

The organization shall be monitored, and the chart updated and provided to the Department when changes to the Design-Builder's organizational chart occur.

Staffing Requirements

The Design-Builder shall provide to the Department, within 15 calendar days after the initial Notice to Proceed (NTP), a list of the contacts (and contact details) of Key Personnel on site and Key Personnel on call who are available 24 hours per day during the executions of the Work.

The Design-Builder shall include a procedure for a structured and managed replacement of Key Personnel on the project team of the Design-Builder.

Any licenses or certifications that are required to meet the requirements of the Request for Qualifications (RFQ) and Request for Proposals (RFP) shall be in place by the time the first NTP is issued.

○ *PROJECT SCHEDULE AND COST MANAGEMENT*

CPM Schedule Submittal

The Design-Builder shall prepare a Critical Path Method (CPM) Schedule, in accordance with the Department's Circular Letter 108.03.C and Chapter 3 of the **DB Standard Guidance** and the requirements herein, for review at the Post Award Meeting.

The Design-Builder shall use the preliminary CPM Schedule submitted with the Proposal as a foundation to prepare a Project CPM Schedule and shall submit it to the Department for Review and Acceptance. Acceptance of the initial Project CPM Schedule by the Department shall be a condition of starting any Work. The Design-Builder shall submit an updated Project CPM Schedule on a monthly basis for the Department's Review and Comment in accordance with Department's Circular Letter 108.03.C and Chapter 9 of the **DB Standard Guidance**. The Design-Builder shall provide a narrative with each CPM Schedule submittal, which shall include:

- A detailed description of the status of the Project and changes to the CPM;
- Identification of strategies for mitigation of Project risks or issues impacting the CPM Schedule describing constraints and discussing contingencies;
- How the proposed project phasing and sequence of Work and allocation of resources enables the Design-Builder to progress the Work to achieve the contractual completion dates;
- How the phasing ensures timely deliveries of materials to achieve the CPM Schedule milestones;
- Identification of categories of Work performed by Design Builder's own direct labor force and those performed by Subcontractors; and

- Pay Item activities and all Work included in the Pay Item activities corresponding to totals as reflected on the Schedule of Items.
- Any other requirements from the Department's Circular 108.03.C and Chapter 9 of the **DB Standard Guidance**

The Design-Builder shall include all Design Reviews submittals and any resubmittals in the CPM Schedule in order for the Department to appropriately allocate resources for performing the reviews and to track and document any possible schedule impacts. The Department will review as many submittals as it can within the limitations of its staff; however, at TDOT's sole discretion, it may limit the number of reviews, submissions, and resubmissions in a given month. Ten (10) business days shall be allocated in the CPM Schedule for activities requiring the Department's Review and Acceptance, or Review and Comment, unless otherwise indicated in a Special Provision or third-party review.

Schedule and Cost Controls

The Design-Builder shall develop procedures for schedule and cost control on the Project, including the cost control and schedule management system to be used to control and coordinate the cost and schedule of the Work.

All submittals required to be reviewed and approved by third-party stakeholders shall be tracked individually. Each such submittal shall have separate activities that track submittal development, required reviews, and revisions either required by third-party stake holders, the Department, or the Design-Builder.

The cost-control approach shall include a description of the proposed approach for calculating progress performance for preparing the monthly payment requests using the Pay Item activities, Schedule of Items and CPM Schedule. Schedule shall be time and cost loaded, depicting Pay Items and subordinated activities and their respective prices (distributed over time). The Design-Builder shall include a procedure for re-scheduling of its Work to achieve schedule recovery objectives and how these objectives will be enforced with its work force and subcontractors.

Liquidated Damages for Failure to Meet Completion Deadline

The Design-Builder shall complete the Project within the time limitations set forth in **Contract Book 2 (Design-Build Contract)** and Special Provision 108B.

If the Design-Builder fails to complete the Project within the time limitations set forth in the Contract, then the Department will suffer substantial losses and damages. The Contract therefore provides that a sum shall be deducted from monies due the Design-Builder, not as a penalty, but as Liquidated Damages, if such completion is delayed.

If Design-Builder fails to complete all Work specified in the contract on or before the Design-Builder's completion date, set forth in RFP Book 2 Section D.3, a sum of money equal to **$30,000** per Calendar Day for the first 30 calendar days after the Design-Builder's completion date shall be deducted from monies due to the Design-Builder, not as penalty, but as liquidated damages. For each calendar day thereafter, a sum of money equal to **$100,000** shall be deducted

from monies due to the Design-Builder, not as a penalty, but as liquidated damages.

The Time Value (B) used for calculation of selection is **$30,000**.

The Time Value (C) used for the calculation of selection is **$50,000.**

○ *QUALITY MANAGEMENT PLAN*

The Design-Builder shall establish and implement a Quality Program and prepare a Quality Management Plan in accordance with Section 2.5 of the **DB Standard Guidance** and the requirements herein. Additionally, the Quality Plan shall also include:

- Design Quality Management Plan
- Construction Quality Management Plan
- Environmental Management Plan
- Safety and Health Plan

The Department expects Quality Program improvements throughout the delivery of the entire Project. It is of the utmost importance that the Design-Builder involves its staff and partners with the Department to ensure overall Project satisfaction. The Department will strive for an oversight role in the Quality Program for the Project; however, this will only be possible if the Design-Builder's Quality Program exhibits sufficient staff and sound processes and practices that place quality design and workmanship above production and/or cost by all team members. The Design-Builder's Schedule shall allow for the Department's involvement.

Design Quality Management Plan

The Design Quality Management Plan (DQMP) shall conform to the requirements of Section 5 of the **DB Standard Guidance** and describe:

- Quality roles and responsibilities of the Design-Builder's design Quality Team, including but not limited to the Design Quality Manager (DQM) and Design Manager;
- Procedures for implementing the design Work;
- Design development, submittal and design review process for preparation of final signed and sealed construction plans used to construct the proposed improvements;
- Processes and procedures for the Department's Review and Acceptance prior to starting any design Work;
- Quality control and quality assurance procedures for ensuring the quality of design Work and conformance**,** including design-quality checks and certifications, and independent Design Reviews prior to submittal for the Department's Review and Acceptance.

The DQMP shall provide all Design Documents and perform Design Reviews in accordance with the Design Review schedule established in the CPM Schedule, and in accordance with Contract requirements. Ten (10) business days shall be allocated in the CPM Schedule for

activities requiring the Department's Review and Acceptance, or Review and Comment, unless otherwise indicated in a Special Provision or third-party review.

The Design Manager shall be responsible for design quality control and ensuring that the design submittals and design reviews are performed in accordance with the DQMP and the Contract Documents. In accordance with Section 2.5.2 of the **DB Standard Guidance**, the DQM shall provide an independent review and certify that the Design Documents comply with all Contract requirements (QA/QC Stamps) prior to requesting Review and Acceptance by the Department. Failure by the Design-Builder to perform its Quality Management function will result in the immediate rejection of the Design Documents and the Design-Builder shall revise and resubmit. Additional review comments may be added to the resubmission by the Department.

The DQMP shall describe how nonconformances are identified and tracked, how resolutions to nonconformances are developed, and how the actions taken to correct nonconformances are documented, either in Design Documents or construction records and reviewed or re-inspected. This section will apply to both design and construction of the Project. The Design Engineer who signed the applicable Design Documents shall review and approve all resolutions of nonconformances that require design changes, repairs, or rework.

The DQMP shall describe the corrective and preventive actions the Design-Builder will take upon the identification of actual or potential major and systemic nonconformances, identified internally or by TDOT. The Design-Builder shall advise TDOT when corrective action has been implemented so that TDOT may verify implementation, should TDOT so choose. This section will apply to both design and construction of the Project.

The DQMP shall be submitted for the Department's Review and Acceptance prior to starting any design work.

Construction Quality Management Plan

The Construction Quality Management Plan (CQMP) shall describe the quality roles and responsibilities of the Design-Builder's construction Quality Team and procedures for implementing the construction work in accordance with Chapter 7 of the **DB Standard Guidance**.

Although the Department will provide Construction Engineering and Inspection (CEI) and Quality Assurance Testing, the Design-Builder is responsible for ensuring the quality of the Work and shall prepare procedures in the CQMP for quality control of materials and how the Design-Builder plans to inspect the project to ensure compliance with the Contract Documents.

The Construction Manager shall be responsible for quality control during construction and ensuring that quality control testing and inspections are performed in accordance with the CQMP and the Contract Documents. In accordance with Section 2.5.3 of the **DB Standard Guidance**, the Design-Builder shall provide a Construction Quality Manager (CQM) to oversee, manage, certify and perform construction Quality Management activities. The CQM shall independently review the submittals for the Department, and upon completion shall certify to the Department that the information is accurate and complete. The CQM shall certify

that all Work Product has been checked and/or inspected by the Quality Team, and that all Work complies with the Contract Documents. The CQM shall also certify to the Department that the CQMP and all measures, protocols, and procedures provided therein, are functioning properly and are being followed. The Design-Builder shall guarantee and provide full cooperation in relation to CEI, audits, reviews, request for information etc.

The CQMP shall be submitted for the Department's Review and Acceptance prior to starting any construction work.

Environmental Management Plan

The Design-Builder shall prepare an Environmental Compliance Plan (ECP) in accordance with Section 2.5.4 of the **DB Standard Guidance**.

Safety And Health Plan

The Design-Builder shall prepare a Safety and Health Plan in accordance with Section 2.5.5 of the **DB Standard Guidance**.

○ *PUBLIC RELATIONS AND PUBLIC INFORMATION PLAN*

The Design-Builder shall comply with Section 7.2.8 of the **DB Standard Guidance** and address the following the project-specific requirements:

Internal and External Communications

The Design-Builder shall describe the internal and external communication process between the Design-Builder and the Department, the Department's staff, external stakeholders, third parties and public affected by the Work.

The Design-Builder shall provide all information required for communication purposes. The communication activities are mainly intended for the Department and Department staff (internal stakeholders) but shall also focus on neighboring public and communities (e.g., City of East Ridge), companies and organizations, emergency services, Hamilton County, City of Chattanooga, environmental agencies, CSX Transportation, referenced utilities and other external services.

The focus on the construction communication shall support the following goals:

- Ensure that the entire Project is executed in the least disruptive and positive manner possible for the Department.
- Maintain the best possible long-term relations with all relevant external stakeholders.
- Ensure that the Work is performed in the most effective and efficient way.

Handling Complaints

The Design-Builder shall process complaints that result from performing the Work, whether received directly or through the Department to the Design-Builder, as soon as possible and

react in a proactive way.

The Design-Builder shall notify the Department within two hours after receiving a complaint and inform what actions will be taken in order to resolve the cause of the complaint.

The Design-Builder shall keep a complete and updated complaint register of all complaints received, addressed directly to the Design-Builder or through the Department.

The complaint register shall include all relevant information in relation to the complaint (who, when received, contents), the actions planned concerning the complaint, the person(s) responsible for the communication and the status of the complaints (open, closed) and be available to the Department upon request.

The Design-Builder shall coordinate all public communication with the Department.

Provide Information for Project Website

The Design-Builder shall coordinate with the Department and provide Project-related information to the Department for Review and Acceptance including:

- Contact information;
- Project maps;
- Current Project activities and progress;
- Timing of street and interstate ramp closures and openings;
- Recommended route alternatives during closures, with maps;
- Newsletters and meeting materials; and
- Calendar of, and announcements for, meetings and special events.

Liaison with the Media

Unless otherwise specifically authorized in writing by the Department, the Design-Builder shall provide no news release, press release, or any other statement to a member of the news media regarding this Project. The Design-Builder shall require this clause within all Subcontractors agreements.

○ *RECORDS MANAGEMENT PLAN*

The Design-Builder shall describe procedures for managing and maintaining Project record documents in accordance with Sections 5.2.11 and Chapter 7 of the **DB Standard Guidance** and the project-specific requirements herein.

The Department will perform a combination of audits, reviews, inspections etc. to assess whether the Design-Builder's integrated project management is functioning properly and determine whether its records and information are reliable and up to date.

Upon completion of the Project, the Design-Builder shall provide the State Innovative Delivery Office a transmittal letter, an electronic copy (CAD and signed PDF's) of the As-Built

drawings, and final foundation type, including footing elevations and lengths of individual piles, prior to final payment of funds to the Design-Builder.

The Professional Engineer in charge of the development of the Project plans shall place his seal, including signature and date, on the right side of the title sheet. All plan sheets shall contain the seal, including signature and date, of the Professional Engineer in charge of its development.

The As-Built Plans and the Design-Builder Specifications following construction completion shall incorporate any changes to the Readiness-for-Construction Design Review Plans and Specifications, changes made during construction as well as all utility locations within Right-of-Way (ROW) as described in the **DB Standard Guidance.**

Upon completion of the Project, the Design-Builder shall provide TDOT Structures Division a final revised set of plans for all structures (bridges, walls, etc.). The plans shall be delivered electronically via a cloud-based solution as agreed to by the Department. Bridge plans and design calculations shall not be bundled and must be sent as individual files labeled “Bridge Plans Only” and “Bridge Design Calculations Only” respectively for each bridge.

3. ROADWAY

The roadway shall be designed to adhere to the latest editions of all appropriate TDOT Roadway Standard Drawings, TDOT Roadway Design Guidelines and Instructional Bulletins, TDOT Drainage Manual, TDOT Traffic Design Manual, TDOT Design CADD Standards, TDOT Survey Manual and the Department accepted AASHTO *Policy on Geometric Design of Highways and Streets*, and *Manual on Uniform Traffic Control Devices (MUTCD)* in effect at the time of procurement.

Microstation and Geopak or OpenRoads Designer (ORD) shall be used in the development of 3D parametric modeling to provide model-centric design deliverables. If the Design-Builder uses ORD, the Design-Builder shall use ORD in accordance with requirements and guidelines provided on TDOT's website:

www.tn.gov/tdot/roadway-design/tdot-cadd-support/tdot-openroads-designer.html

o GENERAL

The Project shall consist of the following I-24 and I-75 Segments:

Segment 1 (I-24 from S. Germantown Road to Spring Creek Road) shall consist of:

- Reconstruct all concrete pavement and shoulders to asphalt pavement;
- Replace the median barrier with a 51-in single slope concrete median barrier;
- Reconstruct the existing interstate access ramps to the configuration shown in the Functional Plans;
- Replace the storm sewer system for a complete operational system designed in accordance with TDOT's Drainage Manual. Drainage structures that can be retained and reused are limited to the following: STA 91+98 – 30" RCP, STA 99+52 – 36" RCP, STA 145+02 – 24" RCP, STA 155+34 – DBL 8x7 RCBC, STA 175+78 (westbound roadway) - 48" RCP, and STA 176+52 (eastbound roadway) - 48" RCP;
- Widening to add an additional lane eastbound and westbound from Germantown Rd. to Moore Rd. and two (2) additional lanes eastbound and westbound from Moore Rd. to Spring Creek Rd. along I-24 as shown on the Functional Plans;
- Removal of the existing temporary ramps between Germantown Road and Belvoir Avenue from N Terrace and S Terrace to I-24;
- Adding new noise walls along I-24;
- Replacing the S Moore Road and McBrien Road overpass bridges and approaches including new sidewalks, bike lanes, lighting, traffic signals and fencing as shown on the Functional Plans;
- Full depth repairs as required and milling and resurfacing all existing asphalt pavement on N Terrace and S Terrace;

- Repairing and stabilizing an existing slide on N Terrace between Belvoir Avenue and S Moore Road;
- Removing and replacing all guardrail. Installing new guardrail in accordance with TDOT's Roadway Design Guidelines;
- Cleaning and placing new texture coat on all existing median barrier to be retained;
- Replacing all roadway lighting on I-24. Replace all roadway lighting on N Terrace and S Terrace. Replace all roadway lighting on S Moore Road between N Terrace and S Terrace. Replace all roadway lighting on McBrien Road between N Terrace and S Terrace;
- Coordinating utility relocations;
- Relocating and improving ITS facilities;
- Installing new overhead signs and sign structures and update existing signs and sign structures to the ultimate build configuration; and
- Replacing control access fence.

Segment 2 (I-75 from approximately 400' south of the CSX Railroad bridge to near the E. Brainerd Road Interchange) shall consist of:

- Widen I-75 northbound and southbound;
- Replace the existing I-75 bridge over the CSX Railroad with a new structure (no modifications to the existing structure allowed) with a minimum vertical clearance of 23' - 6" above top of rail and shall provide a minimum horizontal clearance to provide offsets from the existing track and one future track without requiring crash walls;
- Reconstruct portions of I-75 necessary to achieve a new vertical profile to accommodate the new bridge over the CSX Railroad with new concrete pavement in accordance with the design criteria. All existing overhead structures to be retained in the area of reconstruction shall be modified to maintain the required minimum vertical clearance of 17' 6". The existing retaining wall along the shoulder of I-75 NB approximately between STA 440+50 and 443+50 shall be modified as required to accommodate the new vertical profile;
- Replacing the existing median barrier with a 51-inch single slope concrete median barrier from approx. 750 ft south of the CSX railroad crossing bridge to approximately 500 ft north of the CSX Railroad bridge;
- Rehabilitating the existing concrete pavement from approx. 300 ft north of the CSX Railroad bridge to East Brainerd Road;
- Removing and replacing all guardrail. Installing new guardrail in accordance with TDOT's Roadway Design Guidelines;
- Cleaning and placing new texture coat on all existing median barrier to be retained;
- Replacing all lighting;

- Coordinating utility relocations;
- Relocating and improving ITS facilities;
- Installing new overhead signs and sign structures and update existing signs and sign structures to the ultimate build configuration; and
- Replacing control access fence.

The following concrete repair quantities are anticipated:

Concrete Repair (Full Depth): 2,000 C.Y.

Hot Applied Fiber-Polymer Patching Material: 9,000 POUNDS

Repair of spalls, minor potholes, and missing or replaced snow plowable markers in the existing concrete pavement shall be repaired using Special Provision 502FRP.

Concrete repairs shall be performed in accordance with Special Provision 502A and Standard Drawing RP-J-23.

Following concrete repairs, all existing concrete pavement on I-75 shall be ground and the joints sawed, cleaned, and sealed in accordance with Special Provision 502J and 503.

High early strength concrete is prohibited for new concrete roadway pavement unless otherwise approved by the Department.

Segment 3 (I-75 Interchange with I-24 from just west of the Spring Creek Road overpass on I-24 to approximately 400' south of the CSX Railroad bridge on I-75 North and just north of the Tennessee Welcome Center on I-75 South) shall consist of:

- Resurface and restripe the I-75 southbound to I-24 westbound interstate-to-interstate ramp, I-24 eastbound from just west of Spring Creek Road to I-75 northbound interstate-to-interstate ramp and I-75 southbound from 400 ft south of the CSX Railroad bridge through the interchange to just west of Spring Creek Road to the ultimate build configuration;
- Resurface and restripe the I-75 northbound to I-24 westbound interstate-to-interstate ramp, the I-24 eastbound from just west of Spring Creek Road to I-75 southbound interstate-to-interstate ramp and I-75 northbound through the interchange to 400 ft south of the CSX Railroad bridge to the ultimate build configuration;
- Update and install new signs on the existing sign structures to the ultimate build configuration; and
- Replacing control access fence.

Payment for Select Quantity Overruns

The following table is provided to cover select quantities that are above those anticipated in the scope. Additional repair areas/quantities shall be pre-approved (in writing) by the Department prior to commencing Work or no payment will be received, see **DB Standard Guidance** section 2.11.2 for additional details. No payment will be provided for repairs required due to Work being

performed by the Design-Builder. When the Design-Builder utilizes any item in the table below, he must provide the Department with an invoice detailing the location, purpose, and quantity used, for tracking purposes. Failure to provide invoices throughout the progress of the Project may result in non-payment for overrun quantities.

ITEM	TYPE	UNIT	UNIT PRICE	QUANTITY
Uniformed Police Officer	As specified by Special Provision 712DB-PO	HOUR	$60	Hours exceeding 20,000
Temporary Traffic Control	Changeable Message Sign (CMS) Unit	EACH	$6,500	Signs exceeding 15 Note: CMS for PSWZ not included in quantity.
Concrete Repairs	FULL DEPTH PCC PAVEMENT REPAIR	C.Y.	$750	Quantity that exceeds 2,000 C.Y.
	HOT APPLIED FIBER-POLYMER PATCHING MATERIAL	POUND	$4.50	Quantity that exceeds 6500 POUNDs

Design Requirements

Reference DB Standard Guidance: § 9.2.6, 9.2.7 & 2.11.2 The proposed horizontal and vertical alignments of I-75 and I-24 shall be designed and constructed to meet or exceed a minimum 60-mph design speed for a rolling urban freeway. TDOT Design Standards supersede Green Book requirements where applicable.

All proposed ramps and crossroads shall be designed and constructed to match the design speeds shown on the Functional Plans. On-ramps that merge into mainline lanes (do not become a continuous lane) shall be designed in accordance with the minimum acceleration length required in the Green Book. In cases where sight distance may be limited by an obstruction between the ramp and the mainline lanes, the minimum length shall be increased to include stopping sight distance as required by the Green Book once the obstruction is cleared plus the minimum acceleration length required.

All ramps: Traffic lanes on ramps with 2 or more lanes shall be 12 ft. wide. Traffic lanes on one-lane ramps shall be 16 ft. wide. Outside shoulders shall be a minimum of 6 ft. wide (stabilized) and inside shoulders shall be a minimum of 4 ft. wide (stabilized).

I-24: Typical section shall consist of 12-ft inside shoulders, 12-ft traffic lanes (one lane draining toward the median barrier with total number of lanes as shown in the Functional Plans), and 12-ft outside shoulder (10-ft stabilized if open shoulder and full width stabilized if adjacent to concrete barrier rail) except in areas where a design exception has been previously approved at the Belvoir Avenue underpass.

Terraces: Full depth pavement replacement, subgrade repair, and drainage repair will be required in certain locations as shown in the below table.

Location	Approx. Begin STA	Approx. End STA	Repair
North Terrace	90+15	95+70	Full depth pavement replacement and resolve drainage issues. Water ponds on right side of road at bottom of sag.
North of I-24 WB	100+55	102+60	Fix drainage issues at along N. Terrace. Remove/upgrade existing area drainage
North Terrace	104+70	114+85	Full depth pavement replacement, left lane
North Terrace	140+70	144+10	Full depth pavement replacement, left lane
South Terrace	606+50	608+60	Replace guardrail

All local roads and terraces: All disturbed storm sewer manhole lids will be reset to be flush with the pavement in accordance with City of Chattanooga standards. Adjustments to other utilities will be made by the utility company. Existing catch basin grates shall be replaced with bicycle/pedestrian safe grates.

S. Moore Road: Bridge and approach typical sections (between the bridge ends and the Terraces) shall consist of 5 @ 11-ft. traffic lanes, 5-ft. bicycle lane with a 6-ft. buffer on both sides of the roadway, and 6-ft. sidewalk on both sides of the roadway. The roadway typical section beyond the Terraces will transition back to the existing conditions using tapers/transitions as shown on the Functional Plans.

McBrien Road: Bridge and approach typical sections (between the bridge ends and the Terraces) shall consist of 4 @ 11-ft. traffic lane, 5-ft. bicycle lane with a 6- ft. buffer on both sides of the roadway, and 6-ft. sidewalk on both sides of the roadway. The roadway typical section beyond the Terraces will transition back to the existing conditions using tapers/transitions as shown on the Functional Plans.

I-75: Typical section for widening only shall consist of existing 11-ft inside shoulder (stabilized), 12-ft traffic lanes (total number of lanes as shown in the Functional Plans), 12-ft outside shoulder (10-ft stabilized if open shoulder and full width stabilized if adjacent to concrete barrier rail). Reconstructed roadway for profile changes: Inside shoulder shall be 11-ft wide, 5 travel lanes shall be 12-ft wide (maximum of two lanes draining toward the median barrier) and outside shoulder shall be 12-ft wide (10-ft stabilized).

Vertical clearances over roadways for all alignments (entire roadway width including the full shoulder width) shall have a 16 ft., 6 in. minimum vertical clearance and all overhead sign

structures for all alignments shall have a 17 ft., 6 in. minimum vertical clearance. Vertical clearance over the CSX Railroad shall be a minimum of 23 ft., 6in. over the highest point of existing and future track. Reduction of existing vertical clearances will not be allowed during any construction phases of the Project. This requirement shall include all temporary roadway surfaces used during construction. The Design-Builder shall submit plans as outlined in the TDOT Design Guidelines to the TDOT Structures Division for Grade Approval.

The Design-Builder shall be responsible for the design and construction of all proposed overhead structures within the Project limits. The Design- Builder shall ensure minimum vertical clearance is provided throughout the duration of construction and upon completion of the Project as defined in the TDOT Roadway Design Guidelines. The Design-Builder shall submit plans as outlined in the TDOT Roadway Design Guidelines to the TDOT Structures Division for Grade Approval.

The Design-Builder shall be responsible for preparation of final signed and sealed construction plans used to construct the proposed improvements. They shall be prepared in accordance with TDOT's Design Guidelines and the previous design standards referenced in this section.

If the Design-Builder wishes to change the horizontal or vertical alignment or deems that additional ROW is needed outside of the proposed ROW as shown in the Functional Plans, they shall be responsible for any and all additional environmental technical studies and completion of the re-evaluation of the NEPA document modification and approvals to the Interstate Access Request (IAR), ROW appraisals and acquisitions, utilities coordination/relocation and any permits necessary.

The ramp construction and closures shall be phased in accordance with Special Provision 108B. Access to all side roads shall be maintained throughout the duration of construction except where specifically allowed in Special Provision 108B.

The Design-Builder shall identify the need for any special roadway design details (i.e., any special drainage structures, rock embankment, special guardrail, retaining walls, concrete barrier designs, etc.) and shall provide special design drawings to the Department for Review and Acceptance.

The Design-Builder shall ensure that all applicable "General and Special Notes" found in Section VI of the current edition of the TDOT Roadway Design Guidelines are adhered to during construction.

The geometric configurations of all roadway components shall be designed to provide adequate drainage and prevent hydroplaning (during construction and when complete). Cross slopes shall be in accordance with the requirements of the roadway typical section as shown in the Functional Plans. Design-Builder shall provide hydraulic calculations (including spread calculations) to the Department.

All permanent proposed slopes associated with the roadway shall be sodded.

All existing access-control fence located within the Project limits as shown on the Functional Plans shall be replaced with new access-control fence except in those areas where a noise wall is required, and the fence can be tied to it and maintain a continuous control of access.

All permanent and temporary safety appurtenances (sign supports, guardrail, barrier rail, impact attenuators, etc.) shall meet current TDOT standards and shall have all required Department certification documents.

All curb ramps within the Project Limits shall comply with the Americans with Disabilities Act (ADA) Standards for Accessible Design.

Portions of the City of Chattanooga are protected from flooding by a system that includes levees, walls, pumps and other earthworks. The area along the western section of this Project that stretches from Belvoir Avenue to west of Spring Creek Road is in close proximity or contains several of these flood control measures. No modification or excavation of the flood wall along North Terrace between Spring Creek Road and McBrien Road, and the flood wall along North Terrace between McBrien Road and S. Moore Road will be allowed. No excavation shall be allowed within two ft of these existing flood walls. The Design-Builder shall not impact the existing Brainerd Levee Pump Station System located within the existing right-of-way. Any impacts to the above facilities shall be the responsibility of the Design-Builder, including all costs associated with recertification through FEMA and the City of Chattanooga costs for review prior to submission.

Deviations and Exceptions

The functional design of the Project is based upon an approved Interstate Access Request (IAR) (original and modifications for Phase 2). Any deviations from the approved IAR including ingress and egress points will require coordination the Federal Highway Administration (FHWA) and may require a revision and approval from the Federal Highway Administration to the IAR.

The Design-Builder shall be responsible for any IAR modifications and approvals. All proposed modifications require an Alternative Technical Concept (ATC) and are subject to Department approval.

Deviations from horizontal alignments (greater than 5.0 feet) and/or vertical alignments (greater than 1.0 foot) as shown on the Functional Plans will require an Alternative Technical Concept (ATC) with Department approval. Vertical profile deviations to create a rolling profile where more than two PIs are created within any 1,000 ft section of roadway are not allowed. The Design-Builder is responsible for any impacts resulting from deviations from the Functional Plans or IAR.

The existing 11-ft. inside shoulders on Segment 2 (I-75) will not require a design exception. TDOT has identified and obtained approval for a Design exception on I-24 eastbound and westbound at Belvoir Avenue for the outside shoulder width. A copy of the approved exception is included in the Reference Documents.

No additional design exceptions will be allowed without Department approval.

Roadside Safety Hardware

All existing roadside hardware (guardrails, guardrail terminals, anchors, concrete median barriers and/or bridge parapet wall transitions, and crush cushions) along I-75, I-24, and exit-

entrance ramps shall be removed as needed and replaced following the Department's current standards.

https://www.tn.gov/content/tn/tdot/roadway-design/standard-drawings-library/standard-roadway-drawings/safety-design-and-fences.html

Installation of the new hardware shall satisfy site specific clear zone as well as Length of Need requirements. All new guardrail shall be 31-inch MASH TL-3 compliant, median concrete barrier shall be 51-inch Single Slope MASH TL-5 compliant, and bridge parapet walls shall be 36-inch MASH TL-4 compliant. Prior to any removal of the existing roadside safety hardware, the Design-Builder shall confirm with the Department if the removal of hardware is necessary to complete the Work as specified in the Design-Builder plans and/or construction requirements. As needed, the Design-Builder shall propose a MASH-compliant alternative for the Department's Review and Acceptance to overcome existing site limitations prior to installation of permanent devices. All new hardware shall be on the Department's Qualified Products List (List 45)

https://www.tn.gov/tdot/materials-and-tests/research---product-evaluation-and-qualified-products-list.html

Work Zone

After removal of the existing hardware, the Design-Builder shall immediately install appropriate work zone traffic control devices and work zone positive protection devices as needed per TDOT T-WZ series Standard Drawings.
https://www.tn.gov/content/tn/tdot/roadway-design/standard-drawings-library/standard-roadway-drawings/design---traffic-control.html

All work shall follow *TDOT Work Zone Safety and Mobility Manual* and Transportation Management Plan (TMP) requirements and final installation shall be approved by the regional traffic engineer.

○ *DRAINAGE*

The Design-Builder shall be responsible for design and construction of the entire stormwater management system within the Project limits, including bridges, stormwater conveyances (open- channel and closed-conduit), stormwater inlets, and stormwater collection systems.

All stormwater runoff that flows through the Project, whether originating within or outside of the Project, must be accounted for in the design of the Drainage System.

The analysis, design, and construction of all components of the stormwater management system shall address the interim conditions during construction of the Project and the final design.

For reference, a preliminary drainage analysis has been completed and the resulting design is included on the Functional Plans.

Design Requirements

All drainage analysis and design shall be in accordance with the Department's Drainage Manual.

The Design-Builder shall use a 50-year design storm for all new (and existing to remain) storm sewer systems in accordance with the Department's Drainage Manual.

All drainage systems shall be designed to convey the 50-year storm without overtopping of any existing or proposed drainage or transportation elements.

The Design-Builder shall design culvert outfalls, channels and ditches within the Project limits in accordance with requirements of the Drainage Manual. Appropriate energy dissipation devices shall be designed at culvert outlets to prevent scouring and appropriate channel linings shall be designed such that erosion within and downstream of the channels and ditches is minimized. Energy dissipation devices shall be designed to fit within the existing right-of-way.

The Design-Builder shall provide aggregate pipe underdrains as specified in the pavement design and shall provide appropriate outlets for the underdrains as specified by the TDOT Standard Drawings.

The Design-Builder shall re-grade existing ditches to remain in-place and disturbed by construction by creating a straight-line profile along the centerline of the channel, as measured along the flow line.

The Design-Builder shall re-establish drainage in situations where sedimentation has changed the flow line from the existing profile. No Work should be done to Waters of the State or US, which might appear to be a ditch, without proper permits.

The Design-Builder shall provide erosion control for the construction Project per the guidelines specified in the Department's Drainage Manual.

The Design-Builder shall design the drainage system to accommodate construction staging. The design shall include temporary erosion control, sediment basins, and other BMPs needed to satisfy NPDES, local municipality, and other regulatory requirements. All environmental approval commitments related to drainage design and erosion control shall be included as "notes" on the plans for each stage of construction.

Existing Drainage Systems

The Design-Builder shall obtain the Department's acceptance to utilize any existing stormwater system (any and all pipes, structures, ditches, detention/retention systems, or any other component necessary for the conveyance of stormwater) within or outside of the Project limits.

The design of stormwater management facilities shall be compatible with existing or any known proposed improvements to drainage systems on adjacent properties and shall preserve existing drainage patterns wherever possible.

If existing drainage patterns must be altered due to a temporary or permanent aspect of the design of the Project, the Design-Builder shall provide documentation of any/all impacts to downstream and/or adjacent properties and/or road crossings for approval prior to alteration of existing drainage patterns. Survey data shall be collected for all downstream/adjacent

properties that are impacted, such as road crossing information, structure damage elevations, and channel cross sections (at a minimum), and shall be used in support of hydraulic calculations for the offsite drainage systems. Engineering analyses and certifications shall be provided to the Department and the local jurisdiction for approval prior to performing the alteration.

The Design-Builder shall acquire all applicable municipal drainage plans, watershed management plans, and records of citizen concerns. The Design-Builder shall acquire all pertinent existing storm drain plans, bridge hydraulic studies, and/or survey data, including data for all culverts, drainage systems, storm sewer systems, and bridge sites within the Project limits. The Design-Builder shall also identify existing drainage areas and calculate the estimated runoff to the highway drainage system. The Design-Builder shall analyze existing storm drainage systems, culverts (boxes and cross pipes), and open channels impacted or affected by the Project design.

Damage to existing infrastructure due to the Design-Builder's operation shall be immediately repaired to maintain existing system capacity and TDOT's Drainage Manual requirements at all times. This permanent repair shall be at the Design-Builder's expense.

The use of blind junctions and/or non-accessible structures shall not be allowed unless otherwise approved in writing by the Department. The Design-Builder shall not install and/or utilize longitudinal storm sewer pipes under travel lanes unless otherwise approved in writing by the Department. If no modification or upgrading of the existing stormwater management system is required, the Design-Builder shall, at a minimum, maintain the existing system. This maintenance includes, but is not limited to, silt removal from any pipe, ditch, or structure, and removal of any debris prior to the use of any existing stormwater system. This maintenance shall be at the Design- Builder's expense.

If documentation is not available for certain components of the existing drainage system within the Project limits and these components are planned to remain in place, the Design-Builder shall investigate and video record or photograph these components to determine condition, size, material, location, and other pertinent information.

There are existing floodwalls within the project limits along the north side of I-24 at approximately STA 143+50 to STA 179+00 owned and maintained by the City of Chattanooga. The Design-Builder shall not impact these floodwalls or their functionality either during construction or in the final condition. If the walls or their functionality are impacted, re-certification with FEMA will be required by the Design-Builder.

The Design-Builder shall replace all drainage structures along I-24 for Segment 1 from station 74+00 to station 179+00 for a complete, operational drainage system designed in accordance with TDOT's Drainage Manual. The following pipes may be retained and reused in the new system: STA 91+98 - 30" RCP, STA 99+52 – 36" RCP, STA 142+44 – 24" RCP, STA 145+02 – 24" RCP, STA 155+34 – DBL 8x7 RCBC, STA 175+78 (westbound roadway) – 48" RCP, and STA 176+52 (eastbound roadway) - 48" RCP, unless pipes are deemed hydraulically or structurally deficient.

The Design-Builder can use the existing cross drainage structures for Segment 2 unless corrugated metal pipe (CMP) is existing or if the existing cross drainage structures are deemed

hydraulically or structurally deficient.

The Design-Builder shall replace or supplement any pipes or culverts that are deemed hydraulically or structurally deficient in the existing condition or as a result of this Project. Video inspection and supporting documentation shall be provided to the Department for concurrence, with the exception of Segment 3. Existing drainage structures and pipes within Segment 3 may remain.

Only pipes within the defined Project limits are subject to be replaced or supplemented. The Design-Builder shall not perform any work outside of the Project limits, including drainage structure repair, maintenance, or any other work.

The Design-Builder shall replace damaged, destroyed, missing, or permanently attached castings on existing drainage structures. This shall include, but is not limited, to any structure located within the proposed roadway that is not already being modified or addressed within the proposed drainage work or a structure which is within the resurfacing limits, which is not being affected by any proposed drainage work.

Within the Project limits, there are thirteen (13) major outfalls that the Design-Builder shall use to discharge the surface runoff from the Project ROW. These include the following:

- An existing double barrel 8x7 reinforced concrete box culvert at STA. 155+34.04 +/-, 264.17-ft. RT +/-, which collects all of the runoff from I-24 from approx. Germantown Road to Spring Creek Road and drains to the south of S Terrace near McBrien Road and ultimately to Spring Creek. The Department's responsibility ends near the existing southern right of way limits. An extension has been constructed onto the end of the Department's limits of responsibility in the past and the DB Team shall not perform any Work beyond those limits. For the purposes of design, the DB Team shall assume that the capacity of the existing structure is the limiting factor for this drainage system. The overall drainage area at the outfall of the double barrel 8'x7' box culvert is 2631.14 acres.

- An existing 42-in. reinforced concrete pipe at STA. 902+62.56 +/-, 65.75-ft. RT +/-, which collects runoff from the Brainerd Road area and is metered by an existing storm water pump station operated by the City of Chattanooga (identified as Pump Station #3 in original TVA construction plans), which ultimately drains to Spring Creek. The drainage area at the outfall of the 42-inch pipe is 49.16 Acres.

- An existing 30-in. reinforced concrete pipe at STA. 629+92.59 +/-, 17.29-ft. LT +/-, which collects runoff from the I-24/I-75 Interchange and ultimately drains into area wetlands that drain into to Spring Creek. The drainage area at the outfall of the 30-inch pipe is 11.91 Acres.

- An existing 36-in. reinforced concrete pipe at STA. 376+68.50 +/-, 250.00-ft. RT +/-, which collects runoff from the I-24/I-75 interchange and drains southeast into a low wetland area, ultimately draining into West Chickamauga Creek. The drainage area at the outfall of the 18-inch pipe is 5.22 Acres.

- An existing 60-in. reinforced concrete pipe at STA. 386+09.43 +/-, 287.28-ft. RT +/-, which collects runoff from the I-24/I-75 interchange and receives outflow from another 54-in. reinforced concrete pipe draining the Eastgate Towncenter area and is metered by an

existing storm water pump station operated by City of Chattanooga (identified as Pump Station #1 in original TVA construction plans). Combined flows drain southeast into a low wetland area, ultimately draining into West Chickamauga Creek. The drainage area at the outfall of the 54-in. pipe is 159.10 Acres.

- An existing 8-foot x 8-foot reinforced concrete box at STA.442+27.59 +/-, 122.93-ft. RT +/- which collects runoff from a portion of Brainerd Subdivision as well as the CSX Railroad ROW and drains southeast, ultimately flowing into South Chickamauga Creek. The drainage area at the outfall of the 8-ft. x 8-ft. box is 72.87 Acres.

- An existing 48-in. reinforced concrete pipe at Sta. 608+55.01 +/-, 340.88-ft. LT +/-, which collects runoff from west of the Spring Creek Road area and runoff from I-24 at Spring Creek Road crossing and ultimately drains south to Spring Creek. The drainage area at the outfall of the 48-inch pipe is 49.25 Acres.

- An existing 18-inch reinforced concrete pipe at STA 449+45.39 +/-, 88.12-ft LT +/-, which collects roadway drainage along a portion of I-75 and drains northward onto CSX right of way The drainage area at the outfall of the 18-inch pipe is 2.73 acres.

- An existing 32-inch reinforced concrete pipe at STA 455+77.32 +/-, 119.72-ft. RT, which collects roadway drainage along a portion of I-75 and runoff from south and west of E Brainerd Road and ultimately drains to South Chickamauga Creek. The drainage area at the outfall of the 32-inch pipe is 6.82 acres.

- An existing 36-inch reinforced concrete pipe at STA 460+38.90 +/-, 96.27-ft. RT +/-, which collects runoff from south and west of E Brainerd Road and runoff from I-75 and ultimately drains south to South Chickamauga Creek. The drainage area at the outfall of the 36-inch pipe is 15.23 acres.

- An existing 42-inch reinforced concrete pipe at STA 477+22.14 +/-, 135.03-ft. RT +/-, which collects runoff from south of E Brainerd Road and runoff from I-75 and E Brainerd Road to I-75 SB entrance ramp and ultimately drains south to South Chickamauga Creek. The drainage area at the outfall of the 42-inch pipe is 32.76 acres.

- An existing 36-inch reinforced concrete pipe at STA 479+76.10 +/-, 143.71-ft. RT +/-, which collects runoff from south of E Brainerd Road and runoff from I-75 and E Brainerd Road to I-75 SB entrance ramp and ultimately drains south to South Chickamauga Creek. The drainage area at the outfall of the 36-inch pipe is 3.30 acres.

- An existing 48-inch corrugated metal pipe at STA 486+85.66 +/-, 142.48-ft. RT +/-, which collects runoff from north and south of E Brainerd Road and runoff from I-75 and ultimately drains south to South Chickamauga Creek. The drainage area at the outfall of the 48-inch pipe is 26.45 acres.

The Design-Builder shall video inspect and verify all existing drainage systems for Segment 1 (from station 74+50 to station 179+00) and Segment 2 that are to remain, are clean, operable, and determined to be hydraulically sufficient and structurally adequate. Any repairs, replacements, debris removal and/or deficiencies shall be corrected by the Design-Builder. The most current information available to the Department for the existing drainage systems for the

Project include a field-run topographic survey of the existing horizontal and vertical alignments, storm pipe inverts, and pipe material type.

Floodplain Requirements

The Project will impact multiple FEMA-regulated special flood hazard areas (SFHAs) situated within two separate participating FEMA Communities: East Ridge and Chattanooga. The Design- Builder shall design the Project to follow FEMA regulations in FEMA- regulated floodplains, according to requirements listed in Code of Federal Regulations (CFR) Parts 59, 60, 65, and 70. This design may include but is not limited to: bridge structures over streams, lengthening culverts over streams, increasing the tie slope, and/or utilizing retaining walls to reduce fill in the floodplain.

Where regulatory floodways exist, the Design-Builder shall design the Project to meet conditions of CFR Part 60.3 and 65.12, which state that encroachments to regulatory floodways must not cause increases to Base Flood Elevations (BFEs), floodway elevations, or floodway widths greater than 0.00 feet. If encroachments occur within regulatory floodways, an Engineering Analysis and No-Rise Certification shall be submitted to the local jurisdictions and the Department for review and approval. If grade changes occur that will increase BFEs, then a hydraulic analysis and floodplain impact report shall be submitted to the Department and local jurisdictions for review prior to RFC plans. If determined by the Department and/or local Floodplain Administrators that a Conditional Letter of Map Revision (CLOMR) is required, local community approval and the subsequent submission to FEMA shall occur as early in the Project timeline as possible, and the Design-Builder shall be responsible for engineering fees and application fees. The Design-Builder shall allow up to six months in the schedule for FEMA approval of any required CLOMR review. Regardless of whether a CLOMR is required, the Design-Builder shall submit an application for a Letter of Map Revision (LOMR) to FEMA within six (6) months of completion of construction in order to document final changes to BFEs and floodways. The LOMR submittal shall be based on certified as-built survey data of the completed Project, and the Design-Builder shall be responsible for engineering fees and application fees.

The Design-Builder shall not store excavated material, equipment, cleared debris, construction debris, etc. within defined floodplains as shown on the latest FEMA maps.

Existing floodwalls within the Project limits shall remain undisturbed by the Design-Builder. If damage or modifications are made to existing floodwalls, the walls shall be repaired or replaced at the Design-Builder's expense. If the Design-Builder is uncertain of the presence of floodwalls at a given location within the Project limits, then the local Floodplain Administrator shall be contacted for a determination.

There are existing floodwalls within the project limits along the north side of I-24 at approximately STA 143+50 to STA 179+00 owned and maintained by the City of Chattanooga. The Design-Builder shall not impact these floodwalls or their functionality either during construction or in the final condition. If the walls or their functionality are impacted, re-certification with FEMA will be required by the Design-Builder.

Hydraulic Design File Report for Hydraulic Structures

The Design-Builder shall prepare a Hydraulic Design File (HDF) Report and any other required documentation for all existing and/or proposed bridge-class structure crossing sites, and for culverts that convey at least 500 cubic feet per second for the design storm. All aspects of the drainage design must meet all criteria listed in the latest edition of the TDOT Design Procedures for Hydraulic Structures, the Department's Drainage Manual, and any Environmental Commitments identified in the NEPA Approval. Additional required documentation may include, but not be limited to, the preparation and submittal of any CLOMR or LOMR required for community and/or FEMA coordination. The HDF Report shall further include the detailed calculations with electronic and printed copies of the computer software input and output files, as well as a discussion about hydrologic and hydraulic analyses and reasons for the design recommendations. At a minimum, for each bridge-class crossing or structure conveying more than 500 cubic feet per second for the design storm, the HDF Report shall include:

- Correspondence in chronological order.
- Maps- located on a portion of the county map or city map and 7.5-minute USGS quadrangle (preferably color).
- Hydraulic report summary.
- Photographs - See TDOT Hydraulic Manual-Chapter 10 for minimum requirements. Aerial photographs should be included if available.
- Analysis
    - Discharge calculations.
    - Frequency discharge relationship.
    - Stage discharge relationship.
    - Supporting hydraulic information (previous flood studies, gage data, etc..).
    - Existing structure analysis, with cross sections plotted (if applicable).
    - Natural water surface model with no bridge or road fill
    - Proposed structure analysis, with cross sections plotted and any alternatives.
    - Scour analysis, if applicable.
    - Deck drainage analysis.
    - On-site inspection report.
    - Other information.

Where multiple structures occur on a single project, the correspondence section should not be repeated. The cover of the design file should include the project description, PIN, and/or project number as indicated in Department schedules. Also, each stream crossing station, stream name, and associated bridge identification number (if available) should be indicated on the cover. Survey data should be included in the file for future reference.

The Hydraulic Design File will be reviewed, approved, and filed in the Hydraulic Design Section's files.

○ *PAVEMENT MARKINGS*

The Design-Builder shall prepare pavement marking plans for the Department's concurrence. Pavement markings shall be constructed for the Ultimate Phase as shown in the signing and striping Functional Plans and roll plots. The design and installation of permanent pavement markings shall be in strict accordance with the current approved edition of the Manual on Uniform Traffic Control Devices (MUTCD), TDOT Roadway Design Guidelines, TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, TDOT Traffic Design Manual, and the current edition of the TDOT Standard Specifications. All pavement marking removal on final surfaces shall be accomplished by water blasting or another non-marring method. Any damage to the pavement surface caused by the selected method shall be removed and replaced at the contractor's expense.

Permanent pavement line markings shall be thermoplastic installed to permanent standards at the end of each day's Work. Short, unmarked sections shall not be allowed. On the final surface, the Design-Builder shall have the option of using temporary pavement markings installed to permanent standards at the end of each day's Work and then installing the permanent markings after the paving operation is completed. All pavement markings beyond the immediate work area that are affected by the Work shall be reapplied to permanent standards.

Permanent pavement markings on concrete shall be tape only. Contrast striping shall be used for all permanent striping on concrete pavement/structures along I-75 from approximately STA 407+00 to STA 486+00. Permanent pavement markings for crosswalks shall be thermoplastic longitudinal type only. Pavement markings depicting interstate shields shall be placed on the pavement at locations shown on the Signing and Marking Roll Plots. Any modifications to the locations shall be approved by the Department.

The appropriate permanent Interstate Pavement Marking Shields shall be placed on the approaches of all lanes to the I-75 and I-24 Interchange designating the destination of each lane in accordance with the Ultimate Signing and Marking Roll Plots. All pavement marking shields shall be thermoplastic.

See Ultimate Signing and Marking Roll Plots as provided on the Project Website for guidance.

Requirements for temporary pavement markings can be found in Section 10.

○ *SIGNING*

The Design-Builder shall prepare signage plans for the Department's concurrence/review prior to ordering. Signs shall be constructed for the Ultimate Phase as shown in the Signing and Marking Roll Plots. In addition, the Design-Builder shall ensure all signs beyond the Project limits are consistent with new alignments and travel lanes.

The design and installation of permanent roadway signs shall be in strict accordance with the current edition of the MUTCD, TDOT Roadway Design Guidelines and TDOT Standard Drawings, the current edition of the Standard Highway Signs, the TDOT Supplemental to the Standard Highway Signs, the current edition of the TDOT Standard Specifications, and TDOT Traffic Design Manual.

After the permanent sign locations have been staked, but prior to ordering any material for supports, there shall be a Field Review and Acceptance by the Department.

All existing sign footings shall be removed 12 inches below ground line or 12 inches below top of subgrade if located within the proposed roadway or shoulder.

The Design-Builder shall verify all support lengths at the site prior to erection.

The Design-Builder shall design the structure to support signs across the entire length of the travel way.

All sign sheeting shall be Type 3 Prismatic or better. All existing signs that do not meet the retro- reflectivity requirements shall be replaced. All yellow reflective warning signs on I-75, I-24, and ramps shall be fluorescent yellow.

The Design-Builder shall furnish layout drawings of all extruded panel signs with spacing of all letters, numerals, shields, and arrows. The layout drawings shall be reviewed by TDOT Traffic Operations Division prior to construction/installation.

All permanent signing plans: Signing Layouts, Sign Schedules, Overhead Structures Drawings & Miscellaneous Detail Sheets shall be reviewed by the Department prior to ordering and construction/installation.

Emergency Reference Markers shall be installed on Project per details provided by the Department.

All existing post-mounted signing shall be removed and replaced with new sign faces and new breakaway supports (refer to Signing and Marking Roll Plot for guidance). See Ultimate Signing and Marking Roll Plot as provided on the Project Website for guidance.

Overhead Sign Structures

All overhead sign structures shall be constructed to meet the ultimate design configuration. See Ultimate Signing and Marking Roll Plot.

The Design-Builder shall design new Overhead Sign Structures to support signs across the entire length of the travel way.

All Cantilever Sign Structures shall be removed and shall be replaced with new Overhead Sign Structures. All Overhead Sign Structures shall be designed per LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals and reviewed and concurred with by TDOT Structures Division prior to construction.

All existing Overhead Sign Structures in Segments 1 and 2 shall be replaced with new Overhead Sign Structures. The existing Overhead Sign Structures placed in the Phase 1 Construction limits have been designed for the ultimate sign configuration. The Design-Builder shall update the reflective sheeting and sign legends on the existing Overhead Sign Structures placed in Phase 1 in accordance with the Ultimate Signing and Marking Roll Plots. The Design-Builder shall confirm loading requirements for the required additional signs on these structures is adequate. The Design-Builder shall also verify that the minimum vertical clearances are achieved with the existing Overhead Sign Structures and modify as necessary to ensure they are met in the ultimate configuration.

See Ultimate Signing and Marking Roll Plots as provided on the Project Website for guidance.

○ *TRAFFIC SIGNALS*

New traffic signals on S. Moore Road and McBrien Road at N and S Terrace are proposed under this Scope of Work. In the event that the Design-Builder impacts any existing traffic signals during Project construction or for maintenance of traffic related to the construction of this Project, the Design-Builder shall be required to repair and/or replace the affected traffic signal systems (including but not limited to cabinet, controller, traffic signal heads, wiring, detection equipment, conduit and pull boxes, traffic signal poles and associated traffic signal timing and all other materials and methods to provide a fully functional and operational traffic signal). Permanent and temporary traffic signals shall meet the requirements of Special Provision 730C. The Design-Builder shall coordinate with the cities of East Ridge and Chattanooga regarding any impacts to their signals, including signal timings. The Design-Builder shall obtain TDOT, City of East Ridge and City of Chattanooga approval of new traffic signal timing before updating any signal timings.

During construction, video detection for traffic signal actuation shall be maintained at all times. The use of temporary poles for mounting video detection cameras will be allowed.

○ *LIGHTING*

The Design-Builder shall prepare lighting designs/plans in accordance with TDOT Standard Specifications for Road and Bridge Construction, TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, TDOT Traffic Design Manual, Chapter 15, the latest edition to the National Electric Code, National Fire Protection Association (NFPA) 70, and Electric Power Board of Chattanooga (EPB).

The Design-Builder shall use LED luminaires for the entire Project including ramps.

All existing light standards located within the Project limits along I-75, I-24, and ramps shall be removed and replaced except as follows:

- All new lighting installed under Phase 1 (I-75 Interchange with I-24 from just west of the Spring Creek Road overpass on I-24 to approximately 400’ south of the CSX Railroad bridge on I-75 North and just north of the Tennessee Welcome Center on I-75 South); and
- All lighting west of the S Germantown Road bridge.

New lighting standards and luminaires shall be designed to replace any existing lighting removed by the Design Builder to assure that I-75, I-24, and ramps have adequate lighting to meet TDOT standards. Power to existing lighting located outside the Project limits affected by the Project shall be restored so that no existing luminaires are inoperable. All wiring, conduits, pull boxes, poles, luminaires, cabinets, and all other necessary items/components needed to provide a full functioning lighting system shall be new items and shall be in accordance with EPB specifications.

The Design-Builder shall submit lighting photometrics for proposed roadway lighting sections

(including underpass lighting) to the Department for concurrence prior to ordering materials or beginning construction/installation. Design-Builder shall use AG132 software for photometric analysis. When submitting the photometric layout plans, the accompanying AG132 software files shall be included in the submittal.

If the Design-Builder elects to remove the lighting system prior to construction, temporary lighting will be required at all locations where existing lighting is taken out of service. No areas of outage longer than 7-days shall be allowed on the Project site. All temporary lighting shall be provided in accordance with TDOT standards.

The Design-Builder shall not allow light pollution/light hindrance into residential areas during construction.

All wiring shall be concealed underground in Schedule 80 PVC rigid conduit. The conduit shall be installed a minimum depth of 36 inches as measured from finished subgrade.

The ground wire shall be run inside conduit within structures, shall be colored green and have THW insulation.

Existing foundations shall be removed a minimum of twelve inches below ground line.

Light standards shall be round tapered poles. Length shall be determined by required mounting height.

All proposed roadway light standards shall be designed in accordance with the requirements of the latest edition of the LRFD *Standard Specifications for Structural Support for Highway Signs, Luminaires and Traffic Signals* published by the American Association of State Highway and Transportation Officials.

The Design-Builder shall coordinate with TDOT's Traffic Operations Division and Electric Power Board of Chattanooga to determine the proposed lighting fixture type (i.e., mast arm, offset, etc.) to be used on the Project and any specific design parameters.

All proposed roadway light standards shall be mounted on bases with an access door. Transformer bases shall meet AASHTO specifications and have FHWA approval. Standards shall be aluminum with transformer bases.

Bracket arms (if used) shall be round tapered truss type with strap mounting and lengths as scheduled. Bracket arm upsweep shall be the same for all light standards of the same type.

See Lighting Roll Plot as provided on the Project Website for guidance in regard to proposed lighting facilities.

○ *GROUND SURVEY*

The ground survey including survey control will be provided by the Department.

The Design-Builder shall verify the ground survey and survey control before utilizing in the design of the Project. In addition, the Design-Builder shall be responsible for field surveys and support activities, such as, but not limited to geotechnical investigations, ROW stakeout, construction stakeout, etc.

If the Design-Builder's design footprint extends beyond the limits of the survey provided by the Department, the Design-Builder shall be responsible for securing the necessary additional survey.

All field survey activities shall be performed in accordance with the latest version of the TDOT Survey manual and any other applicable design standards previously referenced.

If the Design-Builder uses ORD, the Design-Builder shall provide the following four (4) deliverables as outlined in TDOT's Requirements for Model-Centric Design document (also detailed in the Survey (ORD) training manual Appendix A):

1. Survey file containing 2D graphics imported from the original Field Book(s) (e.g., utilities (plan), pavement edges, buildings, vegetation, etc).
2. Terrain file containing the existing DTM features (e.g., contours, triangles, etc).
3. Alignment file containing the survey preliminary alignment and projected utilities (profile).
4. Utility file containing the existing drainage and utility model (plan).

Note that these do not substitute the survey checklist for field and office procedures, as referenced and outlined in the TDOT Survey Manual, but instead accompanies it and other procedural documents in place.

○ *PAVEMENT DESIGN REPORT*

The Pavement Design Report for this Project has been developed by the Department.

Proposed asphalt and concrete pavements shall be constructed utilizing the pavement designs provided in this report unless otherwise approved in advance by the Department. Design-Builder shall place a prime coat complying with TDOT Standard Specifications Section 402 to any untreated or treated flexible base layer unless otherwise approved in advance by the Department.

For Segments 1, paving on inside shoulders shall be full depth pavement.

For Segment 2, Work on inside concrete shoulders shall include concrete pavement repair and joint repair.

The Pavement Design and minimum criteria for pavement related Alternative Technical Concepts (ATC) are in **Appendix A**.

4. STRUCTURES

The Design-Builder shall be responsible for the design and construction of all structures within the Project limits including interstate and interchange ramp bridges, retaining walls and noise walls, as further described below.

The Design-Builder shall be responsible for the removal and disposal of all deficient structures, or portions thereof.

Upon completion of the Project, the Design-Builder shall provide TDOT Structures Division a final revised set of plans for all structures (bridges, walls, etc.). The plans shall be delivered electronically via Dropbox. Bridge plans and design calculations shall not be bundled and must be sent as individual files labeled "Bridge Plans Only" and "Bridge Design Calculations Only" respectively for each bridge.

o *BRIDGES*

The Design-Builder shall be responsible for the design and construction of one (1) new bridge on I-75 over CSX railroad, one (1) new bridge on S. Moore Rd. over I-24, and one (1) new bridge on McBrien Rd. over I-24. Replacement bridges must be completely new construction. No existing components can be reused.

The Design-Builder shall be responsible for the design and construction of all remaining structures necessary to complete the Project.

New bridge elements shall be designed using the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Ninth Edition (2020), and the AASHTO Guide Specifications for LRFD Seismic Bridge Design, Second Edition (2011) with all interims, and the TDOT Structures Division Structural Memorandums.

The Design-Builder shall adhere to the Department's Standard Specifications for Road and Bridge Construction (2021 Edition) for construction materials and methods.

High early strength concrete is prohibited for bridges and bridge approaches unless otherwise approved by the Department.

Design Requirements

Any Accelerated Bridge Construction (ABC) methods proposed shall be submitted to the Department through an ATC for approval by the Department.

Girders shall be continuous for live loads for pre-stressed girders, and continuous for all loads for structural steel girders. Structural steel, if proposed, shall be A709 (50 kilo pound per square inch [ksi] minimum yield strength) weathering steel for all bridges, and either I- girders or tub girders may be used. The minimum final concrete beam strength, if proposed, shall be 5,000 pounds per square inch (psi).

The new bridges shall be designed for HL-93 live loading. The bridge design shall include 35 pounds per square foot (psf) for a future wearing surface. The new 51-inch single slope

bridge median barriers shall be in accordance with Standard Drawing STD-1-3SS. The new bridge on mainline I-75 shall have a split 51-inch bridge median barrier. The modified 51-inch barrier shall be detailed on the bridge plans. An applied texture finish is required on the inside (traffic) face and top of the parapet rail. The color shall be white, AMS STD-595 color No. 37886.

ITS conduits shall be provided inside the barriers when required. The Department will determine if additional conduits will be required for future needs.

For all bridges, the Design-Builder shall perform a hydraulic analysis for bridge deck drainage and shall meet the criteria in the TDOT Design Procedures for Hydraulic Structures. Any conduits proposed for deck drainage shall be encapsulated in the bridge components. No drainage conduits shall be exposed.

Existing utility conduits attached to existing bridges are to be removed and replaced. New and relocated utilities shall be placed between the beams so they are out of view from the traveling public and protected against vehicular impact. Utilities shall not be placed on the cantilevers of new structures. The utilities shall be relocated as indicated by other sections in this RFP.

The replacement bridges for S. Moore Rd. and McBrien Rd over I-24 shall have under bridge lighting to properly light I-24. All electrical conduits required for the bridge and roadway lighting shall be encapsulated in the structure. No electrical conduits shall be exposed.

The Design-Builder shall submit shop drawings for bridge components, erection plans and calculations for concurrence by the Department. For demolition of the existing S. Moore Rd. and McBrien Rd. bridges, the Design-Builder shall submit demolition plans and calculations for concurrence by the Department. The shop drawings, erection plans, and demolition plans shall be submitted in a timely manner allowing ten (10) calendar days for the Department's review.

The Design-Builder shall conduct and submit a load rating analysis for each of the bridges to be widened and new bridges that are to be constructed. The load ratings are to be completed and approved before completion of the Project. They shall be submitted in a format to be concurred with by the Department.

The Design-Builder shall propose a MASH TL-3 guardrail attachment to bridge end detail (to be concurred with by the Department) for locations where the existing guardrail is attached to bridges. The Design-Builder shall perform repairs to existing bridges as shown in the TDOT Bridge Inspection Reports and Deck Surveys included on the Project website. The Design-Builder is to verify the information shown in the above referenced documents.

The Design-Builder shall maintain a 16-foot, 6-inch minimum vertical clearance over travel lanes at all times. Reduction of existing vertical clearances will not be allowed during any construction phases of the Project. The I-75 bridge over CSXT Railroad shall have a minimum vertical clearance of 23' - 6" above the top of rail and shall provide a minimum horizontal clearance to provide offsets from the existing track and one future track without requiring crash walls.

Place a 51-inch single slope concrete median barrier (reference TDOT Standard Drawing STD-1-3SS).

Place concrete parapets on the new bridges (reference TDOT Standard Drawing STD-1-1SS and Standard Drawing STD-11-1).

All exposed surfaces of the parapets, slab cantilevers, concrete beams surfaces, abutment beams, end walls, wing walls, bent caps, and columns of the bridges shall receive a texture finish, mountain grey, AMS STD-595 Color No. 36440 except the top and traffic face of the parapets which shall be white, AMS STD 595 Color No. 37886.

Drilled shafts shall be constructed according to Special Provision 625 Drilled Shaft Specifications and shall be socketed at least two times the shaft diameter into competent bedrock.

The bridges shall be constructed while maintaining the minimum number of lanes open to traffic during construction as specified in this RFP. The minimum vertical and horizontal clearances shall be maintained during construction as specified in this RFP and TDOT's Standard Specifications for Road and Bridge Construction.

Bridges shall be designed and detailed according to current TDOT Structural Design Guidelines & Memorandums Structural Design Guidelines (tn.gov).

For the I-75 over CSX Railroad Bridge, the Design-Builder shall provide all necessary and pertinent information as outlined in the TDOT Design Guidelines to the State Railroad Coordinator in the preliminary design phase.

○ *NOISE BARRIER WALLS*

The Design-Builder shall be responsible for the design and construction of noise barrier walls per the NEPA document, the Noise Barrier Evaluation dated December 2021, and Functional Plans. The noise barrier walls shall be designed using the AASHTO LRFD Bridge Design Specifications, Edition (2017), Section 15. The Noise Barrier Evaluation includes the preliminary noise barrier design information based on the Functional Plans. The FHWA TNM files are included in the Reference Documents and should be used by the Design-Builder to assess proposed design changes. TDOT will use the TNM files to evaluate any modifications to the noise barrier proposed by the Design-Builder.

The Design-Builder shall ensure that all proposed Work is completed within existing Right-of-Way (ROW). The Design-Builder shall be responsible for securing any additional ROW in accordance with Section 7 of **Contract Book 3 (Project-Specific Information).**

The top of wall elevation shall not be less than the top of wall elevation as shown in the noise analysis. The bottom of the wall shall not provide any gaps between the wall and the final grade except as required to accommodate drainage.

Ground-mounted barriers and barriers on bridges shall be connected to ensure no gaps.

The traffic face of the walls shall be absorptive and meet the following requirements:

- Concrete formliners shall be used to achieve the specified pattern and texture on both the highway and community sides of the barrier. Methods that involve rolling of any kind to achieve the specified pattern and texture shall not be permitted.
- A minimum 1-inch depth of reveal at joints shall be achieved on both the highway and

community sides of the noise barrier.

- Top noise barrier panels shall include a 12-inch-wide smooth band across the top of each panel on both sides.
- All posts shall be cut flush with the highest adjacent panel.
- The formliners for both the highway and community sides of the noise barrier shall be approved by the TDOT Environmental Division (Tammy Sellers, 615.741.5367), TDOT Structures Division (Robert Lefevre, 615.741.0798), and TDOT Region 2 prior to the manufacture of the noise wall panels.
- The highway side of the noise barrier shall be Architectural Polymers #905O Small Aged Ohio Ashlar or an approved equal. Four custom form liners, each with a unique pattern, (5' X 10') shall be developed with 20" tall coursing and 2" average joint relief.
- The Design-Builder shall apply an Anti-Graffiti product to the highway side of the Noise Wall. The product must be on TDOT's QPL 26 list and be intended for wall applications. It must be applied in accordance with the manufacturer's specifications.
- The highway side of the noise barrier (including posts) shall be texture coated to match other structures.
- The formliner used on the community side shall be Random Cut Stone #1106 manufactured by Custom Rock or an approved equal.
- The community side of the noise barrier (including posts) shall be texture coated using Federal Standard Color 36373.
- Texture coating shall be applied to ensure all panels and posts appear uniform in color. Several applications shall be applied to ensure all color uniformity. The Design-Builder shall obtain approval from TDOT Region 2 that the noise barrier surfaces are uniform in color before ceasing texture coating operations.
- The Design-Builder shall cast a sample barrier panel with the approved formliners and colors. If the sample meets the requirements of this provision, TDOT will approve the panel and this panel shall serve as a standard for acceptance of subsequent noise barrier panels. If accepted, the demonstration panel can be incorporated into the completed Project.
- The demonstration panel shall be delivered to the Project Site. The delivery location shall be approved in advance by the TDOT Environmental Division and Region 2 Construction Division.
- The Design-Builder shall insure all panels are protected during all aspects of truck loading/unloading and transport to the Project installation location.
- The panels shall be flush with one another; gaps between barrier panels shall not be permitted.
- The horizontal joints between panels shall line up from one bay of panels to the next. Horizontal joints shall have tongue-and-groove configurations.
- No gaps shall exist between the base of the barrier panels and the ground except as required to accommodate drainage.

- Prior to installation, the Design-Builder shall inspect delivered products for any defects.
- Panels that exhibit deficiencies or damage after installation shall be replaced or repaired by the Design-Builder at the discretion of TDOT and to the satisfaction of TDOT at the expense of the Design-Builder. Deficiencies include, but are not limited to, crumbling, cracking, crazing, scaling, spalling, efflorescence, and segregation.
- After installation, the Design-Builder shall remove dirt from panels with water.

The location of the posts shall consider the location of any drainage structures, utilities, or other obstructions that would interfere with post placement.

The new noise walls shall be constructed using concrete posts and concrete panels. The post spacing shall not exceed 20 feet. Ground mounted noise wall posts shall be embedded into drilled shaft foundations. Bolted connections will not be allowed.

The panels shall be flush with the finished grade, unless drainage requires a minimal opening for conveyance underneath. The bottom panels in a bay may be tapered in height with a minimum height of 1 foot.

The posts and panels shall be flush at the top. The top of wall elevation shall vary by no more than 2 feet in adjacent bays.

Only the minimum amount of vegetation necessary for the placement of the walls may be removed as directed by the Department. Where possible, stumps and roots are to remain to prevent ground disturbance. Any damage to vegetated areas outside the limits of construction shall be repaired at the Design-Builder's expense. These areas are to be returned to their pre-construction state as directed and concurred with by the Department.

The Design-Builder shall notify the Department and all adjoining properties and stakeholders thirty (30) days prior to proposed noise barrier wall clearing, or construction.

○ *RETAINING WALLS*

Retaining walls shall be built in accordance with Special Provision 624, Retaining Walls.

All retaining wall finish requirements for retaining walls visible to the public and traffic shall receive Scott System #167D Ashlar Stone D or approved equivalent. Retaining walls not visible to the public or traffic shall receive a Class II, Rubbed Finish as specified in the TDOT specifications.

The Design-Builder shall cast a sample with the approved formliners and colors for TDOT approval.

The retaining wall locations, wall lengths, and the beginning and end stations of walls, as shown on the Functional Plans are approximate. The final locations and wall lengths shall be determined by the Design Builder.

Retaining walls being constructed in sensitive environmental areas or areas close to existing streams shall adhere to the environmental requirements set forth in the RFP.

○ *MINOR STRUCTURES*

The Design-Builder shall be responsible for needed repairs of existing minor structures as determined by video inspection. The existing box culvert will be repaired in accordance with recommendations from the inspection report provided with the Reference Documents.

5. INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

The Design-Builder shall prepare ITS design/plans and install ITS related equipment/structures as described herein in accordance with the TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, TDOT Standard Specifications, TDOT Traffic Design Manual, TDOT ITS Project Development Guidelines and TDOT Special Provision 725 in RFP Book 2 (Design-Build Contract).

○ *FIELD INVESTIGATIONS*

The Design-Builder shall be responsible for verification of existing conditions, including research of all existing TDOT Intelligent Transportation System (ITS) records/plans and all other ITS related information.

The Design-Builder shall conduct the field survey and provide a complete list of all ITS field devices tracked by the Department, that includes, but not limited to make, model, and serial number, within the Project limits and beyond if those ITS field devices are to be taken out of service, altered or upgraded by the Design-Builder.

The list shall be provided within sixty (60) calendar days of NTP.

The Department shall provide a complete list of all assets being tracked by the Department and what information is needed for each ITS field device type. The Design-Builder shall submit the list to the Department for Review and Acceptance.

The Design-Builder shall coordinate with the electrical power companies and provide electrical power for all ITS devices included in the Project. The Design-Builder shall pay all costs for providing electrical power service. In addition, the Design-Builder shall pay all electric service recurring costs for the ITS until Substantial Completion.

See ITS Roll Plot as provided on the Project Website for guidance in regard to proposed ITS facilities.

○ *DESIGN REQUIREMENTS*

Fiber and Electrical Power for ITS devices

The Design-Builder shall maintain the existing fiber conduit, electrical conduit and communications to the greatest extent possible. If fiber conduit relocation is required, the Design-Builder shall design and install the relocated fiber line and splice it into the existing fiber line prior to the start of any roadway construction. The Design-Builder shall encase all conduit so as to not be exposed.

All fiber and electrical conduit shall be designed to minimize conflicts with or damage to other roadway items such as drainage structures, foundations, signing, lighting, guardrail, retaining walls, and landscaping.

The proposed conduit relocation is shown on the ITS Roll Plot as provided on the Project Website.

The proposed fiber and power relocation designs shall be reviewed and receive concurrence from the Traffic Operation Division prior to ordering materials or beginning relocation.

Pull boxes for fiber optic trunk line shall be placed every 1200 feet. Pull boxes must meet all requirements set forth in the TDOT Fiber Optic Standard Drawings. The ITS system redundancy shall be tested with TDOT TMC IT prior to fiber and power relocation.

CCTV

The Design-Builder shall maintain the existing CCTV cameras to the greatest extent possible during construction. If relocation of CCTV cameras is required, then CCTV cameras within the Project limits shall be removed and replaced with proposed CCTV cameras meeting the requirements of Special Provision 725.

All CCTV camera poles located in the median shall be removed unless otherwise directed by the Department. All proposed CCTV camera poles shall be located outside of clear zone unless guardrail or barrier is present. Proposed CCTV camera poles shall not be placed in the median.

Dynamic Message Signs (DMS)

Design-Builder shall remove and replace the existing structures with proposed DMS support structures meeting the requirements of Special Provision 725. All proposed DMS signs and supporting equipment shown on the ITS Roll Plot shall be new. All existing DMS signs and supporting equipment shall be removed and returned to the Department at a location to be determined.

Radar Detection System (RDS)

The Design-Builder shall remove and replace the existing RDS detection devices and support structures with all new RDS detection devices and support structures that meet the requirements of Special Provision 725. All the existing RDS devices and support structures shall be returned to the Department.

If an existing light standard is utilized as a RDS support structure, the Design-Builder shall not remove the light standard, only the RDS equipment

When appropriate and possible, co-locate RDS detection devices with CCTV cameras or with DMS to reduce the number of support structures to be replaced. The Design-Builder shall ensure desired detection accuracy irrespective of the installation type. If co-locating with CCTV support structure, Design-Builder shall coordinate with TDOT Region 2 to ensure location is easily accessible for maintenance of RDS and does not interfere with lowering device. If co-locating with DMS structure, Design-Builder shall coordinate with TDOT Region 2 to ensure location is easily accessible for maintenance of RDS.

The proposed RDS system design should maximize the use of RDS installations that detect traffic in both directions of travel. All new RDS support structures shall be located outside of clear zone unless guardrail or barrier is present.

○ *MAINTENANCE OF COMMUNICATION AND ELECTRICAL POWER TO ITS DEVICES*

The Design-Builder shall ensure that no loss of power or communications between existing ITS field devices and the Transportation Management Center will occur during construction.

The Work may cause the decommissioning of portions of the existing ITS system within the Project limits. The Design-Builder shall be responsible for any temporary power and communications that may be necessary to provide continual communications to all non-decommissioned ITS field devices within the Project limits.

The Design-Builder shall implement a Maintenance of Communication (MOC) plan (detailing Work to be performed, schedule of Work, and a strategy for minimizing downtime) to preserve the ITS operations during the Project construction phase. The MOC plan shall be submitted to TDOT Traffic Operations Division for the Review and Acceptance prior to any change to the existing communication system, decommissioning of existing ITS field devices and supporting equipment, and temporary ITS relocations and/or installations.

The Liquidated Damages associated with temporary loss of power and/or connectivity of each ITS field device and supporting equipment due to construction, installation, integration with the temporary communications systems, or relocation shall be per Special Provision 108B.

○ *ADDITIONAL REQUIREMENTS*

The Design-Builder is required to perform system testing prior to any planned construction activity that would cause a temporary loss of connectivity. The testing is required to determine system wide impacts for mitigation practices that can be deployed.

The Design-Builder shall use specific or compatible ITS software and hardware components to ensure networking and device connectivity and compatibility.

○ *SUBMITTAL REQUIREMENTS*

All ITS submittals, made as part of the Project submittal program, shall be concurred with by the Traffic Operation Division.

The Department shall concur with the placement and location of all ITS field devices, structures and support pole locations prior to purchasing, construction or installation.

The Design-Builder shall submit all ITS designs/plans (ITS devices, support equipment, and support structures) to the Department for concurrence prior to ordering materials or beginning construction/installation. Permitting for utility Work shall follow the same process as outlined in Section 8.

In addition to the requirements set forth in Section 17.2.6 of Special Provision 725, As-Built Plans shall also be submitted in PDF and DGN formats. The Design-Builder shall provide the Department with a survey using Tennessee State Plane Coordinates showing the As-Built location of all ITS related items along with any design calculations.

6. GEOTECHNICAL

The Design-Builder shall perform a design level geotechnical investigation to validate and augment the geotechnical information included in this RFP.

○ *GEOTECHNICAL INVESTIGATIONS*

The geotechnical exploration investigations shall be performed in accordance with the current *TDOT Geotechnical Guidelines* located on the Geotechnical Engineering Sections webpage on the Department's website:

https://www.tn.gov/content/dam/tn/tdot/hq-materials-tests/geotech/GeotechnicalGuidelines.pdf

The Design-Builder shall determine the amount and level of the geotechnical investigations to cover geological risks associated with this Project.

The Design-Builder shall perform a slope analysis for all proposed slopes. This analysis shall also include the investigation and recommendation for repair/stabilization of an existing slide on N Terrace between Belvoir Avenue and S Moore Road.

The Design-Builder shall be responsible for obtaining the borings for all abutments, bents, piers, retaining wall foundation locations, and noise wall foundation locations where subsurface information is not sufficient or is warranted by variability in the geology. All borings shall be deep enough to show a complete soil and rock profile to the depth of the foundation-supporting layer. Refer to Section 1: Geotechnical Projects with Structural Components, of the current *TDOT Geotechnical Guidelines*.

The Design-Builder shall collect appropriate field data and samples for geotechnical evaluation of embankments, subgrade, soil and rock cuts, culverts, bridge and retaining wall structures, storm water management structures and ponds, minor structures, including drainage pipes, and any other earth supported structures or elements of highway design and construction relevant to the Project. Refer to Section 2: Geotechnical Projects with Roadway Design Components, of the current *TDOT Geotechnical Guidelines*.

The prequalified geotechnical firm shall also determine if additional subsurface information, other than that required and noted elsewhere in the Contract Documents, is required based upon the final roadway and structure designs. If a determination is made that additional subsurface information is required; the Design-Builder shall perform all additional subsurface investigation and laboratory testing in accordance with the current *TDOT Geotechnical Guidelines*.

Notification Requirements

Any required lane, shoulder and/or ramp closures to perform geotechnical investigations must be approved in accordance with Section 10 of this Book.

The Design-Builder shall notify the Department and all adjoining properties and stakeholders thirty (30) days prior to commencing any activity on private property. Property owner's names and addresses shall be obtained using the latest records available from the county Tax

Assessor's office. To promote good relationships, a diligent effort shall be made to contact each property owner or tenant prior to entering the property. However, personal contact is preferable to explain that entry is required, the purpose of the activity, the activities involved and to determine facts pertinent to the activity.

The Department may limit when drilling activities or other geotechnical work including lane closures may occur within the Department's Right-of-Way.

The Department may require the Design-Builder to immediately halt drilling activities or other geotechnical work underway.

The Design-Builder shall be required to provide traffic control for all drilling activities occurring within the Department's Right-of-Way including but not limited to lane closures and shoulder closures.

The Design-Builder shall provide field quality control for all bridge foundations, retaining foundations and noise wall foundations including verifying subsurface conditions for drilled piers and bearing for shallow foundations.

○ *GEOTECHNICAL REPORTS*

The Design-Builder shall provide geotechnical reports, design and construction summaries that contain pertinent subsurface investigations, test, and engineering evaluations.

Prior to any geotechnical design submittal, as outlined in the *TDOT Geotechnical Guidelines*, the foundation design recommendation reports shall be sealed and signed by a Professional Engineer registered in the State of Tennessee who has completed a minimum of three geotechnical design projects of scope and complexity like that anticipated for this Project using the LRFD method and in accordance with the latest edition of the AASHTO LRFD Bridge Design Specifications.

Report to include specific requirements for settlement monitoring in fill areas. The Design-Builder shall provide the Department all settlement monitoring data as requested.

7. RIGHT-OF-WAY

The Department has secured NEPA approval and anticipates the need for additional Right-of-Way (ROW).

The Design-Builder shall be responsible for performing all acquisition activities, including appraisals, appraisal reviews and acquisitions, and any required utilities coordination/relocation and acquisition of related permits. The Design-Builder shall also be responsible for preparing any additional environmental technical studies and completion of the NEPA document re-evaluation. The following explains the Design-Builder's responsibilities related to any additional right-of-way required.

This project crosses CSX Railroad; however, no acquisition of easements is needed to perform this scope of work.

○ *ACQUISITION SERVICES REQUIREMENTS*

The Design-Builder, acting as an agent on behalf of the Department, shall provide ROW acquisition services for the Project.

ROW acquisition services shall include certified title reports, appraisal, appraisal review, negotiations, relocation assistance services, property management services, parcel closings and all related activities.

All appraiser/s, appraisal reviewer/s and acquisition/relocation firms shall be selected from the Department's ROW Office's pre-qualified list.

The Department will retain authority for approving just compensation, relocation benefits and claims administrative settlements, court settlements and court awards.

The Department must issue a NTP with ROW Acquisition to the Design-Builder prior to any offers being made to acquire the property. This represents a hold point in the Design- Builder's Baseline Schedule.

The Department must also issue a NTP with Construction to the Design-Builder once the property has been acquired prior to commencing construction on the property. This also represents a hold point in the Design-Builder's Baseline Schedule.

The Department will be responsible for the actual purchase price paid to a landowner for ROW, including fee simple, or any and all easements, and for any relocation assistance payments.

The Department will be responsible for actual payments to property owners and certain expenses related to the acquisitions and associated legal costs as well as any additional monies paid the landowners to reach an administrative settlement or pay for court settlements and awards.

The Design-Builder will be responsible for all costs associated with the services provided by the appraiser(s), review appraiser(s), acquisition/relocation firm, title company, engineering and legal services related to the acquisition of ROW, the costs of any public hearings that may be required, and any other cost associated with the services related to the purchase of ROW.

○ *TITLE REPORTS AND CLOSINGS*

The Design-Builder shall provide a current title report (no older than one hundred and eighty (180) days) for each parcel at the time of the initial offer to landowner. Each title examination report shall be prepared by a Department's approved title company (each of the Department's Regional ROW Offices has a list of approved title firms). The Design-Builder shall furnish an original and three legible copies of a title report, including summary of 5 years sale history, on a form to be provided by the Department, designated as ROW Form-49, with copies of all recorded deeds, liens, selloffs, easements, subdivision plats, divorce decrees, wills, judgments, and other pertinent documents attached, for each numbered tract on the ROW plan. The Design-Builder shall furnish one updating of the title report; the process of updating the title report shall be performed as part of the closing.

The following terms and conditions shall also apply:

- Preliminary reports of title are required on all tracts for which a taking or an acquisition is shown on the acquisition table.
- Title insurance is not required.
- An original and three (3) legible copies of the "Preliminary Report of Title" (Form 49) are to be submitted. All attachments must accompany the original and all three (3) copies.
- Reports must include information on all contiguous parcels of land which form a single tract under the same ownership.
- In addition to the information to be provided on the R.O.W. Form 49, each preliminary report of title shall contain the tax map, and parcel number for the particular tract as well as the civil district in which the tract is located. In addition, include documentation of all Environmental Liens if they apply.
- The Design-Builder shall furnish the correct mailing address of the property owner for each tract number. If the ROW plan is revised so to add additional tracts from which there will be an acquisition as shown by the acquisition table, all services covered by this agreement are to be provided for those additional tracts.
- Facsimile of title report shall not be accepted.
- Completion and filing of Form 1099 published by the Internal Revenue Service, is required in connection with closing of ROW acquisition.
- Copies of Tax Maps showing all tracts are to be included. These maps are to be complete, full-size sheets whenever possible.
- Copies of subdivision plots are to be included when the only deed description of an individual parcel consists of a lot number in the mentioned subdivision.
- Please number the pages of each "Preliminary Report of Title".
- If any instrument is not legible on the provided copy, (attachments) then a typed legible instrument must accompany illegible copies,

The Design-Builder shall close all negotiated tracts on the Project. This service shall include:

- updating the title report to the time of closing;
- the preparation of the warranty deed and any releases;
- the preparation of a closing statement (ROW Form-24 provided by the Department);
- the preparation of the deed transmittal statement (ROW Form-29 provided by the Department);
- the preparation of the Tax Proration Form;
- the preparation of the W-9 form; and
- the preparation of the closing log form (ROW Form 17A provided by the Department).

The Design Builder is responsible for the arrangement of and making of such disbursements as may be necessary to cause the removal of property taxes, judgments and instruments constituting liens for money owed, and the recording of the warranty deed.

The Department will be responsible for the reimbursement to the Design-Builder for the recording of releases and/or partial releases and the recording of any other required releases for liens or encumbrances and all cost associated with obtaining any releases and any other such documents.

The Design-Builder agrees to discuss time and location for each proposed closing with the prospective grantor(s) and within reason to accomplish same in accordance with the grantor(s') advice. Normal closings are expected to take place within 45 days after the seller's acknowledgement of sale price and conditions (ROW form 30-A) is executed. Extenuating circumstances requiring more than 45 days shall be reported by letter (or by FAX) no later than the 45th day from the date of the executed agreement of sale with a request for an extension. Requests for extensions beyond the normal accepted time will be considered on a case-by-case basis. Within 24 hours after closing, the Design-Builder shall notify the Regional Transportation Manager 2 of this fact. All closings are to be done by personal contact, at a time and place that is convenient to the landowner. Where a closing by mail is requested, the written consent of the Department is required, except when the closing involves Out-of-State property owners.

○ *APPRAISAL AND APPRAISAL REVIEWS*

The Design-Builder shall prepare appraisals in accordance with TDOT's Guidelines for Appraisers, Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (the "Uniform Act"), the Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs (Part 24 of title 49 CFR), and the Uniform Standards for Professional Appraisal Practice (USPAP). Appraisal and Related Service shall include all or parts of the following: real estate appraisal, real estate appraisal review, real estate consultation, pre-trial conference, deposition, and court testimony, as further defined.

The Design-Builder shall complete all appraisal services and Work product to the standards

set forth herein. Failure on the part of the Design-Builder to complete each assignment according to said standards by the agreed upon due date shall be considered a material breach of this Contract.

The Design-Builder shall complete all appraisal services in accordance with the Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs (Part 24 of title 49 CFR), the Uniform Standards of Professional Appraisal Practice [USPAP (Appraisal Foundation)], [Guidelines For Appraisers (https://www.tn.gov/content/dam/tn/tdot/right-of-way-division/TDOT_Guidelines_for_Appraisers__06-30-15.pdf)] and Federal, State and local laws, rules, and regulations.

The Design-Builder shall furnish an original and two (2) copies of each Market Data Brochure and each Appraisal Report. The Design-Builder shall also furnish one additional copy of each appraisal report together with all exhibits and comparable data write-ups. This copy shall be clearly identified as the landowner's copy. Unless specifically directed otherwise in writing, all appraisal services products are to be delivered to the regional office.

In addition to the standard photos of the subject property and exterior photos of the acquired improvements, the Design-Builder shall provide a typical interior photo of acquired/ affected structures having substantial contributory value (i.e., residences, commercial structures, large barns, etc.) Legible digital images are acceptable.

The Design-Builder shall update the appraisal report(s) on any tract(s) involved in condemnation covered under Work Orders issued hereunder to "date of possession" when requested to do so by the Department. Appraisal updates shall be completed within sixty (60) days after the request is made in writing by the Department. All such updates shall be in compliance with standards set forth above except that the standards in force as of the date of employment to conduct the updated appraisal service shall apply. The "update" appraisal request may require the Design-Builder to consider and include minor plan revisions and changes in market conditions.

Upon request by the Department, the Design-Builder shall testify in any judicial or arbitration proceeding involving the determination of the value of the property, in support of the opinion of value of any and all of the property included in his/her appraisal report. Further, the Design-Builder agrees to attend, as requested by the Department, any pre-trial conferences, meetings, depositions, etc. related to such proceedings. The Design-Builder shall be compensated for these litigation- related services in accordance with the Expert Valuation Witness Rates in effect at the time the service is rendered. The Expert Valuation Witness Rate Schedule may be adjusted periodically.

The Design-Builder shall execute disclaimers of any past, present or contemplated future personal interest in any of the properties included in the proposed agreement, as required by the Department, or if applicable, FHWA.

The Design-Builder shall maintain throughout the term of this Contract Errors and Omissions insurance in the amount of not less than one million dollars ($1,000,000.00), and proof of which shall be made available to the State upon demand.

The Design-Builder shall provide appraisal reviews complying with technical review

guidelines found in the Department's Guidelines for Appraisers, the Uniform Act, and (USPAP), and the Department's ROW Procedures Manual and make a recommendation of just compensation. Design-Builder's ROW staff that performs acquisition and relocation/property management services shall be from the Department's pre-qualified consultant list for acquisition and relocation assistance and related services and the Design-Builder shall include a Department's pre-qualified Fee Appraiser from Department's prequalified appraiser list. The review appraiser shall be approved by the Department and shall also be on the Department's prequalified fee appraiser list. The Department shall have final approval of all the Design-Builder's ROW staff.

○ *ACQUISITION, RELOCATION ASSISTANCE, AND PROPERTY MANAGEMENT*

The Design-Builder shall acquire property in accordance with all Federal and State laws and regulations, including but not limited to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (the "Uniform Act") the Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs and (Part 24 of title 49 CFR). The acquisition of property shall follow the guidelines as established by the Department's ROW Procedures Manual. The Design-Builder shall execute a certification in its proposal that it has received the Department's ROW Procedures Manual and will comply with the procedures.

The Department has an Appeals Advisory Board to hear any Relocation Assistance appeals.

The Department agrees to assist with any out of state relocation by persons displaced within the rights of way by arranging with such other state(s) for verification of the relocation assistance claim.

The Design-Builder shall establish an acquisition/relocation office at a location that is accessible to the property owners and displacees on or near the Project and approved by the Department. The purpose of maintaining this office is to ensure effective and responsive service to meet the property owners' and displacees' needs. The office must be operational by the time acquisitions begin. The Design-Builder shall supply relocation and negotiation personnel with substantial experience in highway ROW acquisition, or similar Work in numbers sufficient to accomplish the required Work in a timely manner. Design- Builder's ROW staff that performs acquisition and relocation/property management services shall be from the Department's pre-qualified consultant list for acquisition and relocation assistance and related services. All relocation and negotiation personnel are to be approved by the Department for each Project hereunder. After the Department has approved the personnel for a Project, changes may only be made with the written approval of the Department. This office shall be staffed by persons knowledgeable of the Uniform Act and the Department's ROW Procedures Manual. This office shall be open during normal business hours and after hours by appointment.

The Design-Builder shall submit procedures for handling ROW acquisitions and relocations to the Department for concurrence prior to commencing ROW activities. This represents a hold point in the Design-Builder's Baseline Schedule. These procedures are to show the Design-Builder's methods, including the appropriate steps and workflow required for certified title

reports, appraisals, appraisal review, negotiations, acquisition, relocations and parcel closings and all related activities. These procedures shall include the Department's review and concurrence of just compensation, administrative settlements, relocation benefits and claims.

A Department's Representative will be available to make timely decisions concerning establishing review and concurrence of just compensation, concurrence of administrative settlements, concurrence of relocation benefits and claims, on behalf of the Department. The Department's Representative is committed to issuing decisions on approval requests within sixty (60) days. The commitment is based on the plan providing a reasonable and orderly workflow and the Work being provided to the Department's Representative as completed.

The Design-Builder shall maintain accurate parcel files and, at the termination of the Work on the Project, turn over to the Department all relocation and negotiation files, appraisal and appraisal review files, and any other pertinent acquisition files, records or reports. All files shall be documented in accordance with the applicable State and Federal requirements. During the Work on the Project, the Design-Builder shall make all such files available, upon demand, for inspection by the Department and/or by the FHWA, when applicable.

The Design-Builder shall submit a Project specific Conceptual Stage Relocation Plan and an Acquisition Stage Relocation Plan for the Department's Review and Acceptance. The plan shall identify a prioritized schedule of ROW activities including but not limited to appraisal, appraisal review, the specific parcels to be acquired and all relocations. The plan shall allow for the orderly relocation of displaced persons based on time frames not less than those provided by the Uniform Act and/or the

Department's ROW Procedures Manual. This plan shall be updated as necessary during the life of the Project.

The Design-Builder shall make the necessary relocation survey and promptly prepare and submit all required relocation documents in accordance with State and Federal regulations. The Design- Builder shall perform all relocations in accordance with the Uniform Act and the Department's ROW Procedures Manual as applicable.

The Design-Builder shall submit bi-monthly status reports to the Department's ROW Division to manage and track the acquisition process. The status report must include but not be limited to the appraisal, appraisal review, and acquisition and relocation assistance status of all parcels. The Department's standard appraisal, appraisal review, acquisition and relocation assistance and property management forms and documents shall be used as applicable.

The Design-Builder shall provide necessary property management services during the period of the Design-Builders Work. Those property management services include, but are not limited to private property owner utility adjustment cost estimates, salvage appraisals on improvements being acquired, moving cost determination, including the moving of on-premise signs and outdoor advertising devices, and determination and collection of rent after the "90 day" notice to vacate has expired.

The Design-Builder shall coordinate all Work through the State's Regional ROW Transportation Manager 2 or his designated representative.

The Design-Builder shall recommend tracts for condemnation. When the Design-Builder

recommends a tract for condemnation, the request for condemnation must have the necessary supporting documentation attached to properly completed forms as indicated by the Regional ROW Office. The Regional ROW Office will check these forms and process this information to obtain a voucher. In general, all voucher requests for any payment will be handled in this manner.

The Design-Builder shall conduct any public meetings as requested by the Department and as required by the Department's ROW procedures and practices

The Design Builder shall meet and coordinate with public officials of governmental agencies and civic groups as required or as requested by the State.

The Department will be responsible for the costs associated with the payment to property owners for negotiated settlements, administrative settlements, and relocation benefits. The Department is also responsible for the costs associated with the payment to be deposited with the court in condemnation cases. In addition, any payments agreed to by the property owner and the Attorney General's Office during the condemnation process either by settlement or through the courts including court costs and any mediation expenses is the responsibility of the Department. The Design-Builder shall be responsible for disbursement of these payments and providing indefeasible title to the Department. All payments will be made in accordance with the policies and procedures established in the Department's ROW Procedures Manual.

The Design-Builder shall prepare, obtain execution of, and record documents conveying title to such properties to the Department and deliver all executed and recorded general warranty deeds to the Department. For all property purchased in conjunction with the Project, title shall be acquired in fee simple (except for the acquisition of slope, construction or permanent drainage easements, in lieu of fee simple title, with respect to any portion of the ROW, which must be concurred with by the Department's Design Division) and shall be conveyed to the Department, Grantee, by a Departments-approved general warranty deed, free and clear of all liens and encumbrances except encumbrances expressly permitted by the Department in writing in advance. All easements shall be acquired in the name of the Department.

Because these acquisitions are being made on behalf of the Department, the Department shall make the ultimate determination in each case as to whether settlement is appropriate or whether the filing of a condemnation action is necessary, taking into consideration the recommendations of the Design-Builder. When the Department authorizes the filing of condemnation, the Design-Builder shall prepare all required documents necessary to file and forwarded to the appropriate Department Regional ROW Office.

The Design-Builder shall provide the necessary staff and resources as directed by the Department to work with the Department and the Attorney General's Office throughout the entire condemnation process until the property is acquired by settlement, by deed, or by Final Consent Judgment executed by the Department and the appropriate court. The Design-Builder shall provide updated appraisals (i.e., appraisal reports effective as of the date of possession) and expert testimony supporting condemnation proceedings upon request by the Department and/or the Attorney General's Office.

The Design-Builder shall be responsible for all contacts with landowners for ROW and construction items and shall be responsible for properly setting all ROW monuments associated with the Project.

The Design-Builder shall maintain adequate access to all occupied properties to ensure emergency and personal vehicle access. Utility service must be available to all occupied properties at all times prior to and until relocation is complete.

During the acquisition process and for a period of three (3) years after final payment is made to the Design-Builder for any phase of the Work, and until the Department has indefeasible title to the property, all Project documents and records not previously delivered to the Department, including but not limited to design and engineering costs, construction costs, costs of acquisition of ROW, and all documents and records necessary to determine compliance with the laws relating to the acquisition of ROW and the costs of relocation of utilities, shall be maintained and made available to the Department for inspection or audit. Throughout the design, acquisition, and construction phases of the Project, copies of all documents/correspondence shall be submitted to both the Department Headquarters Office and the respective Department's Regional Office.

The Design-Builder shall ensure no open burning will occur within 1,000 feet of an occupied dwelling.

The Design-Builder shall maintain a sufficient buffer or hold off zone around parcels which have not been acquired and/or occupied properties to ensure compliance with ROW procedures prior to starting construction activities in these affected areas. There should be no construction-related activities within the hold off zone until the property is acquired and/or vacated. The Department will provide written notification before the contractor can enter the hold off zone.

Fidelity Bond: The Design Builder shall furnish a fidelity bond in the amount of $250,000.00 with the State being made the insured for the period of time from the first offer to the owners until all tracts have a recorded deed or vouchers submitted for condemnation, in such form as approved by the State. The bond shall indicate the State's ROW Project number (both Federal and State numbers, if applicable).

8. UTILITIES

As defined in CI/ASCE 38-02, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, the Department has performed a utility quality level B verification for this Project. With the exception of the locations listed in section titled "Coordination Responsibilities", this information is provided to the Design-Builder for use as preliminary estimate of the horizontal and vertical locations of the existing utilities within the Project limits.

A utilities conflict matrix of existing utility facilities is provided for reference only on the Project website and reflects the most current information available to the Department. Utilities that may potentially be in conflict with the Project are listed in the matrix.

○ *UTILITY INVESTIGATIONS*

The Design-Builder shall be responsible for identifying any utility conflicts, coordinating with the utilities in the design of the relocated facilities, and preparing construction plans for the relocation of the utility facilities, as required to accommodate the proposed Project design. Exact locations shall be determined in the field by contacting the utility companies involved and additional SUE investigations as necessary. Notification by calling the Tennessee One Call System, Inc., at 1-800- 351-1111 as required by TCA 65-31-106 shall be required.

The Design-Builder shall make all reasonable efforts to design the Project to avoid conflicts with utilities and minimize impacts where conflicts cannot be avoided.

The Design-Builder shall be responsible for verifying all information related to the survey information as to the location (both vertical and horizontal of the Utilities). The providing of information by the Department shall not relieve the Deign-Builder of this obligation, nor transfer any of that responsibility to the Department.

○ *GENERAL REQUIREMENTS*

The Design-Builder shall be familiar with 1680-6-1 Rules and Regulations for Accommodating Utilities within Highway Rights-of-Way, Tennessee Code Annotated (TCA) Part 8 Relocation of Utilities 54-5-801 through 54-5-856, and 23 CFR Part 645 "Utilities". Adherence to the above referenced regulations and procedures are mandatory.

Utility facility relocations shall require the proposed plans to be submitted to the Department as a utility relocation plan and schedule of calendar days for review and approval for the accommodation of utilities within highway right-of-way. The Design Builder with the consent of the utility, can make that submittal on behalf of the utility after the review and approval by the utility of the utility relocation plans.

The Design-Builder must utilize a firm which is prequalified with the Department to perform utility coordination services and the Design Builder must adhere to TDOT policy #301-01 "Standard Procurement of Engineering and Technical Services".

Immediately after submittal of the accepted final Definitive Design Plans, the Design-Builder shall use the TDOT Utility Manual as a guide to utility coordination. In compliance with the statute (TCA 54-5-854), a minimum of 120 calendar days shall be included in the Critical Path

Method Schedule after submission of Definitive Design plans for Utility Owners to develop relocation plans.

The Design-Builder shall utilize a single dedicated person responsible for managing all utility coordination and required concurrence with the TDOT Utility Office. The Utility Coordination Manager shall have the following knowledge, skills, and abilities:

- A minimum of 4 years of experience performing utility coordination in accordance with TDOT standards, policies, and procedures.
- Knowledge of the Department plans production process and utility coordination practices.
- Knowledge of aforementioned rules, regulations, and codes.

○ *COORDINATION RESPONSIBILITIES*

The Design-Builder shall coordinate the relocation or adjustment of the utilities in accordance with Section 6.2 of **Design Build Standard Guidance**. The Department will process and certify all compensable utilities. The Design-Builder shall process and certify all non-compensable utilities for potential conflict and/or relocations. The Department will be the approving authority for all utility permits, compensable agreements, and acceptance of utility relocation plans.

Prior to submitting the bid, the Design-Builder shall be solely responsible for contacting owners of all affected utilities in order to determine the extent to which utility relocations and/or adjustments will have upon the schedule of work for the Project. While some work may be required in the vicinity of utility facilities that will remain in place, other utility facilities may need to be adjusted concurrently with the Design-Builder's operations.

The Design-Builder shall be responsible for confirming the utility locations, confirming the type of facilities, identifying the utility owners and determining the cost responsibilities in order to coordinate the relocation of any utilities in conflict with the Project with respect to the "General Requirements" section.

The Design-Builder shall notify each individual utility owner of their plan of operation in the area of the utilities. Prior to commencing work, the Design-Builder shall contact the utility owners and request them to properly locate their respective utility on the ground. This notification shall be given at least three (3) business days prior to commencement of operations around the utility in accordance with TCA 65-31-106.

The following Utilities have been identified by the Department as having facilities within the Project corridor for which the Department contemplates an adjustment, protection, or relocation is possible.

Utility	Owner	Contact	Phone Number Email Address
Telephone	AT&T	Joe Perrel	O:423-266-1566 M:423-488-2825 Jp1389@att.com
Electric and Fiber	Electric Power Board of Chattanooga	David Henderson	O:423-648-3257 M:423-802-7562 hendersondc@epb.net
Water	TN American Water	Grady Stout OR Caroline Archer	O:423-771-4713 M:423-486-5879 Grady.stout@Amwater.com OR 423-596-9081 Caroline.Archer@amwater.com
Sewer	Hamilton County W&WW Treatment Authority	Michael Patrick OR Eric Brooks	423-209-7842 Mpatrick@HamiltonTN.gov OR 423-762-4120 ericb@HamiltonTN.gov
Sewer	City of Chattanooga, Public Works	Dennis Malone OR Bill Payne	O:423-643-6188 M:423-421-5035 dmalone@chattanooga.gov OR 423-643-6160 bpayne@chattanooga.gov
Gas	Chattanooga Gas	Brandon Stephens OR Socrates Alvarez	O:404-584-3915 M:404-323-4038 bstephen@southernco.com OR 423-661-4528 ssalvare@southernco.com
CATV	Comcast/Xfinity	Tim Gregory	706-252-4185 Tim_gregory@comcast.com
Electric	TVA	Stephen Williams	862-255-6272 sewilliams@tva.gov
Fiber	ATT Long Distance	Trina Ivey	678-641-5522 Ki2863@att.com
Telephone	Centurylink-Lumen	Jim Arterburn	423-626-6882 Jim.arterburn@Centurylink.com
Fiber	Zayo Group	Amber Bell	423-598-2937 Amber.bell@zayo.com
Petroleum	Plantation Pipeline Company	Tom Bickel	770-330-1696 Tom_Bickel@Kindermorgan.com
	Colonial Pipeline Company	Kevin Raley	706-891-7584 kraley@colpipe.com

○ *COMPENSABLE UTILITIES*

The Department shall make the necessary arrangements with the utility owners on compensable utilities identified and submitted by the Design-Builder and the Design-Builder shall make the necessary arrangements with the utility owners for all non-compensable utilities including new installations required for the Project, adjustments, relocations or removals where the Design-Builder and utility company determine that such work is essential for highway safety and performance of the required construction.

The Design-Builder shall be responsible for determining the cost responsibility (compensable or non-compensable utilities) for the utility relocations. The Department will be responsible for non- betterment (compensable utilities) utility relocation cost when the utility company has prior rights- of-way or compensable interest. The utility company shall be responsible for the relocation costs if they cannot furnish evidence of prior rights- of-way or compensable interest (non-compensable utilities) in their facilities. The Design-Builder shall be responsible for all costs associated with utility relocations due to haul roads and/or any other temporary conditions resulting from the Design-Builder's methods of operation or sequence of work.

If the Design-Builder elects to make arrangements with a utility company to incorporate a new utility installation or relocation as part of the highway construction, the utility work done by the Design-Builder and the associated costs for the work shall be negotiated and agreed upon between the Design-Builder and the utility company.

If the Design-Builder is requested, in writing, by an entity to relocate, upgrade or incorporate new facilities as part of the highway construction, designs shall be coordinated with the utility owner, and the Department. The associated design and construction costs shall be negotiated and agreed upon between the Design-Builder and the utility company. Environmental permitting for utility work construction shall follow the same process as outlined in Section 9. Any and all design permits for utility facilities, such as water and sewer permits from TDEC, shall remain the responsibility of the utility to obtain and provide to the Design-Builder.

No additional compensation or time shall be granted for any delays, inconveniences, or damage sustained by the Design-Builder or its Subcontractors due to interference from compensable utilities or the operation of relocating utilities.

○ *ADDITIONAL REQUIREMENTS*

The Design-Builder shall accommodate utility adjustments, reconstruction, new installation and routine maintenance work by others that may be underway or take place during the progress of the contract.

In the event of a utility conflict, the Design-Builder shall request that the utility company submit relocation plans (plans to be provided by the Design-Builder to Utility Owners) that show existing utilities and proposed utility relocations.

The Department will be the approving authority for all utility permits, agreements and acceptance of plans.

The Department Utility Office must execute approved agreements on Design-Build highway projects. The Utility Relocation Agreements (Cost Agreement) and encroachment permit

agreements are available from the Department.

Sampling, testing, monitoring and reporting shall be performed by the Design-Builder in accordance with standard industry practices for water, wastewater, oil, and gas and in accordance with the Utility Owners standard specifications and requirements.
For the I-75 over CSX Railroad Bridge, design and construction activities shall be in accordance with the Special Provision 105C Protection of Railroad Property, Railroad Flagging and Insurance requirements as included in Contract Book 2 (Design-Build Contract), the CSX Public Project Information as included in the Reference Documents, and the Design-Build Standard Guidance.

○ *CONSTRUCTION REQUIREMENTS*

The Design-Builder shall provide all necessary protective measures to safeguard existing utilities from damage during construction of this Project. In the event that special equipment is required to work over and around the utilities, the Design-Builder shall be required to furnish such equipment.

Any damage to the existing facilities associated with the construction activities shall be the sole responsibility of the Design-Builder to repair the damaged utility at no additional cost to the Department or the respective Utility Owner.

9. ENVIRONMENTAL

The NEPA document has been approved by FHWA and is included on the Project Website. The project commitment sheets and the study area are referenced in these documents. The Design-Builder shall refer to the NEPA document for a complete description of the environmental commitments for the Project.

The Design-Builder shall adhere to all project commitments and requirements included in the NEPA document. If the Design-Builder's design footprint extends beyond the study area and/or changes to impacts to identified resources, the Design-Builder shall be responsible for the additional environmental technical studies and re-evaluation of the NEPA document. If the proposed project does not go to construction within 3 years of the approval date of the NEPA document, the Design-Builder shall be responsible for the NEPA document re-evaluation.

No additional time will be allotted to the Project schedule for the Design-Builder's preparation of the NEPA document re-evaluation, TDOT Environmental Division staff's review and concurrence of the NEPA document re-evaluation, agency coordination, and subsequent FHWA approval of the NEPA document re-evaluation.

○ *ENVIRONMENTAL BOUNDARIES*

The Design-Builder is responsible to make sure all features from the Environmental Boundaries Report (EBR), provided by the Department's Region 2 Environmental Tech Office, are field verified. The Design-Builder shall be responsible for any mitigation for impacts to environmental features included in the EBR or additional features identified prior to and during construction. The Environmental Boundaries Report must be completed in accordance with Department practices; the Design-Builder shall be responsible for obtaining any necessary Documentation Standards from the TDOT Environmental Division.

For impacts to any streams, springs, wetlands, sinkholes or other water resource features identified during construction not included in the original EBR, it shall be the responsibility of the Design- Builder to provide the items listed below to the Department's Region 2, Environmental Tech Office for review prior to submittal to the regulatory agencies:

<u>Streams</u>

- Hydrologic Determination Field Data Sheet (Version 1.54)
- Ecology Water Resources Field Data Sheet
- A location map, marked up plan sheets, and a U.S. Geological Survey (USGS) Quad map showing the proposed stream(s) using Department-provided map templates
- Photo summary of each feature including photo views of the location of the proposed alteration, upstream, downstream, and along the centerline of the Project.

Wetlands

- Wetland Determination Data Form (U.S. Army Corps of Engineers, (USACE)) – Eastern Mountain and Piedmont Region: Version 2.0
- Tennessee Division of Water Resources: Tennessee Rapid Assessment Methodology (TRAM) documentation for wetlands including TRAM Decision Key, TRAM Outstanding Natural Resource Water or Exceptional Tennessee Water Decision Table, appropriate HGM field data forms (if applicable) or Non-HGM field data forms (if applicable) for the wetland type being assessed, and TRAM Quantitative Summary Table.
- A location map, marked up plan sheets, and a USGS Quad map showing the proposed wetland(s) using Department-provided map templates.
- Photo summary of each feature including photo views of the location of the proposed alteration and wetland boundaries.

This determination shall be completed by a Tennessee Qualified Hydrologic Professional (TN-QHP). The Tennessee Qualified Hydrologic Professional (TN-QHP) Certification must be submitted along with the Hydrologic Determination Field Data Sheet for the individual preparing the stream data sheets and forms.

All additional environmental field studies are to be performed by Design-Builder's personnel with the required qualifications.

State or Federal Endangered/Threatened Species

Due to concerns for spawning populations of the federally threatened snail darter (Percina tanasi), no work will be allowed in Spring Creek, West Chickamauga Creek, or South Chickamauga Creek during the period from February 1 through April 30 during all years of construction.

Due to concerns for the state threatened Chickamauga crayfish (Cambarus extraneus), the Department will coordinate with TWRA staff to conduct sweeps/surveys prior to any in-stream work. The Design-Builder shall provide at least twenty-one (21) calendar days advance notice to the Region 2 Environmental Tech Office.

If the Design-Builder makes changes to the plans, construction methodology, and/or ROW; this will immediately require additional review(s) of the proposed changes by the U.S. Fish and Wildlife Service (USFWS), Tennessee Wildlife Resources Agency (TWRA), and the Tennessee Department of Environment and Conservation (TDEC) Division of Natural Areas. The Design-Builder shall contact the Department's Region 2 Environmental Tech Office prior to any coordination. If TWRA or USFWS requires any species surveys, sweeps, or relocations, the Department will require the Design-Builder to perform the work. The Design-Builder must provide the following to the Department's Region 2 Environmental Tech Office before starting coordination with the USFWS and TWRA.

Surveys shall be conducted as appropriate, depending on the species. The Design- Builder's biologist shall prepare a sampling plan as recommended by the USFWS, TWRA, and/or TDEC.

Division of Natural Areas. The plan shall include (at a minimum) the techniques, equipment, analytical techniques or metrics (e.g., IBI, TMI), time frame, staff qualifications, and the appropriate collection permits identification numbers (if applicable).

- A sweep is generally associated with fish, mussels, or crayfish; and is typically conducted immediately prior to commencement of construction work in the water. The sweep is performed the same day as installation of the coffer dams or when the work is being done in the water. A plan describing the methods for conducting the sweep shall be required. All sweep methods and procedures must be coordinated with USFWS and TWRA prior to the sweep.
- A relocation plan, if applicable, shall be submitted to the USFWS (for Federal- listed plants) and the TDEC Division of Natural Areas (for State-listed plants) for approval. This shall include, at a minimum, a description of the translocation site including the ownership of the parcel, the technique for moving the plants, the proposed relocation site, the time frame for the move, long term protection strategies at the translocation site, and the qualifications of the staff involved.

The Design-Builder shall (in consultation with the Department) allow time in the CPM for the Department's Region 2 Environmental Tech Office to coordinate with TWRA, USFWS, and the TDEC Division of Natural Areas, if required.

Migratory Birds

The Design-Builder shall perform all construction work in observance of the Migratory Bird Treaty Act (MBTA) of 1918 (last amended in 1998) and the USFWS/TDOT Memorandum of Agreement outlining procedures for addressing cliff and barn swallow nesting sites found on Department projects. MBTA of 1918 (amended 1998) provides protections to all migratory birds, with the exception of pigeons and starlings.

Cliff swallows (Petrochelidon pyrrhonota) and barn swallows (Hirundo rustica) nests, eggs, or birds (young and adults) shall not be disturbed between April 15 and July 31. From August 1 to April 14, nests may be removed or destroyed, and measures may be implemented to prevent future nest building at the site (e.g., closing off area using netting).

Rare Plant Species

If impacts to the rare plant species listed on the Species Form of the EBR or their habitats are unavoidable, the plans must include measures to translocate the species to a suitable, high-quality mitigation site as noted above. Due to the uncommonly high concentration of rare plant species in the wetlands around the project, the Design-Builder must submit the plans to the Department's Region 2 Environmental Tech Office for coordination with TDEC's Division of Natural Areas for their Review and Approval prior to commencing work or translocation in these areas.

Other Natural Resources

The Design-Builder shall ensure identification, survey and monitoring of other natural resources such as sinkholes, caves, or specialized habitats. The Design-Builder shall coordinate with the Department's Region 2 Environmental Tech Office for coordination with regulatory agencies (i.e., TDEC) when necessary and obtain any necessary permits for modifications to the natural resources (i.e., TDEC Underground Injection Control Permit, etc.).

GPS/GIS data collection

The Design-Builder's data collection for streams, wetlands, springs, sinkholes or other jurisdictional features shall be with mapping grade accuracy (defined as sub meter).

Mitigation of Streams and Wetlands

The Department will provide up to 36.2 functional feet of stream mitigation credits for the Design-Builder's use, but is encouraged to minimize their use. The Design-Builder shall be responsible for the balance of stream and wetland mitigation required for the Project including all costs associated with obtaining mitigation, maintenance, and monitoring of the mitigation site. This may include (but is not limited to):

- Planning;
- Design;
- Permitting;
- Construction of on-site/off-site mitigation for stream and/or wetlands impacts;
- Post-construction monitoring and maintenance of the mitigation sites;
- Number of wetland mitigation credits provided by the Department; and/or
- Purchasing of stream mitigation from an approved site/organization.

All stream & wetland mitigation shall follow the requirements outlined in the Stream Mitigation Guidelines for the State of Tennessee, prepared by the TDEC, Division of Water Resources Permits Section and federal mitigation requirements of the Department of the Army, Corps of Engineers 33 CFR Parts 325 and 332. All proposed stream and wetland mitigation shall be submitted to and coordinated with the Department's Region 2 Environmental Tech Office for coordination with regulatory agencies prior to the submittal of the permit application. It shall be the responsibility of the Design-Builder to make any and all adjustments deemed necessary by the regulatory agencies to the proposed mitigation plan.

The Design-Builder shall be responsible for all on-site/off-site mitigation requirements listed in the permits and all costs associated with mitigation requirements.

○ *PERMITTING*

The Department has not, nor will the Department, procure permits for the Design-Builder. The Design-Builder shall determine all of the permits required in order to perform the work.

The Design-Builder shall be solely responsible for and obtain any necessary building, demolition, grading, and environmental permits or approvals, including but not limited to archaeology, ecology, historical, hazardous materials, air and noise, TVA 26a, TDEC ARAP/401, USACE Section 404, and TDEC National Pollution Discharge Elimination System (NPDES) permits, from federal, state and/or local agencies regarding any material and staging areas and the operation of any project- dedicated asphalt and/or concrete plants, and any waste or borrow areas that will be used. Any such permits shall be supplied to the Department's Region 2 Environmental Tech Office prior to the commencement of activities in the permitted area(s).

The Design-Builder is responsible, under the laws and regulations listed above, to avoid and minimize, to the maximum extent practicable, impacts to Waters of the State and/or Waters of the U.S. when designing and constructing the project. Avoidance and minimization of impacts are beneficial to the Design-Builder because such actions avoid or reduce the amount of compensatory mitigation that may be required to obtain water quality permits prior to construction.

If environmental permits are necessary prior to completion of the Definitive Design Plans, the Design Builder shall contact the Department's Alternative Contracting Office immediately for guidance.

The Department's Region 2 Environmental Tech Office and Headquarters Environmental Division Permitting Section shall be included in all correspondence and/or negotiations with agencies.

The Design-Builder shall obtain and pay for all regulatory permits as required by applicable laws, the plans, or contract specifications. This includes stormwater discharges associated with construction support activities including, but not limited to: equipment staging yards, material storage areas, excess excavated materials disposal, demolition disposal (waste) areas, and borrow areas. These areas are to be addressed in accordance with the TDOT Waste and Borrow Manual (May 15, 2017 Version). The Design-Builder shall be cognizant of and adhere to the requirements of the various permits that will be necessary for construction and operation of the Project.

Applying for and Obtaining Permits

The Design-Builder shall be responsible for preparing all documents (permit application package) and attending all public meetings necessary to obtain the environmental permits required for the construction of this Project. The Design-Builder shall use Permittee Bill of Rights TCA 69-3-141 in determining the number of days for the review of submissions and resubmissions of all relevant permitting documents to TDEC.

The Design-Builder shall acquire information and prepare permit drawings/sketches that reflect the impacts and minimization efforts resulting from the Design-Builder's design of this Project. If water quality permits are required, there shall be scheduled reviews of permittable plans, application, and permit conditions by the Department's Region 2 Environmental Tech

Office and upon request, Headquarters Environmental Division Permitting Section to ensure regulatory practices are consistent.

The Design-Builder shall be responsible for developing the permit application for all jurisdictional water resource impacts. The Design-Builder shall be responsible for all public notice requirements such as documentation to be placed in the local paper and in the field and answering of public notice comments. The Design-Builder shall employ all personnel that it deems necessary in order to provide permit compliance.

The Design-Builder shall submit the permit application in its own name and ensure the permit is issued in its name. If under the applicable laws and regulations, the permit application cannot be submitted in the Design-Builder's name, the Design-Builder shall submit the permit application as an Authorized Agent of the Department and ensure the permits are issued with the Department as the Permittee. The Design-Builder shall attend a final review meeting with the Department to review all permit applications prior to submitting the application to the permitting agencies.

Environmental permits may also be required when activities such as core sampling, seismic exploratory operations, geotechnical investigations, ROW fence replacement, and historic resources surveys are within Waters of the State or Waters of the U.S. These permits may also be required for placement and operations of scientific measurement devices.

The Department's Region 2 Environmental Tech Office and Headquarters Environmental Division Permitting Section shall be invited to any meeting between the Design-Builder and the respective regulatory agency to discuss issues related to the application for (or refusal of) a permit. The Design- Builder shall inform the Department a minimum of ten (10) business days in advance of the time and location such a meeting is to take place.

The Design-Builder shall represent the Department in any proceedings relating to reservations, objections, appeals and/or applications for preliminary injunctions initiated by others against the permit application or by itself against the permit decision. In such proceedings, the Design-Builder shall do everything in its power to defend the submitted application.

If any regulatory agency rejects or denies the permit application, it is the Design-Builder's responsibility to make the necessary revisions to ensure the permit is approved. If revisions are required to obtain permits, there should be scheduled reviews of the revisions by the Department's Regional Environmental Tech Office and upon request, the Headquarters Environmental Division Permitting Section to ensure regulatory practices are consistent. The Design-Builder shall be responsible for preparing designs and proposing construction methods that are permittable. All permits required for a particular construction activity shall be acquired prior to commencing the particular construction activity. All costs and delays associated with incomplete permit packages, agency rejection, agency denials, agency processing time, or any permit violations shall be the responsibility of the Design-Builder, and will not be considered sufficient reason for time extension.

The Design-Builder shall provide the Department with a copy of the draft permit decision and a copy of the final permit immediately upon receipt.

The Design-Builder shall plan, implement, monitor and maintain all applicable Erosion Prevention and Sediment Control (EPSC) measures and Best Management Practices (BMPs) in accordance with all TDOT standards during construction.

The Design-Builder shall bear all cost and risks associated with applying for, obtaining and complying with permits.

Permit Application Package Contents

The permit application package (applicable for USACE §404 and TDEC ARAPs) shall include, but not be limited to, the following information.:

- Signed application letter to the TDEC Division of Water Resources, Permits Section and USACE listing all water quality impacts.
- The signed application letter shall indicate the following:
    - Alternatives for each impact to environmental features;
    - Proposed methods utilized by the Design-Builder to minimize impacts to each environmental feature; and
    - Proposed mitigation for impacts to environmental features (if required).
- Labeled USGS color quadrangle map. The map shall have the following information shown:
    - Impact areas labeled by permit type;
    - Longitude and latitude (precision to four decimal places) listed for each impact;
    - Quadrangle name and number;
    - Project information (including PIN, State Project Number, project description, County name, nearest city);
    - Scale bar (quad map scale shall be set to 1:24,000); and
    - North arrow.
- Copy of signed CN1091 form (the originally-signed CN1091 form shall be submitted to TDEC).
- Signed DA/TVA form or DA form (if applicable). DA/TVA form must be filled out if an Individual Section 404 Permit is required.
- Individual Section 404 Permit applications require the names and addresses of property owners adjacent to all permit impacts listed on a separate permit sketch.
- Individual permit sketches.
- Hydrologic Determination Field Data Sheet (if applicable).
- Ecology Field Data Sheet (if applicable).
- Habitat Assessment Field Data Sheet (if applicable).
- Wetland Determination Data Form (if applicable).

- TRAM Decision Form (if applicable).
- Quad map showing impact area and listing all environmental features.
- Photographs of all environmental features.
- Marked-up plan sheets from the Environmental Boundaries Report.
- A copy of all coordination correspondence between the Department and the USFWS.
- TDEC Division of Natural Areas, endangered species database search.
- A copy of all coordination correspondence between the Department and the TWRA.
- Federal Emergency Management Agency (FEMA) flood map for the subject project with construction limits labeled.
- FEMA No-Rise Certification letter or Conditional Letter of Map Revision (CLOMR) (if applicable).
- A copy of approved NEPA document (Environment Assessment, Finding of No Significant Impact, Categorical Exclusion, etc.).
- A copy of the State Historic Preservation Office (SHPO) letter (Architectural & Archaeological).
- Mitigation plan/plans for all streams and wetlands (if applicable).
- Half-size copy of the bridge layout(s) (if applicable).
- Half-size set of plans showing all environmental features. The plans shall be highlighted according to the following guidelines:
    - New culvert construction (extensions included) shall be highlighted in orange on the proposed layout.
    - Existing culverts shall be highlighted in blue on the present layout (blue on the proposed layout if sections are remaining).
    - Stream inlet and outlet protection measures and channel transitions shall also be quantified, labeled on the plans, and recorded in the impact table.
    - Streams/springs shall be highlighted in blue on the present and proposed layout.
    - Wetlands shall be highlighted on present layout (green for permanent impacts and yellow for temporary impacts). Be sure to label plans accordingly.
    - Bank stabilization, outfall structures, and sinkholes should be highlighted in pink on proposed layout.

Any temporary construction measures, including de-watering, construction access, haul roads, EPSC measures, temporary crossings, stream diversions, etc. shall be addressed in the permit application. The Design-Builder shall clearly indicate the location of and impacts from haul roads on jurisdictional areas. The Design-Builder shall identify all proposed borrow and waste sites and provide all clearance documentation per the TDOT Waste and Borrow Manual (May

17, 2017 edition):

https://www.tn.gov/content/dam/tn/tdot/construction/old_web_page/WasteBorrowManual.pdf

These details shall be included in the permit application data. Further, the Design-Builder shall describe the methods of construction of all structures.

NPDES Permit Specific Requirements

A TDEC National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction stormwater runoff is required for this Project. It shall be the responsibility of the Design-Builder to develop final EPSC sheets, a Storm Water Pollution Prevention Plan (SWPPP) and obtain the NPDES CGP for the Project.

The Design-Builder shall request the latest SWPPP template and prepare a SWPPP, Documentation and Permits Binder and a Notice of Intent (NOI) using the Department's most current format to be approved by the Department prior to submittal of the NPDES CGP to TDEC.

The SWPPP template and Manual shall be used as a guide in preparation of the SWPPP and the Design-Builder is responsible for complying with all requirements of the CGP.

The SWPPP shall include the EPSC plans for application of coverage under the CGP. The SWPPP and Notice of Intent (NOI) shall be submitted at least forty-five (45) business days prior to beginning construction activities. Once a Notice of Coverage (NOC) is received by the Design-Builder, the EPSC plans and SWPPP shall be kept current for all stages of construction. Any changes in scope subsequent to submitting the SWPPP for coverage under the CGP shall be submitted to both TDEC and the Department for their records.

As outlined in the NPDES CGP, the Department will perform the Environmental Quality Assurance Project Compliance Assessments (QA Inspections) on this Project, which will include any waste and borrow areas.

If at any time the Design-Builder is not in compliance with any applicable permit regulations, all non-compliance items must be addressed by the Design-Builder within 24 hours of such identification. The Department has the authority to suspend work until such time as the deficiencies have been corrected. The Design-Builder shall not be granted any cost or time compensation for any work suspensions associated with non-compliance. Any monetary fees and/or fines associated with any violations shall be the sole responsibly of the Design-Builder. In the event that a Notice of Violation (NOV) is issues by a regulatory agency, the response to the NOV shall be written by the Design-Builder and approved by the Department's Region 2 Environmental Tech Office prior to submittal to the agency.

The Design-Builder shall prepare EPSC plans detailing BMPs to prevent erosion, control sedimentation, and prevent the discharge of any pollutants from leaving the Department's ROW/easements or entering jurisdictional features, or stormwater conveyances and be transported to receiving waters during the construction of the Project. The Design-Builder shall identify all outfall locations on the EPSC plans with an appropriate numbering or lettering system. The Design- Builder shall revise the SWPPP and the EPSC plans as necessary based on actual construction activities throughout the duration of the Project. All SWPPP and EPSC

revisions shall be documented. The Design-Builder shall certify that the individual who prepared and reviewed the EPSC plans and SWPPP is currently certified according to the CGP. The Design-Builder shall also certify that the BMPs are designed so that if properly implemented, installed, and maintained, they will manage erosion and prevent sedimentation to waters of the state and on adjacent property owners, as well as comply with the terms of the TDEC NPDES Construction General Permit.

The Design-Builder shall follow all of the Department's Design Standards/Guidelines when developing the EPSC plans and SWPPP for the subject project.

Water Quality Permits Specific Requirements

The Design-builder assumes all responsibility as the Authorized Agent of the Department (Permittee) as indicated in the permit that relates to protection of the "Waters of the United States" and/or "Waters of the State of Tennessee" pursuant to the following:

- Sections 401 and 404 of the Federal Clean Water Act (33 U.S.C. §1344), and all implementing regulations, including without limitation, regulations of the U.S. Army Corps of Engineers governing permits for discharges of dredged or fill material into waters of the United States in 33 CFR Part 323;
- The Tennessee Water Quality Control Act (T.C.A. §69-3-101, et. seq.) and all implementing regulations, including without limitation the Rules of the Tennessee Department of Environment and Conservation (TDEC) governing National Pollutant Discharge Elimination System (NPDES) permits in Chapter 1200-4-10, and Aquatic Resource Alteration Permits in Chapter 1200-4-7; Class V Injection Well Permits for work in or near sinkholes;
- Section 26a of the Tennessee Valley Authority (TVA) Act of 1933 as amended (49 Stat 1079, 16 U. S. C. sec. 831y1.) and all implementing regulations, including without limitation the regulations of the Tennessee Valley Authority governing construction in the Tennessee River System in 18 C.F.R., Part 1304.

Permit Register

The Design-Builder shall administer a permit register and provide an updated permit register in every progress report. The permit register shall include an overview of all permits required of the Project.

The permit register requires each permit to be indicated as follows:

- Name and address of the granting authority;
- Purpose of the permit;
- Reference to the document in which the permit conditions are defined;
- Status of permit;
- Date by which the authorization of the specific permit is anticipated;

- Permit conditions relevant for the Work;
- Date by which the permit is required (milestone);
- How the Design-Builder ensures that he shall comply with the permit requirements and conditions; and
- Validity and the expiry date (if any) of the permit.

○ *NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) DOCUMENT*

The Design-Builder shall review and adhere to all approved NEPA documents and technical reports; specifically, any environmental commitments listed on the "Green Sheet" of the approved NEPA documents. These commitments are to be taken into account throughout the design and construction process. All commitments listed with respect to their technical area are to be fulfilled during construction activities and/or prior to completion of the Project.

The NEPA document, including the "Green Sheet" environmental commitments are provided on the Project Website.

Should any environmental features within the NEPA study area, not addressed in the NEPA document be uncovered during construction activities, all construction activities shall stop immediately in that area and the Design-Builder shall contact the TDOT NEPA Programs Office for consultation. All technical study activities must be completed in accordance with Department practices; the Design-Builder shall be responsible for obtaining any necessary Documentation Standards from the TDOT NEPA Programs Office.

In accordance with the NEPA, a re-evaluation(s) of the approved document may be required to address any additional ROW and/or easements not studied under the original footprint of the proposed project or changes to the Project design that were not covered under the approved NEPA document. The re-evaluation(s) may take place at any time during the development of the Project. Depending on the magnitude of the design changes required, the re-evaluation may require review and approval by FHWA; however, any minor changes may be documented, reviewed, and concurred with by the Department's Environmental Division.

Should any changes to the design of the project occur, the Design-Builder shall provide the Environmental Division with a notification and copy of the revised plans. The Design-Builder shall be responsible for any technical studies and the NEPA document re-evaluation required.

○ *DISPOSAL OF MATERIALS*

Design-Builder shall not dispose of any material within interchange areas located within the Project limits. All disposal activities shall be in accordance with the TDOT Waste and Borrow Manual (May 15, 2017 edition) located at:

https://www.tn.gov/content/dam/tn/tdot/construction/old_web_page/WasteBorrowManual.pdf

Borrow and waste disposal areas shall be located in non-wetland areas and above the 100-year, Federal Emergency Management Agency floodplain. Borrow and waste disposal areas shall not affect any Waters of the State/U.S. unless these areas are specifically covered by an ARAP,

§404, and/or NPDES permit, obtained solely by the Design-Builder.

○ *DEPARTMENT INSPECTIONS*

The Department will review and monitor the Project by monthly Quality Assurance Inspections (see DBSG), including all waste and borrow areas and any required permittee responsible mitigation sites, to ensure compliance with all applicable environmental regulations and stormwater management activities throughout the duration of the Project.

If at any time, the Design-Builder is not in compliance with any applicable permit regulations, all non-compliance items must be addressed by the Design-Builder within 24 hours of such identification. The Department has the authority to suspend work until such time as the deficiencies have been corrected.

The Design-Builder shall not be granted any cost or time compensation for any work suspensions associated with non- compliance. Any monetary fees and/or fines associated with any violations, assessed by regulatory agencies, shall be the responsibility of the Design-Builder.

○ *EROSION PREVENTION AND SEDIMENT CONTROL (ESPC)*

All Erosion Prevention and Sediment Control (EPSC) designs and implementation shall be the responsibility of the Design-Builder.

Sod shall be used for permanent stabilization and be placed at locations to prevent damage to adjacent facilities and property due to erosion on all newly graded cut and fill slopes as work progresses.

- Pre-construction vegetative ground cover shall not be destroyed, removed or disturbed (i.e., clearing and grubbing initiated) more than 14 calendar days prior to grading or earth moving activities unless the area is mulched, seeded with mulch or other temporary cover is applied.

- Clearing, grubbing, and other disturbances to riparian vegetation shall be limited to the minimum necessary for slope construction and equipment operations. Existing vegetation, including stream and wetland buffers (unless permitted), should be preserved to the maximum extent possible. Unnecessary vegetation removal is prohibited.

Temporary stabilization shall be initiated within 14 calendar days when construction activities on a portion of the site are temporarily ceased and earth disturbing activities shall not resume until after 14 calendar days. Permanent stabilization measures in disturbed areas shall be initiated within 14 calendar days after final grading of any phase of construction.

Steep slopes shall be temporarily stabilized not later than 7 calendar days after construction activity on the slope has temporarily or permanently ceased. Steep slopes are defined as natural or created slopes of 35% grade or greater, regardless of height.

Permanent stabilization shall replace temporary measures as soon as practicable. Priority shall

be given to finishing operations and permanent EPSC measures over temporary EPSC measures.

Inspection, repair, and maintenance of EPSC structures shall be performed on a regular basis and sediment shall be removed from sediment control structures when the design capacity has been reduced by fifty percent (50%). During sediment removal, the Design-Builder shall take care to ensure that structural components of EPSC structures are not damaged and thus made ineffective. If damage does occur, the Design-Builder shall repair the structures at their own expense.

EPSC controls shall be inspected according to permit requirements to verify measures have been installed and maintained in accordance with TDOT standard drawings, specifications, and good engineering practices. EPSC inspections shall be documented in accordance with the TDOT Erosion Prevention & Sediment Control Manual and a copy of each inspection report shall be provided to the Department within five (5) days after the inspection.

Sediment removed from sediment control structures shall be placed and be treated in a manner so that the sediment is contained within the Project limits and does not migrate onto adjacent properties and into Waters of the State/United States.

The Design-Builder shall establish and maintain a comprehensive and proactive method to inspect and prevent the off-site migration or deposit of sediment off the Project limits (e.g., R.O.W., easements, etc.), into Waters of the State/United States, or onto roadways used by the general public. If sediment escapes the construction site, off-site accumulations of sediment that have not reached a stream must be removed at a frequency sufficient to minimize off-site impacts (e.g., fugitive sediment that has escaped the construction site and has collected in a street must be removed so that it is not subsequently washed into storm sewers and streams by the next rain and/or so that it does not pose a safety hazard to users of public streets). Arrangements concerning removal of sediment on adjoining property must be settled with the adjoining property owner before removal of sediment.

Upon conclusion of the inspections, EPSC measures found to be ineffective shall be repaired, replaced, or modified before the next rain event, if possible, but in no case more than 24 hours after the inspection or when the condition is identified. If the repair, replacement, or modification is not practical within the 24-hour timeframe, written documentation must be provided in the field diary and EPSC inspection report. An estimated repair, replacement or modification schedule shall be documented within 24-hours of identification. All costs associated with modifications made to these measures shall be the responsibility of the Design-Builder and all modifications shall be concurred with by the Department.

Temporary EPSC measures may be removed at the beginning of the workday but must be replaced at the end of the workday or before/during a precipitation event.

Delaying planting of cover vegetation until winter months or dry months should be avoided.

Offsite vehicle tracking of sediments and the generation of dust shall be minimized. A stabilized construction access (a point of entrance/exit to the construction project) shall be provided to reduce the tracking of mud and dirt onto public roads by construction vehicles.

The Design-Builder shall have a plan in place for dust control. The dust control plan shall be

developed prior to the start of any construction activities and shall be submitted to the Department for approval.

The EPSC plan shall be updated by the Design-Builder whenever EPSC inspections indicate, or where State or Federal officials determine EPSC measures are proving ineffective in eliminating or significantly minimizing pollutant sources or are otherwise not achieving the general objectives of controlling pollutants in storm water discharges associated with the construction activity.

The accepted EPSC plan shall require that EPSC measures be in place before clearing, grubbing, excavation, grading, culvert or bridge construction, cutting, filling or any other earthwork occurs, except as such work may be necessary to install EPSC measures.

EPSC measures shall be installed and functional prior to any earth moving operations and shall be maintained throughout the construction period except as such work may be necessary to install EPSC measures.

The Design-Builder shall establish and maintain a proactive method to prevent litter and construction wastes from entering Waters of the State/United States. These materials shall be removed from stormwater exposure prior to anticipated storm events or before being carried offsite by wind, or otherwise prevented from becoming a pollutant source for stormwater discharges. After use, materials used for EPSC shall be removed from the site by the Design-Builder.

10. CONSTRUCTION

The Design-Builder shall meet the requirements of the Department's Standard Specifications for Road and Bridge Construction (Current Edition), contractual Special Provisions, the Manual on Uniform Traffic Control Devices (MUTCD), and the Tennessee Occupational Safety and Health Administration (TOSHA).

The Design-Builder shall ensure that all applicable "General and Special Notes" found in Section VI of the current edition of the State of Tennessee Department of Transportation Design Division Roadway Design Guidelines are included in the plans and adhered to during construction.

Reference Special Provision 108B Project Completion Time and Liquidated Damages as included in Contract Book 2 (Design- Build Contract).

○ *CONSTRUCTION SERVICES*

The Design-Builder shall supervise and administer all construction activities in accordance with Contract requirements.

The Design-Builder shall perform all other construction Work required to complete the Project in conformance with all Contract requirements, including Legal Requirements.

The Design-Builder shall comply with all applicable laws.

The Design-Builder shall keep the Work location and its vicinity free from accumulation of waste materials and rubbish caused by the Design-Builder's operations.

The Design-Builder shall be responsible for quality control during the execution of work in accordance with the CQMP.

Any area that is disturbed outside limits of construction during the life of this Project shall be repaired by the Design-Builder at their expense. All repaired areas shall be inspected and be deemed satisfactory by the Department.

The Design-Builder shall coordinate his Work with that of other contractors working on or near the Project. The Design-Builder shall consider the schedule of other contractors when developing his schedule to maintain continuity of Work and compliance with the Project schedule.

○ *MAINTENANCE DURING CONSTRUCTION*

The Design-Builder shall prepare a maintenance plan for Department Review and Acceptance that meets the requirements herein.

The Design-Builder is responsible for the maintenance of the Project in accordance with the approved maintenance plan until Project completion and acceptance by the Department.

General Requirements

The Design-Builder shall maintain the Project from the date of the Design-Builder's executed contract with the Department until Project completion and acceptance by the Department, in a manner that provides a safe and reliable transportation system.

The Design-Builder shall be fully responsible for maintenance as required by the Department's Standard Specification for Road and Bridge Construction, section 104.05 Maintenance During Construction. The Design-Builder shall be responsible for all components of the transportation system within construction limits to include, but not limited to, asphalt roadway, concrete roadway, signing, ITS, roadway lighting, control access fence, and guardrail until final acceptance of the Project by the Department.

ROW Mowing & Litter Removal

The Design-Builder shall deliver a ROW Mowing & Litter Removal service to provide a consistent vegetation height and a clean non-littered appearance from the date of the Design-Builder's executed contract with the Department until Project completion and acceptance by the Department.

See Special Provision 806 regarding Contract Mowing, Special Provision 719A regarding Removal and Disposal of Litter, and Special Provision 107AQ regarding Air Quality for Mowing for further details.

It shall be the Design-Builder's responsibility to mow and pick up litter on the full ROW of all three Segments including the median and on top of all bluffs and elevated sections of each Mowing and Litter Cycle.

Annually, there will be a minimum of six (6) Mowing & twelve (12) Litter Cycles. The Department shall direct the Design-Builder with the exact dates for the annual Mowing & Litter Cycle.

Sweeping & Drain Cleaning

The Design-Builder shall provide removal of dirt and debris such as tire and metal fragments, hub caps, rock, etc. accumulated on the roadway along curbs, gutters, median barriers, bridge curbs and gore areas and ramps at interchanges in accordance with Special Provision 719 from the date of the Design-Builder's executed contract with the Department until Project completion and acceptance by the Department.

Acceptance of the Project

Upon Acceptance of the Project, the Department will assume responsibility for the operation and maintenance of the entire Project. Nothing contained herein shall otherwise limit any warranty obligations of the Design-Builder with respect to any Defect or non-conforming Work.

○ *MAINTENANCE OF TRAFFIC*

All interstate and side road construction and closures shall be phased in accordance with Special Provision 108B. Access to all side roads shall be maintained during construction unless specified elsewhere in this RFP.

Definitions

- Road Closure: Complete removal of traffic from a section of roadway using a signed detour route.
- Lane Closure: Reduction in the current number of lanes provided to traffic
- Rolling Road Block: Temporarily delaying traffic for a limited amount of time without stopping traffic or providing a detour.

General Requirements

The objective is to ensure a strategic plan for traffic management on the Project, to minimize lane/road closure, and cause the least interference with traffic.

The Design-Builder shall:

- Develop a Transportation Management Plan including a Traffic Control System that addresses major aspects of the Work for individual construction areas, phases and stages including temporary traffic control, transportation and information strategies. The Transportation Management Plan shall be in accordance with *TDOT Standard Specifications for Road and Bridge Construction*, TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, *TDOT Traffic Design Manual*, *TDOT Design Guidelines*, *TDOT Work Zone Safety and Mobility Manual*, *ATSSA Quality Guidelines for Temporary Traffic Control Devices and Features* (Current Edition), *Special Provision 712PQWS* and the latest edition of the *Manual of Uniform Traffic Control Devices*.
- Use Traffic Control materials from the Department's Qualified Products List (QPL) (https://www.tn.gov/tdot/materials-and-tests/research---product-evaluation-and-qualified-products-list.html)
- The Design-Builder shall insure drainage spread across all traffic lanes does not exceed allowable spread. Design-Builder shall provide drainage/spread calculations for all phases of traffic control phasing.

The Transportation Management Plan shall describe in detail all accommodations for traffic access and flow during all stages of construction for the life of the Project. The plan shall include the following:

- Detailed proposed sequencing plan that includes each step of the Project including all major traffic shifts or changes, minor shifts or changes, closures, alternate traffic patterns.

- Overall goals of the sequencing plan and how the plan aligns with the Project Critical Path.
- Plans for providing Queue Protection during operations requiring temporary lane closures, temporary road closures, rolling roadblocks, traffic pacing, and setting up or removing long- term lane shifts.
- Conceptual construction staging diagrams (scale: 1 inch = 200 feet) including lane configuration and traffic management of the Interstate, State Routes, and local streets during the different stages of construction. Staging areas within the Project limits shall be approved by the Department.
- Narrative description of how Design-Builder will schedule and sequence the construction to minimize impacts on the environment, communities and traveling public while still providing acceptable construction performance.
- Brief description of the laydown, recycling, staging, disposal areas, waste and borrow pits, and maintenance locations to be used during construction.
- Description of how the ROW and adjacent roads and properties will be maintained and protected, including the intended measures to be used to mitigate and minimize noise, vibration, light, dust, erosion/run-off and local road damage.

Temporary Lane/Road Closure

The Design-Builder shall maintain a minimum of 3 lanes in each direction on I-24 and I-75 throughout construction except for Department-approved night or weekend lane or roadway closures as noted below and in the Special Provision 108B. Failure to meet the below requirements will result in Liquidated Damages as specified in Special Provision 108B.

Within Segment 1, on I-24, the Design-Builder will be allowed to rent one lane for a single period of a maximum duration of 9 days in each direction for reconstruction purposes. A minimum of 2 lanes shall be open at all times in all directions. If the Design-Builder does not use all days bid, they will not be allowed any additional closures for unused days. The cost for renting the lane for a day or any portion thereof shall be $50,000. The lane rental cost of **$50,000** shall be Time Value (C) used for the calculation of selection.

Within Segment 1, on I-24, the Design-Builder will be allowed two complete roadway closures over a weekend in each direction for reconstructing the mainline at the tie ins at S Germantown Road. The Design-Builder shall provide a detour for I-24 with a minimum of2 lanes in each direction. A total of 4 complete roadway closures over a weekend will be allowed at no cost to the Design-Builder.

Within Segment 2, on I-75, the Design-Builder will be allowed a total of 10 weekend lane closures in a single direction to restrict traffic to 2 lanes. These weekend lane closures are for construction purposes as deemed appropriate by the Design-Builder and will be provided at no cost to the Design-Builder.

Minimum lane widths shall be eleven (11) feet. Minimum inside and outside shoulder widths shall be two (2) feet.

The Design-Builder will be allowed to temporarily close S. Moore Rd. and McBrien Rd. in order to construct new bridges over I-24 at these locations. The Design-Builder shall only be allowed to close one of these bridges at a time and shall construct each bridge in a continuous manner until the roadway can be reopened to unimpeded traffic flow. The Design-Builder shall only close the portion of S. Moore Rd. and McBrien Rd. necessary to construct the new bridges.

Rolling roadblocks for operations specified in the Special Provision 108B other than blasting will only be allowed from 9:00 PM until 6:00 AM with a maximum duration of thirty (30) minutes.

All temporary lane closures and road closures must be approved by the Department in advance. For lane closures on I-24, I-75 and ramps, request for approval must be sent to the Department seven (7) calendar days in advance of the proposed lane closure. Requests for road closures of S. Moore Rd. and McBrien Rd. must be sent to the Department twenty-one (21) calendar days in advance of the proposed closure. For local street closures, requests for approval must be sent twenty-one (21) calendar days in advance of the proposed closure to the Department, the City of Chattanooga, City of East Ridge, and others as described below. Requests for road closures must also include proposed detour routes and detour signing details. No less than seven (7) days prior to the closure of the road, the Design-Builder shall notify the following individuals or agencies completely describing the affected roads and the approximate duration of the construction: these parties include, but are not limited to: i) local law enforcement office, ii) local fire department, iii) ambulance service, iv) U.S. Postal Service, v) City of Chattanooga and East Ridge Public Works, vi) railroad company (if applicable), vi) the City of Chattanooga and Hamilton County's Parks and Recreation Department (if applicable), vii) Hamilton County Public Works, viii) Chattanooga Airport, ix) Parkridge East Hospital, x) local school superintendent, xi) TDOT's Region 2 Traffic Management Center (TMC), and xii) Georgia Department of Transportation's Traffic Management Center.

There will be periods when the Design-Builder will not be allowed to have any type of closures due to holidays as specified in subsection 104.04 of the Standard Specification and during major events. Major events and known periods when lanes cannot be closed include, but are not limited to: Riverbend, Ironman Triathlon, and various Chattanooga marathons/triathlons that use SR29 and/or SR153. The Department may deny any request for lane closures.

The Design-Builder shall notify the Department and the local governmental agency responsible for traffic control maintenance at least seven (7) days in advance of any cold planing activity at signalized intersections where detector loops are in the pavement. The maintaining agency will then be responsible for disconnecting the loop detectors and making any necessary timing adjustments in the signal controller prior to the construction.

All detour plans shall be approved by the Department prior to

Temporary Marking, Detours, Ramps, Lane Shifts and Median Cross-overs

Temporary marking shall adhere to guidance outlined in Section IV of current edition of the Department's Design Division Roadway Design Guidelines for pavement markings except as noted below. The minimum temporary pavement marking width shall be 6-inches.

Temporary pavement line markings shall be reflective tape or reflectorized paint installed to permanent standards at the end of each day's Work. Short, unmarked sections will not be allowed.

Prior to opening to traffic the Design-Builder shall meet the following requirements: i) temporary pavement marking on detours, lane shifts and median cross-overs shall be installed and maintained to the same standards as for permanent markings on the main roadway, ii) transitional markings on the existing roadway must be in place and all existing markings in the area of these transitional markings shall be obliterated and all existing raised pavement markers shall be removed to eliminate conflicting markings and iii) all temporary lane shifts and detours shall be paved, striped, signed and the vertical panels are to be in place.

All pavement marking removal on final surfaces shall be accomplished by water blasting or another non-marring method. Any damage to the pavement surface caused by the selected method shall be removed and replaced at the contractor's expense.

The Design-Builder shall provide acceleration distance meeting Green Book requirements for temporary ramps where distance is available.

Temporary Modification of Existing Signals

The Design-Builder may make modifications to existing traffic signals within the Project Limits to accommodate detours, construction, incidents, etc. with prior approval from TDOT and City of Chattanooga and/or City of East Ridge. The Design-Builder shall install video detection used for temporary signals that can be integrated into the City of Chattanooga's ITS system. Any modifications must be restored to their original or proposed condition.

Temporary Signage

All temporary signage shall be in accordance with *TDOT Standard Specifications for Road and Bridge Construction*, TDOT Standard Drawings, TDOT Standard Traffic Operations Drawings, *TDOT Traffic Design Manual*, *TDOT Design Guidelines*, *TDOT Work Zone Safety and Mobility Manual*, and the latest edition of the *Manual of Uniform Traffic Control Devices*.

Changeable Message Signs

Changeable Message Signs shall be used in advance of changed roadway conditions such as lane closures, road closures, lane shifts, or detour routes. The locations of these Changeable Message signs shall be reviewed by the Department prior to implementation. Portable changeable message signs should be used as a supplement to and not as a substitute for conventional signs and pavement markings. Portable changeable message sign trailers should be delineated on a permanent basis by affixing retroreflective material, known as conspicuity material, in a continuous line on the face of the trailer as seen by oncoming road users.

Emergency Signage

All existing "emergency reference markers" and "hospital signs" shall be maintained within full view of the motoring public throughout all phases of construction.

Tourist Oriented Directional Signs (TODS)

All existing "Tourist Oriented Directional Signs" shall be maintained within full view of the monitoring public throughout all phases of construction.

Construction Work Zone

Traffic control devices shall not be displayed or erected unless related conditions are present necessitating warning.

Bridge Deck Preparation for Traffic during Phased Construction

Design-Builder shall provide skid resistance prior to opening any bridge decks to traffic. The deck and approaches shall be ground for rideability in accordance with TDOT Standard Specifications when the entire bridge is complete.

Pavement Edge Drop-off Traffic Control

Differences in elevation between adjacent traffic lanes or traffic lane and shoulder where the traffic lane is being used by traffic, caused by base, paving or resurfacing:

- Differences in elevation between adjacent roadway elements greater than 0.75 inch and not exceeding 1.75 inches:
    - Warning signs, uneven lanes (w8-11) and/or shoulder drop-off with plaque (w8-17 and w8-17p), shall be placed in advance of and throughout the exposed area. Maximum spacing between signs shall be 2,000 feet with a minimum of 2 signs per exposed area. Where uneven pavement is encountered, signs shall be placed on each side of the roadway.
    - Differences in elevation between adjacent traffic lanes being utilized by traffic caused by added pavement shall be eliminated within three workdays.
    - Differences in elevation between adjacent traffic lanes being utilized by traffic caused by cold planing shall be eliminated within three workdays.
    - When the difference in elevation is between the traffic lane being utilized by traffic and shoulder the difference in elevation shall be eliminated within seven workdays after the condition is created.
- Differences in elevation between adjacent roadway elements greater than 1.75 inches and not exceeding 6 inches, traffic is not to be allowed to traverse this difference in elevation.
    - Separation shall be accomplished by drums, barricades or other approved devices in accordance with the following:
        - Where posted speeds are 50 mph or greater, spacing of the protective devices shall not exceed 100 feet.
        - Where posted speeds are less than 50 mph, the maximum spacing of the protective devices in feet shall not exceed twice the posted speed in miles per hour or 50 feet, whichever spacing is greater.

- If the difference in elevation is eliminated or decreased to 2 inches or less by the end of each workday, cones may be used during daylight hours in lieu of drums, barricades or other approved protective devices mentioned in paragraph a, provided warning signs are erected. Warning signs (uneven lanes and/or shoulder drop-off) shall be placed in advance of and throughout the exposed area. Maximum spacing between signs shall be 2,000 feet with a minimum of 2 signs per exposed area. Where uneven pavement is encountered, signs shall be placed on each side of the roadway.
- When the difference in elevation is between the through traffic lane and the shoulder and the elevation difference is less than 3 inches, the contractor may use warning signs and/or protective devices as applicable and approved by the regional traffic engineer. See paragraph a regarding use of drums, barricades or other approved protective devices. Warning signs (uneven lanes and/or shoulder drop-off) will be placed in advance of and throughout the exposed area. Maximum spacing between signs shall be 2,000 feet with a minimum of 2 signs per exposed area. Where uneven pavement is encountered, signs shall be placed on each side of the roadway.

In these situations, the contractor shall limit his operations to one work zone not exceeding 2 miles in length unless otherwise noted on the plans or approved by the engineer. Once the contractor begins work in a work zone, a continuous operation shall be maintained until the difference in elevation is eliminated. Simultaneous work on separate roadways of divided highways will be considered independently in regard to restriction of work zone activity.

- Differences in elevation between adjacent roadway elements greater than 6 inches but not exceeding 18 inches, the contractor, with the engineer's approval, may utilize one of the following:
  - (a) The contractor shall accomplish separation by drums, barricades or other approved devices in accordance with the following:
    - Where posted speeds are 50 mph or greater, spacing of the protective devices shall not exceed 100 feet.
    - Where posted speeds are less than 50 mph, the maximum spacing of the protective devices in feet shall not exceed twice the posted speed in miles per hour or 50 feet, whichever spacing is greater.

  In order to use this method, the contractor must reduce the difference in elevation to 6 inches or less by the end of the workday that the condition is created.
  - (b) The contractor shall provide drums, barricades or other approved separation devices as specified in paragraph (a) and construct a stone wedge with a 4:1 slope, or flatter, to eliminate the vertical offset if the lower elevation is at or below subgrade at the end of each day.
  - (c) The contractor shall provide drums, barricades or other approved separation devices as specified in paragraph (a) and if the lower elevation is base stone or asphalt pavement, placement of subsequent layers of pavement must begin the next work day and progress continuously until the difference in elevation is eliminated or reduced to six inches or less.

- The contractor shall provide separation by portable barrier rail.

For preceding conditions (a), (b), and (c), the contractor shall use the shoulder drop-off warning sign with plaque (w8-17 and w8-17p). It shall be placed in advance of and throughout the exposed area. Maximum spacing between the signs shall be 2,000 feet with a minimum of 2 signs per exposed area. In these situations, the contractor shall limit his operations to one work zone not exceeding 1 mile in length unless otherwise noted on the plans or approved by the engineer. Once the contractor begins work in a work zone, a continuous operation shall be maintained until the difference is eliminated. Simultaneous work on separate roadways of divided highways will be considered independently in regard to restriction of work zone activity.

- For differences in elevation between adjacent roadway elements greater than 18 inches.

  Separation will be provided by use of portable barrier rail.

  In this situation the contractor shall limit his operations to one work zone not exceeding 1 mile in length unless otherwise noted on the plans or approved by the engineer. Once the contractor begins work in a work zone, a continuous operation shall be maintained until the difference in elevation is eliminated. Simultaneous work on separate roadways of divided highways will be considered independently in regard to restriction of work zone activity.

If the difference in elevation is within 30 feet of the nearest traffic lane being used by traffic caused by grading, excavation for utilities, drainage structures, undercutting, etc.:

- If the difference in elevation is within 8 feet of the nearest traffic lane with difference in elevation greater than 3/4 inch and not exceeding 2 inches.
  - Warning signs (uneven lanes and/or shoulder drop-off) shall be placed in advance of and throughout the exposed area. Maximum spacing between signs shall be 2,000 feet with a minimum of 2 signs per exposed area. Where uneven pavement is encountered, signs shall be placed on each side of the roadway.
- If the difference in elevation is within 8 feet of the nearest traffic lane with difference in elevation greater than 2 inches and not exceeding 6 inches:
  - Separation shall be accomplished by drums, barricades or other approved devices in accordance with the following:
    - Where posted speeds are 50 mph or greater, spacing of the protective devices shall not exceed 100 feet.
    - Where posted speeds are less than 50 mph the maximum spacing of the protective devices in feet shall not exceed twice the posted speed in miles per hour or 50 feet, whichever spacing is greater.
- If the difference in elevation is within 8 feet of the nearest traffic lane with difference in elevation greater than 6 inches:
  - Separation shall be accomplished by drums, barricades or other approved devices in accordance with the following:

        - Where posted speeds are 50 mph or greater, spacing of the protective devices shall not exceed 100 feet.
        - Where posted speeds are less than 50 mph the maximum spacing of the protective devices in feet shall not exceed twice the posted speed in miles per hour or 50 feet, whichever spacing is greater.
    - Eliminate vertical offset by constructing a stone wedge or grading to a 4:1 slope, or flatter, or use portable barrier rail.

    The contractor shall schedule the work so as to minimize the time traffic is exposed to an elevation difference. Once the contractor begins an activity that creates an elevation difference within 8 feet of a traffic lane, the activity shall be pursued as a continuous operation until the elevation difference is eliminated.

If the difference in elevation is farther than 8 feet from the nearest traffic lane but not more than 30 feet from the nearest traffic lane:

Separation shall be accomplished by drums, barricades or other approved devices in accordance with the following:

- Where posted speeds are 50 mph or greater, spacing of the protective devices shall not exceed 100 feet.
- Where posted speeds are less than 50 mph, the maximum spacing of the protective devices in feet shall not exceed twice the posted speed in miles per hour or 50 feet, whichever spacing is greater.

The contractor shall schedule the work so as to minimize the time traffic is exposed to an elevation difference. Once the contractor begins an activity that creates an elevation difference, the activity shall be pursued as a continuous operation until the elevation difference is eliminated.

Portable Smart Work Zone

The Design-Builder shall use a portable smart work zone work system (PSWZ) to provide queue protection caused by construction activities. The PSWZ shall clearly alert motorist of speed differentials ahead. The PSWZ equipment shall conform to Special Provision 725PSWZS and Special Provision 712SFS. Plans for the PSWZ shall be submitted to the Department separately for concurrence. Plans shall include at a minimum equipment specification, equipment spacing, message matrix, speed thresholds, and software used to control equipment. The PSWZ equipment spacing and design shall conform to the following minimum standards:

- The PSWZ shall be in place prior to the start of construction.
- Starting Point: The PSWZ shall begin 7 miles in advance of the work zone on I-24 EB, 5 miles in advance of the work zone for both I-75 NB and I-75 SB.
- Portable Radar Detection System (PRDS) Sensor Spacing: Sensors shall be spaced every half mile for the entire extent of the PSWZ in each direction.
- Portable Changeable Message Sign (PCMS) Spacing: PCMSs shall be placed at 7 miles in

advance (I-24 EB only), 5 miles in advance, 3.5 miles in advance, 2 miles in advance, 1 mile in advance, and every half mile thereafter until the end of the work zone in each direction. One PCMS shall be placed on SR153 prior to the I-75 SB ramp.

- Portable Closed Circuit Television camera (PCCTV): The Design-Builder shall provide two (2) PCCTV devices that can be moved to critical areas as needed.
- The PSWZ shall be continuous between the I-75 work zone and I-24 work zone.
- The Design-Builder shall provide one speed feedback sign assembly in each direction.

The use of a PSWZ does not relieve the Design-Builder to provide queue protection in accordance with Special Provision 712PTQ for cases when the queue extends beyond the PSWZ. Additionally, the Design-Builder shall provide additional queue protection in accordance with Special Provision 712PTQ during any interstate daytime lane restrictions.

11. MISCELLANEOUS

○ *CHATTANOOGA AIRPORT – HEIGHT RESTRICTIONS*

The Project is in the immediate proximity of the Chattanooga Airport and in-line with the runway glide slope. Height restrictions may apply to proposed structures including but not limited to bridges, lighting (including poles), ITS devices, utilities, and overhead signing. Height restrictions may also apply to construction equipment including but not limited to cranes.

The Design-Builder shall be responsible for filing notice with the FAA for all construction activities, proposed structures, or alterations that may affect navigable airspace. The Design-Builder shall file a Notice of Proposed Construction or Alteration (FAA Form 7460-1) and provide copies to the Department of all filings. Guidance can be found on the FAA website.

Appendix A: Engineering Pavement Analysis

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION
DESIGN DIVISION
SUITE 1200, JAMES K. POLK BUILDING
505 DEADERICK STREET
NASHVILLE, TENNESSEE 37243-1402
(615) 741-0835

JOSEPH GALBATO, III
INTERIM COMMISSIONER

BILL LEE
GOVERNOR

January 28, 2022

Robert Rodgers, CE Mgr II
Region 2 Project Development
4005 Cromwell R
Chattanooga, TN 37421

SUBJECT: Recommended Pavement Design
Project No. 33I075-F1-006
Pin No. 114174.01
I-24/I-75
Interchange at I-24, phase 2
Hamilton County

Dear Mr. Rodgers,

The following are the recommended pavement designs for the subject project.

1. Full depth pavement design for I-24 (SN=6.47)
2. Full depth pavement design for I-75 (SN=6.56)
3. Full depth pavement design for South Terrace
4. Full depth pavement design for Ramps

See the attached pavement design sheets for details. This pavement design is valid until 12-30-2022. Proceeding this date an updated traffic data should be requested and a revised pavement design issued. Please direct any questions you might have concerning this design to the pavement design office.

Sincerely,

Darell Bridges

Darell Bridges
Trans. Proj. Spec. Spv. 1

Sampson Udeh

Sampson Udeh
Pavemen Design Coordinator

SUU:db
File copy

DATE: 01/28/22 FULL DEPTH DESIGN FOR I-24 ROUTE: I-24/I-75

COUNTY: HAMILTON PROJ NO: 33I075-F1-006 PIN 114174.01

DESCRIPTION: INTERCHANGE AT I-24, PHASE 2

ROADWAY & INSIDE SHOULDER DESIGN REGION II

		DESCRIPTION				THICKNESS		
411-03.10		ACS (PG76-22) GR "D"				1.25		
307-03.08		AC MIX(PG76-22) GR "B-M2"				2.00		
307-03.01		AC MIX(PG76-22) GR "A"				6.50		
307-01.22		AC MIX(PG76-22)GR"A-S"				3.00		
303-01		MINERAL AGG BASE GRADING "D"				12.00		
		TOTALS				24.75		

OUTSIDE SHOULDER DESIGN

		DESCRIPTION				THICKNESS		
411-01.07		ACS (PG64-22) GR "E"				1.25		
307-01.08		AC MIX (PG64-22)GR "B-M2"				2.00		
303-01		MINERAL AGG BASE GRA "D"				21.50		
		TOTALS				24.75		

REMARKS: 1) 6.5" OF A-MIX TO BE APPLIED AT TWO EQUAL LIFTS
2) SUBSURFACE DRAINAGE - AGGREGATE UNDERDRAIN W/PIPE

DATE: 01/28/22 CONCRETE DESIGN FOR I-75 ROUTE: I-24/I-75

COUNTY: HAMILTON PROJ NO: 33I075-F1-006 PIN 114174.01

DESCRIPTION: INTERCHANGE AT I-24, PHASE 2

ROADWAY DESIGN REGION II

	DESCRIPTION	THICKNESS
501-01	PORTLAND CEM CONC (PLAIN)	13.00
313-03	TREATED PERMEABLE BASE	4.00
303-01	MINERAL AGG BASE GRADING "D"	6.00
	TOTALS	23.00

SHOULDER DESIGN

	DESCRIPTION	THICKNESS
501-01	PORTLAND CEM CONC (PLAIN)	13.00
313-03	TREATED PERMEABLE BASE	4.00
303-01	MINERAL AGG BASE GRADING "D"	6.00
	TOTALS	23.00

REMARKS: 1) SUBSURFACE DRAINAGE - AGGREGATE UNDERDRAIN W/PIPE
2) FOR EXISTING PAVEMENT IT IS RECOMMENDED TO SEAL ALL LONGITUDINAL AND TRANSVERSE CRACKS WITH SILICON SEALANT AND REPAIR ALL CRACKED SLABS USING PARTIAL DEPTH CONCRETE REPAIR

DATE: 01/28/22 FULL DEPTH DESIGN FOR SOUTH TERRACE ROUTE: I-24/I-75

COUNTY: HAMILTON PROJ NO: 33I075-F1-006 PIN 114174.01

DESCRIPTION: INTERCHANGE AT I-24, PHASE 2

ROADWAY DESIGN REGION: II

	DESCRIPTION	THICKNESS
411-02.10	ACS (PG70-22) GR "D"	1.25
307-02.08	AC MIX (PG70-22) GR "B-M2"	2.25
307-02.01	AC MIX (PG70-22) GR "A"	4.00
303-01	MINERAL AGG BASE GRADING "D"	10.00
	TOTALS	17.50

REMARKS: 1) CURB & GUTTER SECTION ONLY
2) USE ABOVE DESIGN FOR NORTH TERRACE
3) WHERE NEEDED MILL 1.25" FROM THE EXISTING PAVEMENT AND OVERLAY USING 1.25" OF D-MIX

DATE: 01/28/22 DESIGN FOR RAMPS ROUTE: I-24/I-75

COUNTY: HAMILTON PROJ NO: 33I075-F1-006 PIN 114174.01

DESCRIPTION: INTERCHANGE AT I-24, PHASE 2

ROADWAY DESIGN REGION II

	DESCRIPTION	THICKNESS
501-01	PORTLAND CEM CONC (PLAIN)	10.00
313-03	TREATED PERMEABLE BASE	4.00
303-01	MINERAL AGG BASE GRADING "D"	6.00
	TOTALS	20.00

SHOULDER DESIGN

	DESCRIPTION	THICKNESS
501-01	PORTLAND CEM CONC (PLAIN)	10.00
313-03	TREATED PERMEABLE BASE	4.00
303-01	MINERAL AGG BASE GRADING "D"	6.00
	TOTALS	20.00

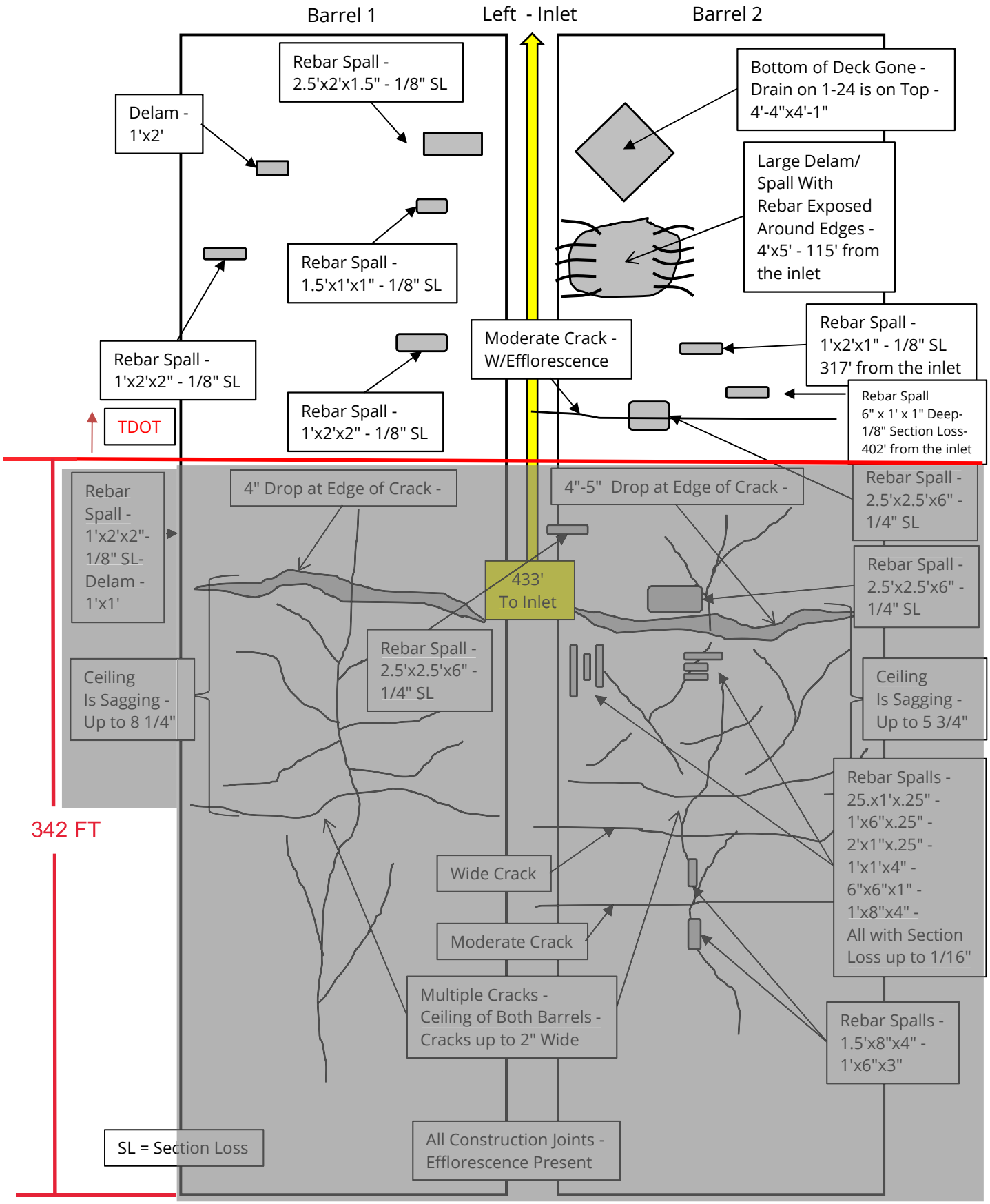
REMARKS: 1) SUBSURFACE DRAINAGE - AGGREGATE UNDERDRAIN W/PIPE

Appendix B: Box Culvert Repair Recommendations

Route Carried: I-24 EB WB
Route Direction: To I-75

Plan View

Over: Branch
Flow: Lt-Rt on I-24



33-I0024-13.58
33I00240075

Plan View

Privately Owned Section

2 Barrel Culvert
Inspection Date: 4/4/2022