I-69 ORX SECTION 1

RFP DRAFT #4

ATTACHMENTS TO THE TECHNICAL

PROVISIONS September 6, 2021

Revisions since last update:

(1) Updated Attachment 18.13 – Pavement Design
(2) Added Special Note for Dowel Bar and Tie Bar Placement in JPC Pavement

Table of Contents

Attachment TP 8.1 Special Note for CPM Schedule 1
Attachment TP 11.7 Environmental Commitments 9
Attachment TP 12.4 Form TC 62-75 24
Attachment TP 13.10 - SPECIAL NOTE FOR PAVER MOUNTED TEMPERATURE PROFILES 27
Attachment TP 13.10 - SPECIAL NOTE FOR ELECTRONIC DELIVERY MANAGEMENT SYSTEM 29
Attachment TP 13.10 - SPECIAL NOTE FOR INTELLIGENT COMPACTION OF AGGREGATE BASES AND SOILS 31
Attachment TP 13.10 - SPECIAL NOTE FOR INTELLIGENT COMPACTION OF ASPHALT MIXTURES 34
Attachment TP 14.1 - Sloped and Mitered Headwall 38
Attachment TP 17.1 - SPECIAL NOTE FOR ASPHALT APPROACH PAVEMENT 40
Attachment TP 17.1 - SPECIAL NOTE FOR CONCRETE PATCHING 41
Attachment TP 17.1 - SPECIAL NOTE FOR BRIDGE RESTORATION AND WATERPROOFING WITH CONCRETE OVERLAY 44
Attachment TP 17.1 - SPECIAL NOTE FOR CONCRETE COATING 46
Attachment TP 17.1 - SPECIAL NOTE FOR ELIMINATING TRANSVERSE JOINTS ON BRIDGES 49
Attachment TP 17.1 - SPECIAL NOTE FOR EPOXY INJECTION CRACK REPAIRS 52
Attachment TP 17.1 - SPECIAL NOTE FOR BRIDGE JOINT STEAL REPLACMENET 55
Attachment TP 17.1 - SPECIAL NOTE FOR NON-EPOXY ADHESIVES 57
Attachment TP 17.1 - SPECIAL NOTE FOR PARTIAL DEPTH CONCRETE DECK PATCHING 58
Attachment TP 17.1 - SPECIAL NOTE FOR REPLACING EXPANSION DAMS AND/OR INSTALLING ARMORED EDGES FOR CONCRETE ON BRIDGES 59
Attachment TP 17.1 - SPECIAL PROVISION 69 - EMBANKMENT AT BRIDGE END BENT STRUCTURES 62
Attachment TP 17.3 - SPECIAL NOTE FOR DRILLED SHAFTS 66
Attachment TP 17.3 - SPECIAL NOTE FOR BRIDGE CLEANING AND PREVENTATVE MAINTENANCE 75
Attachment TP 17.3 - SPECIAL NOTE FOR SEALING BRIDGE DECKS 79

Attachment TP 17.4 - SPECIAL NOTE FOR LIGHTWEIGHT AGGREGATE FILL 82
Attachment TP 17.4 - SPECIAL NOTE FOR CELLULAR CONCRETE FILL 87
Attachment TP 17.4 - SPECIAL NOTE FOR EPS FOAM BLOCK EMBANKMENTS 92
Attachment TP 17.4 - SPECIAL NOTE FOR WATERPROOFING MEMBRANE 99
Attachment TP 18.12 - Special Note for MSE Retaining Walls 100
Attachment TP 18.13 - PAVEMENT DESIGN 128
Attachment TP 18.13 - Special Note for Dowel Bar and Tie Bar Placement in JPC Pavement 134
Attachment TP 21.2 - ITS Specifications 136

SPECIAL NOTE FOR CPM SCHEDULE

A. General. The Progress Schedule required for this Project is the CPM schedule. The DBT shall designate a Schedule Representative who shall be responsible for coordinating with the Engineer during the preparation and maintenance of the schedule. The DBT shall submit an interim schedulefollowed by a baseline schedule, or only a baseline schedule, depending on when the DBT starts work as described below.

B. Interim Schedule. If the DBT starts work within 60 days of execution of the contract, they shall submit an interim schedule. The interim schedule shall be in CPM schedule format. The interim schedule shall include detailed activities for the work to be accomplished during the first 90 days of the Contract, and a summary of activities for the balance of the work.

C. Baseline Schedule. The DBT shall submit a baseline schedule within 60 days of the execution of the Contract. The baseline schedule shall be in CPM schedule format and as described below. The Engineer will review the baseline schedule and will either “approve,” “approve as noted,” or “reject"the schedule within 21 days of receipt. If the Engineer does not provide written notification regarding the disposition of the baseline schedule within 21 days, the submission will be considered rejected.

For baseline schedules that are “approved as noted,” the DBT shall make the necessary revisions and resubmit the revised schedule within 14 days. The Engineer will only reject baseline schedules that are not in compliance with Contract requirements.

For baseline schedules that are “rejected,” the Engineer will indicate in writing all portions of the schedule that are not in compliance with the contract requirements. The Project Engineer will conduct a mandatory meeting with the DBT and the DBT’s Schedule Representative within 14 days of the Engineer’s written notice. The purpose of this meeting is to resolve all issues with the baseline schedule. At this meeting, the DBT shall provide clarification and all additional informationnecessary for the Engineer to “approve” the baseline schedule.

In the event the baseline schedule is not “approved” within 120 days of execution of the Contract, all work shall cease on the Project and no progress payments shall be made until the baseline schedule is “approved.” Approval of the baseline schedule does not revise the Contract Documents.The baseline schedule must be “approved” or “approved as noted” by the Engineer prior to the Engineer evaluating any DBT claims associated with time impacts.

1. **Schedule Requirements.** Generate the baseline schedule using Primavera P6 Project Management by Oracle Corporation, Redwood Shores, CA 94065, or an equivalent program approved by the Engineer. The DBT shall provide any necessary training and license needed forKYTC to use the software. Submit the Primavera P6 XER file in the Version required by KYTC.

The DBT shall provide a working day schedule that shows the various activities of work in sufficient detail to demonstrate a reasonable and workable plan to complete the Project by the Original Contract Completion Date. Show the order and interdependence of activities and the sequence for accomplishing the work. Describe all activities in sufficient detail so that the Engineer can readily identify the work and measure the progress of each activity. The baseline schedule must reflect the scope of work, required phasing, maintenance of traffic requirements, interim completion dates, the Completion Date, and other Project milestones established in the Contract Documents. Include activities for design processes, mobilization, inspection, testing, submittals, working drawings, shop drawing preparation, submittal review time for KYTC shop drawings, material procurement and fabrication, and the delivery of materials, plant, and equipment, and other similar activities. Design reviews shall be numbered and include “KYTC”.

The DBT shall be responsible for assuring all work, including all Subcontractor work, is included in the schedule. The DBT shall be responsible for assuring that all work sequences are logical and thatthe schedule indicates a coordinated plan.

Failure by the DBT to include any element of work required for performance of the Contract shall not excuse the DBT from completing all work within the required time. The Engineer's review of thebaseline schedule will be for compliance with the Specifications and Contract requirements.

Approval by the Engineer shall not relieve the DBT of any of their responsibilities for the accuracy orfeasibility of the schedule. Omissions and errors shall be corrected as described in Section F in this note and shall not affect Contract time, the Completion Date, or total Contract payment.

a. Administrative Identifier Information:
    i. Project Number
    ii. County
    iii. Route Number
    iv. FHWA Number
    v. PID Number
    vi. Contract Signed Date
    vii. Completion Date
    viii. DB Design Manager and DBT Name
    ix. DB Design Manager and DBT Dated Signature
    x. KYTC's Dated Approval Signature
b. General Settings
    i. Calculate the critical path as "longest path"
    ii. The schedule may only be calculated using retained logic
    iii. Total float shall be calculated as finish float
    iv. Ignore relationships to and from other projects
    v. Use "Duration" as the activity percent complete type
c. Project Activities:
    i. Activity Identification (ID). Assign each activity a unique identification number. Activity ID length shall not exceed 10 characters and will not include any commas. Once accepted, the Activity ID shall be used forthe duration of the Project.
    ii. Activity Name. Each activity shall have a narrative name (description) consisting of averb or work function (e.g., form, pour, excavate) and an object (e.g., slab, footing, underdrain). Activity Name will not include commas.
    iii. Activity Original Duration. Assign a planned duration in working days for each activity. Do not exceed a duration of 20 working days for any construction activity unless approved by the Engineer. Do not represent the maintenance of traffic, erosion control,and other similar items as single activities extending to the Completion Date. Break these Contract Items into component activities in order to meet the durationrequirements of this paragraph.
    iv. Activity Relationships:
        1. All activities, except the first activity, shall have a predecessor(s). Allactivities, except the final activity, shall have a successor(s).
        2. Use only finish-to-start relationships with no leads or lags to link activities, or use start-to-start relationships with lags no greater than the

predecessorduration to link activities.

3. Use of finish-to-finish relationship is permitted when both activities arealready linked with a start-to-start relationship.
4. Activities shall not have open-ended relationships. Open-ended is defined as when an activity has either no predecessor or no successor, or when an activity's only predecessor relationships are finish-to-finish or only successor relationships are start-to-start.

d. Project Milestones:

i. Start Project:

The DBT shall include as the first milestone in the schedule, a milestone named "Start Project." The date used for this milestone is the date the Contract is executed and signed by KYTC.

ii. End Project Milestone:

The DBT shall include as the last activity in the Project schedule, a milestone named "End Project." The date used for this milestone is considered the Project Completiondate.

iii. Start Phase Milestone:

The DBT shall include as the first activity for a Project phase, an activity named "Start Phase X," where "X" identifies the phase of work. The DBT may include additional milestones but, as a minimum, must include all contractual milestones.

iv. End Phase Milestone:

The DBT shall include as the last activity in a Project phase, an activity named "EndPhase X," where "X" identifies the phase of work. The DBT may include additional milestones, but at a minimum contractual milestones.

e. Level of Effort Activities (Hammocks):

Level of Effort (hammock) activities are summary activities used for graphical display only. Use hammocks to show the duration of specified Contract work periods, phasesand road closures. The hammock activity type is allowed to have a start-to-start relationship with the first activity in a series of activities and a finish-to-finish relationship with the last activity in a series of activities.

f. Constraints:

Use constraints sparingly in the schedule. If constraints are used, use only early constraints or late constraints. Do not use As Late As Possible, Finish On, Mandatory Finish, Mandatory Start, or Start On constraints. A Mandatory Finish will be allowed on the End Project Milestone with approval by the Engineer.

g. Calendars

i. All calendars shall be Project level calendars, not Global or Resource calendars.

ii. At a minimum, calendars should be established for KYTC reviews, standard work week, cure/settlement periods, milestones, and any items with temperature restrictions as per the specifications.

iii. After baseline approval, any changes to activity calendar assignments must be approved by the Engineer.

iv. Each activity shall be assigned to an activity calendar. A schedule may utilize more than one activity calendar, but only one activity calendar shall be assigned to each activity, All activity calendars shall be project calendars as classified by Primavera.

v. Seasonal (winter) and environmental shutdown periods shall be shown using non-

working calendars.

vi. Seasonal Calendars can only be assigned to an activity according to specification and/or approval by the Engineer.

vii. Weather and Seasonal Conditions shall be entered into all calendars containing physical work as non-work days per month as per the Weather and Seasonal Conditions Table. Anticipated Days Lost Due to Weather shall be randomly distributed throughout each calendar containing physical work and should not be tightly grouped or concentrated on particular days within each week.

Weather and Seasonal Conditions Table	
Month	**Anticipated Days Lost Due to Weather**
January	8
February	8
March	7
April	6
May	5
June	5
July	4
August	4
September	5
October	6
November	6
December	6

viii. All project milestones shall be on a 7 day/week calendar with no non-work days.

ix. All review periods for KYTC shall be included on a designated calendar of 5 days/week and shall include typical government holidays.

x. Activity calendars for non-work activities, including but not limited to submittals, reviews, procurement, fabrication, cure times, and utility relocations performed by others shall not show any non-work days.

xi. Anticipated weather and/or shutdown periods shall not be included for any days past the contract completion date. In the event the contract completion date is amended to a later date, weather days will be granted on a day for day basis pending an Accepted Weather Delay Analysis according to Section I.

xii. Extend calendars to a minimum of one year after the Contract Completion Date.

h. Linking Projects:

Independent projects shall not be linked.

i. Activity Codes:

The DBT shall include the following codes for each activity:

i. Area
ii. Phase
iii. Responsibility for each task, DBT and Subcontractors
iv. Work types for each task, as identified by KYTC
v. DBE and non-DBE DBT/designer tasks
vi. Funding code

j. Schedule Options

The schedule may only be calculated using retained logic. Show open ends as non-critical. Schedule durations are to be contiguous (no suspend or resume dates). Total float shall be calculated as finish float.

k. Cost Loading:

i. Cost Loading Activities: Costs for incremental design preparation will be assigned tothe respective design phase submittal milestone(s). Equipment costs will be assigned to their respective Procurement Activities (i.e., the delivery milestone activity). Costs for installation of the material/equipment (labor, construction equipment, mobilization, and temporary materials) will be assigned to their respective construction activities. Evenly disperse overhead and profit to each activity over the duration of the Project. The total of all cost loaded activities, including costs for material and equipment delivered for installation on the Project,and labor and construction equipment loaded construction activities, shall total to 100 percent of the value of the Contract.

2. **Submission Requirements**. Submit all schedules within the time frames specified. Submit the schedule and information in electronic file format. Submit the following information along withthe electronic baseline schedule:

a. A baseline schedule in a bar chart format including the Administrative Identifier Informationdiscussed in Section C.1.a on the first page of the schedule. For each activity on the chart, indicate the Activity ID, Activity Name, Original Duration, Remaining Duration, Total Float, Early Start Date, Early Finish Date, and Calendar ID. Use arrows to show the relationships among activities.

b. A baseline schedule in a bar chart format, on paper. Identify the critical path of the Projecton the bar chart in red. The critical path is defined as: the longest path of activities in the Project that determines the Project Completion Date. The activities that make up the critical path of activities are the “Critical Activities.”

c. A Three Week Look Ahead and a Six Week Look Ahead Schedule in bar chart format. This schedule shall have all the requirements of the baseline schedule in bar chart format exceptthat it shall be limited to those activities that have an early start or early finish within a three-week and a six-week period of the data date.

d. A Scheduling Statistics Report. Submit a report of baseline schedule statistics, including number of activities, number of activities on the longest path, number of started activities,number of completed activities, number of relationships, percent complete, and number and type of constraints.

e. A Logic Diagram (if requested by the Engineer). Submit a diagram in PERT chart formatshowing the logic of the baseline schedule.

f. An Activity ID Sort. Submit a listing of all activities included in the baseline schedule sortedby ascending Activity Identification Number.

g. A Total Float Sort. Submit a listing of all activities included in the baseline schedule sortedby increasing total float and by early start date.

h. A Detailed Predecessor/Successor Sort. Submit a listing of all activities included in the baseline schedule indicating the activities that immediately precede and immediately succeed that activity in the schedule logic.

i. Earned Value Report. Listing all activities having a budget amount and cost. A compilation oftotal earnings on the Project from the notice to proceed to the most recent monthly progress payment request and the difference between the previous request amount and the current payment request amount. Sort report first by resource and then by activity.

j. A graphical representation of actual work completed versus planned work.

D. Float. Use of float suppression techniques, such as preferential sequencing (arranging critical path through activities more susceptible to Department caused delay), lag logic restraints, zero total or free float constraints, extending activity times, or imposing constraint dates other than as required bythe Contract, shall be cause for rejection of the Project schedule or its updates.

1. Definitions of Float: Total Float is the length of time along a given network path that the actualstart and finish of activity(s) can be delayed without delaying the Project completion date. Project Float is the length of time between the End Project Milestone and the Contract Completion Date.
2. Ownership of Float: Float available in the schedule at any time shall not be considered for the exclusive use of either KYTC or the DBT. During the course of Contract execution, any float generated due to the efficiencies of either party is not for the sole use of the party generating the float; rather it is a shared commodity to be reasonably used by either party. Efficiencies gained as a result of favorable weather within a calendar month, where the number of days of normally anticipated weather is less than expected, shall also contribute to the Project Float. A schedule showing work completing in less time than the Contract time, and accepted by KYTC, shall be considered to have Project Float. Project Float shall be a resource available to both KYTC and the DBT. If a delay occurs which impacts the Project's critical path, consumes all available float, and extends the work beyond the Contract Completion Date, KYTC will consider atime extension.
3. Negative Float: Negative float shall not be a basis for requesting time extensions. Any extensionof time shall be addressed in accordance with the Section F. Scheduled completion date(s) that extend beyond the Contract (or phase) completion date(s) may be used in computations for assessment of liquidated damages. The use of this computation is not to be construed as an order by KYTC to accelerate the Project.

E. Monthly Update Schedule. A monthly update schedule is a schedule in which only progress isupdated from the prior data date to the current data date. Work added and/or excusable delays encountered since the prior data date must be represented as a schedule revision as described in Section F. Omissions and errors shall be corrected as described in Section F in this note and shall not affect the Completion Date, the Contract time, or total Contract payment.

1. Update Requirements. On the tenth day of the current month, during the life of the Project, submit an updated schedule and all required information with a data date of the last day of the preceding month. The date for submission and data date may be adjusted to accommodate regularly scheduled progress meetings. Submit the monthly updated bar chart on paper and a copy of the updated schedule in electronic format in Section C.2. The Engineer will “approve” or “reject” the schedule update within 14 days of receipt of the updated CPM schedule. If the schedule is rejected, the DBT will resubmit the revised update within 7 days from notification of the rejection. The Engineer may withhold estimates if the updated schedule is not submitted as required by this section. For each updated schedule, identify the actual start and

finish dates for all completed activities and the actual start date and remaining duration for all activities in progress. Correct out-of-sequence progress listings generated by the Scheduling Statistics Report on the critical path. Minor logic revisions to correct out-of- sequence progress to critical or non-critical path activities may be made as part of the monthly schedule update. Submit proposed significant changes and/or changes to the critical path in accordance with Section F. The Project schedule shall be reviewed at each monthly progress meeting. Provide a written narrative with reasons for any changes listed below.

a. **Written Narrative**. A Written Narrative will be required with the Monthly Update Schedule to detail the reasons for any of the following changes: Any revision that modifies the critical path, change of calendars, change in Logic/Relationships, Durations, Workday vs. Non workday, new activities, change in Activity Name, previously omitted progress, change to previously reported progress and/or Schedule of Values changes.

Submit the following with each updated schedule:

i. CPM Schedule in Bar Chart Format
ii. Three Week and Six Week Look Ahead CPM Schedule in Bar Chart Format
iii. Logic Diagram (If requested by the Engineer)
iv. Activity ID Sort (If requested by the Engineer)
v. Total Float Sort (If requested by the Engineer)
vi. Detailed Predecessor/Successor Sort (If requested by the Engineer)
vii. Schedule Statistics Report
viii. Electronic files (formatted as described above)
ix. Earned Value Report

The DBT may submit a statement that there were no changes in the schedule logic, activity durations, or calendars since the previous update in lieu of submission of items iii, iv, v and vi.

2. Early Completion Monthly Update Schedule. An Early Completion Monthly Update Schedule is defined as a monthly update schedule submitted by the DBT in which the Finish Date precedes the Contract Completion Date.

3. Late Completion Monthly Update Schedule. A Late Completion Monthly Update Schedule is defined as a monthly update schedule submitted by the DBT in which the Finish Date exceeds the Contract Completion Date. In the event the Finish Date is more than 14 days beyond the current contract completion date and a schedule revision is not warranted, the DBT must proceed in accordance with Section H.

F. Revisions. The work may require and/or the DBT may make revisions to the CPM schedule. Addition of new activities or new calendars or changes to existing activities, calendars, or logic constitute a revision. All revisions must be reported in narrative form on a cover sheet accompanying the monthly update schedule as detailed in Section E.1.a. Any revision that modifies the critical path or impacts an interim date or Project completion date must be represented on a companion schedule submitted with the monthly update schedule or as a fragnet within the monthly update schedule. A fragnet is defined as the sequence of new activities that are proposed to be added to the existing schedule. The fragnet shall identify the predecessors to the new activities and demonstrate the impacts to successor activities. If submitted as a fragnet, the DBT shall compute two finish dates. The first finish date shall be computed without consideration of any impact by the fragnet. The second finish date shall be computed with consideration of any impact by the fragnet. The DBT shall also

submit a written narrative stating the reason for the proposed revisions. The Engineer will "approve" or "reject" proposed revisions within 10 days of receipt of appropriate schedules and narrative. If the revision is rejected, the DBT will resubmit the revision within 7 days from notification of the rejection.

Any revision that modifies an activity's costs shall be submitted with a written narrative stating the reason for the proposed revision. The Engineer will review and "approve" or "reject" proposed cost revisions.

All approved revisions shall be incorporated into the Monthly Update Schedule.

G. Time Extensions for Delays in Accordance with 108.06. The work may require and/or the DBT may request an extension of the Completion Date. Perform the following analysis to compute the duration of the time extension. Submit two paper copies and two electronic copies of each analysis performed.

1. Determine Project progress prior to circumstance(s) necessitating the time extension. The previous accepted monthly update, updated to the date of the circumstance alleging to have caused delay, shall be used to display the prior progress of the Project. This schedule is referredto as the Un-impacted Schedule
2. Prepare a fragmentary network (fragnet) depicting the circumstance that is believed to havedelayed the Project.
3. Insert the fragnet into the Un-impacted Schedule, run the schedule calculations and determine the finish date. This schedule is referred to as the Impacted Schedule.
4. Compare the Impacted Schedule finish date with the Un-impacted Schedule finish date in orderto determine the duration of any warranted time extension.

Submit the impacted schedule with the request for time extension. Include a narrative report describing the effects of new activities and relationships to interim and Contract Completion Dates. All approved time extensions shall be incorporated into the monthly update with the fragnet used to determine impacts incorporated into the schedule. Omissions and errors shall be corrected as described in SectionF in this note and shall not affect Completion Date, Contract time, or total Contract payment.

H. Recovery Schedule. If the Monthly Update Schedule or Revised Monthly Update Schedule projects a finish date for the Project more than 14 Calendar Days later than the current Completion Date, submit a recovery schedule showing a plan to finish by the current Completion Date if requested by the Engineer. KYTC will withhold Estimates until the Engineer approves the recovery schedule. The Engineer will use the schedule to evaluate time extensions and associated costs requested by the DBT. In the event the Current Completion Date is in dispute, the recovery schedule will need to be submitted once the dispute has been resolved.

I. Weather Delay Schedule. A Weather Delay Schedule indicates the effect of the actual weather experienced in a given period as compared to the anticipated weather included in the baseline schedule as depicted in the Weather and Seasonal Conditions table of Section C.1.g.vii. The Weather Delay schedule is a calculation performed by the software after the anticipated weather days have been removed and the actual weather days have been inserted into the appropriate calendar. Submit the Weather Delay Schedule no later than the 5th of the month following the weather impacted work.

The Weather Delay Schedule will be prepared by making a copy of the previously accepted Monthly Progress Schedule file. This copy will be the Weather Impacted Schedule. For the month that incurred actual weather days, remove the anticipated weather only from calendars associated with the work that was delayed and input the actual weather days experienced into the Weather Impacted Schedule. Schedule the project without changing the data date.

The following is a DRAFT list of commitments for the project. The final commitment list will be issued in the Record of Decision, currently anticipated in August 2021. References to INDOT and other Indiana state agencies should be ignored.

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
TRANSPORTATION			
Traffic During Construction	A Traffic Management Plan will be developed for the project in coordination with local government officials, emergency service providers, and schools.	Final Design	DBT
Emergency Management Coordination	The project team will continue to coordinate with emergency and law enforcement agencies as the project progresses to ensure their response needs are accommodated. Median emergency crossover locations will be confirmed in coordination with emergency and law enforcement agencies.	Ongoing	DBT
Emergency Management Coordination	The team will work with fire departments regarding the location, design, and construction of access doors within noise barrier walls for water hydrant access.	Final Design	DBT
Local Service Roads	Where reasonable and cost effective, local service roads will be used to maintain community accessibility.	Final Design	DBT
Local Service Roads	"Landlocked parcels," whose access is altered or cut off by the alignment, will be provided local service roads or they will be acquired.	Prior to Construction	KYTC
Local Service Roads	Changes in roads used by school bus routes will be discussed with the school systems well in advance.	Final Design and During Construction	KYTC
Local Service Roads	Where roads are severed, provisions for turnarounds will be included and further refined during the final design phase.	Final Design	DBT
Road Closures	Efforts will be made to minimize the disruption of local crossroads to minimize impacts to school bus and emergency provider routes.	Final Design	DBT
Road Closures	During and following construction, appropriate signing will be placed at the nearest intersections to warn that the road does not provide for through traffic.	During Construction	DBT
Pedestrian and Bicycle Access	The proposed design will accommodate pedestrian and bicycle access by maintaining or reestablishing connectivity for non-motorized users. Specific measures include incorporating sidewalks in locations where existing sidewalks are present or where curb and gutters are planned; providing paved shoulders of sufficient width to accommodate bicycles at over/underpass locations; maintaining access to the Merrill Way Trail via Kimsey Lane and extending the trail along the relocated Kimsey Lane to Van Wyk Road; and not precluding future extensions of Pigeon Creek Greenway.	Final Design	DBT

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Pedestrian and Bicycle Access	Coordination with local government agencies will continue to determine if any are willing to assume ownership of the US 41 bridges, such as for future use as a dedicated pedestrian and bicycle facility.	Ongoing	KYTC
Ohio River Navigation	Final concurrence from the United States Coast Guard to determine how river navigation can be least impacted with the construction of the new bridge over the Ohio River will occur following submittal of final design drawings and opportunities for public input.	Prior to Construction	Not applicable to Section 1
RELOCATIONS			
Relocations	Acquisitions and relocations required by the project will be completed in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Uniform Act), as amended, 49 CFR Part 24, and Title VI of the Civil Rights Act of 1964.	Prior to Construction	KYTC. Applies to DBT for any supplemental property acquisition.
ENVIRONMENTAL JUSTICE/TITLE IV			
Transit	INDOT and KYTC will continue to coordinate with transit agencies to ensure that implementation of the project does not impede potential cross-river express service in conjunction with the Henderson Area Rapid Transit (HART).	Ongoing	KYTC
VISUAL			
Mitigation and Minimization	Throughout final design, techniques will be evaluated using stakeholder and public input to minimize visual impacts and enhance the aesthetics of the project.	Final Design	DBT
Mitigation and Minimization	Techniques to mitigate visual impacts from the new interstate may include providing sound walls that limit noise and visibility of the interstate from adjacent land use areas, providing fences between the interstate and adjacent land use areas to increase physical and visual perceptions of safety, creating public art at key locations along the project alternative, and providing a vegetation buffer with shade trees, ornamental trees, shrubs, and perennials between the interstate and adjacent land use areas.	Final Design	DBT
Mitigation and Minimization	For bridge alternatives, techniques may include lighting and structural elements, wayfinding, and functional treatments. Lighting and structural elements may include providing appropriately scaled lighting elements along the length of the bridge. Wayfinding elements may include providing gateway signage at the entrances of both the north and south ends of the bridge. Functional treatments may include the integration of visual pattern elements of functional treatments with those of adjacent land uses.	Final Design	DBT

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Streetscaping	At the KY 351 interchange, streetscaping will be provided in support the City of Henderson's vision for this gateway corridor as part of project improvements.	Final Design	DBT
NOISE			
Geometrics	During final design, shifting the roadway alignment vertically and/or horizontally will be considered, where feasible, to minimize noise impacts where other factors are not prohibitive.	Final Design	DBT
Abatement Measures	A final determination on the locations of noise barriers will be made during final design. At such time, additional noise analyses will be performed to more accurately determine barrier performance, barrier characteristics (length and height), and the optimal barrier location for any potential noise barriers that may be recommended for noise abatement.	Final Design	DBT
Abatement Measures	Potentially benefited property owners and/or tenants in areas where noise barrier mitigation is recommended based on INDOT/KYTC feasible and reasonableness criteria will be surveyed during final design to determine the desires of benefited receptors in accordance with the reasonableness policies of the INDOT/KYTC.	Final Design	DBT
Abatement Measures	Once all feasibility and reasonableness criteria have been evaluated during the final design process, the noise barriers that meet all criteria will be incorporated into the project.	Final Design	DBT
Construction Noise	Construction vehicles will be required to follow INDOT and KYTC standard specifications on controlling noise.	During Construction	DBT
Construction Noise	Construction noise is unavoidable but temporary in nature and reasonable efforts will be made to reduce impacts to receptors to the extent practicable.	During Construction	DBT
Construction Noise	In the unusual instance where construction would persist for a period longer than 2 years and where impacts to nearby receptors are determined to be likely, the project team shall have the flexibility to incorporate construction noise abatement measures into the project. This may involve shielding of equipment with acoustic barriers, restricting certain types of work to specific hours of the day, requiring source control on equipment (mufflers), and/or other measures to reduce noise impacts.	During Construction	DBT
STREAMS AND OTHER SURFACE WATERS			
Avoidance and Minimization	The realignment of surface streams or open water features will be avoided where possible.	Final Design	DBT

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Avoidance and Minimization	In instances where avoidance is not possible, stream impacts will be minimized and mitigated. Continued efforts will be made during final design to identify design features that minimize impacts at stream crossings, including measures to keep channel and bank modifications to a minimum and, where feasible, avoid channel alterations below the ordinary high water mark (OHWM) elevation.	Final Design	KYTC is responsible for mitigation associated with the base design. DBT is responsible for any additional mitigation required.
Avoidance and Minimization	During final design, consideration will be given to using alternative armoring materials and may include portions of dry land under bridge openings that would not normally be armored with riprap.	Final Design	DBT
Avoidance and Minimization	The use of bio-engineering techniques to provide natural armoring of stream banks will be considered and implemented where practicable.	Final Design	DBT
Avoidance and Minimization	Installation of riprap will be limited to areas necessary to protect structure integrity. If riprap is required, it will be installed outside the stream bed and between the toe of slope and the OHWM where possible. In some instances, such as culvert inlets and outlets, riprap may need to be placed within the stream bed to prevent scour. Riprap will be installed at the same elevation as the stream bed to avoid interfering with fish passage. Riprap may also be needed above the OHWM to protect bridge piers and abutments from scour where bioengineering will not suffice.	Final Design/ During Construction	DBT
Avoidance and Minimization	Where reasonable, below-water work will be restricted to placement of piers, pilings and/or footings, shaping of spill slopes around the bridge abutments, and placement of riprap.	During Construction	DBT
Mitigation and Relocation	Where direct impacts to streams are unavoidable, mitigation will be provided in coordination with regulatory agencies during the Clean Water Act (CWA) Section 404 permitting process.	Final Design	KYTC is responsible for mitigation associated with the base design. DBT is responsible for any additional mitigation required.
Mitigation and Relocation	Stream mitigation ratios will be determined in consultation with the Indiana Department of Environmental Management (IDEM), Kentucky Division of Water (KDOW), and the U.S. Army Corps of Engineers (USACE), and mitigation and monitoring plans will be developed as appropriate. The potential to use mitigation banks or state in-lieu fee programs will be explored.	Final Design	KYTC is responsible for mitigation associated with the base design. DBT is responsible for any additional mitigation required.

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Mitigation and Relocation	If needed, stream mitigation and monitoring plans will be developed for stream relocations, as appropriate. Site-specific plans for stream relocations will be developed during final design considering the needs of sensitive species and other environmental concerns. Plans will include the planting of woody and herbaceous vegetation to stabilize stream banks.	Final Design	KYTC is responsible for mitigation associated with the base design. DBT is responsible for any additional mitigation required.
Mitigation and Relocation	Continued efforts will be made during final design to identify features that further avoid and minimize impacts. Where practicable, stream relocations will follow the natural stream channel design standards. Streams within the right-of-way that can accommodate tree or shrub plantings to minimize the impacts of thermal inputs will be identified during final design and, where feasible, the outside edge of these streams will be positioned adjacent to existing forested areas	Final Design	DBT
Outstanding Surface Water Resource	Further coordination with the Kentucky Department for Environmental Protection (KDEP) will occur to ensure that the water quality and aquatic habitat in the portion of the Ohio River that is designated as an Outstanding Surface Water Resources will be maintained and protected unless it can be demonstrated that the proposed modification to the river would not have a harmful effect.	Ongoing	Not applicable to Section 1.
Erosion Control and SWPPP	A Stormwater Pollution Prevention Plan (SWPPP) will be developed and approved by INDOT, KYTC, IDEM, and KDEP prior to construction.	Prior to Construction	DBT
Erosion Control and SWPPP	Best management practices (BMPs) will be used in the construction of the project to minimize impacts of erosion and sedimentation. Erosion and sediment control measures will be installed prior to construction and will be maintained throughout construction.	During Construction	DBT
Erosion Control and SWPPP	Erosion and sediment controls will include the use of measures that will avoid and minimize impacts to aquatic resources specifically. These measures will be inspected weekly and after rain events and will be repaired or replaced as required. Measures will be adjusted to the phase of construction. Temporary measures will not be removed until the location is stabilized. Permanent measures will remain in place post construction.	During Construction	DTB
Floodways/ Floodplains	A hydraulic design study that addresses structure size and types will be conducted during final design to ensure that flood elevations are not affected.	Final Design	DBT

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Floodways/ Floodplains	Longitudinal and transverse floodplain encroachments will be minimized, where reasonable, through design practices such as longer bridges and perpendicular river/stream crossings. Flood easements may be acquired at these and/or other locations if required.	Final Design	DBT
WETLANDS			
Avoidance and Minimization	Wetlands and wetland complexes will be avoided when possible.	Final Design	DBT
Avoidance and Minimization	If unable to be avoided completely, wetland impacts will be minimized with shifts in the alignment wherever practicable and feasible in final design.	Final Design	DBT
Avoidance and Minimization	Water resources within the right-of-way will be identified on design plans, and these areas will have approved erosion control measures as part of the overall erosion control plan to prevent any filling or contamination of these areas during construction.	Final Design	DBT
Avoidance and Minimization	Compaction of wetland soils and rutting within wetlands will be minimized by using low ground-pressure equipment and installing temporary equipment mats.	During Construction	DBT
Avoidance and Minimization	Soil characteristics can be changed during construction due to inadvertent mixing of topsoil and subsoil. To prevent such mixing in unsaturated wetlands, topsoil will be removed from within the highway construction limits and stockpiled for restoration as close as feasible to its original horizon.	During Construction	DBT
Avoidance and Minimization	To minimize impacts in areas where construction might divert drainage or block the normal flow of water through a wetland, cross-drainage will be provided to maintain the hydrologic characteristics of the wetland. Restoration of each wetland will involve returning contours to pre-construction levels and removing temporary control measures.	During Construction	DBT
Avoidance and Minimization	Some wetland vegetation will be cut, removed, or crushed during construction. After the completion of construction, wetland areas within the project area will be allowed to revegetate naturally or, if needed, reseeded with native wetland species.	After Construction	DBT
Mitigation and Monitoring	Permanent impacts to wetlands will be mitigated through compensatory mitigation alternatives, to include mitigation banks, in-lieu fee programs, and permittee responsible improvements to existing water resources and natural habitat. The acreage needed for wetland mitigation is determined based on the expected impact acreage, type of wetland, and jurisdiction using mitigation ratios. Impacted wetlands will be replaced at the appropriate mitigation ratio in coordination with USACE.	Ongoing	KYTC is responsible for mitigation associated with the base design. DBT is responsible for any additional mitigation required.

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Mitigation and Monitoring	If needed, a Wetland Mitigation and Monitoring Plan will be prepared as required under CWA Section 404.	Ongoing	KYTC is responsible for mitigation associated with the base design. DBT is responsible for any additional mitigation required.
Mitigation and Monitoring	Additional measures to avoid or minimize impacts to specific wetlands will be considered, including narrowing the right-of-way, installing drainage features such as swales to ensure that roadway runoff does not enter wetland areas, and designing culverts to maintain the flow of water to a wetland area otherwise cut off from its existing water source.	Final Design	DBT
NON-WETLAND FORESTED FLOODPLAINS			
Replacement	In Indiana, trees removed within a non-wetland forested floodway/ floodplain will be replaced in accordance with INDR's Construction in a Floodway Permit guidelines.	During Construction	Not applicable to Section 1.
THREATENED AND ENDANGERED SPECIES			
Additional Consultation	Identification of conservation measures for threatened and endangered species were coordinated with USFWS, as documented in the *Biological Assessment (BA) for Multiple Species at the I-69 Ohio River Crossing Project* and subsequent *Biological Opinion (BO) on the Fat Pocketbook (Potamilus capax) and Sheepnose (Plethobasus cyphyus) and Conference Opinion on the Longsolid (Fusconaia subrotunda)*. Since the BA and BO were completed prior to the identification of Central Alternative 1B Modified (Selected), additional coordination will occur with USFWS to determine if the mitigation measures identified in the BA and BO will need to be amended.	Ongoing	KYTC
Standards and Agreements	Construction, operations, and maintenance activities will follow the conditions of the federal and state permits and abide by FHWA, INDOT, and KYTC standards and agreements.	During Construction	DBT
Erosion and Sediment Control	Erosion and sediment control BMPs will be installed prior to the start of earth disturbing activities to include tree removal, will be phased and modified during construction, and post construction BMPs will be maintained.	During Construction	DBT
Research and Monitoring	All research and monitoring will be done in cooperation with IDNR, KYDNR, and USFWS. Actions and research/monitoring results will be effectively communicated to the parties involved in protection and conservation of endangered species. Open communication and partnerships will be sought at every reasonable opportunity to further coordination of conservation efforts.	Ongoing	KYTC

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Mussels	FWHA has committed to implement the following eleven conservation measures (CMs) specific to mussels, as documented in the *Biological Opinion on the Fat Pocketbook (Potamilus capax) and Sheepnose (Plethobasus cyphyus) and Conference Opinion on the Longsolid (Fusconaia subrotunda)* for the project. The eleven CMs are:	Ongoing	Not applicable to Section 1.
Mussels	• CM1 Erosion and Sediment Controls: A Stormwater Pollution Prevention Plan (SWPPP) will be developed and approved by INDOT, KYTC, Indiana Department of Environmental Management (IDEM), and the Kentucky Department of Environmental Protection (KDEP) prior to construction. BMPs will be used, including erosion and sediment control measures that will be implemented prior to, and maintained throughout, construction. Temporary seeding and mulch will be used to stabilize disturbed areas.	Prior to Construction, During Construction	Not applicable to Section 1.
Mussels	• CM2 Equipment Maintenance, Cleaning, Fueling, and Monitoring Plan (EMCFM Plan): An EMCFM Plan will be developed to prevent equipment related impacts from reaching waterways within the Action Area. Staging, refueling, and clean-up areas will be constructed a minimum of 100 feet from the normal water line, bank of jurisdictional water, or waters of the State to reduce the risk of fluids from equipment leaking into waterways. Fuel and other petroleum products will be stored in the staging area and BMPs will be implemented to minimize the potential for fuel spills and contamination. A spill response plan will be required, and equipment will be monitored during construction operations for any oil, hydraulic, or fuel leaks. If leaks are found, the use of that equipment will be halted until leaks are repaired. All effluent from upland staging areas will be filtered using a variety of BMPs prior to confluence with any waterbodies.	During Construction	Not applicable to Section 1.
Mussels	• CM3 Catch Barges for US 41 Roadway Removal: The removal of the existing southbound US 41 Bridge will be designed to minimize and avoid impacts to waterways and mussel habitat to the greatest extent feasible. Catch barges will be used underneath sections of the bridge/roadway as they are demolished to minimize debris from entering the waterway.	During Construction	Not applicable to Section 1.
Mussels	• CM4 Demolition and Recovery of the US 41 Bridge: The demolition and recovery of the US 41 Bridge will be designed to minimize impacts to the surrounding aquatic environment. The design has not been finalized; however, explosives may be used to demolish the bridge during a navigation stoppage, followed by the use of barge-mounted equipment to remove the debris from the river bed and transport it offsite.	During Construction	Not applicable to Section 1.

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Mussels	• CM5 US 41 Pier Removal: Barge work platforms will be used to limit material falling into the Ohio River for the US 41 Bridge pier removal. Pier material below the waterline will be dredged from the river bottom and the use of a floating turbidity curtain may be used to limit downstream sedimentation.	During Construction	Not applicable to Section 1.
Mussels	• CM6 Upland Storage of Bridge Materials: All bridge materials will be stored at an upland staging area, away from the normal water line.	During Construction	Not applicable to Section 1.
Mussels	• CM7 from BO, Barge Spud Locations: To minimize impacts to Ohio River substrates, barges and other boat traffic will be restricted to deploying spuds within impact areas around causeways and piers to isolate substrate impacts to a smaller footprint.	During Construction	Not applicable to Section 1.
Mussels	• CM8 Concrete Pouring: Concrete will be poured in a manner to avoid spills into the Ohio River. Piers will be constructed using incased drilled shafts, precast waterline footing platforms, or in the dry, with caissons or cofferdams, preventing concrete spills into the river, while facilitating proper installation. If concrete spills occur, protocols outlined in the SWPPP will be implemented.	During Construction	Not applicable to Section 1.
Mussels	• CM9 Environmentally Sensitive Area Minimization Procedures: Construction activities will be avoided/minimized in areas of high environmental quality, including the mussel habitat, to the greatest extent possible.	During Construction	Not applicable to Section 1.
Mussels	• CM10 Revegetation of Riparian Areas & Limited Use of Riprap: The use of bio-engineering techniques to provide natural armoring of stream banks will be considered and implemented where practicable. Installation of riprap would be limited to areas necessary to protect structural integrity. If riprap is required to protect erodible slopes, it will be installed outside the stream bed and between the toe of slope and the ordinary high water mark where possible. Design plans will include the planting of native woody and herbaceous vegetation to stabilize stream banks except for areas under bridges.	During Construction	Not applicable to Section 1.
Mussels	• CM11 Contribution to Mussel Propagation: FHWA, INDOT and KYTC are committed to making a monetary contribution, based on the number of federally listed mussels in the Action Area (68 Fat Pocketbooks and 9 Sheepnose, Section 4.0). These funds are intended to support recovery efforts by funding propagation efforts for the Fat Pocketbook, Sheepnose, and/or Longsolid at a permitted mussel propagation facility. For the Fat Pocketbook mussel, FHWA has agreed to contribute a total of $29,784.00 ($438.00 per individual x 68 individuals = $29,784.00). For the Sheepnose, FHWA has agreed to contribute a total of $2,817 ($313.00 per individual x 9 individuals = $2,817.00). Therefore, the total contribution should be $32,601.00.	Prior to Construction	Not applicable to Section 1.

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Mussels	In order to monitor the impacts of incidental take, FHWA must report the progress of the project and its impact on the species to USFWS as specified in the ITS (50 CFR §402.14(i)(3)). FHWA will inform USFWS as soon as possible if the amount of take is exceeded or if any Fat Pocketbook, Sheepnose, and Longsolid are observed, injured, or crushed within the project area. FHWA will report any results of monitoring to USFWS, as soon as possible.	During Construction	Not applicable to Section 1.
Mussels	FHWA will re-initiate consultation with USFWS if the amount or extent of the project area changes, or the project is modified in manner not considered in the Biological Opinion; if new information reveals that the project may affect a listed species or designated critical habitat in a manner or extent not considered in the Biological Opinion; or a new species is listed or critical habitat designated that the project may affect.	Ongoing	KYTC
Bats	The potential construction impacts to the Indiana bat and northern long-eared bat summer habitat will be addressed through the *KYTC Programmatic Conservation Memorandum of Agreement for the Indiana Bat*, which will dictate mitigation requirements for construction impacts. USFWS confirmed that the programmatic agreement will be applied in both states, with the exception that Indiana tree clearing restrictions would be followed within Indiana.	Ongoing	KYTC is responsible for mitigation associated with the base design. DBT is responsible for any additional mitigation required.
Bats	Potential impacts to Indiana, gray, and northern long-eared bats can be mitigated through the below list of conservation measures, as documented in the *Biological Assessment for Multiple Species at the I-69 Ohio River Crossing Project*.		KYTC is responsible for mitigation associated with the base design. DBT is responsible for any additional mitigation required.
Bats	Potential take of 45.8 acres of summer roosting, foraging, and commuting habitat of the Indiana bat will be mitigated following the guidance provided in the above-referenced KYTC Programmatic Agreement, which allows for use of the Imperiled Bat Conservation Fund (IBCF) for forest habitat removal for the entire I-69 ORX project corridor. If the project's final design and construction impacts less than 45.8 acres of Indiana bat habitat, then less mitigation will be required.	Ongoing	Specified acreage is for entire I-69 ORX project. KYTC is responsible for mitigation associated with the base design of Section 1. DBT is responsible for any additional mitigation required.

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Bats	Adhering to seasonal tree clearing in both Indiana and Kentucky reduces the potential for adverse effects to northern long-eared bats and Indiana bats while they are in tree roosts. In Indiana, tree clearing for trees having a 3 inch or greater DBH will not be allowed between April 1 and September 30. In Kentucky, KYTC has indicated they would prefer to use the most recent programmatic agreement and adhere to feasible tree cutting restrictions determined by project needs.	During Construction	DBT
Bats	To reduce potential for future take of roosting Indiana, northern long-eared, and gray bats using highway structures (bridges and overpasses), all of the structures within the project corridor will be checked again, since construction will occur more than two years from when the initial survey was completed (August 12, 2018).	During Construction	DBT
Bats	Erosion and sediment control measures proposed for the project, such as numerous water quality protective measures to avoid and minimize impacts to aquatic resources, will help prevent negative impacts to the gray bat and Indiana bat that forage on aquatic insects.	During Construction	DBT
Bats	Prior to construction, all existing bridges that will be removed between 15 May and 15 August will be surveyed for the presence of endangered or threatened bats.	During Construction	DBT
Least Terns	Future surveys will be completed for nesting least terns if low water allows for suitable habitat to become available within the project corridor. Changes in the river caused by drought, etc., could occur before or during the project's construction. Therefore, if suitable habitat (such as a sandbar or a shoal) becomes present during the project development process and/or construction, surveys will be completed to ensure this habitat is not being used for nesting.	Prior to Construction	Not applicable to Section 1.
CULTURAL RESOURCES			
Historic Properties	A Memorandum of Agreement (MOA) has been prepared by FWHA, INDOT, and KYTC, in consultation with the Indiana and Kentucky SHPOs and other consulting parties, to resolve adverse effects to historic properties in accordance with Section 106 of the NHPA. Mitigation for potential construction impacts to historic and archaeological sites are addressed in the stipulations contained in the executed MOA, which include the following:	Ongoing	KYTC
Historic Properties	• Documentation of two historic contexts: agriculture in Henderson County from 1798 to 1870, and Slavery, Segregation and the Ascent of the African American Community in Henderson County 1798 to 1965 *[to be confirmed/edited after MOA is executed]*	Ongoing	KYTC

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Historic Properties	• Preservation of historic district(s) in Downtown Henderson: $50,000 of funding provided by FHWA and KYTC to benefit one or more of the districts *[to be confirmed/edited after MOA is executed]*	Ongoing	KYTC
Historic Properties	• Statewide Truss Bridge Survey and Management Plan, to be completed within 24 months of the execution of the MOA *[to be confirmed/edited after MOA is executed]*	Ongoing	KYTC
Historic Properties	If the I-69 ORX project is modified in a manner that necessitates modifications to the area of potential effects (APE) or the conclusions of the Finding of Effect, FHWA, INDOT, and KYTC will follow the stipulations for such modifications set forth in the MOA.	Ongoing	The DBT shall be responsible for any cultural resources surveys, coordination, and mitigation resulting from changes to the base design.
Archaeological Resources	The executed MOA stipulates the identification and evaluation efforts as well as any additional testing that should occur, should resolution of adverse effects to archaeological resources be required. If a NRHP-eligible archaeological site is located, and direct effects to the property cannot be avoided, the MOA stipulates mitigation procedures to be followed.	Prior to Construction	KYTC
GROUNDWATER AND HAZARDOUS MATERIALS			
Groundwater Protection Plan	Prior to construction, a Groundwater Protection Plan complying with 401 KAR 5:037 Groundwater Protection Plans will be developed (Indiana lacks a similar rule). The plan will establish a series of practices to protect groundwater during demolition and construction. Activities such as well and septic system plugging, equipment storage, spill response, precautions for work within wellhead protection areas, and BMPs will be addressed in the plan.	Prior to Construction	DBT
Contaminated Soil, Groundwater, and Underground Storage Tanks	An updated Phase I Environmental Site Assessment (ESA) will be completed based on final design of Central Alternative 1B Modified (Selected). Limited Phase II Subsurface Investigations will be conducted as required. Registered Underground Storage Tank (UST) sites will be assessed and closed in accordance with state UST closure guidelines and sampling requirements.	Prior to Construction	KYTC will conduct required Phase II ESAs for the base design. DBT shall be responsible for any surveys or remediation resulting from changes to the base design.

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Demolition	Residential, commercial, and bridge structures impacted by the project will be evaluated for the presence of potential demolition/disposal issues such as regulated asbestos containing materials, mercury, lead, and polychlorinated biphenyls. These issues will be addressed prior to demolition.	During Construction	DBT
Landfills	Written approval from IDEM and and/or KDEP, as appropriate, will be secured for any construction activity/post-closure use at disposal sites.	Ongoing	DBT
Landfills	Existing buried waste will remain properly covered/capped or be disposed off-site.	During Construction	DBT
Landfills	If wastes encountered during construction are too close to wetlands, streams, or other sensitive areas, they will be removed and properly disposed.	During Construction	DBT
Spill Plan	A spill response plan that is acceptable to INDOT, KYTC, IDEM, and KDEP will be required for the project. This response plan will include, at minimum, protocols for contact with emergency response personnel, Safety Data Sheets, and copies of agreements with agencies that would be part of a spill-response effort. The plans will include communication protocols to ensure proper and timely notification of nearby public drinking water supplies in the event of a spill. This will include the wellhead protection areas at Ellis Park and Trocadero Plaza, as well as the Ohio River public water supply intakes for Evansville Water and Sewer Utility and Henderson Municipal Water and Sewer.	Prior to Construction	DBT
Water Wells	Water wells, monitoring wells, and injection wells within the project area will be labeled on design plans and properly abandoned/plugged to prevent the migration of surface water or contaminants to the subsurface and to prevent migration of potential contaminants among and between water bearing zones.	Final Design	DBT
Water Wells	Well closures will be conducted by state-licensed water well drillers in accordance with state regulations 329 IAC 12-13 and 401 KAR 6:310-350.	During Construction	DBT
Geotechnical Boreholes	During geotechnical investigations, INDOT's *Aquifer Protection Guidelines and KYTC's Sealing Geotechnical Boreholes* will be followed to ensure boreholes are properly closed in a manner that is protective of groundwater.	Ongoing	DBT
Geotechnical Boreholes	Existing landfills will be marked on project plans and unique special provisions will be developed in coordination with IDEM or KDEP for any work to be conducted near those areas.	Final Design	DBT
Petroleum Wells	If evidence of unplugged or improperly abandoned petroleum wells is encountered during construction, the IDNR Division of Oil and Gas, and/or Kentucky Energy and Environment Cabinet (KEEC) Division of Oil and Gas, as applicable, will be contacted. The wells will be abandoned/plugged in a manner that is protective of groundwater.	During Construction	DBT

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Dewatering	If dewatering activities are needed for construction (e.g., for foundations), a hydrological modeling assessment may be required to identify if any drinking water supply wells, wetlands, surface water resources, or hazardous materials sites (e.g., landfills) have the potential to be impacted. If impacts cannot be avoided, coordination with applicable agencies and stakeholders will be conducted to identify appropriate minimization and avoidance measures.	During Construction	DBT
INDIRECT AND CUMULATIVE IMPACTS			
Indirect and Cumulative Impacts	Potential indirect impacts to sensitive resources in the vicinity of the proposed US 60 and US 41 interchanges could be minimized by local, state, and federal regulations that are intended to manage growth and protect resources. The City of Henderson and Henderson County land use plans and zoning regulations can be used to control development in these interchange areas to avoid and/or minimize impacts to wetlands, streams, farmlands, and forests.	Ongoing	KYTC
MIGRATORY BIRDS			
Surveys	Bridges will be surveyed between May 7 and September 7 for the presence of migratory birds or nests prior to construction activities, including demolition of the southbound US 41 bridge. If nests are found with eggs, chicks, or parents actively tending to the nest, the local USFWS office will be contacted prior to disturbance.	Prior to Construction	DBT
WILDLIFE PASSAGE			
Wildlife Crossings	During final design, the states will evaluate the potential and value of including one or more wildlife crossings, particularly cost-effective opportunities to provide animal crossings above flood elevations. In Kentucky, a wildlife passage will be evaluated near the southern limits of the Ohio River floodplain.	Final Design	Not applicable to Section 1.
Wildlife Passage in Streams	Perennial streams in the project area will be spanned by bridges. Embedded box culverts or 3-sided box culverts will be utilized for other stream crossings where practical. During final design, the states will evaluate the potential and value of including an embedded box culvert as a wildlife crossing.	Final Design	DBT
Wildlife Passage in Streams	Articulated concrete block mats, fabric-formed concrete mats, or other similar smooth-surfaced materials that will not impair wildlife movement will be considered for stream crossings with defined banks during final design.	Final Design	DBT
AIR QUALITY			

RESOURCE	COMMITMENT OR MITIGATION MEASURE	TIMING OF ACTION	RESPONSIBILITY
Air Quality	During construction, the states will incorporate the following air quality control strategies, and other identified BMPs, to the maximum extent practicable and comply with local air quality regulations: utilize alternatively fueled equipment; utilize other emission controls that are applicable to the equipment; and reduce idling time on equipment.	Construction	DBT
GREEN RIVER NATIONAL WILDLIFE REFUGE			
Pedestrian Access	As the design of the project is further developed, cost-effective opportunities to provide safe, grade-separated pedestrian access to the proposed refuge across I-69 will be evaluated.	Final Design	Not applicable to Section 1
Access	INDOT and KYTC will continue to coordinate with USFWS regarding establishment of and access to refuge facilities. All existing public roads in the area of the proposed refuge will be maintained.	Final Design	Not applicable to Section 1
Access	INDOT and KYTC will work with USFWS during final design to determine appropriate signage identifying and indicating access points for the refuge.	Final Design	Not applicable to Section 1

KENTUCKY TRANSPORTATION CABINET
Department of Highways
DIVISION OF RIGHT OF WAY AND UTILITIES

TC 62-75
Rev. 05/2019

PROJECT REPORT

SECTION 1: PROJECT INFORMATION

COUNTY	ITEM NO.	
PROJECT NO.	**FEDERAL NUMBER**	**PROJECT**

LENGTH OF PROJECT	# OF PARCELS	CROSS SECTIONS AVAILABLE AND USED?
		☐ Yes ☐ No

COMPILED BY	DATE COMPILED

SECTION 2: PROJECT SUMMARY

# OF ENTIRE ACQUISITIONS		# OF PARTIAL ACQUISITIONS			RELOCATIONS	
				W/1 Remainder	Residential	
Vacant		Vacant		W/2 Remainder	Non-Residential	
Improved		Improved		W/3 or more	Misc. Move	
				W/LL Remainder	Outdoor Ads	

OF PARCELS IN "MAJOR" CATEGORY _____

OF PARCELS IN "MINOR" CATEGORY _____

OF PARCELS IN MAR CATEGORY _____

SECTION 3: PROJECT DESCRIPTION (*overall complexity of project, special problems that may be encountered, estimated availability of data, recommended studies and analysis) Text limited for accurate printing. Use attachment if needed.*

KENTUCKY TRANSPORTATION CABINET
Department of Highways
DIVISION OF RIGHT OF WAY AND UTILITIES

TC 62-75
Rev. 05/2019

PROJECT REPORT

SECTION 4: PARCEL INFORMATION

COUNTY	ITEM NO.	PROJECT NO.	FEDERAL NO.

PROJECT NAME

INSTRUCTIONS: *After entering information in the last available field below, click 'tab' to access additional fields.*

Parcel No.	Type Property	No Tr	No Rem	V/I[1]	P/T[2]	Size Tract AC/SF	R/W To be Acquired AC/SF	Type and Size of Easements SF	REMARKS *Number and type of improvements before acquisition, present use of property, current zoning, improvements acquired, physical changes such as grade, access, right of way proximity, physical effects of easements, SLI affected, etc.*	Complexity Rating[3]	Recommended Format 62-20 Narrative	Appraisers Proposed Fee

[1] ***V****=Vacant* ***I****=Improved* [2] ***P****=Partial* ***T****=Total* [3] ***BV****=Before Value* ***BAV****=Before & After Value* ***MAR****=Minor Acquisition Rev.*

KENTUCKY TRANSPORTATION CABINET
Department of Highways
DIVISION OF RIGHT OF WAY AND UTILITIES

TC 62-75
Rev. 05/2019

PROJECT REPORT

SECTION 5: RELOCATION INFORMATION

COUNTY	ITEM NO.	PROJECT NO.	FEDERAL NO.

PROJECT NAME

INSTRUCTIONS: *After entering information in the last available field below, click 'tab' to access additional fields.*

Parcel No.	Relo Type[4]	REMARKS **DETAILED SUMMARY:** *(Text is unlimited. Additional space will be added as needed.)* *Type of Relocation, Type of improvements acquired, present use of property, type of move, anticipated problems, etc.*

[4]***RHP***=*Replacement Housing Payment* ***B***=*Business* ***M***=*Miscellaneous Move* ***S***=*Sign/Billboard*

SPECIAL NOTE FOR PAVER MOUNTED TEMPERATURE PROFILES

This Special Note will apply when indicated on the plans or in the proposal. Section references herein are to the Department's Standard Specifications for Road and Bridge Construction current edition.

1.0 DESCRIPTION. Provide a paver mounted infrared temperature equipment to continually monitor the temperature of the asphalt mat immediately behind all paver(s) during the placement operations for all mainline pavements (including ramps for Interstates and Parkways) within the project limits. Provide thermal profiles that include material temperature and measurement locations.

2.0 MATERIALS AND EQUIPMENT. In addition to the equipment specified in Subsection 403.02 Utilize a thermal equipment supplier that can provide a qualified representative for on-site technical assistance during the initial setup, pre-construction verification, and data management and processing as needed during the Project to maintain equipment within specifications and requirements.

Provide operator settings, user manuals, required viewing/export software for analysis. Ensure the temperature equipment will meet the following:

(A) A device with one or more infrared sensors that is capable of measuring in at least 1 foot intervals across the paving width, with a minimum width of 12 feet, or extending to the recording limits of the equipment, whichever is greater. A Maximum of two (2) brackets are allowed in the influence area under the sensors. A temperature profile must be made on at least 1 foot intervals longitudinally down the road:

(B) Infrared sensor(s):

(1) Measuring from 32°F to 400°F with an accuracy of ± 2.0% of the sensor reading.

(C) Ability to measure the following:

(1) The placement distance using a Global Positioning System (GPS) or a Distance Measuring Instrument (DMI) and a Global Positioning System (GPS).

(2) Stationing

(D) GPS: Accuracy ± 4 feet in the X and Y Direction

(E) Latest version of software to collect, display, retain and analyze the mat temperature readings during placement. The software must have the ability to create and analyze:

(1) Full collected width of the thermal profiles,

(2) Paver speed and

(3) Paver stops and duration for the entire Project.

(F) Ability to export data automatically to a remote data server ("the cloud").

At the preconstruction meeting, provide the Cabinet with rights to allow for web access to the data file location. Access to the data is not to be hindered in any way. The Contractor will provide the Cabinet with any vendor specific software, user id, passwords, etc. needed to access the data through this service, cost of this access is incidental to the thermal profile bid item. The Cabinet is to have access to all data as it is being collected. If a third party is used for collecting and distributing the data the Cabinet is to have the same access rights and time as the Contractor.

This web-based software must also provide the Department with the ability to download the raw files and software and to convert them into the correct format.

(G) The thermal profile data files must provide the following data in a neat easy to read table format.

(1) Project information including Road Name and Number, PCN, Beginning and Ending MPs.

(2) IR Bar Manufacturer and Model number

(3) Number of Temperature Sensors (N)

(4) Spacing between sensors and height of sensors above the asphalt mat

(5) Total number of individual records taken each day (DATA BLOCK)

(a) Date and Time reading taken
(b) Latitude and Longitude
(c) Distance paver has moved from last test location
(d) Direction and speed of the paver
(e) Surface temperature of each of the sensors

3.0 CONSTRUCTION. Provide the Engineer with all required documentation at the pre-construction conference.

(A) Install and operate equipment in accordance with the manufacturer's specifications.

(B) Verify that the temperature sensors are within ± 2.0% using an independent temperature device on a material of known temperature. Collect and compare the GPS coordinates from the equipment with an independent measuring device.

(1) Ensure the independent survey grade GPS measurement device is calibrated to the correct coordinate system (using a control point), prior to using these coordinates to validate the equipment GPS.

(2) The comparison is considered acceptable if the coordinates are within 4 feet of each other in the X and Y direction.

(C) Collect thermal profiles on all Driving Lanes during the paving operation and transfer the data to the "cloud" network or if automatic data transmission is not available, transfer the data to the Engineer at the end of daily paving.

(D) Contact the Department immediately when System Failure occurs. Daily Percent Coverage will be considered zero when the repairs are not completed within two (2) working days of System Failure. The start of this two (2) working day period begins the next working day after System Failure.

(E) Evaluate thermal profile segments, every 150 feet, and summarize the segregation of temperature results. Results are to be labeled as Minimal 0°-25°F, Moderate 25.1°-50°F and Severe >50°. Severe readings over 3 consecutive segments or over 4 or more segments in a day warrant investigation on the cause of the differential temperature distribution.

4.0 MEASUREMENT. The Department will measure the total area of the pavement lanes mapped by the infrared scanners. Full payment will be provided for all lanes with greater than 85% coverage. Partial payment will be made for all areas covered from 50% coverage to 85% coverage at the following rate Coverage area percentage X Total bid amount. And area with less than 50% coverage will not be measured for payment.

5.0 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

1. Payment is full compensation for all work associated with providing all required equipment, training, and documentation.
2. Delays due to GPS satellite reception of signals or equipment breakdowns will not be considered justification for contract modifications or contract extensions.

Code	Pay Item	Pay Unit
24891EC	PAVE MOUNT INFRARED TEMP EQUIPMENT	SQFT

SPECIAL NOTE FOR HMA ELECTRONIC DELIVERY MANAGEMENT SYSTEM
(HMA e-Ticketing)

This Special Note will apply when indicated on the plans or in the proposal. Section references herein are to the Department's Standard Specifications for Road and Bridge Construction current edition.

1.0 DESCRIPTION. Incorporate a GPS Fleet Management System for all HMA delivered to the project in order to monitor, track, and report loads of HMA during the construction processes from the point of measurement and loading to the point of incorporation to the project.

2.0 MATERIALS AND EQUIPMENT. Submit to the Engineer for approval, no fewer than 30 days prior to HMA placement activities, a GPS fleet management system supplier that can provide a qualified representative for on-site technical assistance during the initial setup, pre-construction verifications, and data management and processing as needed during the Project to maintain equipment.

Provide operator settings, user manuals, training videos, and required viewing/export software for review. Provide equipment that will meet the following:

1. A wireless fleet management or GPS device that is capable of tracking all delivery trucks (both company-owned and third-party) must be installed on all trucks and equipment (dump trucks, belly dumps, side-load dumps, transfer vehicles, pavers, or any other trucks/vehicles) used to transfer and incorporate HMA into the project. KYTC personnel shall have the ability to access Real Time monitoring through the use of a mobile device such as an iPad, smartphone, etc.

2. The fleet management system shall be fully integrated with the Contractor's Load Read-Out scale system at the HMA plant site.

3. The fleet management system shall have the ability to measure and track vehicles and their contents (weights and material types) continuously from the plant site to the project site. The system shall have internal battery backup capabilities due to loss of power, and have the ability to store data if GPS connectivity is lost and transmit that same data when unit re-establishes connectivity. To be considered continuous, no two data points shall be more than 60 seconds apart unless the vehicle is stopped. Duration of stop time for any reason shall be recorded.

3.0 CONSTRUCTION. Provide the Engineer with the manufacturer's specifications and all required documentation for data access at the pre-construction conference.

A. Construction Requirements

1. Install and operate equipment in accordance with the manufacturer's specifications.

2. Verify the GPS is working within the requirements of this Special Note.

B. Data Deliverables

Provide to the Engineer a means in which to gather report summaries by way of iOS apps, web pages, or any other method at the disposal of the Engineer. The Engineer may request data at any time during paving operations.

1. Real-time Continuous Data Items

Provide the Engineer access to a GIS map-based data viewer which displays the following information in real-time with a web-based system compatible with iOS and Windows environments.

- Each Truck
  - UniqueTruck ID
  - Truck status
    - Time At Source

        - Time At Destination
        - Time At Paver
        - Time At Scale
        - Time to and from plant/job
        - Time Stopped with Engine Running
    - Time of last transmission
    - Location (Latitude and Longitude in decimal degrees to nearest 0.0000001) every 60 seconds
    - Description of Material being transported (i.e. asphalt base, asphalt surface)
    - Mix Description (i.e. CL2 ASPH BASE 1.00D PG64-22, etc.)
    - Mix Identification Number (Project Specific)
    - Net Weight of material being transported to the nearest 0.01 ton
    - Running Daily Total of Net Weight of material being transported to nearest 0.01 ton.
    - Project Number

- Scale Location
- Project Location
- Point of Delivery (i.e. paver)

2. Daily Summary

The following summary information shall be provided to the Engineer electronically within 4 hours of beginning operations on the next working day

- For each Material
    - List of Individual Loads
        - Contractor Name
        - Project Number
        - Unique Truck ID
        - Net Weight For Payment (nearest 0.01 tons)
        - Date
        - Mix Temperature at Time of Loading, Fahrenheit (to be key entered by plant)
        - Time Loaded
        - Time Unloaded
        - Delivery Location (Latitude/Longitude in decimal degrees to nearest 0.0000001)
- For each Bid Item
        - Total Quantity for Payment (nearest 0.01 tons)

SPECIAL NOTE FOR INTELLIGENT COMPACTION OF AGGREGATE BASES AND SOILS

This Special Note will apply when indicated on the plans or in the proposal. Section references herein are to the Department's current edition of the Standard Specifications for Road and Bridge Construction.

1.0 DESCRIPTION. Provide and use Intelligent Compaction (IC) Rollers for compaction of Aggregate bases, stabilized subgrades, soil, and soil rock mixtures.

2.0 MATERIALS AND EQUIPMENT. The Contractor shall supply sufficient numbers of rollers and other associated equipment necessary to complete the compaction requirements for the specific materials. The Contractor will determine the number of IC rollers to use depending on the scope of the project. The IC roller(s) may be utilized during production with other standard compaction equipment and shall be used for the evaluation of the compaction operations. Provide at least one (1) roller to be used on the project with the following minimum characteristics:

1) Are self propelled vibratory rollers equipped with machine drive power and/or accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials in order to evaluate the applied Compactive effort. www.IntelligentCompaction.com contains a list of acceptable rollers equipped with IC technology.

2) IC rollers can be either smooth drums or pad footed drums based on the type needed for the aggregate base or soil types to compact.

3) The output from the roller is designated as the IC-MV which represents the stiffness of the materials based on the vibration of the roller drums and the resulting response from the underlying materials, or the machine drive power value.

4) Are equipped with integrated on-board documentation systems that are capable of displaying real-time color-coded maps of IC measurement values including the stiffness response values, location of the roller, number of roller passes, machine settings, together with the speed, the frequency and amplitude of roller drums. Ensure the display unit is capable of transferring the data by means of a cloud based near real time system with a USB port backup data transfer.

5) Are equipped with a mounted Global Positioning System GPS radio and receiver either a Real Time Kinematic (RTK-GPS) or Global Navigational Satellite System (GNSS) units that monitor the location and track the number of passes of the rollers. Accuracy of the positioning system must be within 12 inches.

3.0 WORK PLAN. Submit to the Engineer an IC Work Plan at the Preconstruction Conference and/or at least 2 weeks prior to beginning the corresponding construction activates. Describe in the work plan the following:

1. Compaction equipment to be used including:
    - Vendor(s)

- Roller model(s),
- Roller dimensions and weights,
- Description of IC measurement system,
- GPS capabilities,
- Documentation system,
- Software.

2. Roller data collection methods including sampling rates and intervals and data file types.

3. Transfer of data to the Engineer including method, timing, and personnel responsible. Data transfer shall be provided by a real time cloud data collecting and distribution system (ex. Visionlink). The Contractor will provide the Cabinet with any vendor specific software, user id, passwords, etc. needed to access the data through this service, cost of this access is incidental to the IC bid item(s).

4. Training plan and schedule for roller operators, project foreman, project surveyors, and Cabinet personnel; including both classroom and field training from the equipment manufacturer. Training should be conducted at least 1 week before beginning IC construction. The training is to be performed by a qualified representative(s) from the IC Roller manufacture(s) to be used on the project.

4.0 CONSTRUCTION. Prior to the start of production, ensure the proper setup of the GPS, IC roller(s) and the rover(s) by conducting joint GPS correlation and verification testing between the Contractor, GPS representative and IC roller manufacturer using the same datum. Use the project datum system (Northing, Easting and Elevation) when applicable.

1. Ensure GPS correlation and verification testing includes the following minimum processes:

    a. Establish the GPS system to be used either one with a base station or one with mobile receivers only. Ensure all components in the system are set to the correct coordinate system; then,

    b. Verify that the roller and rover are working properly and that there is a connection with the base station; then,

    c. Record the coordinates of the two edges where the front drum of the roller is in contact with the ground from the on-board, color-coded display; then,

    d. Mark the locations of the roller drum edges and move the roller, and place the mobile receiver at each mark and record the readings; then; then,

2. Compare coordinates between the roller and rover receivers. If the coordinates are within12.0 in. of each other, the comparison is acceptable. If the coordinates are not within 12.0 in., diagnose and perform necessary corrections and repeat the above steps until verification is acceptable.

3. Do not begin work until acceptable GPS correlation and verification has been obtained. The Contractor and the Department should conduct random GPS verification testing during production to ensure data locations are accurate. The recommended rate is once per day with a requirement of at least once per week.

4. A test strip is to be used for all materials (DGA, CSB, subgrade and soil) as outlined and sized in section 302.03.04 to determine optimum rolling pattern, for all materials, and the target density for aggregate bases. A new test strip will be required anytime the material changes, equipment changes, or proper compaction has not been obtained for two (2) consecutive test locations.

5. All acceptance testing shall be as outlined in Standard Specifications sections 200 and 300.

6. Any areas a minimum of 50 square feet in area not achieving the 80% of the stiffness value determined by the latest control strip shall be tested by other means approved by the Engineer. If the material doesn't pass the testing is shall be repaired based on current standards to the satisfaction of the Engineer.

5.0 MEASUREMENT. The Department will measure the total tons of aggregate base (DGA and/or CSB), total square yards of stabilized subgrade, and total cubic yards of soil compacted using the IC roller(s). The use of non-IC rollers is allowed on this project, but an IC roller must be used as well.

6.0 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

1. All areas with a minimum of 80% pass coverage and 75% required stiffness readings.

2. Payment is full compensation for all work associated with providing IC equipped rollers, transmission of electronic data files, two copies of IC roller manufacturer software, and training.

3. Delays due to GPS satellite reception of signals to operate the IC equipment or IC roller breakdowns will not be considered justification for contract modifications or contract extensions.

Code	Pay Item	Pay Unit
24779EC	Intelligent Compaction for Soil	CY
24780EC	Intelligent Compaction for Aggregate	TON
24990EC	Intelligent Comp Subgrade Stabilization	SQYD

June 28, 2018

SPECIAL NOTE FOR INTELLIGENT COMPACTION OF ASPHALT MIXTURES

This Special Note will apply when indicated on the plans or in the proposal. Section references herein are to the Department's Standard Specifications for Road and Bridge Construction current edition.

1.0 DESCRIPTION. Provide and use Intelligent Compaction (IC) Rollers for compaction of all asphalt mixtures.

2.0 MATERIALS AND EQUIPMENT. In addition to the equipment specified in Subsection 403.02, a minimum of one (1) IC roller is to be used on the project at all times, two (2) IC rollers will be required when the paving train consists of three (3) or more rollers. The Contractor is to only the IC roller(s) for compaction as the breakdown and/or intermediate roller(s). All IC rollers will meet the following minimum characteristics:

1) Are self propelled double-drum vibratory rollers equipped with accelerometers mounted in or about the drum to measure the interactions between the rollers and compacted materials in order to evaluate the applied compactive effort. The IC rollers must have the approval of the Engineer prior to use. Examples of rollers equipped with IC technology can be found at www.IntelligentCompaction.com.

2) Are equipped with non-contact temperature sensors for measuring pavement surface temperatures.

3) The output from the roller is designated as the IC-MV which represents the stiffness of the materials based on the vibration of the roller drums and the resulting response from the underlying materials.

4) Are equipped with integrated on-board documentation systems that are capable of displaying real-time color-coded maps of IC measurement values including the stiffness response values, location of the roller, number of roller passes, machine settings, together with the material temperature, speed and the frequency and amplitude of roller drums. Ensure the display unit is capable of transferring the data by means of a cloud based near real time system with a USB port backup data transfer.

5) Are equipped with a mounted Global Positioning System GPS radio and receiver either a Real Time Kinematic (RTK-GPS) or Global Navigational Satellite System (GNSS) units that monitor the location and track the number of passes of the rollers. Accuracy of the positioning system is to be a minimum of 12 inches.

3.0 WORK PLAN. Submit to the Engineer an IC Work Plan at the Preconstruction Conference and at least 2 weeks prior to the beginning construction. Describe in the work plan the following:

1. Compaction equipment to be used including:
   - Vendor(s)
   - Roller model(s),
   - Roller dimensions and weights,
   - Description of IC measurement system,
   - GPS capabilities,
   - Documentation system,
   - Temperature measurement system, and
   - Software.

2. Roller data collection methods including sampling rates and intervals and data file types.

3. Transfer of data to the Engineer including method, timing, and personnel responsible. **Data transfer shall be provided by a real time cloud data collecting and distribution system (ex. Visionlink). The Contractor will provide the Cabinet with any vendor specific software, user id, passwords, etc. needed to access the data through this service, cost of this access is incidental to the IC bid item.**

4. Training plan and schedule for roller operators, project foreman, project surveyors, and Cabinet personnel; including both classroom and field training. Training should be conducted at least 1 week before beginning IC construction. The training is to be performed by a qualified representative(s) from the IC Roller manufacture(s) to be used on the project. This training shall include how to access and use the data from the cloud data source.

4.0 CONSTRUCTION. Do not begin work until the Engineer has approved the IC submittals and the IC equipment.

Follow requirements established in Section 400 for production and placement, materials, equipment, acceptance plans and adjustments except as noted or modified in this Specification. Provide the Engineer at least one day's notice prior to beginning construction or prior to resuming production if operations have been temporarily suspended. Ensure paving equipment complies with all requirements specified in Section 400. The IC roller temperatures will be evaluated by the Department with the data from a Paver Mounted Infrared Temperature Gauge.

A. Pre-Construction Test Section(s) Requirements

1. Prior to the start of production, ensure the proper setup of the GPS, IC roller(s) and the rover(s) by conducting joint GPS correlation and verification testing between the Contractor, GPS representative and IC roller manufacturer using the same datum.

1. Ensure GPS correlation and verification testing includes the following minimum processes:

    a. Establish the GPS system to be used either one with a base station or one with mobile receivers only. Ensure all components in the system are set to the correct coordinate system; then,

    b. Verify that the roller and rover are working properly and that there is a connection with the base station; then,

    c. Record the coordinates of the two edges where the front drum of the roller is in contact with the ground from the on-board, color-coded display; then,

    d. Mark the locations of the roller drum edges and move the roller, and place the mobile receiver at each mark and record the readings; then,

2. Compare coordinates between the roller and rover receivers. If the coordinates are within 12.0 in. of each other, the comparison is acceptable. If the coordinates are not within 12.0 in., diagnose and perform necessary corrections and repeat the above steps until verification is acceptable.

3. Do not begin work until acceptable GPS correlation and verification has been obtained.

4. The Contractor and the Department should conduct random GPS verification testing during production to ensure data locations are accurate. The recommended rate is once per day with a requirement of at least once per week.

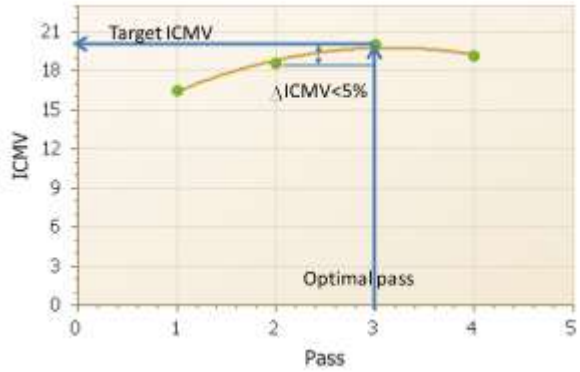
5. All acceptance testing shall be as outlined in Standard Specifications section 400.

B. Construction Test Section(s) Requirements

Construct test section(s) at location(s) agreed on by the Contractor and the Engineer within the project limits. The test section is required to determine a compaction curve of the asphalt mixtures in relationship to number of roller passes and to the stiffness of mixture while meeting the Department in-place compaction requirements. All rollers and the respective number of passes for each is to be determined via control strip each time a material change, equipment change or when the Engineer deems necessary.

Conduct test section(s) on every lift and every asphalt mixture. Ensure test section quantities of 500 to 1,000 tons of mainline mixtures. Operate IC rollers in the low to medium amplitude range and at the same settings (speed, frequency) throughout the section while minimizing overlapping of the roller, **the settings are to be used throughout the project**

with no changes. After each roller pass, the qualified technician from the contractor observed by the Department will use a nondestructive nuclear gauge that has been calibrated to the mixture to estimate the density of the asphalt at 10 locations uniformly spaced throughout the test section within the width of a single roller pass. The density readings and the number of roller passes needed to achieve the specified compaction will be recorded. The estimated target density will be the peak of the average of the nondestructive readings within the desired compaction temperature range for the mixture. The IC roller data in conjunction with the Veda software will create an IC compaction curve for the mixture. The target IC-MV is the point when the increase in the IC-MV of the material between passes is less than 5 percent on the compaction curve. The IC compaction curve is defined as the relationship between the IC-MV and the roller passes. A compaction curve example is as follows:



Subsequent to the determination of the target IC-MV, compact an adjoining > 250 < 500 tons section using same roller settings and the number of estimated roller passes and allow the Department to verify the compaction with the same calibrated nondestructive nuclear gauge following the final roller pass. **The Department will obtain density readings at 10 locations (No cores for calibration are to be taken in the surface layer, use non-destructive density results only!!)** uniformly spaced throughout the test section within the width of the single roller. Obtain GPS measurement of the core locations with a GPS rover. Use the Veda software to perform least square linear regression between the core data and IC-MV in order to correlate the production IC-MV values to the Department specified in-place air voids. A sample linear regression curve example is as follows.



C. Construction Requirements
Use the IC roller on all lifts and types of asphalt within the limits of the project, with the exception of asphalt drainage blanket.

Ensure the optimal number of roller passes determined from the test sections has been applied to a minimum coverage of 80% of the individual IC Construction area. Ensure a minimum of 75% of the individual IC Construction area meets the target IC-MV values determined from the test sections.

Do not continue paving operations if IC Construction areas not meeting the IC criteria are produced until they have been investigated by the Department. Obtain the Engineer's approval to resume paving operations. Non-IC rollers are allowed to be used as the third roller on the project; one of the breakdown or the finish rollers is to be equipped with IC technology.

IC Construction areas are defined as subsections of the project being worked continuously by the Contractor. The magnitude of the IC Construction areas may vary with production but must be at least 750 tons per mixture for evaluation. Partial IC Construction areas of < 750 tons will be included in the previous area evaluation. IC Construction areas may extend over multiple days depending on the operations.

The IC Construction Operations Criteria does not affect the Department's acceptance processes for the materials or construction operations

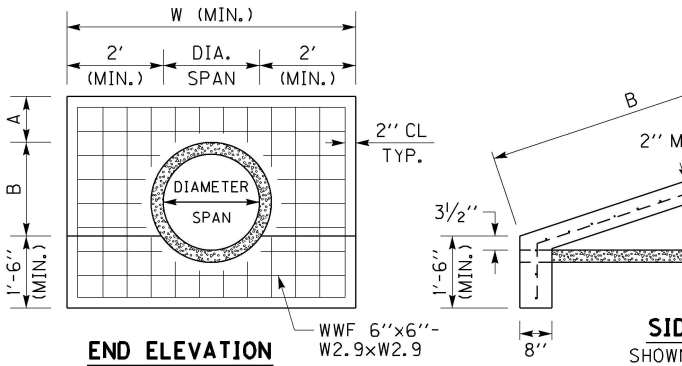
5.0 MEASUREMENT. The Department will measure the total tons of asphalt mixtures compacted using the IC roller(s). Compaction is to be performed by a minimum of one (1) IC roller for a two (2) roller operation and a minimum of two (2) IC rollers when three (3) or more rollers are used for compaction. Material compacted by rollers not equipped with properly functioning IC equipment will not be accepted for payment of the bid item asphalt mixtures IC rolled. Use of non-IC rollers can be accepted on small areas due to equipment malfunctions at the written approval of the Engineer. Paving operations should be suspended for equipment malfunctions that will extend over three days of operation.

6.0 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

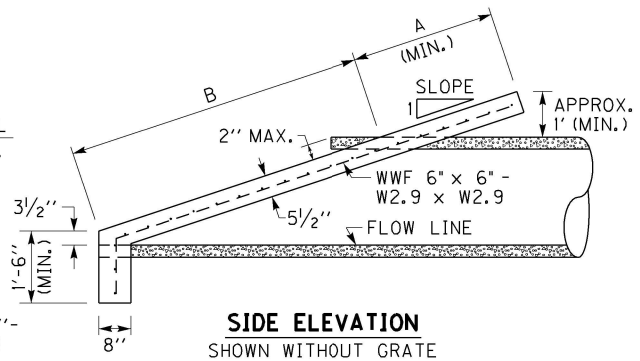
1. Payment is full compensation for all work associated with providing IC equipped rollers, transmission of electronic data files, two copies of IC roller manufacturer software, and training.

2. Delays due to GPS satellite reception of signals to operate the IC equipment or IC roller breakdowns will not be considered justification for contract modifications or contract extensions.

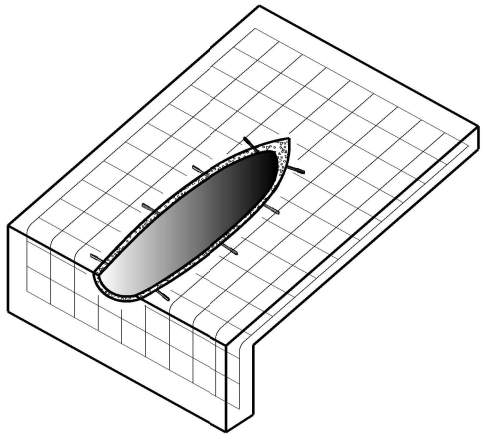
Code	Pay Item	Pay Unit
24781EC	Intelligent Compaction for Asphalt	TON



END ELEVATION
SHOWN WITH WOVEN WIRE REINFORCEMENT



SIDE ELEVATION
SHOWN WITHOUT GRATE



ISOMETRIC VIEW
SHOWN WITH WOVEN WIRE REINFORCEMENT AND WEDGE ANCHORS

COUNTY OF	ITEM NO.	SHEET NO.

~ NOTES ~

BID ITEM AND UNIT TO BID: 24575ES610 HEADWALL (SLOPED & MITERED CONCRETE-FOR _ INCH PIPE) - EACH

1. THE EMBANKMENT FILL MATERIAL IS TO BE PLACED, COMPACTED, AND GRADED AROUND THE PIPE BEFORE THE CONCRETE SLOPE PAVING IS PLACED. THE INTENT IS FOR THE SLOPED & MITERED HEADWALL TO MATCH THE FINAL EMBANKMENT SLOPE.
2. THE PIPE SHALL BE MITERED AFTER THE CONCRETE SLOPE PAVING HAS BEEN PLACED AND SUFFICIENTLY CURED. THE PIPE SHOULD BE MITERED AS CLOSE TO FLUSH WITH THE SLOPE PAVING AS POSSIBLE, AND NO HIGHER THAN 2" ABOVE THE SLOPE PAVING. HAND FINISHING AND/OR CUTTING MAY BE NECESSARY.
3. THE DIMENSION 'A' IS BASED ON THE FINAL GRADED SLOPE. THE DIMENSION 'B' IS BASED ON CIRCULAR REINFORCED CONCRETE PIPE AT 0° SKEW FOR THE LISTED SLOPE. THE DIMENSION 'W' IS BASED ON THE DIAMETER, OR SPAN, OF THE PIPE. NOTE: THE HEADWALL DIMENSIONS AND CONCRETE QUANTITIES MAY VARY BASED ON THE FINAL GRADED SLOPE, PIPE SKEW, AND/OR TYPE OF PIPE.
4. WOVEN WIRE REINFORCEMENT (WWF 6"x6" - W2.9xW2.9) IS REQUIRED FOR THE SLOPE PAVING AND TOE WALL. UTILIZE 2" CLEARANCE FROM ALL EDGES.
5. CONCRETE QUANTITIES SHOWN ARE FOR ONE (1) HEADWALL.
6. AFTER THE PIPE HAS BEEN MITERED, ANCHOR THE PIPE TO THE CONCRETE SLOPE PAVING BY CORE DRILLING AND INSTALLING 1/2" DIAMETER x 7" LENGTH STEEL WEDGE ANCHORS (3" MINIMUM EMBEDMENT) ON 18" CENTERS ALONG THE SIDES OF THE PIPE. HOLE SIZE & DEPTH, TORQUE, & INSTALLATION PROCEDURES PER RECOMMENDATION OF ANCHOR MANUFACTURE. NOTE: STEEL WEDGE ANCHORS ARE NOT REQUIRED FOR REINFORCED CONCRETE PIPE.

⑦ THE FOLLOWING SITUATIONS REQUIRE A HEADWALL WITH A GRATE:
-24" DIAMETER PIPE ON GREATER THAN 30° SKEW
-30" DIAMETER PIPE ON GREATER THAN 15° SKEW
-PIPE WITH GREATER THAN 30" DIAMETER.
-ELLIPTICAL PIPE GREATER THAN 24" EQUIVALENT DIAMETER
SEE SHEET 2 FOR GRATE DETAILS

8. ALL BOLTS AND HARDWARE SHALL BE RUST RESISTANT: ZINC PLATED, STAINLESS STEEL, OR STEEL THAT HAS BEEN GALVANIZED IN ACCORDANCE WITH AASHTO M 232.

DIMENSIONS AND CONCRETE QUANTITIES

PIPE SIZE	3:1 SLOPE				4:1 SLOPE				6:1 SLOPE				GRATE REQUIRED
	A	B	W	CU. YDS. CONCRETE	A	B	W	CU. YDS. CONCRETE	A	B	W	CU. YDS. CONCRETE	
15"	3'	3'-7½"	5'-3"	0.74	4'	4'-8¾"	5'-3"	0.93	6'	6'-11¾"	5'-3"	1.29	NO
18"	3'	4'-5¾"	5'-6"	0.85	4'	5'-10"	5'-6"	1.05	6'	8'-7¼"	5'-6"	1.48	NO
24"	3'	6'-2½"	6'-0"	1.05	4'	8'-1"	6'-0"	1.32	6'	11'-11"	6'-0"	1.87	SEE ⑦
30"	3'	7'-10¾"	6'-6"	1.43	4'	10'-3¾"	6'-6"	1.80	6'	15'-2½"	6'-6"	2.28	SEE ⑦

NOTE: CONCRETE QUANTITIES ARE LISTED FOR IMFORMATIONAL PURPOSES ONLY.

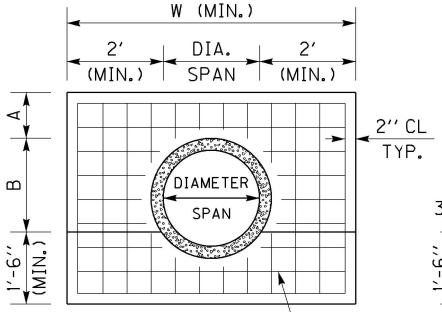
SEE SHEET 2 FOR DIMENSIONS OF HEADWALLS FOR PIPE OVER 30" DIAMETER

NOT TO SCALE

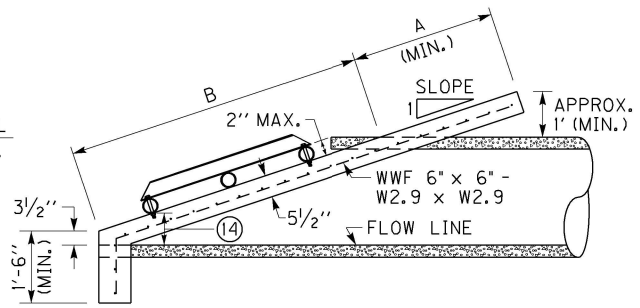
KENTUCKY
DEPARTMENT OF HIGHWAYS

SLOPED & MITERED CONCRETE HEADWALL (SHEET 1 OF 2)

COUNTY OF	ITEM NO.	SHEET NO.



END ELEVATION
SHOWN WITH WOVEN WIRE REINFORCEMENT



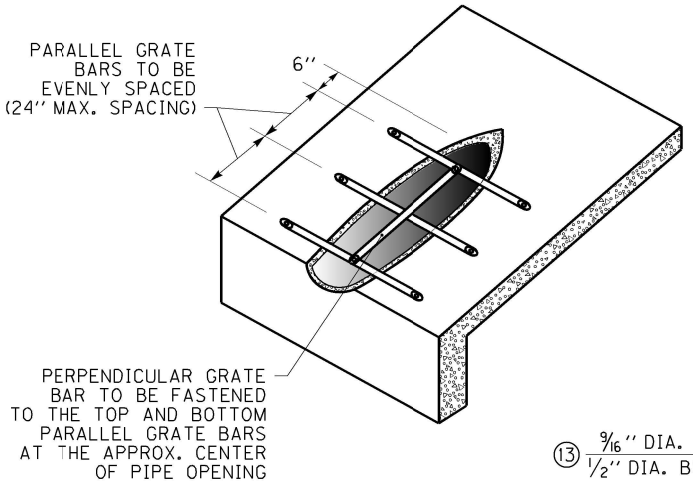
SIDE ELEVATION
SHOWN WITH GRATE

~ NOTES ~

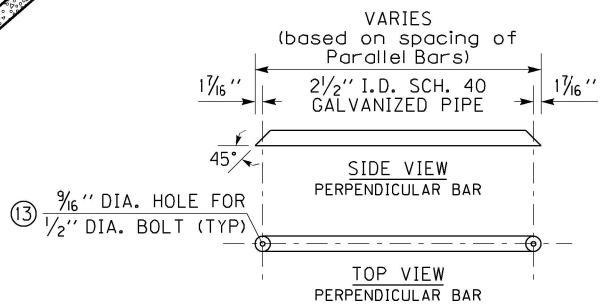
BID ITEM AND UNIT TO BID: 24575ES610
HEADWALL (SLOPED & MITERED CONCRETE-FOR _ INCH PIPE) - EACH

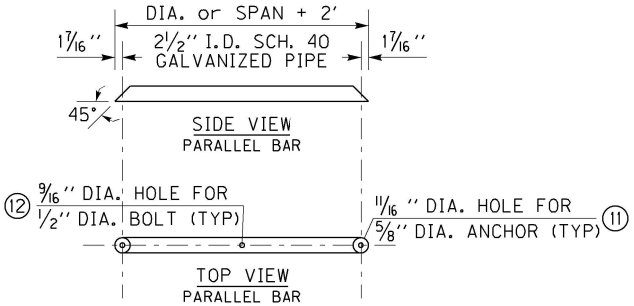
SEE SHEET 1 FOR NOTES 1 THRU 5

7. THE FOLLOWING SITUATIONS REQUIRE A HEADWALL WITH A GRATE:
-24" DIAMETER PIPE ON GREATER THAN 30° SKEW
-30" DIAMETER PIPE ON GREATER THAN 15° SKEW
-PIPE WITH GREATER THAN 30" DIAMETER.
-ELLIPTICAL PIPE GREATER THAN 24" EQUIVALENT DIAMETER
8. ALL BOLTS AND HARDWARE SHALL BE RUST RESISTANT: ZINC PLATED, STAINLESS STEEL, OR STEEL THAT HAS BEEN GALVANIZED IN ACCORDANCE WITH AASHTO M 232.
9. THE PIPE USED TO CONSTRUCT THE GRATE SHALL BE STEEL, SCHEDULE 40, CONFORMING TO ASTM A53, AND GALVANIZED IN ACCORDANCE WITH AASHTO M 111 AFTER FABRICATION.
10. ANY RAW METAL EXPOSED BY FIELD CUTTING AND/OR DRILLING SHALL BE TREATED WITH A COLD GALVANIZING COMPOUND.
(11) FASTEN PARALLEL BARS TO HEADWALL WITH 5/8" DIA. x 4½" LENGTH STEEL WEDGE ANCHORS, MINIMUM EMBEDMENT = 2¾" HOLE SIZE AND DEPTH, TORQUE, & INSTALLATION PROCEDURES PER RECOMMENDATION OF ANCHOR MANUFACTURE
(12) CENTER BOLT HOLE SHALL ONLY BE DRILLED IN THE TOP AND BOTTOM PARALLEL BARS.
(13) FASTEN THE PERPENDICULAR BAR TO THE TOP AND BOTTOM PARALLEL BARS WITH ½" DIA. x 4" LENGTH HEX HEAD BOLTS, HEX HEAD NUTS, & FLAT WASHERS.
(14) THE BOTTOM PARALLEL BAR IS TO BE PLACED SO THAT IT IS APPROX. 6" ABOVE THE FLOWLINE OF THE PIPE.



ISOMETRIC VIEW
SHOWING HEADWALL WITH GRATE





PIPE FOR GRATE DETAILS
SEE NOTE 6 TO DETERMINE IF GRATE IS REQUIRED

NOT TO SCALE

DIMENSIONS AND CONCRETE QUANTITIES

PIPE SIZE	3:1 SLOPE				4:1 SLOPE				6:1 SLOPE				GRATE REQUIRED
	A	B	W	CU. YDS. CONCRETE	A	B	W	CU. YDS. CONCRETE	A	B	W	CU. YDS. CONCRETE	
36"	3'	9'-7½"	7'-0"	1.51	4'	12'-6½"	7'-0"	1.91	6'	18'-6"	7'-0"	2.42	YES
42"	3'	11'-4"	7'-6"	1.76	4'	14'-9¼"	7'-6"	2.23	6'	21'-9½"	7'-6"	3.19	YES

NOTE: CONCRETE QUANTITIES ARE LISTED FOR IMFORMATIONAL PURPOSES ONLY.

SEE SHEET 1 FOR DIMENSIONS OF HEADWALLS FOR PIPE 30" DIAMETER & LESS

KENTUCKY DEPARTMENT OF HIGHWAYS

SLOPED & MITERED CONCRETE HEADWALL (SHEET 2 OF 2)

SPECIAL NOTE FOR ASPHALT APPROACH PAVEMENT

I. DESCRIPTION. Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highway's 2019 Standard Specifications for Road and Bridge Construction and applicable Supplemental Specifications, the Standard Drawings, this Note, and the Design Build Team's drawings. Section references are to the Standard Specifications.

This work consists of the following: (1) Furnish all labor, materials, tools, and equipment; (2) Maintain and control traffic; (3) Install asphalt approach pavement; and (4) Any other work specified as part of this contract.

All construction will be in accordance with Section 606 unless otherwise specified.

II. MATERIALS.

A. Bituminous Asphalt. Use CL4 ASPH SURF 0.38a PG 76-22.

III. CONSTRUCTION.

A. Asphalt Approach Pavement. Mill each existing asphalt approach for a distance of 100' from the bridge end. Remove the bituminous material uniformly by making an edge key, so as to provide a smooth transition to the finished bridge when a new bituminous overlay of compacted depth of approximately 1½" is added to the approaches. The grinding depth may vary depending on the condition of the existing approach and final elevation of bridge end. Dispose of all removed material away from the site.

IV. MEASUREMENT. See Section 606 and the following:

A. Asphalt Approach Pavement. The Department will measure the quantity in square yards, which shall include all labor, equipment, and material needed to complete this work.

V. PAYMENT.

A. Asphalt Approach Pavement. The Department will make payment under the terms of the contract.

SPECIAL NOTE FOR BRIDGE CONCRETE PATCHING

These Notes or designated portions thereof, apply where so indicated on the plans, proposals or bidding instruction.

I. DESCRIPTION. Perform all work in accordance with the Instruction to Proposers (ITP), the Department's 2019 Standard Specifications, and applicable Supplemental Specifications, and these Notes. Section references are to the Standard Specifications.
This work consists of: (1) Furnish all labor, materials, tools, and equipment; (2) Remove existing spalled/delaminated concrete; (3) Prepare the existing surface for concrete patching; (4) Place hook fasteners and welded wire fabric over surfaces to be repaired (where applicable); (5) Apply concrete patching as specified by this; (6) Finish and cure the new Concrete Patches; (7) Maintain & control traffic; and, (8) Any other work specified as part of this contract.

II. MATERIALS.

A. Concrete. Approved Concrete Product for Vertical and Overhead Repair Patch.

B. Steel Reinforcement. Use Grade 60. See Section 602

C. Welded Steel Wire Fabric (WWF). Conform to Section 811

D. Hook Fasteners. Use commercial grade galvanized hook fasteners. Minimum 3/16" diameter.

III. CONSTRUCTION.

A. Concrete Removal and Preparation. The Contractor, as directed by the Engineer shall locate and remove all loose, spalled, deteriorated and delaminated concrete. Sounding shall be used to locate delaminated areas. Care shall be exercised not to damage areas of sound concrete or reinforcing steel during concrete removal operations. Unless specifically *directed by the Engineer*, depth of removal shall not exceed 6 inches. Concrete removal shall be in accordance with a sequence approved by the Engineer.

Concrete removal shall be accomplished by chipping with hand picks, chisels or light duty pneumatic or electric chipping hammers (not to exceed 15 lbs.). If sound concrete is encountered before existing reinforcing steel is exposed, the surface shall be prepared and repaired without further removal of the concrete. When corroded reinforcing steel is exposed, concrete removal shall continue until there is a minimum ¾ inch clearance around the exposed, corroded reinforcing bar. Care shall be taken to not damage bond to adjacent non-exposed reinforcing steel during concrete removal processes.

The perimeter of all areas where concrete is removed shall be tapered at an approximately 45° angle, except that the outer edges of all chipped areas shall be saw cut to minimum depth of ¾ inch to prevent featheredging unless otherwise approved by the Engineer.

After all deteriorated concrete has been removed; the repair surface to receive concrete patching shall be prepared by abrasive blast cleaning. Abrasive blast

cleaning shall remove all fractured surface concrete and all traces of any unsound material or contaminants such as oil, grease, dirt, slurry, or any materials which could interfere with the bond of freshly placed concrete.
The Contractor shall dispose all removed material off State Right Of Way in an approved site.

B. **Steel Reinforcement.** All corroded reinforcing steel exposed during concrete removal shall have corrosion products removed by abrasive grit blasting or wire brush whichever is more appropriate. Furnish for replacement, as directed by the Engineer, additional linear feet of steel reinforcing bars ½" diameter by 20-foot lengths. Place these bars in areas deemed by the Engineer to require additional reinforcement. Field cutting and bending is permitted.
Reinforcing steel displaying deep pitting or loss of more than 20 percent of cross-sectional area shall be removed and replaced. Such bars shall be placed in accordance with the recommendations of ACI 506R, Sections 5.4 and 5.5. In particular, bars shall not be bundled in lapped splices, but shall be placed such that the minimum spacing around each bar is three times the maximum aggregate size to allow for proper encapsulation with concrete patching.
Intersecting reinforcing bars shall be tightly secured to each other using tie wire and adequately supported to minimize movement during concrete placement.
Welded wire fabric (WWF) shall be required and at each repair area larger than 1 square foot if the depth of the repair exceeds 3 inches from the original dimension of the repaired member. Sheets of adjoining WWF shall be lapped by at least one and one-half spaces at all intersections, in both directions, and be securely fastened. WWF fabric shall be supported no closer than ½ inch to the prepared concrete surface and shall have a minimum concrete cover of 1.5 inches.
WWF shall be fastened to preset anchors on a grid not more than 12 inches square. Large knots of tie wire which could result in sand pockets and voids during patching shall be avoided.

C. **Hook Fasteners.** Hook fasteners shall be positioned at the spacing as stated above or as directed by the Engineer. Any given area shall have a minimum of four anchors. The WWF shall not move or deform excessively during concrete patching. Maximum hook fastener spacing shall not exceed 2 feet on a grid pattern over the entire repair area.
Hook fasteners shall be of commercial grade galvanized steel with a minimum diameter of 3/16". They may be mechanically set or grouted, as approved by the Engineer.
The Department will randomly select hook fasteners to be tested to verify pullout force is sufficient. If any anchors fail to meet the minimum acceptable pullout value, corrective measures shall be taken by the Contractor and further testing will be conducted.

D. **Concrete Patching.** Place and finish the new concrete for the patching area in accordance with the manufacturer's recommendations, or as directed by the

Engineer. The Engineer shall approve the Contractor's method of placing and consolidating the concrete prior to the beginning of this operation.

E. **Curing.** On completion of finishing operation, patching concrete shall immediately be prevented from drying out and cracking by fogging, wetting, and/or any appropriate method approved by the Engineer. Curing shall continue for duration recommended by the product manufacturer.

Each Contractor submitting a bid for this work shall make a thorough inspection of the site prior to submitting his bid and shall thoroughly familiarize himself with existing conditions so that the work can be expeditiously performed after a contract is awarded. Submission of the "all inclusive" Lump Sum bid item will be considered evidence of this inspection having been made. Any claims resulting from site conditions will not be honored by the Department. Dispose of all removed material entirely away from the job site as approved by the Engineer. This work is incidental to the contract unit price for "Concrete Patching Repair".

IV. MEASUREMENT

A. Concrete Patching. The Department will measure the quantity per square feet of each area restored.

B. Steel Reinforcement. See Section 602.

C. Welded Wire Fabric & Hook Fasteners. Welded Wire Fabric and Hook Fasteners will not be measured for payment, but shall be considered incidental to "Concrete Patching Repair".

V. PAYMENT

A. Concrete Patching Repair. Payment will be made per the terms of the contract

B. Steel Reinforcement. Payment will be made per the terms of the contract.

SPECIAL NOTE FOR BRIDGE RESTORATION AND WATERPROOFING WITH CONCRETE OVERLAYS

I. DESCRIPTION. Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highway's 2019 Standard Specifications for Road and Bridge Construction and applicable Supplemental Specifications, the Standard Drawings, this Note, and the Design Build Team's detailed drawings. Section references are to the Standard Specifications.

This work consists of the following: (1) Furnish all labor, materials, tools, and equipment; (2) Remove the existing overlay (if present); (3) Complete full-depth and partial depth repairs as directed by the Engineer; (4) Repair/replace damaged and corroded reinforcing bars; (5) Place new concrete overlay and epoxy-sand slurry in accordance with Section 606; (6) Complete asphalt/concrete approach pavement as directed by the Engineer; (7) Maintain and control traffic; and (8) Any other work specified as part of this contract.

All construction will be in accordance with Section 606 unless otherwise specified.

II. MATERIALS.

A. Latex Concrete. See Section 606.03.17.

B. Class "M" Concrete. Use either "M1" or "M2". See Section 601.

C. Bituminous Asphalt. Use CL2 ASPH SURF 0.38D PG64-22.

D. Epoxy-Sand Slurry. See Section 606.03.10.

III. CONSTRUCTION.

A. Remove Existing Overlay. In addition to Section 606.03.03, totally remove the existing concrete overlay by milling.

B. Partial Depth Slab Repair and Latex Overlay. Remove areas determined to be unsound by the Engineer via hydro demolition or via hand held jackhammers weighing less than 45lbs in accordance with Section 606.02.10 D. Repair/Replace all damaged or severely corroded reinforcing bars prior to partial depth repair operation. The Department will not measure material removal and will consider this work incidental to the bid item "PARTIAL DEPTH PATCHING". Mix and place Latex Modified Concrete Overlay in accordance with Sections 606.03.08 and 606.03.17.

C. Asphalt/Concrete Approach Pavement. Approach pavements shall be addressed per the ITP.

D. Surface Texturing. Texture the concrete surface of the overlay in accordance with Section 609.03.10.

IV. MEASUREMENT. See Section 606 and the following:

A. Latex Modified Concrete for Overlay. The Department will measure the quantity in cubic yards using the theoretical volume as follows for each bridge.

B. Latex Modified Concrete for Partial Depth Patching and variable thickness of Overlay. The Department will measure the quantity in cubic yards by deducting the theoretical volume of bridge deck overlay (LMC) from the total volume (as indicated by the batch quantity tickets) of Concrete required to obtain the finished grade shown on the Plans or established by the Engineer.

C. Remove Existing Overlay. The Department will measure the removal of the existing overlay in square yards, which shall include all labor, equipment, and material needed to complete this work.

D. Steel Reinforcement. The Department will measure any reinforcing steel necessary for the partial or full depth patch in pounds, which shall include all labor, equipment, and material needed to complete this work.

E. Asphalt/Concrete Approach Pavement. The Department will measure the quantity in square yards, which shall include all labor, equipment, and material needed to complete this work.

V. PAYMENT. See Section 606 and the following:

A. Latex Modified Concrete for Overlay. Per the terms of the contract.

B. Latex Modified Concrete for Partial Depth Patching and variable thickness of Overlay. Per the terms of the contract.

C. Remove Existing Overlay. Per the terms of the contract.

D. Steel Reinforcement. Per the terms of the contract.

E. Asphalt/Concrete Approach Pavement. Per the terms of the contract

SPECIAL NOTE FOR CONCRETE COATING

I. DESCRIPTION

Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highways 2019 Standard Specifications for Road and Bridge Construction and applicable Supplemental Specifications, the Standard Drawings, this Note, and the Contract Documents. Section references are to the Standard Specifications.

This work consists of the following:

1. Furnish all labor, materials, tools, equipment, and incidental items necessary to complete the work.
2. Provide safe access to the bridge, in accordance with Section 107.01.01, for the Engineer to sound possible repair areas and for workers to complete the construction.
3. Repair cracks as applicable in accordance with the Special Note for Epoxy Injection Crack Repair.
4. Repair delaminated or spalled areas as applicable in accordance with the Special Note for Concrete Patching.
5. Apply Ordinary Surface Finish
6. Prepare the surfaces to receive coating.
7. Apply concrete coating.
8. Any other work as specified as part of this contract.

II. MATERIALS

One of the following coating systems shall be used:

Manufacturer	***Prime Coat***	***Finish Coat***
Sherwin Williams	Macropoxy 646	Acrolon 218 HS
PPG	Amerlock 2	Devoe Devflex HP
Carboline	Carboguard 890	Carbothane 133 HB
Tnemec	Elastogrip 151	Envirocrete 156

The coating shall be tinted and the color shall closely match the existing concrete. The finish product shall be opaque and satin or semi-gloss. The contractor must apply sufficient coats as required to achieve this goal.

Furnish to the Engineer copies of the manufacturer's technical data sheets, installation guidelines, material safety data sheets, and other pertinent data at least two (2) days prior to beginning the work.

III. CONSTRUCTION

A. Perform Concrete Repairs. Repair concrete surface in accordance with the Special Note for Epoxy Injection Crack Repair and/or the Special Note for Concrete Patching

as applicable.

B. Apply Ordinary Surface Finish. Areas receiving epoxy injection, concrete patching, and other surface imperfections, including areas of minor cracking, should receive Ordinary Surface Finish in accordance with Section 601.03.18 of the Standard Specifications. Use mortar of the same cement and fine aggregate as the concrete patching, or as directed by the Engineer. Payment will be incidental to Concrete Sealing.

C. Areas to Receive Concrete Coating:

a. All exposed concrete on abutments and wingwalls to a distance of 6" below final ground elevation.
b. All exposed concrete on piers, including pier caps, and to a distance of 6" below final ground elevation on columns.
c. The inside and outside face of barrier walls to include the top and ends. Coat the outside face to the deck drip notch.

D. Prepare Concrete Surfaces for Repair. All areas specified shall be pressure washed. All equipment for pressure washing shall be operated at a minimum pressure of up 4,000 psi with 0 degree spinner tip and/or fan tips as determined by the engineer at the working location with a minimum flow rate of 3.5 gal/minute provided that these pressures do not damage any components of the structure. Pressure and flow rates shall be reduced to a level satisfactory to the Engineer should any damage occur due to power washing procedures. Pressure washing shall be operated at distance of approximately six inches from and perpendicular to the surface. All pressure washing wands shall be equipped with a gauge to accurately determine the amount pressure used. Pressure washing of any bridge element will proceed from top of wash area to bottom of wash area. Wash water will not be released to a bridge element previously washed. Preform all pressure washing at temperatures above 40 degrees Fahrenheit.

E. Apply Concrete Coating. All areas specified shall have concrete coating applied to as specified after debris removal and power washing. New concrete shall be allowed to properly cure in accordance with the manufacturer's recommendations prior to application. Use compressed air to remove any loose debris from the surfaces that are to be coated after power washing. All coatings shall be applied within manufacturers recommended dry film thickness range. Comply with KYTC "Standard Specifications for Road and Bridge Construction" Section 614.03.02 and coatings supplier recommended conditions for application. Allow the surfaces to be coated to dry before any coating is applied. The coating must be applied to a clean and dry surface. All coating application shall be executed using brushes, rollers, etc. No spray application will be permitted.

The Department requires acceptance testing of samples obtained on a per-lot basis per-shipment. The Division of Materials shall perform acceptance testing. Test samples shall be taken at the Contractor's paint storage site. Department personnel

shall perform sampling. Allow (10) working days for testing and approval of the sampled paint. It is the Contractor's responsibility to maintain an adequate inventory of approved paint. The Department shall assume no responsibility for lost work due to rejection of paint or approved paint subsequently found to be defective during the application process. Preform all concrete coating application at temperatures above 40 degrees Fahrenheit or in accordance with manufactures specifications.

IV. MEASUREMENT

The Department will measure the quantity as lump sum. The Department will not measure preparation of the site for the Engineer's access or removal and reapplication of coatings that do not satisfy the Engineer's approval for payment and will consider them incidental to "Concrete Sealing".

V. PAYMENT.

The Department will make payment per the terms of the contract.

SPECIAL NOTE FOR ELIMINATING TRANSVERSE JOINTS ON BRIDGES

I. DESCRIPTION

Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highway's current Standard Specifications for Road and Bridge Construction and applicable Supplemental Specifications, the Standard Drawings, this Note, and the attached detail drawings. Section references are to the Standard Specifications.

This work consists of the following:

(1) Furnish all labor, materials, tools, and equipment.
(2) Remove existing concrete to eliminate the transverse joint.
(3) Install additional steel reinforcement and new concrete as specified and in accordance with the attached detail drawings.
(4) Maintain and control traffic.
(5) Any other work specified as part of this contract.

II. MATERIALS

A. Class "AA" Concrete. See Section 601.
B. Steel Reinforcement. Use Grade 60. See Section 602.
C. Epoxy Bond Coat. See Section 511 and 826.
D. 12" wide Mastic Tape
E. Galvanized Sheet Metal
F. Structural Steel.

III. CONSTRUCTION

A. Remove Existing Materials. Remove the existing transverse joints, joint filler, and specified areas of concrete as shown on the attached detail drawings, Kentucky Structural Design Guidance Manual Exhibit 616, or at a minimum of 24" of deck. Dispose of all removed material entirely away from the job site. Do not disturb the tops of the beams. This work is incidental to the contract unit price for "Eliminate Transverse Joint".

Clean and leave all existing steel reinforcement encountered in place. Damaged steel reinforcement will be repaired/replaced as directed by the Engineer at no additional cost to the Department.

B. Place New Concrete. After all specified existing materials have been removed, place new Class "AA" Concrete to the scarified grade and finish to receive the new overlay as shown on the detail drawings.

Blast clean and roughen all areas of existing concrete and structural steel to come in contact with new concrete until free of all laitance and deleterious substances immediately prior to the placement of the Class "AA" Concrete. The surface areas of

existing concrete to come in contact with the new Class "AA" Concrete are to be coated with an epoxy bond coat immediately prior to placing new concrete in accordance with Section 511. The interfaces of the new and old concrete shall be as nearly vertical and horizontal as possible.

C. Additional Steel Reinforcement. Furnish steel reinforcing bars for this work, as directed by the attached detail drawings. Splice these bars to the existing reinforcement in the deck in the areas of removed concrete to tie the slabs together as shown on the attached detail drawings. Ensure that all exposed steel reinforcement is tied in accordance with Section 602.03.04 prior to pouring the new Class “AA” concrete.

D. Approach Slab. If called for, provide an approach slab at the ends of the bridge. Approach slab shall conform to Standard Drawing BGX-017-03

E. Armored Edge. Provide armored edge as shown in the attached drawing, as shown in KYTC Structure Design Guidance Manual Exhibit 616, or as detailed by the designer. Armored Edge shall meet the requirements of KYTC Standard Drawing BJE-001-14

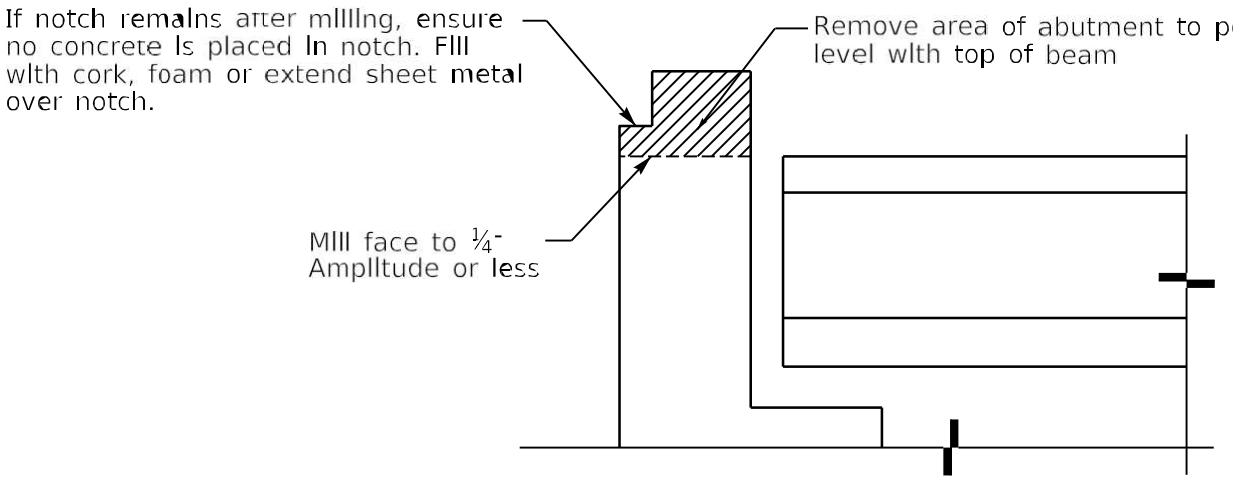
IV. MEASUREMENT

A. Eliminate Transverse Joint. The Department will measure the quantity in linear feet along the centerline of the joint.
B. Steel Reinforcement. See Section 602.

V. PAYMENT

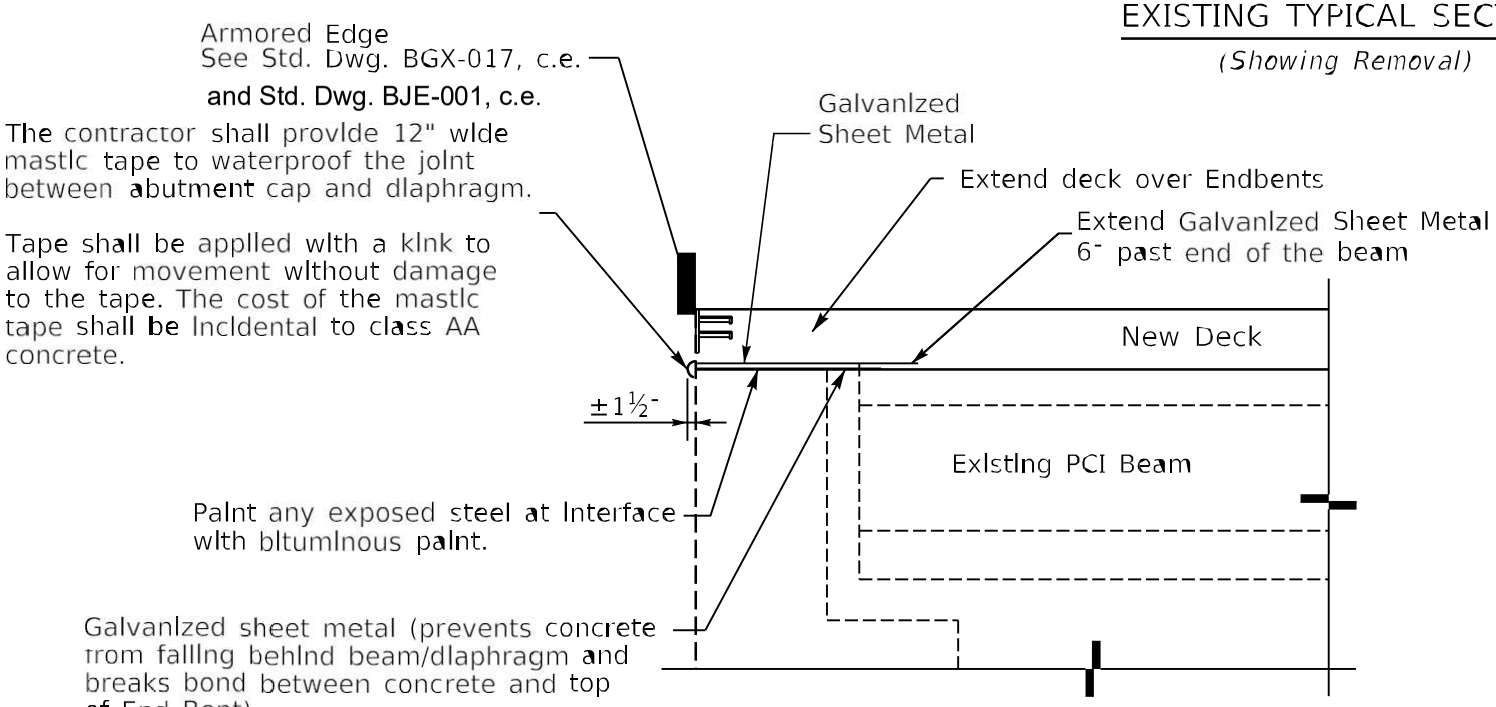
Payment will be per the terms of the contract.

Note:
Ensure that gap between diaphragm and back wall is free of any debris.



EXISTING TYPICAL SECTION

(Showing Removal)



PROPOSED TYPICAL SECTION

(Showing Proposed)

JOINT ELIMINATION AT ENDS OF BRIDGE

SPECIAL NOTE FOR EPOXY INJECTION CRACK REPAIR

I. DESCRIPTION

Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highways current Standard Specifications for Road and Bridge Construction and applicable Supplemental Specifications, the Standard Drawings, this Note, and the Contract Documents. Section references are to the Standard Specifications.

This work consists of the following:

1. Furnish all labor, materials, tools, equipment, and incidental items necessary to complete the work.
2. Provide safe access to the bridge, in accordance with Section 107.01.01, for the Engineer to sound possible repair areas and for workers to complete the construction.
3. Drill injection port holes.
4. Epoxy injection.
5. Finish the repaired surface.
6. Obtain core samples for the Engineer's visual inspection.
7. Repair core holes.
8. Any other work specified as part of this contract.

II. MATERIALS, EQUIPMENT, PERSONNEL

A. Type IV Epoxy Resin. Use either Category I or II suitable for epoxy injection applications. See Section 826. All cracks shall be injected using an adhesive suitable for the field conditions (crack width, temperature, humidity, etc.) recommended by the adhesive manufacture as shown on material data sheets.

B. Equipment. Equipment used to inject the epoxy shall meet the recommendations of the epoxy injection material manufacturer.

C. Personnel. Arrange to have a manufacturer's representative at the job site to familiarize him and the Engineer with the epoxy materials, application procedures and recommended pressure practice. The representative shall direct at least one complete crack or area injection and be assured prior to his departure from the project that the personnel are adequately informed to satisfactorily perform the remaining repairs.

Furnish the Engineer a copy of the manufacturer's comprehensive preparation, mixing, and application instructions which have been developed especially for use with the proposed epoxy injection system. Ensure that any significant changes to these instructions which are recommended by the representative for an unanticipated situation have been approved by the Engineer prior to the adoption of such changes.

III. CONSTRUCTION

A. Investigate Remedial Action. If the crack is larger than or equal to 0.025" wide or has rust stains, repair the crack by epoxy injection. If the crack is less than 0.025" wide, the crack shall be sealed in accordance with the Special Note for Concrete Sealing. Areas of map cracking are to be sounded by the Engineer with a hammer. If the areas are delaminated or spalled, they shall be repaired in accordance with the Special Note for Concrete Patching. Otherwise, the cracks shall be repaired in accordance with this Note.

B. Drill Injection Port Holes. Install injection ports or tees in cracks to be injected. Space injection ports or tees at 6 to 12 inches vertically and 6 to 18 inches horizontally but in no case closer together than the thickness of the concrete member if full depth penetration is desired unless otherwise specified or directed. Set ports or tees in dust free holes made either with vacuum drills or chipping hammers.

C. Epoxy Injection. Seal all surface cracks in the area to be repaired, after injection ports or tees have been inserted into the holes, with paste epoxy between ports to insure retention of the pressure injection within the confines of the member. An alternate procedure of sealing the cracks before the injection holes have been made can be submitted to the Engineer for approval. Limit the application of paste epoxy to clean and dry surfaces. Limit substrate temperatures to not less than 45°F during epoxy applications.

Begin the epoxy injection at the bottom of the fractured area and progress upward using a port or tee filling sequence that will ensure the filling of the lowermost injection ports or tees first.

Establish injection procedures and the depths and spacings of holes at injection ports or tees. Use epoxy with flow characteristics and injection pressure that ensure no further damage will be done to the member being repaired. Ensure that the epoxy will first fill the innermost portion of the cracked concrete and that the potential for creating voids within the crack or epoxy will be minimized.

D. Finish the Repaired Surface. Remove the injection ports or tees flush with the concrete surface after the fractured area has been filled and the epoxy has partially cured (24 hours at ambient temperature not less than 60°F, otherwise not less than 48 hours). Roughen the surfaces of the repaired areas to achieve uniform surface texture. Remove any injection epoxy runs or spills from concrete surfaces.

E. Obtain Core Samples. Obtain two 4-inch diameter core samples in the first 25 linear feet of crack repaired and one core for each 25 linear feet thereafter. Take the core samples from locations determined by the Engineer and for the full crack depth. Cores will be visibly examined by the Engineer to determine the extent of epoxy penetration.

F. Repair Core Holes. Repair core holes in the concrete with non-shrink grout in accordance with Section 601.03.03(B) within 24 hours.

IV. MEASUREMENT

The Department will measure the quantity in linear feet along the centerline of the cracks. The Department will not measure preparation of the site for the Engineer's access or removal and reapplication of repairs that do not satisfy the Engineer's approval for payment and will consider them incidental to "Epoxy Injection Crack Repair".

V. PAYMENT.

The Department will make payment per the terms of the contract.

SPECIAL NOTE FOR BRIDGE JOINT SEAL REPLACEMENT

I. **DESCRIPTION.** Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highway's 2019 Standard Specifications for Road and Bridge Construction and applicable Supplemental Specifications, the Standard Drawings, this Note, and drawings produced by the Design Build Team. Section references are to the Standard Specifications.

This work consists of the following: (1) Furnish all labor, materials, tools, and equipment; (2) Remove existing bridge joint seals; (3) Install new joint seals; (4) Maintain and control traffic; (5) Any other work specified as part of this contract.

All construction will be in accordance with Section 606 unless otherwise specified.

II. MATERIALS.

A. Joint Seal. It shall have a cellular, or micro-cell, polyurethane foam impregnated with a hydrophobic acrylic emulsion, or a hydrophobic polymer. The polyurethane foam external facing shall be factory coated and cured with highway- grade, fuel resistant silicone or a highway-grade elastomeric coating at a width greater than the maximum joint expansion.

B. Preformed Neoprene Strip Seal. See attached detail drawings and Section 807.

III. CONSTRUCTION.

A. Remove Existing Materials. Remove existing Expansion Dam and remove debris and/or expansion joint filler as directed by the Engineer. Clean and leave all existing steel reinforcement encountered in place. Damaged steel reinforcement will be repaired/replaced as directed by the Engineer at no additional cost to the Department. Dispose of all removed material entirely away from the job site. This work is incidental to the contract unit price for "Joint Seal Replacement".

B. Joint Seal. Seal shall be installed in accordance with manufacturer's recommendations concerning approved adhesives, welds between sticks and appurtenances, and adhesion to concrete deck or armored edges. Joint seal is to be installed ½" recessed from the surface.

C. Preformed Neoprene Strip Seal. Place the preformed joint seal in one continuous, unbroken length. Place neoprene strip seal as recommended by the manufacturer and in accordance with Section 609.03.04

D. Shop Plans. Shop plans will not be required. The Contractor is responsible for obtaining field measurements and supplying properly sized materials to complete the work.

IV. MEASUREMENT.

A. Joint Seal Replacement – 2"-, 4". The Department will measure the quantity in linear feet from gutterline to gutterline along the centerline of the joint.

V. PAYMENT. See Section 606 and the following:

A. Joint Seal Replacement. Payment will be per the terms of the contract.

SPECIAL NOTE FOR NON-EPOXY ADHESIVES

This Special Note will apply where indicated on the plans or in the RFP. Section references herein are to the Department's 2019 Standard Specifications for Road and Bridge Construction.

1.0 DESCRIPTION. As an alternate to Type IV epoxy, as specified in Subsection 826.01.02, the Department may allow other structural adhesives for doweling deformed reinforcing bars into hardened concrete providing the requirements herein are met.

2.0 MATERIALS. Furnish an adhesive material from the Department's List of Approved Materials. Submit one cartridge of each component per project to the Engineer for infrared analysis.

3.0 CONSTRUCTION. Do not use the material until the Engineer verifies, by visual inspection, that the material is from the List of Approved Materials.

3.1 Field Installation. Follow the following installation criteria:

1) Drill a dowel hole that is no more than 1/8 inch larger in diameter than the bar.
2) Ensure the dowel hole is dry and free of all drill and coring dust.
3) Place the adhesive in the dowel hole according to the manufacturer's instructions.
4) Insert the bar to the bottom of the hole and twist 1/4 turn. An excess amount of adhesive must be clearly visible as an extruded ring of material surrounding the reinforcing bar at the surface of the concrete.

3.2 Job Site Testing. Contact the Division of Materials in advance of the installation date to set up a testing schedule. After installation of the first 50 reinforcing bars, the Department will randomly select 5 and proof load according to the following table with zero slippage.

REBAR SIZE (#)	10	13	16	19	22
PROOF LOAD	7,000	12,000	19,000	27,000	36,000

If any of the bars fail in bond, either revise the installation procedure, if applicable, or provide another adhesive that is capable of passing this test. The Engineer may require additional job site testing.

4.0 MEASUREMENT AND PAYMENT. The Department will pay according to the terms of the contract.

SPECIAL NOTE FOR PARTIAL DEPTH CONCRETE DECK PATCHING

I. DESCRIPTION. Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highway's 2019 Standard Specifications for Road and Bridge Construction and applicable Supplemental Specifications, the Standard Drawings, this Note, and the attached detail drawings. Section references are to the Standard Specifications.

This work consists of the following: (1) Furnish all labor, materials, tools, and equipment; (2) Complete partial depth repairs as directed by the Engineer; (3) Place new concrete in accordance with Section 606; (4) Maintain and control traffic; and (5) Any other work specified as part of this contract.

All construction will be in accordance with Section 606 unless otherwise specified.

II. MATERIALS.

A. Class "M" Concrete. Use either "M1" or "M2". See Section 601.

III. CONSTRUCTION.

A. Partial Depth Slab Repair. Remove areas determined to be unsound by the Engineer via hydrodemolition or via hand held jackhammers weighing less than 45lbs in accordance with Section 606.02.10 D.

IV. MEASUREMENT. See Section 606 and the following:

A. Partial Depth Patching. The Department will measure the quantity in cubic feet by the total volume (as indicated by the batch quantity tickets) of Concrete required to obtain the finished grade shown on the Plans or established by the Engineer.

V. PAYMENT. See Section 606 and the following:

A. Partial Depth Patching. The Department will make payment under the terms of the contract.

SPECIAL NOTE FOR REPLACING EXPANSION DAMS AND/OR INSTALLING ARMORED EDGES FOR CONCRETE ON BRIDGES

I. DESCRIPTION. Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highway's 2019 Standard Specifications for Road and Bridge Construction and applicable Supplemental Specifications, the Standard Drawings, this Note, and the any detailed drawings of the Design Build Team. Section references are to the Standard Specifications.

This work consists of the following: (1) Furnish all labor, materials, tools, and equipment; (2) Remove existing concrete and expansion device(s) and/or bridge ends; (3) Install armored edges and new concrete as specified and in accordance with the attached detail drawings; (4) Install new joint seals (where required); (5) Maintain and control traffic; and (6) Any other work specified as part of this contract.

II. MATERIALS.

A. Class "AA" Concrete. See Section 601.

B. Structural Steel. Use new, commercial grade steel suitable for welding. The Engineer will base acceptance on visual inspection.

C. Stud Anchors. The armored edge stud anchors are ¾" x 6" embedded stud shear connectors conforming to ASTM A108, Grade 1015 (Nelson Studs or equal).

D. Steel Reinforcement. Use Grade 60. See Section 602.

E. Epoxy Bond Coat. See Section 511.

III. EQUIPMENT.

A. Hammers. See Section 606.02.10 B.

B. Sawing Equipment. See Section 606.02.10 C.

C. Hydraulic Impact Equipment. See Section 606.02.10 D.

IV. CONSTRUCTION.

A. Remove Existing Materials. Remove existing Expansion Dam, Bridge End, Armored Edges and specified areas of concrete as shown on the attached sketches, and KYTC Structures Design Guidance Manual Exhibit 616, as applicable. Remove debris and/or expansion joint filler as directed by the Engineer. Clean and leave all existing steel reinforcement encountered in place. Damaged steel reinforcement will be repaired/replaced as directed by the Engineer at no additional cost to the Department.

Dispose of all removed material entirely away from the job site. This work is incidental to the contract unit price for "Expansion Joint Replacement" or "Armored Edge for Concrete".

B. Place New Concrete and Armored Edges. After all specified existing materials have been removed; place new armored edges to match the grade of the proposed overlay or to match the original grade (See attached detail drawings). Place the new Class "AA" concrete to the scarified grade and finish to receive the new overlay or place the new Class "AA" concrete to the original grade and finish with broom strokes drawn transversely from curb to curb.

All new structural steel shall be cleaned and painted in accordance with requirements of Section 607.03.23, except that surfaces to come in contact with concrete are not to be painted.

Blast clean all areas of existing concrete and structural steel to come in contact with new concrete until free of all laitance and deleterious substances immediately prior to the placement of the Class "AA" Concrete. The surface areas of existing concrete to come in contact with the new Class "AA" Concrete are to be coated with an epoxy bond coat immediately prior to placing new concrete in accordance with Section 511. The interfaces of the new and old concrete shall be as nearly vertical and horizontal as possible.

C. Additional Steel Reinforcement. Furnish for replacement #4 steel reinforcing bars in 20' lengths. Place these bars in areas deemed by the Engineer to require additional reinforcement. Field cutting and bending is permitted. Do not place any additional steel reinforcement above the height of the top row of Nelson Studs on the armored edges. Ensure that all exposed steel reinforcement is tied in accordance with Section 602.03.04 prior to pouring the new Class "AA" concrete.

D. Stage Construction. Installation of concrete and armored edges in two (or more if specified) stages is necessary. Join the armored edges at or near the centerline of the roadway or lane line, field weld and grind smooth.

E. Shop Plans. Shop plans will <u>not</u> be required. The Contractor is responsible for obtaining field measurements and supplying properly sized materials to complete the work.

V. MEASUREMENT.

A. Armored Edge for Concrete. The Department will measure the quantity in linear feet from gutterline to gutterline along the face of the bridge end.

B. Steel Reinforcement. See Section 602.

VI. PAYMENT.

A. Armored Edge for Concrete Payment will be under the terms of this Contract.

B. Steel Reinforcement. Payment will be under the terms of this contract.

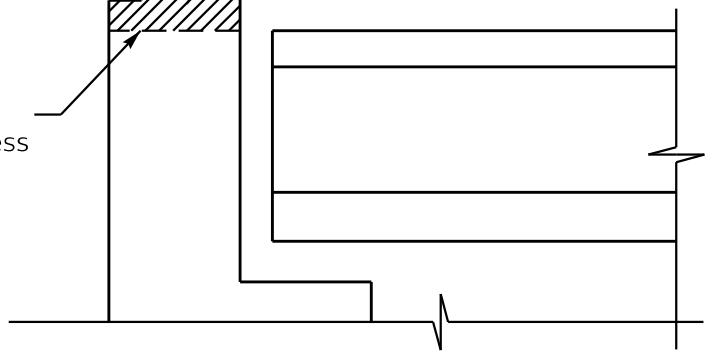
SPECIAL NOTE FOR REPLACING EXPANSION DAMS AND/OR INSTALLING ARMORED EDGES FOR CONCRETE ON BRIDGES

Note:
Ensure that gap between diaphragm and back wall is free of any debris.

If notch remains after milling, ensure no concrete is placed in notch. Fill with cork, foam or extend sheet metal over notch.

Remove area of abutment to point level with top of beam

Mill face to ¼" Amplitude or less



EXISTING TYPICAL SECTION

(Showing Removal)

Armored Edge
See Std. Dwg. BGX-017, c.e.
and Std. Dgn. BJE-001,c.e.

Galvanized Sheet Metal

The contractor shall provide 12" wide mastic tape to waterproof the joint between abutment cap and diaphragm.

Extend deck over Endbents

Extend Galvanized Sheet Metal 6" past end of the beam

Tape shall be applied with a kink to allow for movement without damage to the tape. The cost of the mastic tape shall be incidental to class AA concrete.

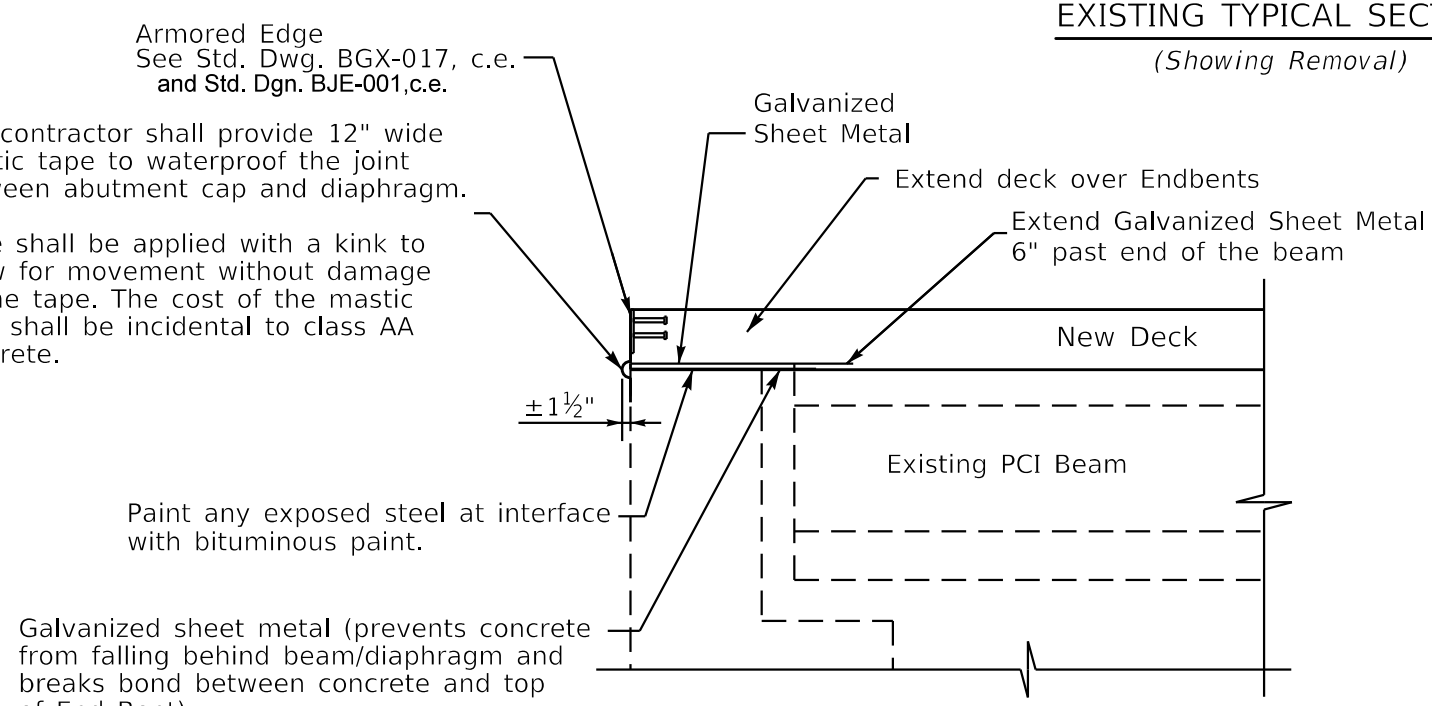
New Deck

±1½"

Existing PCI Beam

Paint any exposed steel at interface with bituminous paint.

Galvanized sheet metal (prevents concrete from falling behind beam/diaphragm and breaks bond between concrete and top of End Bent).



PROPOSED TYPICAL SECTION

(Showing Proposed)

JOINT ELIMINATION AT ENDS OF BRIDGE

SPECIAL PROVISION FOR EMBANKMENT AT BRIDGE END BENT STRUCTURES

This Special Provision will apply when indicated on the plans or in the proposal. Section references herein are to the Department's Standard Specifications for Road and Bridge Construction, Current Edition.

1.0 DESCRIPTION. Construct a soil, granular, or rock embankment with soil, granular or cohesive pile core and place structure granular backfill, as the Plans require. Construct the embankment according to the requirements of this Special Provision, the Plans, Standard Drawing RGX 100 and 105, and the Standard Specifications, Current Edition.

2.0 MATERIALS.

2.1 Granular Embankment. Conform to Subsection 805.10. When Granular Embankment materials are erodible or unstable according to Subsection 805.03.04, use the Special Construction Methods found in 3.2 of the Special Provision.

2.2 Rock Embankment. Provide durable rock from roadway excavation that consists principally of Unweathered Limestone, Durable Shale (SDI equal to or greater than 95 according to KM 64-513), or Durable Sandstone.

2.3 Pile Core. Provide a pile core in the area of the embankments where deep foundations are to be installed unless otherwise specified. The Pile Core is the zone indicated on Standard Drawings RGX 100 and 105 designated as Pile Core. Material control of the pile core area during embankment construction is always required. Proper Pile Core construction is required for installation of foundation elements such as drilled or driven piles or drilled shafts. The type of material used to construct the pile core is as directed in the plans or below. Typically, the pile core area will be constructed from the same material used to construct the surrounding embankment. Pile Core can be classified as one of three types:

A) Pile Core - Conform to Section 206 of the Standard Specifications. Provide pile core material consisting of the same material as the adjacent embankment except the material in the pile core area shall be free of boulders or particle sizes larger than 4 inches in any dimension or any other obstructions that may hinder pile driving operations. If the pile core material hinders pile driving operations, take the appropriate means necessary to reach the required pile tip elevation, at no expense to the Department.

B) Granular Pile Core. Granular pile core is required only when specified in the plans. Select a gradation of durable rock to facilitate pile driving that conforms to Subsection 805.11. If granular pile core material hinders pile driving operations, take appropriate means necessary to reach the required pile tip elevation, at no expense to the Department.

C) Cohesive Pile Core. Cohesive Pile Core is required only when specified in the plans. Conform to Section 206 of the Standard Specifications and use soil with at least 50 percent passing a No. 4 sieve having a minimum Plasticity Index (PI) of 10. In addition, keep the cohesive pile core free of boulders, larger than 4 inches in any dimension, or any other obstructions, which would interfere with drilling operations. If cohesive pile core

material interferes with drilling operations, take appropriate means necessary to maintain excavation stability, at no expense to the Department.

2.4 Structure Granular Backfill. Conform to Subsection 805.11

2.5 Geotextile Fabric. Conform to Type I or Type IV in Section 214 and 843.

3.0 CONSTRUCTION.

3.1 General. Construct roadway embankments at end bents according to Section 206 and in accordance with the Special Provision, the Plans, and Standard Drawings for the full embankment section. In some instances, granular or rock embankment will be required for embankment construction for stability purposes, but this special provision does not prevent the use of soil when appropriate. Refer to the DBT's plans for specific details regarding material requirements for embankment construction.

Place and compact the pile core and structure granular backfill according to the applicable density requirements for the project. If the embankment and pile core are dissimilar materials (i.e., a granular pile core is used with a soil embankment or a cohesive pile core is used with a granular embankment), a Geotextile Fabric, Type IV, will be required between the pile core and embankment in accordance with Sections 214 and 843 of the Standard Specifications.

When granular or rock embankment is required for embankment construction, conform to the general requirements of Subsection 206.03.02 B. In addition, place the material in no greater than 2-foot loose lifts and compact with a vibrating smooth wheel roller capable of producing a minimum centrifugal force of 15 tons. Apply these requirements to the full width of the embankment for a distance of half the embankment height or 50 feet, whichever is greater, as shown on Standard Drawing RGX-105.

When using granular pile core, install 8-inch perforated underdrain pipe at or near the elevation of the original ground in the approximate locations depicted on the standard drawing, and as the Engineer directs, to ensure positive drainage of the embankment. Wrap the perforated pipe with a fabric of a type recommended by the pipe manufacturer.

After constructing the embankment, excavate for the end bent cap, drive piling, install shafts or other foundation elements, place the mortar bed, construct the end bent, and complete the embankment to finish grade according to the construction sequence shown on the Plans or Standard Drawings and as specified hereinafter.

Certain projects may require widening of existing embankments and the removal of substructures. Construct embankment according to the plans. Substructure removal shall be completed according to the plans and Section 203. Excavation may be required at the existing embankment in order to place the structure granular backfill as shown in the Standard Drawings.

After piles are driven or shafts installed (see design drawings), slope the bottom of the excavation towards the ends of the trench as noted on the plans for drainage. Using a separate pour, place concrete mortar, or any class concrete, to provide a base for forming and placing the cap. Place side forms for the end bent after the mortar has set sufficiently to support workmen and forms without being disturbed.

Install 4-inch perforated pipe in accordance with the plans and Standard Drawings. In the event slope protection extends above the elevation of the perforated pipe, extend the pipe through the slope protection.

After placing the end bent cap and achieving required concrete cylinder strengths, remove adjacent forms and fill the excavation with compacted structure granular backfill material (maximum 1' loose lifts) to the level of the berm prior to placing beams for the

bridge. Place Type IV geotextile fabric between embankment material and structure granular backfill. After completing the end bent backwall, or after completing the span end wall, place the compacted structure granular backfill (maximum 1' loose lifts) to subgrade elevation. If the original excavation is enlarged, fill the entire volume with compacted structure granular backfill (maximum 1' loose lifts) at no expense to the Department. Do not place backfill before removing adjacent form work. Place structure granular backfill material in trench ditches at the ends of the excavation. Place Geotextile Fabric, Type IV over the surface of the compacted structure granular backfill prior to placing aggregate base course.

Tamp the backfill with hand tampers, pneumatic tampers, or other means approved by the Engineer. Thoroughly compact the backfill under the overhanging portions of the structure to ensure that the backfill is in intimate contact with the sides of the structure.

Do not apply seeding, sodding, or other vegetation to the exposed granular embankment.

3.2 Special Construction Methods. Erodible or unstable materials may erode even when protected by riprap or channel lining; use the special construction method described below when using these materials.

Use fine aggregates or friable sandstone granular embankment at "dry land" structures only. Do not use them at stream crossings or locations subject to flood waters.

For erodible or unstable materials having 50 percent or more passing the No. 4 sieve, protect with geotextile fabric. Extend the fabric from the original ground to the top of slope over the entire area of the embankment slopes on each side of, and in front of, the end bent. Cover the fabric with at least 12 inches of non-erodible material.

For erodible or unstable materials having less than 50 percent passing a No. 4 sieve, cover with at least 12 inches of non-erodible material.

Where erodible or unstable granular embankment will be protected by riprap or channel lining, place Type IV geotextile fabric between the embankment and the specified slope protection.

4.0 MEASUREMENT.

4.1 Granular Embankment. The Department will measure the quantity in cubic yards using the plan quantity, increased or decreased by authorized adjustments as specified in Section 204. The Department will not measure for payment any Granular Embankment that is not called for in the plans.

The Department will not measure for payment any special construction caused by using erodible or unstable materials and will consider it incidental to the Granular Embankment regardless of whether the erodible or unstable material was specified or permitted.

4.2 Rock Embankment. The Department will not measure for payment any rock embankment and will consider it incidental to roadway excavation or embankment in place, as applicable. Rock embankments will be constructed using granular embankment on projects where there is no available rock present within the excavation limits of the project.

4.3 Pile Core. Pile core will be measured and paid under roadway excavation or embankment in place, as applicable. The Department will not measure the pile core for separate payment. The Department will not measure for payment the 8-inch perforated underdrain pipe and will consider it incidental to the Pile Core.

4.4 Structure Granular Backfill. The Department will measure the quantity in cubic

yards using the plan quantity, increased or decreased by authorized adjustments as specified in Section 204. The Department will not measure any additional material required for backfill outside the limits shown on the Plans and Standard Drawings for payment and will consider it incidental to the work.

The Department will not measure for payment the 4-inch perforated underdrain pipe and will consider it incidental to the Structure Granular Backfill.

4.5 Geotextile Fabric. The Department will not measure the quantity of fabric used for separating dissimilar materials when constructing the embankment and pile core and will consider it incidental to embankment construction.

The Department will not measure for payment the Geotextile Fabric used to separate the Structure Granular Backfill from the embankment and aggregate base course and will consider it incidental to Structure Granular Backfill.

The Department will not measure for payment the Geotextile Fabric required for construction with erodible or unstable materials and will consider it incidental to embankment construction.

4.6 End Bent. The Department will measure the quantities according to the Contract. The Department will not measure furnishing and placing the 2-inch mortar or concrete bed for payment and will consider it incidental to the end bent construction.

4.7 Structure Excavation. The Department will not measure structure excavation on new embankments for payment and will consider it incidental to the Structure Granular Backfill or Concrete as applicable.

5.0 PAYMENT. The Department will make payment for the completed and accepted quantities under the terms of this contract.

SPECIAL NOTE FOR DRILLED SHAFTS

1.0 DESCRIPTION. Furnish all equipment, materials and labor necessary for constructing reinforced concrete drilled shafts in cylindrically excavated holes according to the details shown on the plans or as the Engineer directs. Construct the shaft to the lines and dimensions shown on the plans, or as the Engineer directs. Section references herein are to the Department's 2019 Standard Specifications for Road and Bridge Construction.

2.0 MATERIALS.

2.1 Concrete. Use Class A Modified concrete unless otherwise shown on the plans. The slump at the time of placement shall be 6.5 to 9.5 inches, the coarse aggregate shall be size 67, 68, 78, 8 or 9M, and the water/cementitious material ratio shall not exceed 0.45. Include water reducing and retarding admixtures. Type F high range water reducers used in combination with retarding admixtures or Type G high range water reducers fully meeting trial batch requirements are permitted and Class F fly ash is permitted in conformance with Section 601. Design the mix such that the concrete slump exceeds 4 inches at 4 hours after batching. If the estimated concrete transport, plus time to complete placement, exceeds 4 hours, design the concrete to have a slump that exceeds 4 inches or more for the greater time after batching and demonstrate that the slump requirement can be achieved after the extended time period using a trial batch.

2.2 Steel Reinforcement. Provide Grade 60 deformed bars conforming to Section 811 of the Standard Specifications. Rail steel is permitted for straight bars only. Place according to Section 602 of the Standard Specifications, this Special Note, and the plans. Use non- corrosive centering devices and feet to maintain the specified reinforcement clearances.

2.3 Casings. Provide casing meeting the requirements of ASTM A 252 Grade 2 or better unless otherwise specified. Ensure casing is smooth, clean, watertight, true and straight, and of ample strength to withstand handling, installation, and extraction stresses and the pressure of both concrete and the surrounding earth materials. Ensure the outside diameter of casing is not less than the specified diameter of shaft.

Use only continuous casings. Cut off the casing at the prescribed elevation and trim to within tolerances prior to acceptance. Extend casing into bedrock a sufficient distance to stabilize the shaft excavation against collapse, excessive deformation, and/or flow of water if required and/or shown on the plans.

Install from the work platform continuous casing meeting the design thickness requirements, but not less than 3/8 inch, to the elevations shown on the plans. When drilled shafts are located in open water areas, extend casings above the water elevation to the plan tip elevation to protect the shaft concrete from water action during concrete placement and curing. All casing is permanent unless temporary casing is specified in the contract drawings or documents. Permanent casing is incidental to the applicable drilled shaft unit bid price unless noted otherwise in the contract. Temporary casing may be required for drilled shafts not socketed into bedrock. If temporary surface casings are used, extend each casing up to the work platform. Remove all temporary surface casing prior to final acceptance unless otherwise permitted by the Central Office Construction Engineer.

Ensure casing splices have full penetration butt welds conforming to the current edition of AWS D1.1 with no exterior or interior splice plates and produce true and straight casing.

2.4 Slurry. When slurry is to be used for installation of the Drilled Shaft, submit a detailed plan for its use and disposal. The plan should include, but not be limited to the following:

1) Material properties
2) Mixing requirements and procedures
3) Testing requirements

4) Placement procedures
5) Disposal techniques

Obtain the Central Office Division of Construction's approval for the slurry use and disposal plan before installing drilled shafts.

2.5 Tremies. Provide tremies of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. Ensure the tremie diameter is least 6 times the maximum size coarse aggregate to be used in the concrete mix and no less than 10 inches. Provide adequate wall thickness to prevent crimping or sharp bends that restrict concrete placement. Support tremies used for depositing concrete in a dry drilled shaft excavation so that the free fall of the concrete does not cause the shaft excavation to cave or slough. Maintain a clean and smooth tremie surface to permit both flow of concrete and unimpeded withdrawal during concrete placement. Do not allow any aluminum parts to contact the concrete. Construct tremies used to deposit concrete for wet excavations so that they are watertight and will readily discharge concrete.

2.6 Concrete Pumps. Provide pump lines with a minimum diameter of 5 inches and watertight joints.

2.7 Drop Chutes. Do not use aluminum drop chutes.

3.0 CONSTRUCTION.

3.1 Preconstruction.

3.1.1 Prequalification. The Department will require prequalification by the Division of Construction Procurement before accepting a bid for the construction of Drilled Shafts.

3.1.2 Drilled Shaft Installation Plan. Upon request, the Department will review a Drilled Shaft Installation Plan. Submit the plan no later than 45 calendar days prior to constructing drilled shafts. Items covered in this plan should include, but not be limited to the following:

1) Name and experience record of jobsite drilled shaft superintendent and foremen in charge of drilled shaft operations for each shift.
2) List and size of proposed equipment including cranes, drills, augers, bailing buckets, final cleaning equipment, de-sanding equipment, slurry pumps, core sampling equipment, tremies or concrete pumps, casings, etc.
3) Details of overall construction operation sequence and the sequence of shaft construction in the bents or groups.
4) Details of shaft excavation methods including methods to over-ream or roughen shaft walls, if necessary.
5) Details of slurry when the use of slurry is anticipated. Include methods to mix, circulate, and de-sand the proposed slurry. Provide details of proposed testing, test methods, sampling methods, and test equipment.
6) Details of proposed methods to clean shaft and inside of casing after initial excavation.
7) Details of reinforcement handling, lifting, and placement including support and method to center in shaft. Also include rebar cage support during concrete placement and temporary casing removal.
8) Details of concrete placement including procedures for concrete tremie or pump. Include initial placement, raising during placement, and overfilling of the shaft to expel contaminated concrete.
9) Required submittals including shop drawings and concrete design mixes.
10) Other information shown in the plans or requested by the Engineer.
11) Special considerations for wet construction.

12) Details of environmental control procedures to protect the environment from discharge of excavation spoil, slurry (natural and mineral), and concrete over-pour.

The Division of Construction will review the submitted procedure and provide comments and recommendations. The Contractor is responsible for satisfactory construction and ultimate performance of the Drilled Shaft.

3.2 General Construction. Construct drilled shafts as indicated in the plans or described in this Special Note by either the dry or wet method. When the plans describe a particular method of construction, use this method unless the Engineer permits otherwise. When the plans do not describe a particular method, propose a method on the basis of its suitability to the site conditions. Approval of this proposed method is contingent upon the satisfactory results of the technique shaft.

The construction of the first drilled shaft or technique shaft will be used to determine if the methods and equipment used by the contractor are sufficient to produce a completed shaft meeting the requirements of the plans and specifications. Ability to control dimensions and alignment of excavations within tolerances; to seal the casing into impervious materials; to prevent caving or deterioration of subsurface materials by the use of slurry or other means; to properly clean the completed shaft excavation; to construct excavations in open water areas when required by the plans; to establish methods for belling or over-reaming when required by the plans; to determine the elevation of ground water; to satisfactorily handle, lift, place, and support the reinforcement cage; to satisfactorily place concrete meeting the specifications within the prescribed time frame; and to satisfactorily execute any other necessary construction operations will be evaluated during construction of the first shaft(s). Revise the methods and equipment as necessary at any time during the construction of the first shaft when unable to satisfactorily carry out any of the necessary operations described above or unable to control the dimensions and alignment of the shaft excavation within tolerances. Accurately locate technique so they may be used in the finished structure unless directed otherwise in the contract document or by the Engineer.

If at any time the Contractor fails to satisfactorily demonstrate, to the satisfaction of the Engineer, the adequacy of methods or equipment and alterations are required, additional technique shafts will be required at no additional cost to the Department and with no extension of contract time. Additional technique shafts shall be located as near as possible to the proposed production shafts but in a location as not to interfere with other construction activities. Once approval has been given to construct production shafts, no changes will be permitted in the methods or equipment used to construct the satisfactory shaft without written approval of the Engineer.

Do not make a claim against the Department for costs of construction delays, or any materials, labor, or equipment that may be necessary due to the Contractor's failure to furnish drilled shafts of a length sufficient to obtain the required bearing values, or for variations in length due to subsurface conditions that may be encountered. Soundings, boring logs, soil profiles, or other subsurface data included in the Contract documents are used by the Department for design and making preliminary estimates of quantities and should be used only at the risk of the Contractor for determining equipment, materials, or labor necessary for drilling shafts as required by the contract.

When necessary, set temporary removable surface casing. Use surface casing of sufficient length to prevent caving of the surface soils and to aid in maintaining shaft position and alignment. Pre-drilling with slurry and/or over-reaming to the outside diameter of the casing may be required to install the surface casing at some sites.

Provide equipment capable of constructing shafts to the deepest shaft depth shown in the plans plus 15 feet, 20 percent greater than the longest shaft (measured from the ground or water surface to the tip of the shaft), or 3 times the shaft diameter, whichever is greater. Blasting excavation methods are not permitted.

Use permanent casing unless otherwise noted in the Contract. Place casing as shown on the plans before beginning excavation. If full penetration cannot be attained, the Engineer may direct that excavation through the casing be accomplished and the casing advanced until reaching the plan tip elevation. In some cases, over-reaming to the outside diameter of the casing may be required before placing the casing. Cut off the casing at the prescribed elevation and leave the remainder of the casing in place. Do not use vibratory hammers for casing installation within 50 feet of shafts that have been completed less than 24 hours.

3.2.1 Dry Construction Method. Use the dry construction method only at sites where the ground water

table and soil conditions (generally stiff to hard clays or rock above the water table) make it feasible to construct the shaft in a relatively dry excavation and where the sides and bottom of the shaft are stable and may be visually inspected by the Engineer prior to placing the concrete. The dry connstruction method consists of drilling the shaft excavation, removing accumulated seepage water and loose material from the excavation, and placing the shaft concrete in a relatively dry excavation.

3.2.2 Wet Construction Method. Use the wet construction method at all sites where it is impractical to excavate by the dry method. The wet construction method consists of drilling the shaft excavation below the water table, keeping the shaft filled with water (including natural slurry formed during the drilling process) or slurry as defined in part 2.4 of this Special Note, desanding and cleaning the slurry as required, final cleaning of the excavation by means of a bailing bucket, air lift, submersible pump or other approved devices and placing the shaft concrete (with a tremie or concrete pump beginning at the shaft bottom) which displaces the water or slurry as concrete is placed.

Where drilled shafts are located in open water areas, construct the shafts by the wet method using casings extending from above water elevation to the plan casing tip elevation to protect the shaft concrete from water action during placement and curing. Install the casing in a manner that will produce a positive seal at the bottom of the casing.

3.3 Slurry. When the Contractor elects to use slurry, adjust construction operations so that the slurry is in contact with the bottom 5 feet of the shaft for less than 4 hours unless the Engineer approves otherwise. If the 4-hour limit is exceeded, over-ream the bottom 5 feet of shaft.

3.4 Cleaning. Over-reaming, cleaning, or wire brushing the sidewalls of the shaft excavation and permanent casings may be necessary to remove the depth of softening or to remove excessive slurry cake buildup as indicated by sidewall samples or other test methods employed by the Engineer. Over-ream around the perimeter of the excavation a minimum depth of 1/2 inch and maximum depth of 3 inches.

3.5 Subsurface Exploration. Take subsurface exploration borings when shown on the plans or as the Engineer directs to determine the character of the material that the shaft extends through and the material directly below the shaft excavation. Complete subsurface exploration borings prior to beginning excavation for any drilled shaft in a group. Unless directed otherwise, extend subsurface exploration borings a minimum depth of 3 shaft diameters but not less than 10 feet below the bottom of the anticipated tip of drilled shaft excavation as shown on the plans. For subsurface exploration borings where soil sampling is required use thin-wall tube samples and perform standard penetration tests according to the Department's current Geotechnical Manual. When shafts extend into bedrock, soil samples are not required unless otherwise specified. Perform rock core drilling according to the Department's Geotechnical Manual. When the Engineer directs, perform additional subsurface exploration borings prior to drilled shaft construction. Measure soil samples and/or rock cores and visually identify and describe them on the subsurface log according to the Department's current Geotechnical Manual. Subsurface exploration borings must be performed by contractors/consultants prequalified by the Department's Division of Professional Services for Geotechnical Drilling Services at the time that field work begins.

The Engineer or geotechnical branch representative may be on-site during the subsurface exploration process to evaluate the soil and/or rock core samples. The Engineer or geotechnical branch representative will determine the need to extend the borings to depths greater than the depths previously specified. Handle, label, identify, and store soil and/or rock samples according to the Department's current Geotechnical Manual and deliver them with

the subsurface logs to the geotechnical branch's rock core lab in Frankfort within 24-hours of completing the borings, unless directed otherwise.

The Engineer will inspect the soil samples and/or cores and determine the final depth of required excavation (final drilled shaft tip elevation) based on evaluation of the material's suitability. The Engineer will establish the final tip elevations for shaft locations, other than those for which subsurface exploration borings have been performed, based on the results of the subsurface exploration. Within 15 calendar days after completion of the subsurface exploration borings, the Engineer will notify the contractor of the final tip elevations for shaft locations.

3.6 Excavations. The plans indicate the expected depths, the top of shaft elevations, and the estimated bottom of shaft elevations between which the drilled shaft are to be constructed. Drilled shafts may be extended deeper when the Engineer determines that the material encountered while drilling the shaft excavation is unsuitable and/or is not the same as anticipated in the design of the drilled shaft. Drilled shafts may be shortened when the Engineer determines the material encountered is better than that anticipated.

Begin drilled shaft excavation the excavation, excavation inspection, reinforcement placement, and concrete placement can be completed as one continuous operation. Do not construct new shafts within 24 hours adjacent to recently completed shafts if the center-to- center spacing is less than 3 shaft diameters.

Dispose of excavated material removed from the shaft according to the Standard Specifications or the contract documents.

Do not allow workmen 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 the workmen entering the excavation. Recommended Procedures for the Entry of Drilled Shaft Foundation Excavations, prepared by ADSC: The International Association of Foundation Drilling provides guideline recommendations for down-hole entry of drilled excavations.

3.7 Obstructions. Remove subsurface obstructions at drilled shaft locations. Such obstructions may include man-made materials such as old concrete foundations or natural materials such as boulders. Blasting is not permitted.

3.8 Inspections of Excavations. Provide equipment for checking the dimensions and alignment of each shaft excavation. Determine the dimensions and alignment of the shaft excavation under the observation and direction of the Engineer. Provide equipment necessary to verify shaft cleanliness for the method of inspection selected by the Engineer.

Measure final shaft depths with a weighted tape or other approved methods after final cleaning. Ensure the base of each shaft has less than ½ inch of sediment at the time of concrete placement. For dry excavations, do not allow the depth of water to exceed 3 inches for tremie or pump methods of concrete placement. Verify shaft cleanliness to the Engineer using direct visual inspection or other method the Engineers determines acceptable. Video camera or underwater inspection procedures may be used if specified in the plans. Inspect the side surfaces of rock sockets to ensure they are rough and of such condition to ensure bond between the shaft concrete and the rock. Calipers, bent rods, or other devices may be used to inspect the diameter and roughness of rock sockets. When the Engineer directs, mechanically roughen surfaces found to be smooth.

3.9 Reinforcing Steel Cage Fabrication and Placement. Assemble the reinforcing steel cage, consisting of longitudinal bars, ties, spirals, cage stiffener bars, spacers, centering devices, and other necessary appurtenances and place as a prefabricated unit immediately

after the shaft excavation is inspected and accepted, and just prior to concrete placement.

Tie the reinforcing steel with 100 percent double-wire ties and provide support so that it will remain within allowable tolerances for position. Locate splices as shown on the plans. Splice no more than 50 percent of the longitudinal reinforcing within 2-lap splice lengths of any location or within 3 feet of the splice location if approved mechanical connectors are used. All splices are to be in accordance with plan details. Use bands, temporary cross ties, etc. as required to provide a reinforcement cage of sufficient rigidity to prevent racking, permanent deformations, etc. during installation.

Use concrete centering devices or other approved non-corrosive centering devices at sufficient intervals along the length of the reinforcement cage to ensure concentric spacing for the entire cage length. As a minimum, provide a set of non-corrosive centering devices at intervals not exceeding 5 feet throughout the length of the shaft. When the size of the longitudinal reinforcement exceeds one inch in diameter the minimum spacing may be increased to 10 feet. As a minimum, provide a set of centering devices within 2 feet of the top and 2 feet of the bottom of the shaft. In addition provide one set of centering devices 2 feet above and 2 feet below each change in shaft diameter. Provide feet (bottom supports) at the bottom of the shaft on vertical bars. As a minimum, provide non-corrosive centering devices at 60 degree intervals around the circumference of the shaft to maintain the required reinforcement clearances. Ensure the centering devices maintain the specified annular clearance between the outside of the reinforcing cage and the side of the excavated hole or casing.

Concrete centering devices and feet will be constructed of concrete equal in quality and durability to the concrete specified for the shaft. Use epoxy coated centering devices fabricated from reinforcing steel. Use feet (bottom supports) of adequate size and number to assure the rebar cage is the proper distance above the bottom as determined by part 3.11 3) of this Special Note. The feet are not intended to support the weight of the cage. In the event that the shaft has been excavated below the anticipated tip elevation, extend the reinforcing cage at the tip (low) end by lap splices, mechanical connectors, or welded splices conforming to the Standard Specifications. In this instance, splices need not be staggered and 100 percent of the reinforcing bars may be spliced at a given location. The bottom 12 inches of the shaft may not be reinforced when below plan tip elevation.

During concrete placement, support the reinforcing cage at or near the top of shaft such that the concrete feet are positioned approximately one inch above the bottom of shaft excavation. Not sooner than 24 hours after the completion of concrete placement, remove temporary supports. Provide the needed equipment, including extra cranes if necessary, to provide this cage support.

Prior to placing the reinforcement cage, demonstrate to the satisfaction of the Engineer that the fabrication and handling methods to be used will result in a reinforcing cage placed in the proper position, with the proper clearances, and without permanent bending, squashing, or racking of the reinforcement cage. During this demonstration bring the cage to an upright position, lower into a shaft excavation, and support as if for concrete placement.

Check the elevation of the top of the reinforcing cage before and after the concrete is placed. If the reinforcing cage is not maintained within the specified tolerances, correct to the satisfaction of the Engineer. Do not construct additional shafts until the contractor has modified his reinforcing cage support to obtain the required tolerances.

3.10 Concrete Placement. Place concrete according to the applicable portions of the Standard Specifications and with the requirements set forth herein. Do not apply the provisions of the Special Note 6U for Structural Mass Concrete.

Place concrete as soon as practical after reinforcing steel placement but no later than 4 hours after completion of the shaft excavation. Place concrete continuously from the bottom

to above the top elevation of the shaft. For shafts that extend above ground or water surface, place concrete continuously after the shaft is full until good quality concrete is evident at the top of the shaft. Form any portion of the shaft above ground with a removable form or other approved method to the dimensions shown on the plans.

For shafts constructed in the wet with the top of the shaft below the water surface and below top of casing, place concrete to approximately one shaft diameter but no less than 2 feet above the top of shaft elevation. Remove contaminated concrete and deleterious material, as determined by the Engineer, accumulated above the top of shaft elevation immediately after completing concrete placement. Deleterious material and contaminated concrete may be airlifted under a head of water or slurry provided that the head is maintained at or near the exterior water surface elevation. Carefully remove any concrete remaining above plan top of shaft after curing and excess casing removal.

Place concrete either by free fall, through a tremie, or concrete pump. Use the free fall placement method in dry holes only. The maximum height of free fall placement is 20 feet. Do not allow concrete placed by free fall to contact either the reinforcing cage or hole sidewall. Drop chutes may be used to direct concrete to the base during free fall placement.

Place concrete in the shaft in one continuous operation. Maintain a minimum slump of 4 inches or more throughout the placement for 4 hours after batching. Adjust approved admixtures in the concrete mix for the conditions encountered on the job so that the concrete remains in a workable plastic state throughout the placement. Perform slump loss tests to demonstrate that the concrete will maintain a 4-inch or greater slump for a period of time equal to the estimated transport plus the 2-hour placement time, but not less than 4 hours.

When the Engineer determines the concrete placement methods and/or equipment during construction of any technique and/or production shafts to be inadequate, make appropriate alterations to eliminate unsatisfactory results.

Drilled shafts not meeting the concrete placement requirements of this Special Note or contract plans are unacceptable. Correct all unacceptable completed shafts to the satisfaction of the Engineer.

3.10.1 Tremie Placement. Tremies may be used for concrete placement in either wet or dry holes. Extend the tremie to the shaft base elevation before starting underwater placement. Valves, bottom plates, or plugs may be used only if concrete discharge can begin approximately 2 inches above the excavation bottom. Remove plugs from the excavation unless otherwise approved by the Engineer. Maintain tremie discharge at or near the bottom of excavation as long as practical during concrete placement. Immerse tremie discharge end as deep as practical in the concrete but not less than 10 feet.

If at any time during the concrete pour the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete surface, the entire drilled shaft is considered defective. In such case, remove the reinforcing cage and concrete, complete any necessary sidewall cleaning or over- reaming as directed by the Engineer, and repour the shaft.

3.10.2 Pumped Concrete. Concrete pumps and lines may be used for concrete placement in either wet or dry excavations. Do not begin concrete placement until the pump line discharge orifice is at the shaft base elevation.

For wet excavations, use a plug or similar device to separate the concrete from the fluid in the hole until pumping begins. Remove the plug unless otherwise approved by the engineer.

Ensure the discharge orifice remains at least 10 feet below the surface of the fluid concrete. When lifting the pump line during concrete placement, reduce the

line pressure until the orifice has been repositioned at a higher level in the excavation.

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 Department will consider the shaft defective. In such case, remove the reinforcing cage and concrete, complete any necessary sidewall cleaning or over- reaming as the Engineer directs, and repour the shaft.

3.10.3 Drop Chutes. Drop chutes may be used to direct placement of free fall concrete in excavations where the maximum depth of water does not exceed one inch. Do not use the free fall method of placement in wet excavations. 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. Reduce the height of free fall and/or reduce the rate of concrete flow into the excavation if the concrete placement causes the shaft excavation to cave or slough, or if the concrete strikes the reinforcing cage or sidewall. When the Engineer determines free fall placement cannot be accomplished satisfactorily, use either tremie or pumping to accomplish the pour.

3.11 Construction Tolerances. The following construction tolerances apply to drilled shafts unless otherwise stated in the contract document:

1) Construct drilled shaft within 3 inches of plan position in the horizontal plane at the top of the shaft.
2) Do not vary the vertical alignment of a shaft excavation from the plan alignment by more than 1/4 inch per foot of depth or 6 inches total.
3) Maintain the top of the reinforcing steel cage no more than 6 inches above and no more than 3 inches below plan position.
4) All casing diameters shown on the plans refer to O.D. (outside diameter) dimensions. The casing dimensions are subject to American Pipe Institute tolerances applicable to regular steel pipe. A casing larger in diameter than shown in the plans may be used, at no additional cost, with prior approval by the Department.
5) Maintain the top of shaft concrete within ± 3 inches from the plan top of shaft elevation, measured after excess shaft concrete has been removed.
6) Design excavation equipment and methods so that the completed shaft excavation will have a planar bottom. Maintain the cutting edges of excavation equipment normal to the vertical axis of the equipment within a tolerance of ± 3/8 inch per foot of diameter. The tip elevation of the shaft has a tolerance of ± 6 inches from final shaft tip elevation unless otherwise specified in the plans.

Drilled shaft excavations and completed shafts not constructed within the required tolerances are unacceptable. Correct all unacceptable shaft excavations and completed shafts to the satisfaction of the Engineer. When a shaft excavation is completed with unacceptable tolerances, present corrective measures designed by a registered Professional Engineer for approval.

4.0 MEASUREMENT.

4.1 Drilled Shafts. The Department will not measure for payment any trial batches, concrete required to fill an oversized casing or oversized excavation; obstruction removal; over-reaming or sidewall cleaning; inspection work or inspection equipment; materials or work necessary, including engineering analyses and redesign, to alter unacceptable work methods or to complete corrections for unacceptable work; and will consider them incidental to the Drilled Shaft. Unless noted otherwise in the contract documents, casing is incidental to the drilled shaft.

4.1.1 Drilled Shaft, Common. The Department will measure the length, in linear feet, of drilled shaft above the top of rock elevation shown on the plans. The Department

will consider this quantity Drilled Shaft, Common regardless of the character of material actually encountered.

4.1.2 Drilled Shafts, Solid Rock. The Department will measure the length, in linear feet, of drilled shaft below the top of rock elevation shown on plans. The Department will consider this quantity Drilled Shafts, Solid Rock regardless of the character of material actually encountered during excavation.

4.2 Technique Shaft. The Department will pay for technique shaft at the contract unit price per each as detailed on the plans or as directed by the Engineer. This will constitute full compensation for all costs incurred during installation as described herein for 'Drilled Shaft' or in the contract documents. No additional compensation beyond the number of technique shafts allowed for in the plans will be permitted for additional technique shafts required because of failure to demonstrate adequacy of methods.

4.3 Rock Coring and Rock Sounding. The Department will measure Rock Sounding and Rock Coring shown on the plans, as specified in part 3.5 of this Special Note, and as the Engineer directs, in linear feet to the nearest 0.1-foot. If soil samples are specified in the contract documents they will be incidental to the unit price bid for Rock Sounding. The Department will not measure or pay for subsurface exploration performed deeper than the elevations indicated on the plans and/or in this Special Note, unless directed by the Engineer, and will consider it incidental to these items of work. Additionally, the Department will consider all mobilization, equipment, labor, incidental items, and operations necessary to complete the boring operations incidental to these items of work.

5.0 PAYMENT. The Department will make payment for the completed and accepted quantities under the Terms of the Contract.

SPECIAL NOTE FOR BRIDGE CLEANING AND PREVENTIVE MAINTENACE

1. DESCRIPTION. Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highway's 2019 Standard Specification for Road and Bridge Construction, applicable Supplemental Specifications, Standard Drawings, this Note and Detailed Drawings of the Design Build Team. Section references are to the Standard Specifications. This work consists of the following: (1) Furnish all labor, materials, tools, and equipment; (2) Debris removal; (3) Stratified and pack rust removal; (4) Pressure washing; (5) Apply concrete coating; (6) Lubricate bearing devices. (7) Maintain and control traffic; (8) All other work required for this contract.

2. SUBMITTALS

The Contractor shall comply with the submittal requirements detailed in Section 108 of the Standard Specifications for Road and Bridge Construction (Current Edition) and submit the following **written** items to the Project Engineer **14 days** prior to the work beginning:

A. A detailed Progress of Work Schedule.
B. Traffic Control Plan.
C. Manufacturers' recommended Film Thickness and application conditions for the concrete coating system to be used.

All submittals must be received, accepted and/or approved by the KYTC Engineer prior to beginning any work.

3. MATERIALS.

A. Wash Water

Use clean potable water for all pressure washing.

B. Concrete Coatings

Use one of the coatings from the following manufactures:

Manufacture	Prime Coat	Finish Coat
Sherwin Williams	Macropoxy 646	Acrolon 218 HS
PPG	Amberlock 2	Devoe Devflex
Carboline	Carboguard 890	Carbothane 133 HB
Tnemec	Elastogrip 151	EnviroCrete 15

C. Bearing Lubricant

Use one of the lubricants from the following manufactures:

Manufacture	Lubricant
Bostik Inc.,	'Never Seez - Mariner's Choice'
Mobil Oil	'Mobil Centaur Moly NLGI Grades 1 or 2
Certified Labs	'Premalube #1 WG'

3. CONSTRUCTION.

A. Debris Removal.

All debris shall be removed from the bridge components. See attached detailed drawings for each bridge addressing components having debris removal. Equipment for removing debris from the bridge components shall be determined by the Contractor, subject to the approval of the Engineer. The Contractor shall prevent any debris from entering any body of water, bridge drainage system, or traffic lanes. All debris removed shall be disposed of in a suitable off-site disposal facility. Prior to all cleaning work, the Contractor shall conform that any bridge drainage system is not blocked by un-removable debris by rodding with a sewer road or similar tool. A blocked drainage system is considered to be one from which debris cannot be removed using the means specified in this note. If the Engineer has be notified, and concurs that the drainage system is blocked prior to performing other cleaning work, then proceed at the direction of the engineer. If the Contractor does not inspect the bridge drainage system and notify the engineer prior to beginning work any blocked drains will be considered to be the result of the Contractor's operations, and all clearing and cleaning of the drainage system shall be done as part of the work of the specification. All vegetation present at areas of the bridge that are to be addressed in this proposal shall be removed as determined by the Engineer.

B. Stratified and Pact Rust Removal.

Stratified and pack rust shall be removed from all bearing devices. See attached detailed drawings for each bridge showing location and quantity of the bearing devices. Hand tools including wire brushes, scrapers or impact devices (hand hammers or power chisels) are to be used for removing stratified and pack rust. All surfaces to have stratified and pack rust removed shall be cleaned to an SSPC SP-2 level. All debris collected shall be disposed of in a suitable off-site disposal facility.

C. Pressure Washing.

Specified bridge components shall be pressure washed. See attached detailed drawings for each bridge addressing components to be pressure washed. All equipment for pressure washing shall be operated at a minimum pressure of up 4,000 psi with 0 degree spinner tip and/or fan tips as determined by the engineer at the working location with a minimum flow rate of 3.5 gal/minute provided that these pressures do not damage any components of the structure. Pressure and flow rates shall be reduced to a level satisfactory to the Engineer should any damage occur due to power washing procedures. Pressure washing shall be operated at distance of approximately six inches from and perpendicular to the surface. All pressure washing wands shall be equipped with a gauge to accurately determine the amount pressure used. Pressure washing of any bridge element will proceed from top of wash area to bottom of wash area. Wash water will not be released to a bridge element previously washed. Preform all pressure washing at temperatures above 40 degrees Fahrenheit.

D. Concrete Coatings Application.

All abutment, end bent and pier caps, pedestals, end bent back walls and parapet walls including the abutment and end bent wing walls shall have concrete coating applied to as specified after debris removal and power washing. Use compressed air to remove any loose debris from the surfaces that are to be coated after power washing. See concrete coating diagram. All coatings shall be applied within manufacturers recommended dry film thickness range. Comply with KYTC "Standard Specifications for Road and Bridge Construction" Section 614.03.02 and coatings supplier recommended conditions for application. Allow the surfaces to be coated to dry before any coating is applied. The coating must be applied to a clean and dry surface. All coating application shall be executed using brushes, rollers, etc. No spray application will be permitted. The Department requires acceptance testing of samples obtained on a per-lot basis per-shipment. The Division of Materials shall perform acceptance testing. Test samples shall be taken at the Contractor's paint storage site. Department personnel shall perform sampling. Allow (10) working days for testing and approval of the sampled paint. It is the Contractor's responsibility to maintain an adequate inventory of approved paint. The Department shall assume no responsibility for lost work due to rejection of paint or approved paint subsequently found to be defective during the application process. Preform all concrete coating application at temperatures above 40 degrees Fahrenheit or in accordance with manufactures specifications.

The finish coat shall be gray and will meet the following values.

	L*	a*	b*
Grey	**74.94**	**- 1.54**	**3.92**

E. Bearing Lubrication Application.

Bearing devices shall be lubricated as specified after all stratified rust and pack rust is removed and power washing is complete, bearing devices shall have lubricant applied to all surfaces of the bearing including bearing plates and points of movement. See attached detailed drawings for each bridge showing location and quantity of the bearing devices. Allow bearing devices to dry before lubricant is applied. Preform all bearing lubrication application at temperatures above 40 degrees Fahrenheit or in accordance with manufactures specifications.

F. Sequence of Work.

Complete work in the sequence listed below:

1. Debris Removal
2. Stratified and Pact Rust Removal
3. Pressure Washing
4. Concrete Coating
5. Bearing Lubrication

G. Access.

The Contractor shall provide OSHA compliant safe access for all bridge cleaning and preventive maintenance operations and inspection.

H. Inspection.

The Cabinet will provide inspection for all items required in this contract. Visual inspection will be required upon completion of each work item for each structure component or at the discretion of the Engineer at any time. All visual inspection shall be performed within arm's length distance.

1. **Debris Removal**: Visual Inspection
2. **Stratified Rust or Pack Rust Removal:** Visual Inspection and Scraper Test any surface cleaned to SSPC SP2 will be inspected by a dull scraper test to ascertain adherence of existing coating and a hammer test for tightness of pact rust.
3. **Power Washing:** Visual Inspection
4. **Concrete Coating:**
   Prime Coat Application Check for dry film thickness*, and defects in paint
   Finish Coat Application Check for dry film thickness*, paint appearance, color and quality of application.
   *Destructive DFTs shall be used. Contractor shall repair all test locations, cost will be considered incidental to the contract.
5. **Bearing Greasing:** Visual Inspection.

I. Verifying Field Conditions.

The Contractor shall be familiar with all conditions at each bridge site. The Cabinet will not consider any claims due to the Contractor having not familiarized themselves with requirements of this work. Residual lead paint may present on each bridge. The Contractor is advised to take all necessary protective measures including worker safety and environmental regulations when performing surface preparation. The Department will not consider any claims based on residual lead paint.

J. Damage to the structure.

The Contractor shall bear all responsibility and expense for any and all damage to the structure during the repair work, even to the removal and replacement of a fallen span, should the fallen span result from the Contractors actions.

4. MEASUREMENT.

Bridge Cleaning and Preventative Maintenance: The Cabinet will measure this item as "Lump Sum"

5. PAYMENT.

Bridge Cleaning and Preventative Maintenance: Payment will be made under the terms of the contract.

SPECIAL NOTE FOR SEALING BRIDGE DECKS

These Notes or designated portions thereof, apply where so indicated on the plans, proposals or bidding instruction.

I. **DESCRIPTION.** Perform all work in accordance with the Department's 2019 Standard Specifications, and applicable Supplemental Specifications, the attached sketches, and these Notes. Section references are to the Standard Specifications.

Areas to be sealed: End to end of Bridge and gutterline to gutterline and include 3 inches along the bottom face of the barrier walls.

This work consists of: (1) Furnish all labor, materials, tools, and equipment; (2) Clean the bridge deck; (3) Seal the bridge deck; (4) Maintain & control traffic; and (5) Any other work specified as part of this contract.

II. **MATERIALS.**

A. **Sealer.** Use one of the following:

Product	Supplier
Protectosil BHN	Evonik Industries
Protectosil 300S	Evonik Industries
TK-590-40 Tri-Silane 40%	TK Products
SW-244-100	Chemical Products Industries, Inc.
TK-590-1 MS Tri-Silane	TK Products
MasterProtect H1000	BASF
Aquanil Plus 40	ChemMasters
SIL-ACT ATS-100	Advanced Chemical Technologies
Certivex Penseal BTS 100%	Vexcon
Pentreat 244-40	W.R. Meadows
Aquanil Plus 40A	ChemMasters

B. **Coverage Rate:** Follow all manufacturers recommendations for coverage rates except the application rate must not exceed the square footage coverage rate per gallon of sealer as given in the chart below. If the manufacturer recommends a coverage rate greater than given in the table below, apply sealer at the rate given in the table below for the chosen sealers silane percentage.

% Silane	Coverage rate (ft^2/gallon)
100	300
40	120
20	60

III. CONSTRUCTION.

A. **Curing Compound.** Contrary to Section 609.03.12 of the specifications, curing compound is not to be used on this deck due to potentially causing issues with the concrete sealer. During the deck pour, finishing, and tining operations the Class AA concrete shall be kept continuously moist with the use of a mister until burlap or curing blankets are applied to the surface. At no point should water be pooling or running off the surface or the surface of the concrete be allowed to become dry. After the burlap or curing blankets are installed, cure in accordance with the specifications. Include all costs in the unit price bid for Class AA concrete. Failure to properly cure the concrete in accordance with this note and the specifications may result in weakened or cracked concrete. If the concrete is weakened or cracked due to improper curing, the contractor will be responsible for providing alternates to fix the issues to the Engineer for review and the contractor will be solely responsible for all costs to do so, up to complete replacement. Do not begin any construction on fixing any issues without approval of the Engineer.

B. **Cleaning the Deck.** Dry clean the deck to remove all loose debris. Remove all visible hydrocarbons from the surface with detergent approved by the manufacturer of the deck sealant. Pressure wash all surfaces to be sealed at 2000 to 3000 psi. Install pressure gauges at each wand to verify pressure. Use 30° fan tip or as recommended by the manufacturer of the deck sealant. Hold pressure washing wand a minimum of 45° from the deck with a maximum stand-off distance of 12 inches.

C. **Sealing the Deck.** Allow new concrete to cure a minimum 28 days prior to application of sealer. Monitor weather conditions prior to sealer application. Refer to manufacturer's recommendations for proper ambient conditions. Do not apply sealer if precipitation is anticipated within the time stated by the manufacturer. Allow the deck to dry 24 hours (after washing or rain event) before sealer application. The deck can be reopened to traffic while drying. Sealer must be applied within 48 hours of washing or the deck must be rewashed. Divide the deck into predefined areas of specific square footage to aid in determining usage. Comply with manufacturer's usage recommendation. Using a low pressure pump, apply sealer and spread evenly with broom or squeegee; do not allow pooling to remain. When each predefined area is complete, measure the amount of sealer used to verify proper usage. After sealing, follow manufacturer's recommended cure time before opening to traffic. On vertical surfaces, apply the sealer in a flooding application from the bottom up, so the material runs down 6 to 8 inches below the spray pattern.

D. **Inspection:** Monitor all aspects of the project to assure compliance to this specification. Observe and document general conditions during the entirety of the project. Verify that each phase of work has been satisfactorily completed prior to beginning the next phase. Phases are described as follows:

1. Dry cleaning to remove loose debris, verify and document:
   a. All debris has been removed and disposed of properly.
2. Removal of hydrocarbons, verify and document:
   a. The manufacturer's recommended detergent is used for removal.
   b. Hydrocarbons have been satisfactorily removed.
3. Pressure washing, verify and document:
   a. Washing pressure at the wand.
   b. Tip size used.
   c. Wash angle and stand-off distance.
   d. The deck is satisfactorily cleaned.
4. Sealer application, verify and document:
   a. Proper cure time for new concrete.
   b. Deck surface is dry.
      1. Document time since washed.
      2. Was deck opened to traffic after washing?
   c. Ambient conditions.
      1. Document ambient temperature, surface temperature, relative humidity, and dew point.
   d. Application and distribution method.
   e. Coverage to be complete and even.
   f. Material is not allowed to remain pooled.
   g. Monitor material usage.
   h. No traffic until proper cure time is allowed.

IV. MEASUREMENT

A. **Concrete Sealing.** The Department will measure the quantity per square feet of each area sealed.

V. PAYMENT

A. **Concrete Sealing.** Payment will be per the terms of the contract.

SPECIAL NOTE FOR LIGHTWEIGHT AGGREGATE FILL

Lightweight Fill Material other than those referenced in this document may be acceptable for use if approved by KYTC. The Contractor is responsible for any information required by KYTC for evaluation of other lightweight fill materials.

REFERENCES

All references to the Standard Specifications are to the Kentucky Department of Highways Standard Specifications for Road and Bridge Construction, Current Edition.

All references to AASHTO are to the current Edition.

The requirements in the Standard Specifications or AASHTO shall be used for information not provided. Where there are conflicts between the Standard Specifications or AASHTO, the Standard Specifications shall govern.

PART ONE - GENERAL

1.1 DESCRIPTION

1.1.1 Provide and install Lightweight Aggregate Fill material as specified herein at the locations shown on the Design Build Team's (DBT's) Drawings.

1.2 MANUFACTURER QUALIFICATIONS

1.2.1 The Lightweight Aggregate Fill supplier must be on the list of approved Lightweight Aggregate Fill suppliers (hereafter referred to as the "Approved List") maintained by the Division of Materials, and the lightweight aggregate fill must meet all properties of Section 2.2 of this note. The Approved List is available on the Division of Materials' website at http://transportation.ky.gov/Materials/Documents/LAM.PDF.

1.3 SUBMITTALS

1.3.1 Details of Lightweight Aggregate Fill shown in the DBT plans on the lightweight fill detail sheet are based on the stated maximum allowable unit weight. If the Contractor proposes to use the unit weight specified in the plans, then a material data sheet must be supplied for verification of the proposed material (No additional calculations will be required unless requested by the Engineer). If the Contractor elects to use a Lightweight Aggregate Fill unit weight different than what is shown in this note, design calculations and construction plans clearly showing conformance with the Standard Specifications, AASHTO, and applicable sections of the DBT plans shall be submitted for review 30 calendar days prior to ordering material or beginning excavation for placement of lightweight fill. Lightweight Aggregate Fill designs and construction plans shall be dated, sealed, and signed by a registered professional engineer licensed to practice in Kentucky. The Contractor shall allow 30 calendar days for the Department to review the first complete submission. Additional time required by the Department to review resubmissions shall not be cause for increasing the number of contract working days.

Details need to be enclosed in the submittal about the construction methods proposed. These could include, but are not limited to: required lift thicknesses for lightweight aggregate, selected method of compaction, etc.

Embankment benching, excavation stabilization, final installation and protection details necessary to construct the Lightweight Aggregate Fill and produce a stable final embankment integrated with the remainder of the roadway embankment shall be the responsibility of the Contractor. Design of sheeting, shoring or other earth retention structures necessary to stabilize excavations shall be part of the construction submittal. The Engineer may request that construction plans be supplied prior to any construction.

The format for the construction plans shall be in accordance with the Division of Structural Design's Guidance Manual. The first sheet shall be a title sheet. Refer to Subsection SD-206-2 of the manual for additional requirements. Submittals shall be electronic unless otherwise noted. For additional information contact the Division of Structural Design.

1.3.2 Other documentation including material certifications, etc. shall be submitted in accordance with this Special Note.

1.3.3 Refer to the ITP for additional details regarding submittals.

PART TWO - PRODUCTS

2.1 MATERIALS

2.1.1 Lightweight Aggregate Fill shall be expanded shale, expanded clay or expanded slate that is included on the Department's Approved List. The Lightweight Aggregate Fill must meet all properties of Section 2.2 of this note. Project-specific material samples from approved Suppliers should be submitted for approval at least 30 calendar days prior to beginning work. Materials from Suppliers not on the Approved List may be used provided that the materials are submitted for approval at least 30 calendar days prior to beginning work, and the materials are accepted after testing.

2.1.2 Geotextile Fabric shall be in accordance with Section 843 of the Standard Specifications for a subsurface drainage and separation fabric.

2.2 PROPERTIES

The Lightweight Aggregate supplier is responsible for maintaining a quality control program to ensure compliance with all requirements of this section (2.2). All requirements of Section 2.2 shall be certified to be acceptable by the Supplier. The Department will test all the properties from Section 2.2 below during construction, except the angle of internal friction (2.2.7). However, testing of the angle of internal friction may be requested by Department, if deemed necessary. The lightweight aggregate fill material shall meet the material requirements below.

2.2.1
Unit Weight (compacted, dry): from __30__ pcf to __60__ pcf
The Lightweight Aggregate Manufacturer will be required to provide material with a dry unit weight between 30 pcf and 60 pcf to be placed on the Approved List. These measured unit weights will be in the oven-dry condition.

(Tested by AASHTO T 19)

2.2.2
Gradation:

Sieve Size	**Percent Passing**
1" (25 mm)	100
3/4" (19.0 mm)	90-100
1/2" (13.0 mm)	45-100
3/8" (9.5 mm)	20-75
# 4 (5.0 mm)	0-15
# 30 (0.6 mm)	0-5

(Tested by AASHTO T 27)

2.2.3
Absorption (24 hours): Maximum = 15%

(Tested by AASHTO T 85)

2.2.4
Maximum Los Angeles Abrasion Loss: Maximum = 40 %

(Tested by AASHTO T 96)

2.2.5
Electrochemical: The lightweight aggregate shall meet the requirements for pH, Chlorides and Sulfates under "Reinforced Fill Material" in Section 805 of the current Standard Specifications.

Contrary to the Standard Specifications, Resistivity of the lightweight aggregate shall be tested even when less than 50% passes the No. 4 sieve in the following cases:

(1) Aggregate is internal backfill for a mechanically stabilized earth (MSE) wall with metal strip reinforcement
(2) Aggregate embankment contains steel pile foundations for a bridge structure or retaining wall.

Note: If required, Resistivity Testing shall be performed on fine material produced from the Los Angeles Abrasion Test, typically passing the No. 12 sieve.

2.2.6
Angle of Internal Friction: Minimum Value of Phi (ϕ) is: ϕ = 37 deg.

(Tested by AASHTO T 236 or T 297)

2.3 GEOTECHNICAL DESIGN PARAMETERS

2.3.1
Unit weight:
γ = 75 pcf for design above the Water Table (using 25% absorption and 60 pcf max. dry density)
γ = 80.4 pcf total unit weight below the Water Table (using 34% max. absorption, 60 pcf max. dry density and γ = 62.4 pcf for water)

Note on Unit Weight: When the lightweight aggregate is designed to be located above the water table, 25% absorption of water should be added to the unit weight of the material for design. When lightweight aggregate is to be used below the water table, 34% absorption and the weight of water within the voids between aggregate particles shall be considered in the design.

2.3.2
Angle of Internal Friction:

ϕ = 35 deg. (for lateral earth pressure calculations)
ϕ = 37 deg. (for stability analyses)

Note on Friction Angle: Larger angles of internal friction may be used if validated by laboratory direct shear or triaxial testing that is performed on project specific material. Triaxial test specimens must have a minimum diameter of 6 inches, and a height/diameter ratio from 2.0 to 2.5. (Direct Shear and Triaxial testing shall conform to AASHTO T 236 and T 297, respectively.)

2.3.3 Coefficient of Friction: The coefficient of friction for sliding resistance on cohesionless soils shall be no greater than the tangent of ϕ for the weaker material. The coefficient of friction for sliding resistance for cohesive soils shall be no greater than the adhesion value for the in-situ soil. Lateral earth pressure coefficients or equivalent fluid pressures may be determined by Coulomb or Rankine theories.

2.3.2 Uplift Forces: Where the aggregate will be designed for use below the water table, uplift forces shall be calculated. The thickness of rip-rap, soil, or other material required as a cap to offset the uplift forces shall be determined.

PART THREE - EXECUTION

3.1 SITE CONDITIONS

Examine the work areas of this Section so that conditions encountered dealing with the timely and proper completion of the work are identified (Specification 102.06).

3.2 PREPARATION/INSTALLATION

The area to be filled shall be prepared in accordance with this Note and the DBT plans and shall not have any standing water prior to fill placement.

3.2.1: Geotextile Fabric: The lightweight aggregate material shall be wrapped (including the top, bottom and all sides) with Geotextile Fabric, unless the plans state otherwise. Fabric placement shall be in accordance with Section 214 of the Standard Specifications. Any outdated references to Type I, II, III, or IV Fabric in Section 214 should be disregarded. Contrary to Section 214 of the Standard Specifications, the cost of the geotextile fabric will be incidental to the cost of Lightweight Aggregate Fill.

3.2.2: Lift Thicknesses: Place the lightweight aggregate in uniform lifts not exceeding 12 inches in the loose condition.

3.2.3: Compaction: Grade the lightweight aggregate to the specified lift thickness with rubber-tired equipment with contact pressures of 4.4 psi or less. Then, compact with two to four passes of a single smooth-drum vibratory roller with rubber tires or a vibratory plate compactor. Do not use steel-tracked equipment on the lightweight aggregate material.

3.2.4: Cover Material: Provide a minimum 2-foot compacted soil cap over the top of the Lightweight Aggregate Fill, or other acceptable cover, as indicated in the plans.

3.3 SAMPLING

As stated in Section 805 of the current Standard Specifications, sampling **by the Department** during construction shall be in accordance with the Department's Manual of Field Testing and Sampling Practices. Pursuant to AASHTO T 2, samples should be taken at the last practical point before placement. Sampling from a stockpile of material to be used on the project, as discussed in Section 3.4, may be considered the last practical point before placement.

3.4 TESTING

If testing **by the Department** during construction produces results that are not acceptable according to this special note, the represented material shall be removed and replaced to the extent required by the Engineer and the Geotechnical Branch at no cost to the Department. (NOTE: The Contractor may wish to stockpile lightweight aggregate until acceptance of test results by the Department to eliminate the chance of having to remove material after placement due to unacceptable test results. The material may be stockpiled either on site or at the Supplier's facility.)

PART FOUR - METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.1 METHOD OF MEASUREMENT

4.1.1 No separate measurement shall be made for Lightweight Aggregate Fill. Lightweight Aggregate Fill shall be paid for based on the volume of Lightweight Fill shown on the plans. Changing the limits or character of the installation due to the Contractor's construction methods or the Contractor's choice of a lightweight fill material of different unit weight as outlined in Section 1.3.1 of this Special Note shall not be cause for changing the plan quantities including plan roadway pay quantities.

4.1.2 The Contractor's selected construction methods may require additional excavation, fill or Lightweight Fill volume, or incidental items to satisfy the plan requirements. The Contractor will be responsible for maintaining a stable slope during construction. Sheeting, shoring, temporary walls or other earth retention systems necessary to stabilize any excavation required during Lightweight Fill construction shall be included in the unit price bid for Lightweight Aggregate Fill. All designs, labor, materials, etc. required to complete this work shall be included in the unit price bid per cubic yard for Lightweight Aggregate Fill. Design of any excavation stabilization measures that may be required shall be submitted to the Department for review. A time period of 30 calendar days shall be allowed to complete this review.

4.2 PAYMENT

Work specified in this Section will be paid for per the terms of the contract.

SPECIAL NOTE FOR CELLULAR CONCRETE FILL

REFERENCES:

All references to the Standard Specifications are to the Kentucky Department of Highways Standard Specifications for Road and Bridge Construction, Current Edition.

All references to AASHTO and ASTM are to the current edition.

The requirements in the Standard Specifications, AASHTO, or ASTM shall be used for information not provided. Where there are conflicts between the Standard Specifications, AASHTO, or ASTM the Standard Specifications shall govern.

DEFINITIONS:

Manufacturer – Company that produces lightweight fill materials and provides formulation and methodology for installation.

Applicator – Company subcontracted by the Contractor that mixes fill materials into a slurry per Manufacturer recommendations and places cellular concrete on the project site. (Applicator may be the same as the Manufacturer.)

PART ONE - GENERAL

1.1 DESCRIPTION

1.1.1.1 Provide and install Cellular Concrete Fill material as specified herein and per the design of the DBT.

1.2 MANUFACTURER AND APPLICATOR QUALIFICATIONS

1.2.1 The Manufacturer must certify the foaming agent utilized conforms to requirements of ASTM C869 and the cellular concrete produced must meet all properties of Section 2 of this note.

1.2.2 The cellular concrete Applicator shall be approved by the Engineer and certified by the Manufacturer of the cellular concrete prior to ordering materials or beginning work on excavating for placement of cellular concrete. Use skilled workmen who are trained, experienced and familiar with the requirements and the methods for proper performance of this work.

1.2.3 Any specialized batching, mixing, and placing equipment shall be automated with bulk handling equipment approved by the Manufacturer. Transit mixes are not acceptable for these applications.

1.2.4 The certified Applicator shall have successfully applied cellular concrete on at least ten projects, which have performed satisfactorily for at least ten years.

1.3 SUBMITTALS

1.3.1 Details of the cellular concrete shown in the contract plans on the Cellular Concrete Fill Detail Sheet are based on the stated maximum allowable unit weight. If the Contractor proposes to use the unit weight and configuration specified in the DBT approved plans, a material data sheet will be sufficient for verification of the proposed material. No additional calculations will be required unless requested by the Engineer.

If the Contractor elects to use a different unit weight or configuration, design calculations and construction plans are required clearly showing conformance with the Standard Specifications, ASTM and applicable sections of the contract plans. These calculations and plans shall be submitted to the Engineer for review 30 calendar days prior to ordering material or beginning excavation for placement of lightweight fill. Electronic submission of these documents is acceptable, unless otherwise indicated in the contract documents or requested by the Engineer. Lightweight fill designs and construction plans shall be dated, sealed, and signed by a registered professional engineer licensed to practice in Kentucky. The Contractor shall allow 30 calendar days for the Department to review the first complete submission. Additional time required by the Department to

review resubmissions shall not be cause for increasing the number of contract working days. The additional work required by the Contractor to provide resubmissions shall be at no cost to the Department.

Details need to be enclosed in the submittal about the construction methods proposed. These could include, but are not limited to: procedure for applying waterproofing membrane, a description of any temperature restrictions on placement of the material, etc.

Embankment benching, excavation stabilization, final installation and protection details necessary to construct the lightweight fill and produce a stable final embankment integrated with the remainder of the roadway embankment shall be the responsibility of the Contractor. Design of sheeting, shoring or other earth retention systems necessary to stabilize excavations shall be part of the construction submittal. The Engineer may request that construction plans be supplied prior to any construction.

The format for the construction plans shall be in accordance with the Division of Structural Design's Guidance Manual. The first sheet shall be a title sheet. Refer to Subsection SD-206-2 of the manual for additional requirements. Submittals shall be electronic unless otherwise noted. For additional information contact the Division of Structural Design.

1.3.2 The bid shall be based on work being performed by an experienced Applicator, and the material being provided by a Manufacturer of cellular concrete conforming to the properties of Section 2.2.

1.3.3 Other documentation including concrete mix designs, material certifications, etc. shall be submitted in accordance with this Special Note.

1.3.4 Refer to the proposal for additional details regarding submittals.

PART TWO - PRODUCTS

2.1 MATERIALS

2.1.1 The cellular concrete Manufacturer must produce cellular concrete meeting all requirements of Section 2 of this Special Note. Materials from Manufacturers that have not previously supplied cellular concrete to KYTC projects may submit their product information to the Kentucky Product Evaluation List (KYPEL) for consideration at least 30 calendar days prior to beginning work. For additional information on KYPEL, contact the Division of Materials, Structural Materials Branch.

2.1.2 Foaming Agent: The foaming agent shall be in accordance with the cellular concrete Manufacturer recommendations and ASTM C 869, and shall produce cellular concrete meeting the properties of Section 2.2 of this Special Note.

2.1.3 Cementitious Material: Portland cement shall comply with Section 801 and pozzolans comply with Section 844 of the Standard Specifications. The cellular concrete Manufacturer shall design the mix.

2.1.4 Water: Use potable water.

2.1.5 Admixtures: Admixtures may be used when specifically approved by the Manufacturer of the cellular concrete.

2.1.6 Water-proofing layer: Provide an asphaltic material meeting the properties for Asphalt Mop Coat in Section 808 of the Standard Specifications or an equivalent product in accordance with the lightweight cellular concrete Manufacturer's recommendations. The product shall meet the approval of the Engineer. The coverage rate shall be as recommended by the Manufacturer for protection of the installation from water infiltration.

2.1.7 Drainage Blanket: The drainage blanket shall meet the requirements for "Coarse Aggregate for Rock Drainage Blanket" in Section 805 of the Standard Specifications, unless otherwise stated in the Cellular Concrete Fill Detail Sheet. The cost of the drainage blanket will be incidental to the cost of Cellular Concrete Fill.

2.1.8 Geotextile Fabric: Geotextile Fabric shall be in accordance with Section 843 of the Standard Specifications for a subsurface drainage and separation fabric.

2.2 PROPERTIES

2.2.1 The cellular concrete shall meet the following:

	Class A	**Class B**	**Class C**
Cast Unit Weight	26-30 pcf	31-36 pcf	37-42 pcf
Minimum Compressive * Strength@ 28 days (ASTM C 495)	40 psi	80 psi	120 psi
Long-Term Water Absorption (% Cast Unit Weight) (ASTM C 796)	20%	16%	14%
Coefficient of Permeability (cm/sec) (@ 2.0 psi) (ASTM D 2434)	10^{-4}	10^{-4}	10^{-4}

* If fly ash is used for cement replacement in percentages of 40% or greater, the compressive strength shall be tested @ 56 days.

2.3 GEOTECHNICAL DESIGN PARAMETERS

2.3.1 Unit Weight:

	Class A	**Class B**	**Class C**
Maximum unit weight for design above the water table*	30 pcf	36 pcf	42pcf
Maximum unit weight for design below the water table	36 psf	42 pcf	48 pcf

*Maximum unit weight value for use in design above water table is assumed to be cast unit weight

2.3.3 Uplift Forces
Where the cellular concrete will be designed for use below the water table, uplift forces shall be calculated. The unit weight of cellular concrete used for these calculations shall be the minimum value from Section

2.2.1 of this note for the applicable Class of material. The thickness of rip-rap, soil, or other material required as a cap to offset the uplift forces shall be determined.

2.3.3 Global Stability Analyses
Global stability calculations for the critical embankment section with lightweight cellular concrete will be the responsibility of the Department. If the Contractor decides to use a different unit weight, as discussed in Section 1.3.1, or a different configuration from the lightweight fill detail sheet, the stability calculations for the new lightweight fill section will be the responsibility of the Contractor.

PART THREE - EXECUTION

3.1 SITE CONDITIONS: Examine the areas for work of this Section so that conditions detrimental to timely and proper completion of the work are corrected.

3.2 PREPARATION: The installation of the cellular concrete shall be in accordance with procedures provided by the cellular concrete Manufacturer. The area to be filled shall be prepared in accordance with the contract documents and plans, and shall not have any standing water in it prior to fill placement. Items encased in the fill shall be set and stable prior to installing the cellular concrete.

3.3 INSTALLATION: Use automated job site batching, mixing, and placing equipment certified by the cellular concrete Manufacturer. The Contractor is responsible for maintaining a stable slope during construction.

3.3.1 A drainage blanket shall be constructed in accordance with requirements of the Cellular Concrete Fill Detail Sheet. The drainage blanket beneath the cellular concrete shall be wrapped with Geotextile Fabric, unless the plans state otherwise. Contrary to Section 214 of the Standard Specifications, the cost of geotextile fabric will be incidental to the cost of Cellular Concrete Fill. Any outdated references to Type I, II, III, or IV Fabric in Section 214 should be disregarded.

3.3.2 Mix the materials and convey promptly to the point of placement. Cast the cellular concrete in lifts in such a manner to prevent segregation. The maximum lift thickness shall be 4 feet. Allow a minimum 12-hour curing time between lifts, unless otherwise directed by the Engineer and Manufacturer.

3.3.3 The final surface finish shall be within 6 inches of plan elevation. After all lifts have been constructed, the final surface of the lightweight fill shall be coated with a waterproofing material in accordance with Section 2.1.6 of this Special Note. Coat the top and sides of the final lightweight fill configuration. Apply the product by mop and allow to dry prior to backfilling. Avoid direct contact with construction equipment to prevent damage to the water-proofing layer. Repair any areas damaged during construction prior to backfilling.

3.3.4 A minimum of 2 feet of soil cover, compacted in accordance with the Standard Specifications, will be required above the cellular concrete.

3.4 SAMPLING (to be completed by the Applicator in accordance with this Special te):

Mold four (4) 3" x 6" cylinder test specimens for each 300 cubic yards of lightweight fill placed or for each four (4) hours of placing. Take samples in accordance with ASTM C 495. **Do not rod the samples**. The samples molds shall be provided by the Applicator, and the cost of the sample molds is incidental to the placement of Cellular Concrete Fill.

3.5 CURING:

Mark the cylinders and place in a location that will not be disturbed or subjected to temperature extremes. Avoid excessive or early handling of test cylinders. After 2-3 days, deliver the cylinders to the Department's Division of Materials. Care should be taken during delivery to prevent damage of the specimens. Maintain the curing environment for the molded specimens as specified in ASTM C 495, for cellular concrete using preformed foam. Do not oven dry the specimens. Cure as follows:

Day 1: 70 ± 10ºF
Days 2-25: 73.4 ± 3ºF moist cure
Days 26-28: Dry for 3 days at a temperature of 70 ± 10ºF and relative humidity 50 ± 10%.

3.6 TESTING:

3.6.1 The Applicator shall perform the field unit weight measurement in accordance with ASTM C 796, Section 8. Field unit weight shall be measured using a machined-steel container with a volume of 0.5 cubic feet and a flat smooth rim. The scale used for the weight measurement shall be accurate to within 0.1% of the measured weight. Fill the tared weighing container with a representative sample of the cellular concrete (tap the sides of the container with a rubber hammer during filling). Overfill the container, then strike off excess concrete by holding the strike-off plate in a horizontal position and moving it across the top of the container with a sawing motion. Wipe the outside surface of the container free of spilled concrete with a cloth. Record the weight of the container and concrete. Calculate the unit weight of the cellular concrete. Adjust the mix as required to obtain the specified cast unit weight at the point of placement.

3.6.2 Compressive Strength: The Department, Division of Materials shall test compressive strength in accordance with ASTM C 495. Specimens may be tested at any age to monitor the compressive strength. Note: The maximum load required to break the sample should not be less than 10% of the maximum load range of the testing equipment being used. A testing machine with a load range of 5,000 pounds is appropriate to use when testing cellular concrete.

3.6.3 Absorption: Water absorption must be certified by the Manufacturer to meet the requirements of Section 2.2 prior to use. The procedure shall be as specified in ASTM C 796, Section 8.

3.6.4 Permeability: Permeability must be certified by the Manufacturer to meet the requirements of Section 2.2 prior to use. The procedure shall be as specified in ASTM D 2434.

PART FOUR - METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.1 METHOD OF MEASUREMENT:

4.1.1 No separate measurement shall be made for Cellular Concrete Fill. Lightweight fill shall be paid for based on the volume of cellular concrete shown on the plans. Changing the limits or character of the installation due to the Contractor's construction methods or the Contractor's choice of a lightweight fill material of different unit weight as outlined in Section 1.3.1 of this Special Note shall not be cause for changing the plan pay quantities including plan roadway pay quantities.

4.1.2 The Contractor's selected construction methods may require additional excavation, fill or lightweight fill volume, or incidental items to satisfy the plan requirements. The Contractor will be responsible for maintaining a stable slope during construction. Sheeting, shoring, temporary walls or other earth retention systems necessary to stabilize excavations during lightweight fill construction will not be paid separately. All designs, labor, materials, etc. required to complete this work shall be incidental to Cellular Concrete Fill.

4.2 PAYMENT: Work specified in this section will be paid for per the terms of the contract.

SPECIAL NOTE FOR EPS FOAM BLOCK EMBANKMENTS

This Special Note will apply when indicated on the Design Build Team's (DBT'S) plans.

REFERENCES:

All references to the Standard Specifications are to the Kentucky Department of Highways Standard Specifications for Road and Bridge Construction, Current Edition.

All references to ASTM are to the current edition.

The requirements in the Standard Specifications, NCHRP Publications, or ASTM shall be used for information not provided. Where there are conflicts between the Standard Specifications or ASTM, the Standard Specifications shall govern.

DEFINITIONS:

Manufacturer – Company that produces EPS geofoam blocks to meet the desired specifications and provides formulation and methodology for installation.

Supplier – Subcontracted by the Contractor. Provides EPS geofoam blocks to the Contractor. Responsible for design of lightweight fill as specified in this note, but may hire a subconsultant to perform the design, subject to approval by the Engineer.

1.0 DESCRIPTION.

This work consists of furnishing and installing Expanded Polystyrene (EPS) foam blocks for use as a lightweight fill material. The terms "EPS foam" and "geofoam" are considered synonymous in this Special Note.

1.1 Manufacturer Qualifications

1.1.1 The Manufacturer must have their EPS geofoam product listed in the Kentucky Product Evaluation List (KYPEL) with a status of Phase IV or Phase X and the lightweight fill and associated materials must meet all properties of Section 2 of this note. For additional information on KYPEL, contact the Department's Division of Materials, Structural Materials Branch.

1.2 Submittals

1.2.1 Details on the EPS foam block fill detail sheet shown in the DBT's plans are based on the stated maximum allowable unit weight. If the Contractor uses the given unit weight and configuration specified in the plans, then a material data sheet must be supplied for verification of the proposed material. Also, an installation plan for the geofoam blocks shall be submitted to the Department for review. The Contractor shall allow 30 calendar days for the review. No additional design calculations will be required unless requested by the Engineer.

If the Contractor elects to use a different unit weight or configuration, design calculations and construction plans are required clearly showing conformance with the Standard Specifications, ASTM and applicable sections of the contract plans. These calculations and plans shall be submitted to the Engineer for review 30 calendar days prior to ordering material or beginning excavation for placement of lightweight fill. Electronic submission of these documents is acceptable, unless otherwise indicated in the contract documents or requested by the Engineer. Lightweight fill designs and construction plans shall be dated, sealed, and signed by a registered professional engineer licensed to practice in Kentucky. The Contractor shall allow 30 calendar days for the Department to review the first complete submission. Additional time required by the Department to review resubmissions shall

not be cause for increasing the number of contract working days. The additional work required by the Contractor to provide resubmissions shall be at no cost to the Department.

Embankment benching, excavation stabilization, final installation and protection details necessary to construct the lightweight fill and produce a stable final embankment integrated with the remainder of the roadway embankment shall be the responsibility of the Contractor. Design of sheeting, shoring or other earth retention systems necessary to stabilize excavations shall be part of the construction submittal. The Engineer may request that construction plans for the sheeting/shoring be supplied prior to any construction.

The format for the construction plans for the EPS geofoam embankment shall be in accordance with the Division of Structural Design's Guidance Manual. The first sheet shall be a title sheet. Refer to Subsection SD-206-2 of the manual for additional requirements. Submittals shall be electronic unless otherwise noted. For additional information contact the Division of Structural Design.

1.2.2 The bid shall be based on the Supplier utilizing a Manufacturer that is listed in KYPEL as status of Phase IV or Phase X to supply EPS Geofoam Blocks.

1.2.3 Submit an installation plan for the geomembrane spill protection layer, as outlined in Section 6.4.4 of this special note. See Section 2.4 of this special note for additional requirements for the geomembrane.

1.2.4 Other documentation including material certifications, etc. shall be submitted in accordance with this special note.

1.2.5 Refer to the proposal for additional details regarding submittals.

1.3 Supplier's Representative

1.3.1 A representative of the EPS block Supplier is required to be on site during the first full day of geofoam fill construction to provide training and assistance to the Contractor's personnel and project inspectors.

1.3.2 A one-day minimum follow-up visit by the Supplier's representative will be required within two weeks of the initial visit, or as approved by the Engineer, in order to monitor progress.

1.3.3 After each on-site visit, the Contractor is required to submit a letter to the Section Engineer written by the Supplier's representative documenting the observations of each visit with documentation that the licensed professional engineer responsible for the design has reviewed the letter.

2.0 MATERIALS.

2.1 EPS Foam Blocks. Use EPS foam blocks meeting the requirements of ASTM D6817. The EPS blocks cannot contain chloro-fluorocarbon, hydro-chloro-fluorocarbon, or hydro-fluorocarbon compounds and shall be resistant to biological degradation including insect infestation.

The EPS foam block must be listed in KYPEL as Phase IX or Phase X and the block, and other materials associated with its installation, must meet all material requirements of this note. Materials from other Manufacturers of EPS blocks not listed in KYPEL may submit their product information to KYPEL for consideration at least 30 calendar days prior to beginning work.

For most applications, use EPS Blocks with standard dimensions approximately 2 to 3.5 feet tall by 4 feet wide by 8 to 16 feet long. Other proposed dimensions may be acceptable and will be evaluated on a case-by-case basis.

The EPS block Manufacturer is responsible for maintaining a quality control program to ensure compliance with this section.

2.1.1 Block Properties

*Type	EPS 22	EPS 29	EPS 39	EPS 46
Density (ASTM C1622)	1.35 pcf	1.80 pcf	2.40 pcf	2.85 pcf
Minimum Compressive Strength @ 1% Strain (ASTM D1621)	7.3 psi	10.9 psi	15.0 psi	18.6 psi
Minimum Flexural Strength (ASTM C203)	35 psi	50 psi	60 psi	75 psi
Minimum Oxygen Index (Volume %) (ASTM D2863)	24.0%	24.0%	24.0%	24.0%

*ASTM D6817, Table 1.

2.2 Block-to-Block Connectors. When horizontal forces cannot be resisted by the friction between blocks or when seismic loads are to be resisted, take appropriate measures to permanently secure the blocks and prevent horizontal block-on-block sliding. Secure the blocks as needed during construction to prevent movement and separation. At a minimum, connect the blocks using small sections of epoxy-coated steel reinforcing bars as needed. Bars should conform to Section 602 of the current Standard Specifications. Bars should not prevent the adjacent block surfaces from being in intimate contact. Other equivalent measures may be used if approved by the Engineer.

If required based on Manufacturer recommendations or geotechnical plan notes, use gripper plates to restrain EPS blocks from moving laterally in layer over layer applications. If required, gripper plate material properties and installation shall be in accordance with Manufacturer specifications.

2.3 Leveling Pad. Use sand meeting the requirements of Section 804 under the subsections pertaining to pipe bedding. Ensure that material is free of coal, shale, roots, organic matter, frozen material, and other deleterious materials.

2.4 Spill Protection Layer. The outer surfaces of the final block configuration (except the bottom of the block volume) should be protected against chemical spill, particularly petroleum products. In order to provide this protection, a geomembrane liner will be required unless otherwise specified in the contract documents. The geomembrane should be resistant to petroleum products and manufactured of High Density Polyethylene (HDPE) or Linear Low Density Polyethylene (LLDPE). The geomembrane should also be UV resistant. Use a **textured (both sides)** geomembrane when placed on continuous slopes (not benches). The geomembrane shall meet the minimum specifications below.

Contractor may propose other comparable alternates for the spill protection layer for review by the Engineer.

2.4.1 Geomembrane Properties

Dimensional Properties:

Special order roll dimensions are preferred to minimize the amount of seams.

Thickness (ASTM D5994) 30 mil (0.75 mm)

Tensile Properties (ASTM D6693):

Tensile Strength @ Break 60 lb/in width

Minimum Elongation @ Break 300%

Puncture Resistance (ASTM D4833): 35 lbs.

Tear Resistance (ASTM D1004): 15 lbs.

2.4.2 Geotextile Properties (if required)

The geotextile shall meet requirements of Section 843 of the current Standard Specifications for Geotextile Fabric for Subsurface Drainage and Separation. Place the fabric in accordance with Section 214 of the current Standard Specifications for Slope Protection and Channel Lining.

2.5 Soil Cap. A minimum 2-foot soil cap is required over the top surface of the geomembrane. The soil shall be classified as CL or CH in the Unified Soil Classification System. The first one (1) foot of material above the geomembrane shall have a top size of 0.5 inch.

2.6 Concrete Load Distributor. A concrete load distributor will be required when geofoam is placed beneath the paved roadway and there is less than 5 feet of soil between the pavement base material and the top layer of geofoam. Where a concrete load distributor is included in the design, use Class B concrete conforming to Subsections 601.02 and 601.03, and use epoxy-coated No. 4 steel bars as reinforcement. The steel reinforcement and epoxy coating shall conform to Section 602 of the Standard Specifications.

3.0 GEOTECHNICAL DESIGN PARAMETERS.

Use the geotechnical parameters below for the design of EPS foam block configurations.

3.1 Coefficient of Friction (for internal, block-on-block calculations). An appropriate coefficient of friction should be used to check for horizontal sliding between block layers. A value of 0.6 is typical for most block types. The selected coefficient of friction will be evaluated by the Department during review of the Lightweight Fill plans (if submission of plans is required based on Section 1.2.1). The Manufacturer should provide a coefficient of friction by certification, for use in the design calculations.

3.2 Unit Weight

3.2.1 **Lightweight fill above the groundwater elevation**. Where EPS foam blocks will be above the groundwater elevation the entire design life, a density of 3.2 lb/ft^3 should be used in settlement and stability analyses to account for long-term water absorption.

3.2.2 **Lightweight fill periodically submerged.** Where EPS foam blocks will be submerged periodically due to groundwater fluctuation, a density of 4.7 lb/ft^3 should be used in settlement and stability analyses to account for long-term water absorption.

3.2.3 **Lightweight fill continually below groundwater elevation.** Where EPS foam blocks will be continually below the groundwater table, a density of 6.3 lb/ft^3 should be used in settlement and stability analyses to account for long-term water absorption due to submersion.

3.3 Design for uplift forces. Conditions where blocks will be submerged shall be accounted for by considering uplift forces in design. The uplift forces must be counteracted with overburden or suitable restraint devices with geogrids or geomembranes. The minimum density for the specified block shall be used for these calculations. A minimum factor of safety against uplift of 1.3 should be provided.

3.4 Maximum Design Stress in Blocks. The maximum design stress in the geofoam blocks should not exceed 30% of the compressive strength developed at approximately 1% strain.

3.5 Global, Seismic and Internal Stability Analyses

Global stability calculations for geofoam embankment will be the responsibility of the DBT. If the Contractor elects to use a different unit weight, as discussed in Section 1.2.1, these stability calculations for the new EPS block weights will be the responsibility of the Contractor. Analyses should conform to Transportation Research Board (TRB) recommendations as outlined in NCHRP Web Document 65, Chapter 5 (global and seismic stability) and Chapter 6 (internal stability).

4.0 DELIVERY, STORAGE, AND HANDLING.

4.1 Delivery. Deliver materials in Manufacturer's original, undamaged condition with identification markings and labels intact.

4.2 Storage and Handling. Store EPS blocks so as to prevent them from being damaged. Ballast and/or secure blocks during storage and placement. Cover blocks with light-colored opaque tarps if stored outdoors for more than two weeks.

EPS blocks are combustible. Do not expose them to flame, cigarette smoking, or other ignition sources.

Do not operate any equipment directly on the EPS Blocks. If necessary, light weight rubber-tired equipment (with a contact pressure less than 15 psi may be allowed if a sufficient amount of plywood or other sheathing material is used on top of the blocks to allow the equipment to operate without damaging the blocks and if approved by the Engineer.

Do not expose the EPS Blocks to hydrocarbons, or petroleum-based solvents such as gasoline, diesel fuel, concrete curing compound, tar, and asphalt/mastic compounds.

Allow a minimum of seven days between the Manufacturer molding and the Contractor placing EPS blocks to allow adequate out-gassing of the blowing agent. A longer time period may be required by the Manufacturer.

5.0 SAMPLING AND TESTING.

5.1 Sampling. The Supplier shall obtain samples for testing by the Department, Division of Materials. Samples shall be obtained at a frequency of one set of samples per 500 cubic yards. One set of samples consists of ten (10) cubes, 2 inches on each side. Projects with less than 500 cubic yards of material will not require testing, and strength properties will be accepted based on EPS type and certification by the Manufacturer. The Supplier or Contractor may elect to obtain additional samples for independent testing.

5.2 Testing.

5.2.1 **Density.** The Department will perform 1 test per 500 cubic yards as outlined in Section 2.1 of this note. (The samples for compressive strength testing may also be used for density testing, if done before strength testing. Three (3) cube samples shall be individually measured and the average reported.)

5.2.2 **Compressive Strength.** Each individual sample obtained will be tested by the Department for compressive strength as outlined in Section 2.1 of this Special Note. Acceptance will be based on strength at 1% strain.

6.0 CONSTRUCTION. Place EPS Blocks in accordance with the Manufacturer's recommendations, in tight groups without gaps in the horizontal or vertical directions. The Contractor will be responsible for maintaining a stable slope during construction.

6.1 Surface Preparation. Smooth and level the surface and remove obstructions, debris or sharp objects that may damage the blocks. Conform to Standard Specifications Sections 202 and 207 when preparing the surface to be reinforced.

6.2 Leveling Pad. Construct a leveling pad to the lines, grades, and cross-sections as shown in the plans. Complete all leveling pad fill with a tolerance of ± 0.4 % (1/2 inch per 10 feet). The minimum thickness should be 8 inches, or as directed by the Engineer. There should be no debris or large pieces of vegetation protruding from the subgrade before placement of the leveling pad. Soil particles at the subgrade surface should be no larger than coarse sand to fine gravel (0.08 to 0.8 inch). Leveling pad materials and placement for EPS block construction will be incidental to EPS Foam Block, unless otherwise stated in the plans.

6.3 EPS Block Placement. Place EPS block such that blocks in successive courses are placed at 90° to the previous layer and offset so that joints between block layers are not continuous. Each horizontal joint between courses of block will be secured with a gripper plate or other connection device approved by the Engineer and the Manufacturer. The surface of the blocks must remain level within the ± 0.4% tolerance. Field cut the EPS Blocks for a tight fit at any cross-drain pipe or other similar obstruction as directed by the Engineer. Sand placement may be allowed by the Engineer between the block and obstruction if deemed necessary.

6.4 Spill Protection Layer.

6.4.1 The geomembrane should be installed according to the Manufacturer's recommendations, as shown on the EPS Geofoam Embankment Detail Sheet, and as directed by the Engineer. The chosen geomembrane configuration should prevent sliding of cover soil, protect against installation damage, and ensure adequate performance of any bends or curves in the geomembrane.

6.4.2 The Geomembrane Supplier or Installer is required to provide the layout plan for the installation of the geosynthetic material. Include a brief overview of the Installer's previous geomembrane installation experience with this submittal. This information may be submitted electronically. Allow 30 days for the Department to review this submittal.

6.4.3 The surface beneath the geomembrane shall be uniform and free of all sharp or angular objects prior to geomembrane placement. No objects larger than 0.5 inch should be protruding above the prepared subgrade. Any rebar used to connect blocks should be driven beneath the block surfaces. Gripper plates (if used) should be padded such to avoid puncturing the geomembrane with the sharp edges.

6.4.4 Seaming shall be performed in the field using a welding system and quality control testing in strict accordance with the Manufacturer's specifications. The weld seam shall provide the same physical and chemical resistance properties as the HDPE sheet.

6.4.5 The use of a geotextile above and/or beneath the geomembrane may be required to protect the geomembrane. This will be based on the Manufacturer's recommendations and will depend on the chosen configuration. The geotextile layer is required where geomembrane is placed adjacent to existing and/or proposed rock embankments.

6.4.6 Construction details for geomembrane/geofoam penetrations and adjacent structures should be provided by the Geomembrane Supplier or Installer. Construction for these situations should be conducted carefully to provide a seal that is capable of preventing leakage around the penetration or structure.

6.4.7 The geomembrane should be properly secured during construction to prevent shifting or development of wrinkles or folds. If an anchor trench is proposed for the installation, details should be provided by the Geomembrane Supplier or Installer.

6.4.8 The selected geomembrane material should be stored onsite in accordance with the Manufacturer's instructions, and should not be exposed to sunlight any longer than permitted by the Manufacturer's instructions.

6.5 Soil Cap. Two (2) feet of soil cover is required over the geomembrane. The first one (1) foot of fill placed above the geomembrane shall be a controlled fill with a top size of 0.5 inch. The material shall be placed in a single lift. This reduces the chance of puncturing the geomembrane.

6.6 Concrete Load Distributor. When a concrete load distributor is required (see Section 2.5 of this note), use a cap of reinforced, cast-in-place concrete with a minimum 4-inch thickness. Reinforce the concrete with epoxy-

coated No. 4 bars placed on two-foot centers in both directions, and provide one inch of clear cover from the bottom surface of the concrete.

7.0 ACCEPTANCE. Obtain the Department's approval for all material before incorporating it into the project.

7.1 Certification. Ensure that each EPS block shipment is accompanied by a Manufacturer's certification that the material satisfies the above specifications and any applicable test data for the specified physical properties for each lot number.

8.0 MEASUREMENT.

No separate measurement shall be made for EPS Foam Block. "EPS Foam Block" fill shall be measured based on the volume of lightweight fill shown on the plans. Changing the limits or character of the lightweight fill installation to conform to the lightweight fill Manufacturer's design and construction plans or the Contractor's selected construction methods shall not be cause for changing the plan quantities including plan roadway quantities.

If required, the Concrete Load Distributor and all associated materials will be incidental to EPS Foam Block.

The EPS Foam Block fill Manufacturer's design may require additional excavation, fill or lightweight fill volume, or incidental items to satisfy the lightweight fill design requirements. The Contractor will be responsible for maintaining a stable slope during construction. Sheeting, shoring, temporary walls or other earth retention systems necessary to stabilize any excavation required during lightweight fill construction will not be paid separately. All designs, labor, materials, etc. required to complete this work shall be incidental to EPS Foam Block.

Connection devices and sand Leveling Pad are incidental to EPS Foam Block construction and will not be paid for separately by the Department.

9.0 PAYMENT. Payment includes all equipment, labor, and materials necessary to furnish and install the EPS blocks according to the plans and specifications. The Department will make payment per the terms of the contract.

SPECIAL NOTE FOR WATERPROOFING MEMBRANE

I. DESCRIPTION

Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highways 2019 Standard Specifications for Road and Bridge Construction and applicable Supplemental Specifications, the Standard Drawings, this Note, and the Contract Documents. Section references are to the Standard Specifications.

This work consists of the following:

1. Furnish all labor, materials, tools, equipment, and incidental items necessary to complete the work.
2. Provide safe access to the top of the culvert, in accordance with Section 107.01.01, for the Engineer and for workers to complete the construction.
3. Any other work as specified as part of this contract.

II. MATERIALS

A. Waterproofing Membrane. See Section 808.05.02.

B. Surface Primer. Use surface primer recommended by the manufacture.

III. CONSTRUCTION

A. Surface Preparation. Thoroughly clean the entire surface of the culvert that will receive the membrane prior to installation. Clean by either air blasting or water blasting. If water blasting is used, thoroughly dry area prior to placing the primer and membrane.

B. Prime Coating. Apply material to the surface in accordance with manufactures recommendations.

C. One Step Membrane. Apply the membrane to the entire surface. Overlap the membrane a minimum of 1 foot onto the adjacent surfaces (i.e., parapets). Extend the membrane down the side of the culvert structures by 6". Overlap membrane as necessary to achieve 100% coverage of the surface. Install as recommended by the manufacturer, straight and wrinkle free, with no curled or uplifted edges.

IV. MEASUREMENT

The Department will measure the quantity as square yards. Laps, cutoffs, and waste will not be measured for payment.

V. PAYMENT.

The Department will make payment per the terms of the contract.

SPECIAL NOTE FOR MECHANICALLY STABILIZED EARTH RETAINING WALLS

HENDERSON COUNTY, KENTUCKY

1.0 DESCRIPTION

1.01 General and Experience Requirements:

The work under this section consists of designing, furnishing all materials and constructing Mechanically Stabilized Earth (MSE) retaining walls in accordance with the current Standard Specifications, this Special Note, in compliance with the lines and grades, dimensions and details shown on the project plans, and as directed by the Engineer.

The Contractor shall provide the MSE wall designer with a complete set of project plans and specifications and shall ensure that the wall design is compatible with all other project features that can impact the design and construction of the wall. The following terms are used in this specification for identification of various entities for which the Contractor shall be fully responsible:

Term	Entity
Wall Manufacturer	The entity contractually retained by the contractor to provide materials and construction services for an accepted MSE wall system as identified in Subsection 1.02.
Wall Designer	The entity contractually retained by the contractor to provide design of an accepted MSE wall system as identified in Subsection 1.02. The wall designer may be a representative of the wall manufacturer.
Department / Engineer	Refers to the Kentucky Transportation Cabinet representative and/or a designated consultant acting on behalf of KYTC.

1.02 Accepted Systems:

The contractor shall provide an MSE Wall System that uses inextensible reinforcement and reinforced concrete panels or modular block and is one of the pre-approved systems below. Inclusion of a system on this list does not relieve the Contractor and/or wall manufacturer of the contractual responsibility to satisfy all specific requirements herein and/or elsewhere in the contract documents.

- Reinforced Earth (Reinforced Earth and Retained Earth)
- Hilfiker RSE
- Tricon Retained Soil Wall System
- ISOGRID Retaining Wall System
- Keystone Keysystem I
- Sine Wall MSE Panel System
- Sanders Pre-Cast Concrete Systems

Rev. October 21, 2019

- Vista Wall Systems – Stabilized Earth Wall: Grid Strip Reinforcing
- Vista Wall MSE Structural Wall System: galvanized welded-wire, grid-type soil reinforcement

Heights and lengths of earth retaining walls may vary from, but shall not be less than, those shown on the plans. The height and length to be used for any system shall be the minimum for that system that will effectively retain the earth behind the wall for the loading conditions and the contours, profile, or slope lines shown on the plans, or on the approved working drawings, and in accordance with all relevant internal and external stability design criteria, but not more than the pre-approved height for the particular MSE wall system selected.

1.03 MSE Wall Design Engineer:

Requirements for the Wall Designer's **MSE Wall Design Engineer** (who may be employed by the wall manufacturer or may be a consultant) are:

- Licensed Professional Engineer in the Commonwealth of Kentucky with a minimum of 5 years of geotechnical and/or structural engineering experience.
- Design and/or construction experience on at least five (5) MSE Walls and a minimum of 50,000 square feet of MSE Wall completed in the past five (5) years. Experience on a Reinforced Soil Slope may be substituted for one wall and up to 10,000 square feet.
- Design experience on at least three (3) MSE Walls and a minimum of 30,000 square feet of MSE Wall on highway infrastructure projects using the wall system that will be used on this project completed in the past five (5) years.
- Completion of at least 15 Professional Development Hours related to the design and/or construction of MSE Walls in the past five (5) years. This training may consist of attendance at a related short course, conference, seminar, workshop, or college course. Include documentation of this training with the submittal of the Design Engineer's credentials.

1.04 Wall Aesthetics:

Wall aesthetics shall be as specified in the project documents and request for proposals.

1.05 Certifications:

(A) Certification of Design Parameters: See Subsection 2.01 herein specified.

(B) Certification of Materials: See Subsections 3.04, 3.07, 3.09 & 3.10 herein specified.

1.5 QUALITY CONTROL:

The Department will perform construction inspection for the MSE Walls. However, the Contractor will be required to proactively implement the quality control procedures described herein. All costs associated with MSE Wall Quality Control will be incidental to the cost of the wall.

1.51 MSE Wall Quality Coordinator:

The Contractor shall designate a MSE Wall Quality Coordinator who shall:

- have a minimum of 3 years of construction field experience,

- be responsible for ensuring that the Contractor's quality control procedures are implemented including maintaining and submitting the checklists required in Section 1.57, (but may have other duties and/or responsibilities),
- have sufficient authority to carry out quality coordinator responsibilities, and
- be in the field during MSE Wall construction.

1.52 Mandatory MSE Wall Construction Training:

The MSE Wall Designer or an approved appointee will provide training related to proper MSE Wall construction for Contractor and Department personnel. This training should occur after the contractor has selected the MSE Wall system and the Department has confirmed that the MSE Wall Design Engineer and Manufacturer's Technical Field Representative meet the specified requirements. The training will be conducted in the District by the Manufacturer's Technical Field Representative or an outside consultant meeting the experience requirements of the Manufacturer's Technical Field Representative. The MSE Wall Construction Training is expected to last one full day. Department personnel who will attend will include project inspection personnel and may include other district and central office personnel. The following contractor personnel are required to attend:

- On-Site Supervisor in charge of MSE Wall construction
- MSE Wall Quality Coordinator
- At least one office management level person representing the MSE Wall contractor
- If the MSE Wall is to be constructed by a subcontractor, at least one management level representative (field or office) of the Prime Contractor
- Manufacturer's Technical Field Representative referenced in Section 1.55 herein

At least one week before the training begins, the Contractor shall submit a list of specific persons who plan to attend.

1.53 Quality Control Plan:

The contractor shall submit a Quality Control Plan to the Engineer for review and acceptance which details measurements and documentation (including daily documentation checklists) that will be maintained by the Contractor during construction to assure consistency in meeting specification requirements. The Contractor shall coordinate the development of the Quality Control Plan with the MSE Wall System Manufacturer and the MSE Wall Design Engineer. The Quality Control Plan shall be submitted to the Engineer for acceptance at least four weeks before beginning MSE wall construction.

1.54 MSE Pre-Activity Meeting:

A pre-activity meeting will be scheduled and shall occur after the Quality Control Plan has been submitted and accepted by the Engineer and no later than two (2) weeks prior to commencement of MSE wall construction activity. As a minimum, this meeting shall be attended by representatives of the Contractor and MSE Wall Sub-Contractor (including wall construction crew chiefs and MSE Wall Quality Coordinator), MSE Wall Manufacturer's Technical Field Representative, Department District personnel as designated by the Branch Manager for Project Delivery and Preservation, Central Office Construction, and Geotechnical Branch. No wall construction activity shall be performed until the contractor's final submittals have been approved as having satisfactorily resolved all review comments and the pre-activity

meeting has been held.

1.55 Manufacturer's Technical Field Representative:

The MSE Wall System Manufacturer shall provide a technical field representative to provide assistance to the MSE Wall Contractor. The requirements for the **Manufacturer's Technical Field Representative** are:

- At minimum, an associate's or bachelor's degree with a major in a technical or scientific field such as engineering, engineering or construction technology, geology, physics, mathematics, etc.
- A minimum of five (5) years of technical experience related to engineering and/or construction.
- Construction experience on at least five (5) MSE Walls and a minimum of 50,000 square feet of MSE Wall completed in the past five (5) years. Experience on a Reinforced Soil Slope may be substituted for one wall and up to 10,000 square feet.
- Construction experience on at least three (3) MSE Walls and a minimum of 30,000 square feet of MSE Wall on highway infrastructure projects using the wall system that will be used on this project completed in the past five (5) years.
- Completion of at least ten (10) Professional Development Hours related to the design and/or construction of MSE Walls in the past five (5) years. This training may consist of attendance at a related short course, conference, seminar, workshop, or college course. Include documentation of this training with the submittal of the Technical Field Representative's credentials.

At least four weeks before beginning MSE wall construction, the Contractor shall submit documentation that the Technical Field Representative meets the above requirements.

The minimum required duties of the Manufacturer's Technical Field Representative are:

- Participate in the mandatory training referenced in Section 1.52 herein.
- Participate in the preparation of the Quality Control Plan referenced in Section 1.53 herein.
- Attend the MSE Pre-Activity Meeting referenced in Section 1.54 herein.
- Ensure that the contractor obtains all "Certificates of Analysis" required in Section 3.0 (Materials Requirements) of this Special Note.
- Review all "Certificates of Analysis" and supporting documentation and provide written documentation to the Contractor and Engineer that the reviews have been completed and that all materials meet the specified requirements.
- Review all Supervisor Checklists described in Section 1.57 herein.
- Be present at a minimum, during construction of the initial 10-foot height of the full length of wall for each wall system. Additionally the representative shall be present for the initial 10-foot height of the full length of wall for each wall system as constructed by each additional contractor, and as called upon thereafter by the Engineer, to assist the contractor and Engineer at no additional cost to the Agency.

- After each on-site visit, the Contractor is required to submit a letter to the Engineer written by the Manufacturer's Technical Field Representative documenting the observations of each visit with documentation that the MSE Wall Design Engineer has reviewed the letter.
- The manufacturer's technical field representative may recommend field changes subject to the approval of the MSE Wall Design Engineer and the Department. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the MSE Wall Design Engineer prior to implementation of the changes.
- The Department reserves the right to discuss matters pertaining to this project directly with the technical field representative and to require the Contractor to call the technical field representative to the site for assistance at no additional cost to the Department if, in the opinion of the Engineer, the Contractor is not satisfactorily complying with the plans and specifications.

1.56 Certificates of Analysis:

The Contractor will be responsible for performing and/or subcontracting all testing required to produce the Certificates of Analysis required in Section 3.0 (Materials Requirements) of this Special Note and for submitting the Certificates to the Engineer as required.

1.57 Checklists:

The Contractor's MSE Wall On-Site Supervisor and MSE Wall Quality Coordinator shall complete and both sign the checklists below and submit them to the Engineer with copies to the Manufacturer's Technical Field Representative. The first three of these checklists can be found in FHWA Publication No. FHWA-NHI-10-025 *"Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume II"*, dated November 2009 (these tables are located in the appendix of this document).

Checklists	
Checklist Title	**Submittal Requirements**
Checklist for Drawing Review (FHWA Table 11-2)	At least two weeks before starting MSE wall construction
Checklist for Specification Compliance (FHWA Table 11-3)	Weekly
Checklist for Construction (FHWA Table 11-5)	Weekly
Quality Control Documentation (Quality Control Plan)	Daily

1.58 MSE Wall Design Engineer:

The MSE Wall Design Engineer will be required to play an active role in the construction of the MSE walls and to be available to answer any questions that may arise during construction. Specifically, the MSE Wall Design Engineer is required to:

- Assist the Contractor and Manufacturer's Technical Field Representative with preparing the Quality Control Plan referenced in Section 1.53 herein.

- Make at least one site visit (4 hour minimum) while the Contractor is installing panels and reinforced fill material during the first 10 working days of panel and reinforced fill installation
- Review documentation of the Manufacturer's Technical Field Representative's site visits.

Additionally, the Design Engineer is required to attend the MSE Wall Construction Training and MSE Pre-Activity Meeting.

2.0 DESIGN SUBMITTALS (WORKING DRAWINGS AND DESIGN CALCULATIONS):

2.01 Submittals:

(A) General:

Design calculations and working drawings clearly showing conformance with the current Standard Specifications; AASHTO LRFD Bridge Design Specifications, current edition; KYTC Geotechnical Manual and project requirements shall be submitted for review. The format for the working drawings shall be in accordance with the Division of Structural Design's Guidance Manual. The first sheet shall be a title sheet.

Working drawings and design calculations shall be sealed by a licensed Professional Engineer in the Commonwealth of Kentucky. The MSE wall designer/supplier shall document on the working drawings all assumptions made in the design. The following statement shall be included near the P.E. seal on the first sheet of the working drawings: "All design assumptions are validated through notes or details on these drawings."

The Department assumes no responsibility for errors or omissions in the working drawings. Acceptance of the final working drawings submitted by the contractor shall not relieve the contractor of any responsibility under the contract for the successful completion of the work. Construction of the wall shall not commence until the contractor receives a written Notification to Begin MSE Wall Construction from the Engineer which will be issued once the complete wall package (drawings, calculations and construction procedures) is accepted. Fabrication of any of the wall components before the written Notification to Begin MSE Wall Construction shall be at the sole risk of the Contractor.

A Certificate of Analysis for the Reinforced Fill Material (See Sections 3.05 and 3.07 herein) may be required prior to final acceptance of the MSE Wall design.

(B) Review Submittals:

All review submittals shall be submitted electronically in pdf format through the Contractor to the Project Resident Engineer. The Project Resident Engineer shall forward the plans, calculations, and working drawings to the Department. Submittals may be directly emailed to applicable reviewers with the permission of the Contractor and Resident Engineer provided that the Contractor and Resident Engineer receive email copies of the submittals. Contact the Department before beginning any work on the wall designs and construction plans.

The submittals required shall include working drawings, the Contractor's and MSE Wall supplier's construction procedures, supporting design calculations, verification of experience, and a transmittal

letter. The transmittal letter shall only list the documents included in the submittal. No technical information shall be included in the transmittal letter.

Working drawings, design calculations and MSE supplier's construction procedures modified as necessary by the contractor and Wall Designer for site-specific conditions shall be submitted to the Engineer for review. The Engineer shall have 30 calendar days after receiving the six complete sets to finish a review. The revised package shall be resubmitted to the Engineer for review. The Engineer shall have 15 calendar days to complete this review. This review process shall be repeated until the entire submittal is accepted by the Engineer. Additional time required by the Department to review resubmissions shall not be cause for increasing the number of contract working days. The additional work required by the contractor to provide resubmissions shall be at no cost to the Department.

The Department reserves the right to require the contractor to verify that the Reinforced Wall Fill Material meets all applicable requirement before final acceptance of the design.

(C) Final Submittals:

All final wall tracings, with drawing number, shall be submitted on 3 mil, or thicker, 22" X 36" mylar film. The final mylar tracings of the accepted working drawings submitted to the Division of Structural Design shall be dated, sealed, and signed on Sheet 1 by the licensed Professional Engineer performing the work. Nine copies of the accepted working drawings shall be submitted.

2.02 Working Drawings:

The contractor shall submit complete working drawings and specifications for each installation of the system. Working drawings shall include the following at a minimum:

(1) Layout of the wall including plan and elevation views;

(2) All design parameters and assumptions including design life;

(3) Existing ground elevations and utilities impacted by the wall, and those that should be field verified by the contractor, for each location;

(4) Complete details of all elements and component parts required for the proper construction of the system at each location and any required accommodations for drainage systems, foundation subgrades or other facilities shown on the contract documents;

(5) The working drawing submittal shall clearly detail any special design requirements, <u>if applicable</u>. These special design requirements may include, but are not limited to: structural frames to place reinforcements around obstructions such as deep foundations and storm drain crossings, drainage systems, placement sequence of drainage and unit core fill with respect to reinforced (structure) fill behind a wall face using modular block facing units, guardrail post installation, scour protection, foundation subgrade modification, all corner details (acute, obtuse and 90 degrees), slip joints, joint details of MSE walls with other cast-in-place structures, wedges, shims and other devices such as clamps and bracing to establish and maintain vertical and horizontal wall facing alignments;

(6) A complete listing of components and materials specifications; and

(7) Other site-specific or project specific information required by the contract.

2.03 MSE Wall Design:

(A) General:

The working drawings shall be supplemented with all design calculations for the particular installation as required herein. Installations that deviate from the accepted design (by the Contractor's MSE Wall Design Engineer) shall be accompanied by supporting stability (internal; external; and global/overall and/or compound if required in the project documents) calculations of the proposed structure as well as supporting calculations for all special details not contained in the accepted design. The MSE wall designer/supplier shall note all deviations of the proposed wall design from the accepted design.

The proposed design shall satisfy the design parameters shown on the project plans and listed in this Special Note, and comply with the design requirements of AASHTO LRFD Bridge Design Specifications, current edition and the KYTC Geotechnical and Bridge Design Guidance Manuals. Unless otherwise specified in the contract, all structures shall be designed to conform to the requirements shown in Table 1 and other requirements specified herein.

If the designer uses software other than MSEW, a minimum of one analysis corresponding to the most critical design case for each MSE wall shall be submitted using MSEW software. Sample hand calculations containing a sketch, all external analysis for the design case, and internal analyses for a minimum of three reinforcement levels shall also be submitted for the most critical design case for each MSE wall.

Table 1 - MSE Wall Design Criteria and Parameters	
Design Life	100 years
Friction angle of granular retained backfill (where required)	36°
Friction angle of MSE reinforced fill material	34° *
Total Unit weight of granular retained backfill	120 pcf
Total Unit weight of MSE reinforced fill material	120 pcf **
Minimum reinforcement length	Greater of 8 ft. or 0.7 times effective height
Friction angle for sliding calculation (through reinforced fill)	34° *
Resistance factor for sliding	As specified in AASHTO LRFD Bridge Design Specifications
Wall Eccentricity	Verify as specified in AASHTO LRFD Bridge Design Specifications, current edition
Bearing Resistance Factor	As specified in AASHTO LRFD Bridge Design Specifications
Surcharge Loading	As specified in AASHTO LRFD Bridge Design

(due to vehicle loading behind the walls)	Specifications
Minimum top of leveling pad embedment	2 ft. below final grade or as specified by the Geotechnical Report

* For internally reinforced fill material, a minimum friction angle of 34 degrees shall be substantiated by laboratory tests discussed in Subsection 3.05(D). If the measured friction angle in laboratory tests as per Subsection 3.05(D) is greater than 34 degrees and the fill material is well-graded according to the Unified Soil Classification System (USCS), then the design friction angle may be increased up to a maximum of 38 degrees. See Table 5.

** The Total Unit Weight of the reinforced fill material shall be substantiated by laboratory tests discussed in Subsection 3.05(F). If the Total Unit Weight (i.e. SSD Bulk Density) obtained from laboratory tests as per Subsection 3.05(F) varies by more than +/- 5.0 pcf from the design value, then the design must be adjusted accordingly or reinforced fill material falling within this range must be used. See Table 5.

"H" is the design height of the wall and is defined as the difference in elevation from the finished grade at the top of wall and the top of leveling pad. The length of reinforcement, "L", is measured from the backface of the wall facing unit. If applicable, the length of grid type reinforcement is measured from the backface of the wall to the last full transverse member. "H' " is the effective height of the wall and is defined as: the design height "H" + (strap length "L" – distance from the wall face to the toe of slope) * tan (slope angle of backfill). In the case of horizontal backfill design height "H" equals effective height "H' ".The top of the leveling pad shall always be below the minimum embedment reference line as indicated on the plans for that location. If applicable, the total base length for modular block facing units, BT, as measured from the front face of the wall is the length L as defined above plus the width of the modular block unit (the horizontal dimension of the block unit measured perpendicular to the wall face).

(B) Subsurface Drainage Systems:

Walls shall be provided with subsurface drainage measures as shown on the project plans and specifications. As a minimum, an underdrain system shall be provided for leading subsurface and surface water away from the reinforced fill material and outside the limits of the wall. Geocomposite drains, if used for subsurface drainage, shall be in accordance with Section 845 of the current Standard Specifications.

(C) Obstructions in Reinforced Fill:

(1) General:

Where obstructions, such as deep foundations or storm drains crossings, are located in the reinforced fill material zone, cutting of reinforcements to avoid obstructions shall not be permitted. A minimum offset of one diameter but not less than three (3) feet shall be maintained between the face of any pipe crossings and the back face of retaining wall panels. A minimum clearance of three (3) feet shall be maintained between the face of any other obstruction and the back face of retaining wall panels.

(2) Horizontal Deflection of Reinforcements:

In the horizontal plane at a reinforcing level, a deviation up to fifteen (15) degrees from the normal to the face of the wall may be allowed for strip reinforcement and bolted connection. This

deviation is herein referred to as the splay angle. Grid reinforcements may not be splayed, unless connection has been specifically fabricated to accommodate a splay and connection detail has been approved by the Department. If used, the splay in grid reinforcement is limited to fifteen (15) degrees. For obstructions that cannot be accommodated with splayed reinforcement, structural frames and connections shall be required, and shall be designed in accordance with the AASHTO LRFD Bridge Design Specifications, current edition. The structural frame design shall be such that bending moments are not generated in the fill reinforcement or the connection at the wall face. The design, along with supporting calculations, shall be included in the working drawings.

(3) Vertical Deflection of Reinforcements:

Vertical deflection of the reinforcement to avoid obstructions such as utilities along the wall face shall be limited to a maximum of 15 degrees from normal to face of wall. Bends in the reinforcement shall be smooth and gradual to ensure that galvanization remains intact.

(D) Hydrostatic Pressures:

As determined by the Designer and/or as noted on the plans, for walls potentially subject to inundation, such as those located adjacent to rivers, canals, detention basins or retention basins. Effective unit weights shall be used in the calculations for internal and external stability beginning at levels just below the equivalent surface of the pressure head line. Where the wall is influenced by water fluctuations, the wall shall be designed for rapid drawdown conditions which could result in differential hydrostatic pressure.

(E) Acute Angle Corners:

Wall corners with an included angle of less than 70 degrees shall be designed for bin-type lateral pressures for the extent of the wall where the full length of the reinforcement cannot be installed without encountering a wall face. Acute angle corner structures shall not be stand-alone separate structures. Computations shall be provided that demonstrate deformation compatibility between the acute angle corner structure and the rest of the MSE wall. Full-height vertical slip joints shall be provided at the acute angle corner and after the last column of panels where full length of the reinforcements can be placed. The soil reinforcement attached to the slip joints shall be oriented perpendicular to the slip joint panels and shall be the full design length. Special connection and compaction details shall be provided on the working drawings.

(F) Spacing of Metallic Reinforcement for Flexible Face Wall Systems:

Permanent Flexible Face Wall Systems are not allowed.

(G) Fill Reinforcement for Modular Block Wall Systems:

The reinforcement lengths and percent coverage at a given reinforcement level shall be in accordance with the plans. All reinforcement shall be positively connected to the modular block facing units that is capable of resisting 100% of the maximum tension in the reinforcements at any level within the wall. Detailed documentation for connection strength shall be submitted as noted in Subsection 3.10. The vertical spacing of the reinforcement for walls with modular block facing units shall be as follows:

1. The first (bottom) layer of reinforcement shall be no further than 16 inches above the top of the leveling pad.

2. The last (top) layer of reinforcement shall be no further than 20 inches on the average below the top of the uppermost MBW unit.

3. The maximum vertical spacing between layers of adjacent reinforcement shall not exceed 32 inches. For walls deriving any part of their connection capacity by friction the maximum vertical spacing of the reinforcement should be limited to two times the block depth (front face to back face) to assure construction and long-term stability. The top row of reinforcement should be one-half the vertical spacing.

(H) Initial Batter of Wall:

The initial batter of the wall, both during construction and upon completion, shall be within the vertical and horizontal alignment tolerances included in this Special Note. The initial batter of the wall panels at the start of construction and the means and methods necessary to achieve the batter shall be provided on the working drawings. Subject to Engineer's approval, the initial batter of the wall panels may be modified at the start of construction by the manufacturer's field representative based on the evaluation of the reinforced fill material selected by the contractor. Any such changes shall be documented in writing within 24 hours of the approved changes. This written document shall be sealed by the manufacturer's design engineer who is a licensed Professional Engineer in the Commonwealth of Kentucky. Details of the wedges or shims or other devices, such as clamps and external bracing used to achieve or maintain the wall batter, and the details for removal of temporary wedges or shims shall be as shown on the working drawings and/or accompanying construction manual. Permanent shims shall comply with the design life criteria, and shall maintain the design stress levels required for the walls.

(I) Bridge Abutment Design Considerations:

Shallow Bridge Foundations supported by MSE wall systems are not allowed. All bridge loads must be supported by deep foundations.

3.0 MATERIAL REQUIREMENTS:

The contractor shall furnish the Engineer with Certificates of Analysis documenting that all materials meet the requirements herein.

3.01 Precast Concrete Elements:

Precast concrete shall attain a minimum 28-day compressive strength of 4,000 psi unless a higher strength is specified by the wall supplier. The concrete shall be air entrained containing 5.5 ± 1.5% entrained air at the time the concrete is placed in the forms. A proposed mix design shall be submitted.

Prior to casting, all embedded components shall be set in place to the dimensions and tolerances designated in the plans and specifications. Wall aesthetics shall be in accordance with project plans, special notes, and/or other applicable contract documents.

(A) Concrete Testing and Inspection:

Precast concrete elements shall be subjected to compressive strength testing and inspected for dimensional tolerances and surface conditions. Panels delivered to the site without Department approval will be rejected.

(B) Casting:

Precast concrete face panels shall be cast on a horizontal surface with the front face of the panel at the bottom of the form. Connection hardware shall be set in the rear face. The concrete in each precast concrete panel shall be placed without interruption and shall be consolidated by deploying an approved vibrator, supplemented by such hand tamping as may be necessary to force the concrete into the corner of

the forms, and to eliminate the formation of stone pockets or cleavage planes. Form release agents shall be used on all form faces for all casting operations.

The contractor shall advise the Engineer of the starting date for concrete panel casting at least 14 calendar days prior to beginning the operation if the casting operation is within the State, or 21 calendar days if the casting operation is outside the State.

(C) Finish:

(1) Non-Exposed Surfaces:

Rear faces of precast concrete panels shall be a face floated surface finish and screeded to eliminate open pockets of aggregate and surface distortions in excess of ¼ inch.

(2) Exposed Surfaces:

The type of finish required on exposed surfaces shall be as shown in the plans.

(a) Exposed Aggregate Finish:

(1) Prior to placing concrete, a set retardant shall be applied to the casting forms in accordance with the manufacturer's instructions.

(2) After removal from the forms and after the concrete has set sufficiently to prevent its dislodging, the aggregate shall be exposed by a combination of brushing and washing with clear water. The depth of exposure shall be between 3/8 inch and ½ inch.

(3) An acrylic resin sealer consisting of 80 percent thinner and 20 percent acrylic solids by weight shall be applied to the exposed aggregate surface at a rate of one (1) gallon per 250 square feet.

(b) Concrete Panel Finish:

Concrete panel finish shall be in accordance with the plans and specifications. A sample of the proposed finish consisting of four full-sized panels shall be fabricated for inspection by the Engineer. Fabrication of the remaining panels is not authorized until the Engineer has inspected the sample panels an approved the finish as acceptable.

(D) Tolerances:

Connection device placement shall be within ± 1 inch of the dimensions shown on the drawings. Panel squareness as determined by the difference between the two diagonals shall not exceed ½ inch.

(E) Identification and Markings:

The date of manufacture, the production lot number, and the piece mark shall be inscribed on a non-exposed surface of each element.

(F) Handling, Storage and Shipping:

All panels shall be handled, stored, and shipped in such a manner to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported in firm blocking to protect panel connection devices and the exposed exterior finish. Storing and shipping shall be in accordance with the manufacturer's recommendations.

(G) Compressive Strength:

Precast concrete elements shall not be shipped or placed in the wall until a compressive strength of 3,400 pounds per square inch has been attained. The facing elements shall be cast on a flat and level area and shall be fully supported until a compressive strength of 1,000 pounds per square inch has been attained.

(H) Precast Concrete Panel Joints:

(1) General:

Where the wall wraps around an inside corner, a corner block panel shall be provided with flange extensions that will allow for differential movement without exposing the panel joints. The back face of vertical and horizontal joints shall be covered with geotextile filter. Joint filler, bearing pads, and geotextile filter shall be as recommended by the wall manufacturer and shall meet the requirements shown on the approved working drawings.

If required, as indicated on the plans, flexible open-cell polyurethane foam strips shall be used for filler for vertical joints between panels, and in horizontal joints where pads are used.

All joints between panels on the back side of the wall shall be covered with a Type IV geotextile fabric meeting the requirements of Section 843 of the current Standard Specifications. The minimum width shall be one (1) foot.

(2) Bearing Pads:

All horizontal and diagonal joints between panels shall include bearing pads. Bearing pads shall meet or exceed the following material requirements:

- Preformed EPDM (Ethylene Propylene Diene Monomer) rubber pads conforming to ASTM D 2000 Grade 2, Type A, Class A with a Durometer Hardness of 70.
- Preformed HDPE (High Density Polyethylene) pads with a minimum density of 0.946 grams per cubic centimeter in accordance with ASTM D 1505.

The stiffness (axial and lateral), size, and number of bearing pads shall be determined such that the final joint opening shall be ¾ ± ⅛ inch unless otherwise shown on the plans. The MSE wall designer shall submit substantiating calculations verifying the stiffness (axial and lateral), size, and number of bearing pads assuming, as a minimum, a vertical loading at a given joint equal to 2 times the weight of facing panels directly above that level. As part of the substantiating calculations, the MSE wall designer shall submit results of certified laboratory tests in the form of vertical load-vertical strain and vertical load-lateral strain curves for the specific bearing pads proposed by the MSE wall designer. The vertical load-vertical strain curve should extend beyond the first yield point of the proposed bearing pad.

3.02 Steel Components:

(A) Galvanization:

Fill reinforcement steel shall be hot-dip galvanized in accordance with AASHTO M 111 (ASTM A123). Connection hardware steel can be galvanized by hot-dipping or other means, provided the method satisfies the requirements of AASHTO M 111 (ASTM A123). A minimum galvanization coating of 2.0 oz/ft^2 (605 g/m^2) or 3.4 mils (85 μm) thickness is required. Fill reinforcement steel shall be adequately supported

while lifting and placing such that the galvanization remains intact. Steel members with damaged (peeled) galvanization shall be repaired according to ASTM A780 and as specified in approved working drawings, at no additional cost to the Department.

(B) Metallic Reinforcing Strips and Tie Strips:

Reinforcing strips shall be hot-rolled from bars to the required shape and dimensions. The strips' physical and mechanical properties shall conform to the requirements of ASTM A572, Grade 65 minimum.

Tie strips shall be shop fabricated of hot-rolled steel conforming to the requirements of ASTM A1101, Grade 50 minimum. The minimum bending radius of the tie strips shall be ⅜ inch. Galvanization shall be applied after the strips are fabricated, inclusive of punch holes for bolts as shown on approved drawings.

(C) Metallic Reinforcing Mesh:

Reinforcing mesh shall be shop fabricated of cold-drawn steel wire conforming to the requirements of AASHTO M 32, and shall be welded into the finished mesh fabric in accordance with AASHTO M 55. Galvanization shall be applied after the mesh is fabricated. A minimum galvanization coating of 2.0 oz/ft^2 (605 g/m^2) or 3.4 mils (85 μm) thickness is required.

(D) Connector Pins:

Connector pins and mat bars shall be fabricated and connected to the fill reinforcement mats as shown in the approved working drawings. Connector bars shall be fabricated of cold drawn steel wire conforming to the requirements of AASHTO M 32.

(E) Welded Wire Fabric:

All welded wire fabric shall conform to the requirements of AASHTO M 32, AASHTO M 55, and the approved working drawings. Welded wire fabric shall be galvanized in conformance with the requirements of ASTM A123.

(F) Fasteners:

Connection hardware shall conform to the requirements shown in the approved working drawings. Connection hardware shall be cast in the precast concrete panels such that all connectors are in alignment and able to transfer full and even load to the fill reinforcement. Once the reinforcement is connected to the panel, the amount of slack shall not exceed ⅛ inch between the connector and the reinforcement during field installation. (If wedges are to be used to remove slack, the size, shape, and installation procedure with illustrations shall be included on the drawings and in the construction procedures.) Fasteners shall be galvanized and conform to the requirements of AASHTO M 164 or equivalent.

3.03 Geosynthetic Reinforcement:

Geosynthetic fill reinforcement is not allowed.

3.04 Certificate of Analysis for Fill Reinforcements:

For metallic wall reinforcement, a mill test report containing the ultimate tensile strength for the fill reinforcement shall be included in the certification. For metallic wall reinforcement, a mill test report containing the galvanization coverage shall be included in the certification. For metallic mesh wall reinforcement, a mill test report containing the ultimate weld strength for the fill reinforcement shall be included in the certification.

3.05 Reinforced Wall Fill Material:

Provide internally reinforced wall fill material consisting of quarry-processed limestone from a Department-approved quarry meeting all applicable general requirements of Section 805 of the Standard Specifications, current edition, and requirements herein. Provide material meeting the specific requirements for "Reinforced Fill Material" in Section 805 of the Standard Specifications, current edition, defined as "Non-Erodible" according to Section 805, and meeting all other requirements herein. Approval of the material source by the Department is required prior to beginning MSE wall construction.

(A) General:

Reinforced wall fill material shall be free of shale, organic matter, mica, gypsum, smectite, montmorillonite, or other soft poor durability particles. No salvaged material, such as asphaltic concrete millings or Portland Cement Concrete rubble, etc., will be allowed.

(B) Soundness and Shale:

The reinforced fill material shall have a soundness loss of 30 percent or less when tested in accordance with AASHTO T104 using a magnesium sulfate solution with a test duration of four cycles. Alternatively, the material shall have a soundness loss of 15 percent or less when tested in accordance with AASHTO T104 using a sodium sulfate solution with a test duration of five cycles. A maximum of 2.0% shale is permitted as determined by KM 64-604.

(C) Gradation:

Gradations will be determined per AASTHO T27 and shall be in accordance with Table 2, unless otherwise specified.

Table 2
REINFORCED FILL GRADATION REQUIREMENTS

Sieve Size	Percent Passing
4 inch	100
2 inch	40 – 90
No. 4	0 - 10
No. 200	0 – 5

This is the same gradation as required in Section 805.11 of the Standard Specifications except the requirement for the 2 inch sieve has been added.

Size # 23 in the Standard Specifications falls within these gradation limits.

(D) Internal Friction Angle Requirement:

The reinforced wall fill material shall exhibit an effective (drained) angle of internal friction of not less than 34 degrees, as determined by performing a Direct Shear Test in accordance with AASHTO T236 or ASTM D3080 A minimum of three (3) points (i.e. three normal stresses) is required to constitute a complete test.

The direct shear test shall be performed on the portion finer than the 1-inch sieve. In order to comply with the test method, a minimum 12-inch diameter circular box or minimum 12-inch square box is required. The sample shall be compacted directly in the shear device at the saturated surface dry (SSD) condition and in general accordance with the rodding procedure in AASHTO T-19.

(E) Electrochemical Requirements:

The reinforced wall fill material shall meet the electrochemical requirements of Table 3.

Table 3
ELECTROCHEMICAL REQUIREMENTS FOR METALLIC REINFORCEMENTS

Characteristic	Requirement	Test Method
Resistivity	> 3,000 ohm-cm	AASHTO T-288
pH	5.0 to 10.0	AASHTO T-289
Chlorides	< 200 ppm	ASTM D4327
Sulfates	< 1000 ppm	ASTM D4327
Organic Content	< 1.0 %	AASHTO T-267

* If the resistivity is greater or equal to 5,000 ohm-cm, the chloride and sulfate requirements may be waived.

Table 4 – VACANT

(F) Saturated Surface Dry (SSD) Bulk Density:

The Bulk Density of the Reinforced Fill Material shall be obtained in accordance with AASHTO T19. The Bulk Density at the oven-dry condition shall then be corrected using the Absorption determined according to AASHTO T-85 to determine the SSD Bulk Density, which shall be within +/- 5.0 pcf of the design total unit weight of MSE reinforced fill material or the design shall be adjusted. (See Table 1.)

(G) Limits of Reinforced Wall Fill Material:

The reinforced fill material shall extend to at least one (1) foot beyond the free end of the reinforcement. If applicable, back-to-back walls wherein the free ends of the reinforcement of the two walls are spaced apart less than or equal to one-half the design height of the taller wall, reinforced wall fill material shall be used for the space between the free ends of the reinforcements as well. The design height of the wall is defined as the difference in elevation between finished grade at top of wall and the top of leveling pad. The top of the leveling pad shall always be below the minimum embedment reference line as indicated on the plans for the location under consideration.

3.06 Granular Embankment for Foundation and Retained Backfill:

Provide granular foundation material and granular external retained backfill consisting of "Granular Embankment" meeting the material requirements of Section 805 in the current edition of the Standard Specifications and defined as "Non-Erodible" according to Section 805. If required by design, the extent of the granular foundation material and granular external retained backfill shall be shown in the Geotechnical Notes. Contrary to the Standard Specifications, no natural sand is permitted. Also contrary to the Standard Specifications, the maximum size limit for "Granular Embankment" is 4 inches where shown in the Geotechnical Sheets. Approval of the material source by the Department is required prior to beginning placement of this material.

3.07 Sampling & Testing of Reinforced Wall Fill and Granular Embankment Materials

(A) Reinforced Wall Fill:

To obtain source approval, the contractor shall furnish the Engineer with an 80-pound representative sample of the reinforced wall fill material and a Certificate of Analysis containing results of all tests referenced in Table 5 at least four weeks prior to beginning construction of the MSE wall.

During construction, the reinforced fill material shall be sampled and tested by the Engineer for acceptance and quality control testing. A new sample and Certificate of Analysis shall be provided any time the material and/or source changes.

Table 5 - Sampling Frequency for Reinforced Wall Fill Material

Function	Tests	Frequency
Source Approval	Soundness (AASHTO T104)* % Shale (KM 64-604)* Gradation (AASHTO T27)*	At least four (4) weeks prior to beginning MSE wall construction and once per material change and/or change in source.
Testing by Contractor and/or its Consultant(s)	Direct Shear (AASHTO T236 or ASTM D3080)* Organic Content (AASHTO T267)* SSD Bulk Density (AASHTO T19 & T85)* Resistivity (AASHTO T288)**	Except for Direct Shear, one test is valid for up to 10,000 ft^2 of MSE wall area if there is no material change or change in source. **** Generally, only one Direct Shear test is required unless

	pH (AASHTO T289)** Chlorides and Sulfates (ASTM D4327)**	there is a change in material, source, or gradation.
Acceptance and Quality Control Testing by Department	Gradation (AASHTO T27) % Shale (KM 64-304) At the discretion of the Engineer.	One per 2,000 cubic yards at job site. (A change of more than +/- 5.0 percent passing any sieve size will require additional SSD Bulk Density testing and may require additional Direct Shear testing, both by the Contractor.)
	Any other applicable requirements of Section 805 of the current Standard Specifications	As required by the current Materials Field Sampling and Testing Manual, Standard Specifications, and/or other Department policy.

* The laboratory performing these tests must be accredited by the AASHTO Materials Reference Laboratory (AMRL) for the tests they perform. AMRL accreditation for AASHTO T104 & T27 is required to perform KM 64-604.

** Although accreditation for the specific test methods may not be available, the laboratory performing these tests must be accredited or certified by one of the organizations below. A laboratory's accreditation or certification status does not relieve the laboratory of its responsibility to perform the tests in accordance with the specified methods.

- AMRL - Soil and/or Aggregate (Resistivity and pH only)
- American Association for Laboratory Accreditation (A2LA) - Chemical and/or Environmental
- Kentucky Division of Water - Drinking Water Chemical Analyses

The Contractor may consult the Geotechnical Branch to ensure that a lab is accredited or certified.

**** e.g. 1 to 10,000 ft^2 of wall requires 1 test, 10,001 to 20,000 ft^2 requires 2 tests, etc.

(B) Granular Embankment Material for Foundation and Retained Backfill:

To obtain source approval, the contractor shall furnish the Engineer with an 80-pound representative sample of the Granular Embankment material and a Certificate of Analysis at least four weeks prior to beginning Granular Embankment construction.

Table 6

Sampling Frequency for Granular Embankment for Foundation and Retained Backfill

Function	Frequency
Source	At least four weeks prior to beginning granular embankment construction and once per material change and/or change in source.

Approval	
Acceptance and Quality Control	In accordance with standard procedures for "Granular Embankment".

3.08 Cast-in-Place Concrete:

Cast-in-place concrete shall be Class A, except that the leveling pads shall be Class B, both in accordance with the current Standard Specifications.

3.09 Modular Block (Segmental) Facing Units:

This section covers dry-cast hollow and solid concrete masonry structural retaining wall units, machine made from Portland cement, water, and suitable mineral aggregates. The units are intended for use as facing units in the construction of mortarless, modular block walls (MBW) also known as segmental retaining walls (SRW). Metallic reinforcement specified in Section 3.02 shall be used as reinforcement in the reinforced (structure) wall fill zone.

(A) Casting:

Cementitious material in the modular block facing unit shall be Portland cement conforming to the requirements of ASTM C 150. If fly ash is used it shall not exceed 20% by weight of the total cement content and shall conform to ASTM C 618. Aggregates used in concrete blocks shall conform to ASTM C 33 for normal weight concrete aggregate. Efflorescence control agent shall be used in concrete mix design to prevent efflorescence on the block.

The contractor shall advise the Engineer of the starting date for concrete panel casting at least 14 calendar days prior to beginning the operation if the casting operation is within the State, or 21 calendar days if the casting operation is outside the State.

(B) Physical Requirements:

At the time of delivery to the work site, the modular block facing units shall conform to the following physical requirements:

1) Minimum required compressive strength of 4,000 psi (average 3 coupons)
2) Minimum required compressive strength of 3,500 psi (individual coupon)
3) Minimum oven dry unit weight of 125 pcf
4) Maximum water absorption of 5 % after 24 hours
5) Maximum number of blocks per lot of 2,000. Tests on blocks shall be submitted at the frequency of one set per lot.

Acceptance of the concrete block, with respect to compressive strength, water absorption and unit weight, will be determined on a lot basis. The lot shall be randomly sampled and tested in accordance with ASTM C140. As no additional expense to the Department, the manufacturer shall perform the tests at a Department approved laboratory and submit the results to the Engineer for approval. Compressive strength test specimens shall be cored or shall conform to the saw-cut coupon provisions of ASTM C 140. Block lots represented by test coupons that do not reach an average compressive strength of 4,000 psi will be rejected.

(C) Freeze-Thaw Durability:

In areas where repeated freezing and thawing under saturated conditions occur, the units shall be tested to demonstrate freeze-thaw durability in accordance with Test Method ASTM C1262. Freeze thaw durability shall be based on tests from five specimens made with the same materials, concrete mix design, manufacturing process, and curing method, conducted not more than 18 months prior to delivery. Specimens used for absorption testing shall not subsequently be used for freeze-thaw testing. Specimens shall comply with either or both of the following acceptance criteria depending on the severity of the project location as determined by the Department:

1) The weight loss of four out of five specimens at the conclusion of 150 cycles shall not exceed 1% of its initial weight when tested in water.
2) The weight loss of each of four out of the five test specimens at the conclusion of 50 cycles shall not exceed 1.5% of its initial mass when tested in a saline (3% sodium chloride by weight) solution.

(D) Tolerances for Modular Block Dimensions:

Modular blocks shall be manufactured within the following tolerances:

1) 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 1¼ inches.
2) The height of each individual block shall be within ± 1/16 inch of the specified dimension.
3) When a broken (split) face finish is required, the dimension of the front face shall be within ± 1.0 inch of the theoretical dimension of the unit.

(E) Finish and Appearance:

Units that indicate imperfect molding, honeycomb or open texture concrete and color variation on front face of block due to excess form oil or other reasons shall be rejected. All units shall be visually efflorescence free. 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 1/50 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 exposed faces 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 1.0 inch.

Color and finish shall be as shown on the plans and shall be erected with a running bond configuration.

(F) Pins:

If pins are required to align modular block facing units, they shall consist of a non-degrading polymer or hot-dipped galvanized steel and be made for the express use with the modular block units supplied. Connecting pins supporting the reinforcement shall be hot-dipped galvanized steel and be capable of holding the reinforcement in the proper design position during backfilling.

(G) Cap Units and Adhesive:

The cap unit connection to the block unit immediately under it shall be of a positive interlocking type and not frictional. Cap units shall be cast to or attached to the top of modular block facing units in strict accordance with the requirements of the manufacturer of the blocks and the adhesive. The surface of the block units under the cap units shall be clear of all debris and standing water before the approved adhesive is placed. Contractor shall provide a written 10-year warranty, acceptable to Owner, 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.

(H) Unit (Core) Fill:

Unit (core) fill is defined as free-draining, coarse grained material that is placed within the empty cores of the modular block facing units. Unit (core) fill shall be a well graded crushed stone or granular fill meeting the gradation shown in Table 7. Gradation for unit fill shall be tested at the frequency of 1 test per 50 yd^3 at the job site and for every change in the material source.

Table 7

Gradation for Unit (Core) Fill

U.S. Sieve Size	Percent Passing
1½-inch	100
1-inch	75-100
¾-inch	50-75
No. 4	0-60
No. 40	0-50
No. 200	0-5

3.10 Certificate of Analysis for Modular Block Connection:

For modular block facing units, a certification shall be provided with detailed calculations according to AASHTO and the results of laboratory test results performed in accordance with Section C.3 in Appendix B of FHWA NHI-10-025, dated 2009 ("Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume II"). Such certification shall demonstrate that all connections, including block-to-reinforcement and block-to-block connections, and all related components meet or exceed the current AASHTO 100 year design life requirements and are capable of resisting 100% of the maximum tension in the soil reinforcements at any level within the wall. Long-term connection testing for extensible reinforcements is also required. The effect of wall batter and normal pressures representative of the full range of wall configurations and heights shall be incorporated in the tests.

4.0 CONSTRUCTION REQUIREMENTS:

Construction of MSE walls may be subject to special requirements as specified in the Geotechnical Report and Geotechnical MSE Wall Note Sheets developed by the Design Build Team. These requirements may include but are not limited to: monitoring devices (refer to section 4.5), phased panel and reinforced fill construction, waiting period intervals and foundation modification.

4.01 Excavation:

The contractor shall ensure that temporary slopes are safe during the period of wall construction, and shall adhere to all applicable local, state and federal regulations. During construction of the MSE walls, the contractor shall design, construct, maintain and, when called for, remove temporary excavation support systems (shoring). Temporary excavation support systems may be left in place if approved by the Engineer. The back slope of the excavation shall be benched. Where shoring is required, the contractor shall submit the shoring design, and a plan outlining construction and removal procedures, to the Engineer for review and approval prior to proceeding with the work. Shoring plans shall be prepared and submitted as part of the working drawings and shall bear the seal and signature of a licensed Professional Engineer in the Commonwealth of Kentucky. All shoring design shall include appropriate input and review by a geotechnical engineer.

4.02 Foundation Preparation:

(A) General:

If required, specific ground improvement requirements shall be outlined in the Geotechnical Report and the Geotechnical Note Sheets.

In general the following applies:

The foundation for the reinforced wall fill and retained backfill shall be graded level for the entire area of the base of such backfills, plus an additional 12 inches on all sides, or to the limits shown in the plans.

If soil reinforcement components are to be positioned on native soil, the top one (1) foot of native soil shall meet the requirements of the reinforced backfill material specified in Subsection 3.05.

Foundation replacement material shall consist of "Granular Embankment" meeting the requirements of Section 3.06 herein. The material shall be compacted in accordance with Section 206 of the current Standard Specifications except that the maximum loose lift thickness (prior to compaction) is 12 inches. Type IV Geotextile Fabric shall be placed between the existing embankment material and the proposed "Granular Embankment" in accordance with Sections 214 and 843 of the Standard Specifications.

(B) Proof-Rolling:

The contractor shall perform proof-rolling to evaluate the stability and uniformity of the subgrades on which the MSE structure will be constructed. Proof rolling shall be performed on the entire areas at the following locations:

1) At the bottom of the overexcavation and recompaction zones.
2) At the bottom of the overexcavation and replacement zones.
3) At the base of all walls.
4) At the top of native soil layers and/or existing fill material that has been scarified, moisture-conditioned, and recompacted (if different from the bottom of the overexcavation and recompaction zones, or overexcavation and replacement zones).

Proof-rolling shall be done immediately after subgrade compaction while the moisture content of the subgrade soil is near optimum, or at the moisture content that was used to achieve the required compaction.

Proof-rolling shall be performed again within one day prior to beginning MSE Wall construction.

If proof-rolling is performed after installation of pipe underdrains, the proof-roller shall not be used within 1½ feet of the underdrains.

Proof-rolling shall be performed with a pneumatic-tired tandem axle roller with at least three wheels on each axle, a gross weight of 25 tons (50,000 pounds), a minimum tire pressure of 75 pounds per square inch, and a minimum rolling width of 75 inches. A Caterpillar PS-300B (or PF-300B), Ingersoll-Rand PT-240R, BOMAG BW24R, Dynapac CP271, or equipment with equivalent capabilities shall be used for proof-rolling.

Proof-rolling equipment shall be operated at a speed between 1.5 and 3 miles per hour, or slower as required by the Engineer to permit measurements and/or observations of the deformations, ruts and/or pumping.

Proof-rolling shall be carried out in two directions at right angles to each other with no more than 24 inches between tire tracks of adjacent passes. The contractor shall operate the proof-roller in a pattern that readily allows for the recording of deformation data and complete coverage of the subgrade.

The following actions shall be taken based on the results of the proof-rolling activity:

1) Rutting (i.e. deformation that does not rebound) less than ¼-inch – The grade is acceptable.
2) Rutting greater than ¼-inch and less than 1½ inches – The grade shall be scarified and re-compacted.
3) Rutting greater than 1½ inches – The compacted area shall be removed and reconstructed.
4) Pumping (i.e. deformation that rebounds, or materials that are squeezed out of a wheel's path) greater than one (1) inch – The area shall be remediated as directed by the Engineer.

The contractor shall be responsible for maintaining the condition of the approved proof-rolled soils throughout the duration of the retaining wall construction. Wall construction shall not commence until the foundation subgrade has been approved by the Engineer.

4.03 Concrete Leveling Pad:

Leveling pads shall be constructed of unreinforced Class B concrete meeting the requirements of Section 601 of the current Standard Specifications as shown on the working drawings. Gravel leveling pads shall not be allowed. The elevation of the top of leveling pad shall be within ⅛ inch from the design elevation when measured by a straightedge over any 10-foot run of the leveling pad.

The minimum width of the leveling pad shall be the width of the facing unit plus 8-inches. The centerline of the leveling pad shall be within 1 inch from design location. When the facing units are centered on the leveling pad, the leveling pad shall extend approximately 4-inches beyond the limits of the facing unit as measured in the direction perpendicular to the face of the wall.

Cast-in-place leveling pads shall be cured for a minimum of 48 hours before placement of wall facing units. A geotextile shall be applied over the back of the area of any openings greater than ¼ inch between the facing units and leveling pad steps. The geotextile shall extend a minimum of six (6) inches beyond the edges of the opening. The opening shall be filled with Class B concrete, or shall be concurrently backfilled on both sides with soil.

4.04 Subsurface Drainage:

Prior to wall erection, the contractor shall install a subsurface drainage system as shown on the working

drawings.

4.05 Wall Erection:

(A) General:

Walls shall be erected in accordance with the approved manufacturer's written construction procedures. The contractor shall be responsible for ensuring that a field representative from the manufacturer is available at the site during construction of the **initial 10-foot height of the full length of wall for each wall system. Additionally the representative shall be present for the initial 10-foot height of the full length of wall for each wall system as constructed by each additional contractor,** and as called upon thereafter by the Engineer, to assist the contractor and Engineer at no additional cost to the Department. All temporary construction aids (e.g., wedges, clamps, etc.) shall be in accordance with the manufacturer's recommendations.

(B) Placement Tolerances for Walls with Precast Facing:

For walls with rigid facing, such as precast concrete panels, the panels shall be placed such that their final position is vertical or battered as shown on the working drawings. As wall fill material is placed, the panels shall be maintained in the correct vertical alignment by means of temporary wedges, clamps, or bracing as recommended by the manufacturer. A minimum of two, but not more than three, rows of panel wedges shall remain in place at all times during wall erection. Wedges shall be removed from lower rows as panel erection progresses, so as to prevent chipping or cracking of concrete panels. The contractor shall repair any damage to erected concrete panels as directed by the Engineer and to the Engineer's satisfaction. No external wedges in front of the wall shall remain in place when the wall is complete.

Erection of walls with panel facing shall be in accordance with the following tolerances:

- Vertical and horizontal alignment of the wall face shall not vary by more than ¾ inch when measured along a 10-foot straightedge.
- The overall vertical tolerance (plumbness) of the finished wall shall not exceed ½ inch per 10 feet of wall height. Negative (outward leaning) batter is not acceptable.
- The maximum permissible out of plane offset at any panel joint shall not exceed 3/8 inch.
- The final horizontal and vertical joint gaps between adjacent facing panel units shall be within 1/8 inch and ¼ inch, respectively, of the design final joint opening per the approved calculations required in Subsection 3.01(H).

Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Department.

(C) Placement Tolerances for Permanent Walls with Flexible Facing:

Permanent Flexible Facing is not allowed.

(D) Placement Tolerances for Modular Block Units:

Erection of walls with Modular Block Units shall be as per the following requirements:

- Vertical and horizontal alignment of the wall face shall not vary by more than ¾-inch when measured along a 10-feet straightedge.

- Overall vertical tolerance (plumbness) of the wall shall not exceed 1¼-inch per 10-ft of wall height from the final wall batter. Negative (outward leaning) batter is not acceptable.
- The first row of units shall be level from unit-to-unit and from front-to-back. Use the tail of the units for alignment and measurement.
- All units shall be laid snugly together and parallel to the straight or curved line of the wall face.
- Unless otherwise noted, all blocks shall be dry-stacked and placed with each block evenly spanning the joint in the row below (running bond). Shimming or grinding shall control the elevations of any two adjacent blocks within 1/16 inch.
- The top of blocks shall be checked with a minimum length of 3-feet long straight edge bubble level. Any high points identified by the straight edge shall be ground flat. Block front to back tilting shall be checked frequently, however correction by shimming shall be done no later than 3 completed courses.
- Wall sections not conforming to these tolerances shall be reconstructed at no additional cost to the Department.

(E) Placement of Metallic Reinforcement Elements:

Metallic reinforcement elements shall be placed normal (perpendicular) to the face of the wall, unless otherwise shown on the approved plans. All reinforcement shall be structurally connected to the wall face.

At each level of the reinforcement, the reinforced wall fill material shall be roughly leveled and compacted before placing the next layer of reinforcement. The reinforcement shall bear uniformly on the compacted reinforced fill from the connection to the wall to the free end of the reinforcing elements. The reinforcement placement elevation shall be at the connection elevation to two (2) inches higher than the connection elevation.

Where overlapping of reinforcing may occur, such as at corners, reinforcing connections to panels shall be adjusted to maintain at least three (3) inches of vertical separation between overlapping reinforcement.

(F) Placement of Geotextile:

All joints between precast concrete panels shall be covered with geotextile on the backside of the wall. Adhesive shall be applied to panels only. Adhesive shall not be applied to geotextile fabric or within two (2) inches of a joint. The contractor shall provide geotextile having a minimum width of 12 inches, and shall overlap fabric a minimum of four (4) inches. If applicable, the placement of the geotextile fabric for modular block walls shall be in accordance with the plans.

(G) Joint Pads and Fillers:

The contractor shall install joint pads and fillers as shown on the working drawings.

(H) Placement of Geosynthetic Reinforcement:

Geosynthetic reinforcement is not allowed.

4.06 Reinforced Wall Fill Placement:

(A) General:

Reinforced wall fill material shall be compacted using a static-weighted or vibratory roller. Sheeps-foot or grid-type rollers shall not be used for compacting material within the limits of the fill reinforcement.

Compaction within three (3) feet of the wall facing shall be achieved by a lightweight mechanical tamper or roller system.

Reinforced wall fill placement shall closely follow erection of each course of facing panels. Reinforced fill material shall be placed in such a manner to avoid damage or disturbance of the wall materials, misalignment of facing panels, or damage to fill reinforcement or facing members. The contractor shall place fill material to the level of the connection and in such a manner as to ensure that no voids exist directly beneath reinforcing elements.

If applicable, the fill material for walls with modular block facing units shall not be advanced more than the height of a modular block unit until the drainage fill, core fill and all fill in all openings within the blocks at that level have been placed. The filled units shall be swept clean of all debris before installing the next level of units and/or placing the geogrid materials.

The maximum compacted lift thickness shall not exceed eight (8) inches. The contractor shall decrease this lift thickness, if necessary, to obtain the specified density.

For metallic reinforcements, the fill shall be spread by moving the machinery parallel to or away from the wall facing and in such a manner that the steel reinforcement remains normal to the face of the wall. Construction equipment shall not operate directly on the steel reinforcement. A minimum fill thickness of three (3) inches over the steel reinforcement shall be required prior to operation of vehicles. Sudden braking and sharp turning shall be avoided.

Wall materials which are damaged during reinforced fill material placement shall be removed and replaced by the contractor, at no additional cost to the Department. The contractor may submit alternative corrective procedures to the Engineer for consideration. Proposed alternative corrective procedures shall have the concurrence of the MSE wall supplier and designer, in writing, prior to submission to the Engineer for consideration. All corrective actions shall be at no additional cost to the Department.

(B) Compaction Criteria:

Trial fill sections shall be constructed with Department personnel present to determine appropriate criteria to achieve adequate compaction. The trial fill sections shall be performed as follows:

- One trial fill section is valid for up to 10,000 ft^2 of MSE wall area (e.g. 1 to 10,000 ft^2 of wall requires 1 trial fill section, 10,001 to 20,000 ft^2 requires 2, etc.) and for no more than one individual MSE wall.
- The minimum dimensions of the test pad shall be 15 ft. wide by 50 ft. long.
- The lift thickness shall not exceed eight (8) inches after compaction.
- Compaction shall be determined by using a level to measure the settlement of the trial section at a number of points after each pass (e.g., a minimum of 5 points measured at the center of a 1 ft square metal plate or other method approved by the Engineer).
- A thickness of approximately 2.5 feet shall be constructed to determine the appropriate number of passes, which will maximize compaction without excessively crushing the rock at the surface.
- The number of passes to achieve at least 80 percent of the maximum settlement will be required for production work.

- Only those methods used to establish compaction compliance in the trial fill section shall be used for production work.
- A material change, change in source, a difference of more than +/- 5.0 percent passing any sieve size, and/or change in the approved equipment shall require the contractor to conduct a new trial fill section and obtain re-approval by the Engineer of the minimum number of passes and rolling pattern.
- The Department reserves the right to use other test methods to evaluate the adequacy of the compaction criteria.
- The trial fill sections are incidental to the bid price for Retaining Wall.

Within three (3) feet of the wall facing, compaction criteria shall be determined using test pad sections with Department personnel present to determine appropriate criteria to achieve adequate compaction. The test pad sections shall be performed as follows:

- The minimum dimensions of the test pad shall be 5 ft. wide by 15 ft. long.
- The lift thickness shall not exceed eight (8) inches after compaction.
- Compaction shall be determined by using a level to measure the settlement of the test pad section at a number of points after each pass (e.g., a minimum of 3 points measured at the center of a 1 ft square plate or other method approved by the Engineer).
- A thickness of approximately 2.5 feet shall be constructed to determine the minimum number of passes of a lightweight mechanical tamper or roller system.
- The number of passes to achieve at least 80 percent of the maximum settlement will be required for production work.
- Only those methods used to establish compaction compliance in the test pad section shall be used for production work.
- A material change, change in source, a difference of more than +/- 5.0 percent passing any sieve size, and/or change in the approved equipment shall require the contractor to conduct a new test pad section.
- The test pad sections are incidental to the bid price for Retaining Wall.

(C) Moisture Control:

The free moisture content of the reinforced fill material, as determined by KM 64-306, shall not exceed 2.0% during compaction.

(D) Protection of the Work:

The contractor shall not allow surface runoff from adjacent areas to enter the wall construction site at any time during construction operations. In addition, at the end of each day's operation, the contractor shall slope the last lift of fill material away from the wall facing so that runoff is directed away from the structure. If the subgrade is damaged due to water or otherwise, such that it does not meet the requirements of Subsection 4.02, then as directed by the Engineer, the contractor shall rework and repair the damaged subgrade at no additional expense to the Department. The criteria in Subsection 4.02 shall be used to judge the adequacy of the repair. Rework and repair shall extend to a depth where undamaged work is encountered.

4.07 Retained Backfill Placement:

As required by the Geotechnical Report and plan notes the retained backfill (i.e. external backfill outside of the reinforced volume) may consist of either soil or "Granular Embankment" meeting the requirements of Section 3.06 herein. The material shall be compacted in accordance with Section 206 of the current Standard Specifications except that the maximum loose lift thickness (prior to compaction) is 12 inches. Type IV Geotextile Fabric shall be placed between the existing embankment material and the proposed "Granular Embankment" in accordance with Sections 214 and 843 of the Standard Specifications.

4.5 MONITORING:

4.51 Monitoring Devices:

The Geotechnical Report may require devices to monitor vertical and horizontal displacement both during and after construction. The Contractor will be responsible for providing labor and materials and for cooperating with, and providing, any required assistance to Department personnel with implementation of monitoring activities. The cost of all labor and materials required to support the monitoring program will be incidental to the cost of the.

The approximate locations of any monitoring devices shall be shown in the Working Drawings prepared by the MSE Wall Designer.

4.52 Monitoring Schedule:

The monitoring schedule for any required monitoring device shall be as agreed upon in the Geotechnical Report for the structure.

5.0 METHOD OF MEASUREMENT:

Retaining Walls will not be measured for payment.

Payment will be made under the terms of the contract.

ATTACHMENT 18.13 Pavement Design

See KYTC Pavement Design Guide and Appendix A, B, C, D, and F for additional guidance. All pavement designs provided in this document are intended to provide the minimum structure (based on structural number) for each respective section.

General Notes (All Designs)

1. Type of chemical stabilization (lime or cement) to be determined by DBT based on final geotechnical information and report. Final application rate(s) will also be recommended by the DBT and approved by the KYTC Geotechnical Branch.
2. Category A Ride Quality requirements will apply (Asphalt and Concrete Pavement). This will apply for any segment of the project with a posted speed greater than 45mph and an unbroken segment length greater than 0.4-mile, unless otherwise indicated. For all other segments Category B Ride Quality will apply.
3. Option A asphalt compaction warrants apply.
4. Asphalt Seal is required from outside edge of paved shoulder to a point 2 feet down the ditch or fill slope. Two applications of the following:

00103	Asphalt Seal Coat	2.40 LB/SY
00100	Asphalt Seal Aggregate	20 LB/SY

I-69 Auxilliary Lane, Digouts, and Ramp Extensions between KY 425 and Audubon Parkway
Assumed Design Criteria (CBR=3; ADT=20,747; %T=10.9; AADTT=2,261)

Asphalt Pavement (no pavement type alternate allowed)

Driving Lanes

CL4 Asph Surf 0.50A PG76-22	1.5 in.
CL4 Asph Base 1.0D PG76-22	3.0 in.
CL4 Asph Base 1.0D PG64-22	4.0 in.
CL4 Asph Base 1.0D PG64-22	4.0 in.
Crushed Stone Base	8.0 in.

Shoulders

CL3 Asph Surf 0.5D PG64-22	1.5 in.
CL3 Asph Base 1.0D PG64-22	3.0 in.
CL3 Asph Base 1.0D PG64-22	4.0 in.
CL3 Asph Base 1.0D PG64-22	4.0 in.
Crushed Stone Base	8.0 in.

Notes

1. The existing pavement on US 41 has longitudinal edge drains at the edge of the driving lanes. New longitudinal pavement edge drains will be required for the entire length of the new auxiliary lane between KY 425 and the Audubon Parkway at the outside edge of the new paved shoulder. The existing longitudinal edge drains will have outlets installed at the break location if it is at the low end. All longitudinal pipe drainage systems shall have an outlet to a headwall, median box inlet, ditch box, or curb box inlet. Outlets shall be in a fill section whenever possible. For 4-inch pipe, outlet spacing shall not exceed 500 feet except for grades 1% or less. On these grades, the spacing of the outlets shall not exceed 250 feet. All sags shall have an outlet. Spacing for 6-inch pipe may be doubled. The design engineer shall spot these on the plans or in the proposal.

I-69 Full-Depth Pavement Station 3740+00 to 3783+79 and 3797+30 to 3955+00 (Ramps shall match schedule below) (Alternate Pavement)
Assumed Design Criteria (CBR=3; ADT=33,140; %T=10.9; AADTT=3,612)

Asphalt Pavement

Driving Lanes

CL4 Asph Surf 0.50A PG76-22	1.5 in.
CL4 Asph Base 1.0D PG76-22	3.0 in.
CL4 Asph Base 1.0D PG64-22	3.75 in.
Drainage Blanket-Type II-Asph	4.0 in.
Asphalt Curing Seal	2 lb/sy
DGA Base	4.0 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Shoulders

CL3 Asph Surf 0.50D PG64-22	1.5 in.
CL3 Asph Base 1.0D PG64-22	3.0 in.
CL3 Asph Base 1.0D PG64-22	3.75 in.
Drainage Blanket-Type II Asph	4.0 in.
Asphalt Curing Seal	2 lb/sy
DGA Base	4.0 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Concrete Pavement

Driving Lanes

JPC Pavement-11 inch	11 in.
Crushed Stone Base	6 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Shoulders

JPC Shoulder-11 inch	11 in.
Crushed Stone Base	6 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Notes

1. Longitudinal pavement edge drains will be required regardless of pavement type. All longitudinal pipe drainage systems shall have an outlet to a headwall, median box inlet, ditch box, or curb box inlet. Outlets shall be in a fill section whenever possible. For 4-inch pipe, outlet spacing shall not exceed 500 feet except for grades 1% or less. On these grades, the spacing of the outlets shall not exceed 250 feet. All sags shall have an outlet. Spacing for 6-inch pipe may be doubled. The design engineer shall spot these on the plans or in the proposal.

KY 351 (Alternate Pavement)

Assumed Design Criteria (CBR=3; ADT=15,964; %T=5.9; AADTT=943)

Asphalt Pavement

Driving Lanes

CL3 Asph Surf 0.50A PG64-22	1.5 in.
CL3 Asph Base 1.0D PG64-22	3.0 in.
CL3 Asph Base 1.0D PG64-22	3.5 in.
Crushed Stone Base	6.0 in.
Geogrid Reinforcement for Subgrade	
Fabric-Geotextile Class 1	

Shoulders

Standard Curb and Gutter	
Crushed Stone Base	6.0 in.
Geogrid Reinforcement for Subgrade	
Fabric-Geotextile Class 1	

Concrete Pavement

Driving Lanes

JPC Pavement-8 inch	8 in.
Crushed Stone Base	6 in.
Geogrid Reinforcement for Subgrade	
Fabric-Geotextile Class 1	

Shoulders

Standard Integral Curb	
Crushed Stone Base	6.0 in.
Geogrid Reinforcement for Subgrade	
Fabric-Geotextile Class 1	

Notes

1. Longitudinal pavement edge drains will be required regardless of pavement type. All longitudinal pipe drainage systems shall have an outlet to a headwall, median box inlet, ditch box, or curb box inlet. Outlets shall be in a fill section whenever possible. For 4-inch pipe, outlet spacing shall not exceed 500 feet except for grades 1% or less. On these grades, the spacing of the outlets shall not exceed 250 feet. All sags shall have an outlet. Spacing for 6-inch pipe may be doubled. The design engineer shall spot these on the plans or in the proposal.

US 41 Full-Depth Pavement Station 1227+88 to 1249+75 (Alternate Pavement)

Assumed Design Criteria (CBR=3; ADT=33,140; %T=10.9; AADTT=3,612)

Asphalt Pavement

Driving Lanes

CL4 Asph Surf 0.50A PG76-22	1.5 in.
CL4 Asph Base 1.0D PG76-22	3.0 in.
CL4 Asph Base 1.0D PG64-22	3.75 in.
Drainage Blanket-Type II-Asph	4.0 in.
DGA Base	4.0 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Shoulders

CL3 Asph Surf 0.50D PG64-22	1.5 in.
CL3 Asph Base 1.0D PG64-22	3.0 in.
CL3 Asph Base 1.0D PG64-22	3.75 in.
Drainage Blanket-Type II Asph	4.0 in.
DGA Base	4.0 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Concrete Pavement

Driving Lanes

JPC Pavement-11 inch	11 in.
Crushed Stone Base	6 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Shoulders

JPC Shoulder-11 inch	11 in.
Crushed Stone Base	6 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Notes

1. Longitudinal pavement edge drains will be required regardless of pavement type. All longitudinal pipe drainage systems shall have an outlet to a headwall, median box inlet, ditch box, or curb box inlet. Outlets shall be in a fill section whenever possible. For 4-inch pipe, outlet spacing shall not exceed 500 feet except for grades 1% or less. On these grades, the spacing of the outlets shall not exceed 250 feet. All sags shall have an outlet. Spacing for 6-inch pipe may be doubled. The design engineer shall spot these on the plans or in the proposal.

US 60 Full-Depth Pavement (Alternate Pavement)

Assumed Design Criteria (CBR=3; ADT=7,562; %T=4.9; AADTT=371)

Asphalt Pavement

Driving Lanes

CL2 Asph Surf 0.50B PG64-22	1.5 in.
CL2 Asph Base 1.0D PG64-22	3.0 in.
CL2 Asph Base 1.0D PG64-22	3.5 in.
Crushed Stone Base	6.0 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Shoulders

Standard Curb and Gutter	
Crushed Stone Base	6.0 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Concrete Pavement

Driving Lanes

JPC Pavement-8 inch	8 in.
Crushed Stone Base	6 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Shoulders

Standard Integral Curb	
Crushed Stone Base	6 in.
Sand for Blotter	5 lb/sy
Asphalt Curing Seal	2 lb/sy
Chemical Stabilized Roadbed	12 in.

Notes

1. Longitudinal pavement edge drains will be required regardless of pavement type. All longitudinal pipe drainage systems shall have an outlet to a headwall, median box inlet, ditch box, or curb box inlet. Outlets shall be in a fill section whenever possible. For 4-inch pipe, outlet spacing shall not exceed 500 feet except for grades 1% or less. On these grades, the spacing of the outlets shall not exceed 250 feet. All sags shall have an outlet. Spacing for 6-inch pipe may be doubled. The design engineer shall spot these on the plans or in the proposal.

Kimsey Lane/Van Wyk Road and Tillman-Bethel Road Full-Depth Pavement

Assumed Design Criteria (CBR=3; ADT=620; %T=5; AADTT=31)

Asphalt Pavement

Driving Lanes

CL2 Asph Surf 0.38D PG64-22	1.5 in.
CL2 Asph Base 1.0D PG64-22	4.5 in.
Crushed Stone Base	8.0 in.

Shoulders

CL2 Asph Surf 0.38D PG64-22	1.5 in.
CL2 Asph Base 1.0D PG64-22	4.5 in.
Crushed Stone Base	8.0 in.

Merrill Trail Multi-Use Path Pavement

Asphalt Pavement

CL2 Asph Surf 0.38D PG64-22	1.5 in.
CL2 Asph Base 1.0D PG64-22	3.0 in.
Crushed Stone Base	4.0 in.

KY 2084 Full-Depth Pavement

Assumed Design Criteria (CBR=3; ADT=3494; %T=10.1; AADTT=353)

Asphalt Pavement

Driving Lanes

CL2 Asph Surf 0.38D PG64-22	1.5 in.
CL2 Asph Base 1.0D PG64-22	3.0 in.
CL2 Asph Base 1.0D PG64-22	4.0 in.
Crushed Stone Base	6.0 in.

Shoulders

CL2 Asph Surf 0.38D PG64-22	1.5 in.
CL2 Asph Base 1.0D PG64-22	3.0 in.
Crushed Stone Base	10.0 in.

Entrance Pavement Design(s)

1. Commercial entrances shall be concrete per RPM-150-08 and RPM-152-08 of the Kentucky Standard Drawings, current edition.
2. See the KYTC Highway Design Manual Section 1001.6 for minimum pavement designs for entrances, frontage roads, access roads, and minor approaches. Pavement type should match existing adjacent pavement, unless otherwise approved by the Engineer.

SPECIAL NOTE FOR DOWEL BAR AND TIE BAR PLACEMENT IN JPC PAVEMENT

This Special Note will apply where indicated on the plans or in the proposal. Section references herein are to the Department's current Standard Specifications for Road and Bridge Construction.

1.0 DESCRIPTION. This Special Note applies when new JPC pavement is placed on a project. Allowable tolerances are outlined for both dowel bar and tie bar placement in driving lanes and shoulders. Concrete patches will not be tested under this special note unless they are required as corrective work under subsection 3.1. Testing applies to all joints except that transverse joints in the shoulders will not be tested. *Working with concrete requires at least seven days or more of curing time. The concrete should be dry for at least 24 hrs prior to testing.*

This Special Note specifies the allowable tolerances for placement of dowel bars and tie bars in JPC pavement.

2.0 MATERIALS. Conform to Subsection 501 or 502 of the current Standard Specifications. Consistent with Standard Drawing RPS-020-13, dowel baskets will be manufactured with the mid-point of the dowel bar at T/2.

3.0 CONSTRUCTION.

3.1 Dowel Bars. Transverse dowel bars, which are generally in baskets, should be located in the center of the slab vertically. They should not be skewed or rotated. Contrary to Section 501 of the Standard Specification and Standard Drawing RPS-020-13, place dowel bars to the tolerances shown in the table below.

Dimension	**Tolerance**
Horizontal offset	+ 1 inch
Longitudinal translation	+ 3 inches
Horizontal skew	½ inch, max
Vertical skew	½ inch, max
Vertical depth	The minimum distance below the concrete pavement surface must be: DB=T/3 + ½ inch Where: DB = vertical distance in inches, measured from the concrete pavement surface to any point along the top of dowel bar; and T = actual concrete pavement thickness at joint location, in inches. The maximum distance below the surface to any point along the dowel bar should be 2T/3.

Dowel bars determined to be out of tolerance are to be marked in the field with marking paint. Corrective work will be required for the following circumstances:

- if 3 or more bars are higher than T/3 + ½ inch from the top of the slab or lower than 2T/3 (as measured from the top) for the bottom of the slab
- if 3 or more bars are translated longitudinally 3 inches or more
- if more than two consecutive joints have any bars that are skewed vertically or horizontally

Any corrective work shall be completed in accordance with the current special note 11J – Special Note for Full Depth Concrete Pavement Repair. Contrary to Special Note 11J, all joint repairs completed due to corrective work shall be sealed with silicone rubber unless approved by the Engineer.

3.2 Tie Bars. Install tire bars at a depth equal to ½ of the slab thickness. Tie bars shall be perpendicular to the longitudinal joint and parallel with the concrete pavement surface. Installation shall be to the tolerances outlined below.

- Not less than ½ inch below the saw cut depth of the joints
- 2” clearance from the tie bar and bottom of pavement

Corrective action will be required for the following circumstances:

- 2 consecutive tie bars are missing or outside of the tolerance listed above
- 4 or more bars in a slab are missing or outside of the tolerances listed (does not have to be consecutive)

The correction shall be made by cross stitching to place the new tie bars accordingly.

4.0 MEASUREMENT

4.1 Testing Limits. All driving lanes requiring load transfer assemblies will be tested with Ground Penetrating Radar (GPR) equipment. All longitudinal joints will be tested. The Kentucky Transportation Center (KTC) will perform all testing.

4.2 Validation. A minimum of one location per lane mile will be cored to verify GPR testing. Two 4 inch cores shall be obtained at each location. One core will be taken on each dowel bar end to expose both ends and allow physical measurements. KTC will conduct coring while the contractor shall patch all core holes.

November 5, 2014

COMMONWEALTH OF KENTUCKY

TRANSPORTATION CABINET
DEPARTMENT OF HIGHWAYS

ORX-69 Section 1

Adding ITS devices in Section 1

TABLE OF CONTENTS

TABLE OF CONTENTS 2
Section 1: **PROJECT DESCRIPTION** 3
Section 2: **SITE PREPARATION** 7
Section 3: **ADVANCED GROUNDING SYSTEM** 8
Section 4: **POLE BASE** 9
Section 5: **POLE WITH LOWERING DEVICE** 9
Section 6: **WEB CAMERA ASSEMBLY (CCTV)** 18
Section 7: **RACK MOUNT UPS** 19
Section 8: **COMMUNICATIONS CABLE** 20
Section 9: **CONDUIT** 21
Section 10: **ELECTRICAL SERVICE** 22
Section 11: **MODEL 334 AND 336 ENCLOSURES** 22
Section 12: **JUNCTION BOX** 29
Section 13: **SURGE DEVICES** 30
Section 14: **SMART WORK ZONE TRAILER** 32
Section 15: **Dynamic Message Sign (DMS/VMS – Overhead – Single Pole Mount)** 34
Section 16: **DMS/VMS Manufacturer Contract Requirements** 39
Section 17: **DMS/VMS Construction and Operation** 45
Section 18: **DMS/VMS Controller Requirements** 59
Section 19: **DMS/VMS Requirements for Control Equipment Cabinets** 69
Section 20: **DMS Control Software Requirements** 73
Section 21: **DMS/VMS Requirements for NTCIP Conformance** 83
Section 22: **TRENCHING AND BACKFILLING** 85
Section 23: **Vented Rodent Barrier Detail** 85
Section 24: **GLOSSARY** 87

Section 1: PROJECT DESCRIPTION

GENERAL

This project includes furnishing and installing a DMS/VMS, prior to the Section 1 project area on I-69 northbound as well as installing comprehensive camera coverage in the Section 1 project area to allow monitoring throughout the project area in addition to providing insight into traffic volumes at the interchanges with I-69. In addition, a minimum of 4 Smart Work Zone Trailers are required to be provided as well as a verification camera for the (DMS/VMS – Overhead – Single Pole Mount). The DBT shall utilize this document along with the project ITS RFP to obtain a complete picture of the desired ITS system and requirements. This equipment will expand the traffic monitoring and advisory capabilities of the District, KYTC TOC and TRIMARC.

This ITS Project complies with the requirements of 23 CFR 940. The ITS work to be performed is referenced in the current Kentucky 2009 Statewide ITS Architecture at Appendix C-4,5 and C-4 (Traffic Incident Management System ATMS08, and Traffic Information Dissemination ATMS06), and in the Updated Section 5 and Appendix B of the 2009 Addendum to the Original Kentucky ITS Business Plan.

EQUIPMENT AND MATERIALS

All equipment and materials shall be new, free of defects and damage.

SPECIFICATIONS AND WORKMANSHIP

Unless otherwise specified, all work shall conform to the following:

- Kentucky Standard Specifications for Road and Bridge Construction, latest edition.
- FHWA, Manual on Uniform Traffic Control Devices, latest edition.
- National Electrical Code, latest edition.
- National Electric Safety Code, latest edition.
- KYTC Department of Highways Standard Drawings, current editions.
- KYTC Department of Highways Sepia Drawings, current editions.
- International Municipal Signal Association (IMSA) Specification No. 51-7, current edition.
- AASHTO, Roadside Design Guide, latest edition.
- AASHTO, Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, latest edition.

All work shall be performed in a neat and professional manner. The Contractor shall remove debris and trash from work areas during construction. The Contractor shall restore areas to original condition and clean up all debris after construction.

DAMAGE TO EXISTING FACILITIES

The Contractor shall be responsible for locating all underground utilities prior to excavation. The contractor shall repair damage caused to any public or private facilities at his expense. Utilities include but are not limited to telephone, power, water, gas, fiber optic cable, underground vaults, roadway lighting wiring, traffic signal wiring, and roadway drainage systems.

MATERIALS LIST

The contractor shall provide an equipment list in Microsoft Excel format to the Engineer containing the following information:

- Type of equipment
- Field location
- Make
- Model
- Serial number
- Date of purchase
- Manufacturer contact information
- Equipment vendor contact information (if different)
- Date of Installation
- Date warranty expires

This list shall be provided to the Division of Traffic Operations prior to burn-in testing.

WARRANTY

The Contractor shall provide a copy of all equipment warranty information to the Division of Traffic Operations. A warranty of 2 years from the date of official project completion and acceptance is required for all equipment with the extra stipulation that the warranty period for the DMS/VMS equipment be warrantied for 5 years.

The Contractor shall provide documentation from the manufacturer that ownership of the warranty is transferred to the following:

Kentucky Transportation Cabinet
Division of Traffic Operations
200 Mero Street
Frankfort, KY 40622

TESTING

The Contractor shall demonstrate proper functioning of all devices at the field cabinets.

A 30-day equipment burn-in test will begin after each device is demonstrated to be operational at the field site and remote operation has been integrated and is fully operational. If a device fails during the 30 burn-in day test the Contractor shall repair or replace the device and demonstrate that the device is functioning at the field cabinet and a new 30-day burn-in test will begin for that device. Each device will be accepted after it has successfully completed its 30-day test. The 30-day burn-in test will be conducted by TOC personnel (in Frankfort and/or TRIMARC in Louisville) from the operations center and consist of operational control of PTZ and video of the remote camera location and DMS/VMS control to activate and deactivate messages.

SHOP DRAWINGS

All items that are used on this project shall have shop drawings sent to Engineer, who will contact Division of Traffic Operations for approval. All items shall be approved before purchase of said items.

AS-BUILT DRAWINGS

The Contractor, at the completion of the project, shall submit as-built drawings. As-built drawings shall be submitted in electronic format such as .pdf, .tiff, .dgn or other standard image format acceptable to the Engineer. As-built drawings may be scanned from marked up field plans or drawn in MicroStation. As-built drawings shall be scanned at a resolution that will allow them to be clearly legible on a computer display. As-built drawings shall include the exact location of all above ground equipment, underground conduit, wire, sensors and other equipment. Drawings shall indicate any changes to the design including changes to the numbers of conductors, wire gage, splices, additional conduit, etc. Conduit locations shall be drawn to scale or shall be dimensioned and referenced to permanent roadway features. Turns in conduit shall be referenced so that the conduit paths may be derived from the as-built drawings. Existing underground utilities shall be indicated on the drawings. Two copies of the drawings shall be submitted. One copy of the drawings shall be submitted to the Engineer. One copy of the drawings shall be submitted to the KYTC Division of Traffic Operations Design Services Branch, Ted.Swansegar@ky.gov and one copy to Todd.Hood@peraton.com with one copy delivered to the local District Office Engineer in Charge of the Project. The Contractor shall correct any drawings that are deemed unacceptable to the Engineer. As-built drawings shall be delivered prior to burn-in testing.

COORDINATION

SYSTEM COMPATIBILITY

The Contractor is responsible for coordinating with KYTC/TRIMARC to insure equipment compatibility and to complete integration of equipment into the KYTC?TRIMARC project.

COMMUNICATIONS

Camera shall communicate with the control center over the new ethernet IP connection (coordinated with KYTC/TRIMARC). The Contractor shall be responsible for furnishing and installing all conduits, junction boxes and communication cables installed on Kentucky right-of-way as specified in the plans. The Contractor shall be responsible for the installation and correct operation of all communications systems located in the field cabinet to the field devices. Testing of the Contractor's work will be performed both locally at the cabinet and remotely at the TRIMARC Traffic Operations Center. TRIMARC personnel will assist with any troubleshooting necessary to resolve problems with the communication equipment.

EQUIPMENT LIST

The contractor shall provide an equipment list in Microsoft Excel format to the Engineer containing the following information:

- Type of equipment
- Field location
- Make
- Model
- Serial number
- Date of purchase
- Manufacturer contact information
- Equipment vendor contact information (if different)
- Date of Installation
- Date warranty expires

This list shall be provided to the KYTC Division of Traffic Operations and TRIMARC Systems Administrator prior to burn-in testing. See below for TRIMARC Info:

Mr. Todd Hood
TRIMARC Systems Administrator
901 W. Main St.
Louisville, KY 40202
Phone: 502-587-6624
Office: 502-290-7201
Email: Todd.Hood@peraton.com
Kentucky Transportation Cabinet
Division of Traffic Operations Attn: Ted Swansegar
200 Mero Street
Frankfort, KY 40622
Ted.Swansegar@ky.gov

TESTING

The contractor shall demonstrate proper functioning of all devices at the field communications demarcation point. After each device can be successfully operated at the field communications demarcation point the devices will be integrated into the TRIMARC Traffic Operations Center. A 30 day equipment burn-in test will begin after each device is integrated and can be remotely controlled from the operations centers. The Contractor is responsible for repairing or replacing defective equipment during the period between the field test and the start of the 30 day burn-in test.

The 30 day burn-in test will be conducted by TRIMARC from the operations center and consist of operational control of PTZ and video of the remote camera location.

If a device fails during the 30 burn-in day test, TRIMARC personnel will test the device at the field cabinet. If the device cannot be operated at the field cabinet the Contractor shall repair or replace the device and a new 30-day burn-in test will begin for that device.

The project will be accepted after all devices have completed their 30-day test successfully, acceptable as-built drawings and warranty information have been received.

Section 2: SITE PREPARATION

DESCRIPTION

Site Preparation shall be performed in accordance with the plans, specifications and Standard Drawings.

MATERIALS

Site Preparation shall include all materials required to access and protect the work area.

INSTALLATION

The Contractor shall coordinate with the Engineer prior to performing any site preparation work. This item includes excavation, guardrail removal, guardrail replacement, temporary ditch crossings, temporary barriers and clearing of debris and foliage. Salvaged materials may be used at the discretion of the Engineer. Site preparation shall be one per VMS sign location and WEB/CCTV camera location. There shall not be site preparation for locations that have web cameras installed on existing signal poles and existing highmast.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Site Preparation will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The

Department will consider payment as full compensation for all work required under this section.

Section 3: ADVANCED GROUNDING SYSTEM

DESCRIPTION

Furnish and install Advanced Grounding System in accordance with the plans, specifications and Standard Drawings.

MATERIALS

Unless otherwise specified, the grounding system provided will be as shown in "Advanced Grounding System Details". Minimum ground resistance reading needs to be 10 ohms or less as tested via the 3 point fall of potential test method.

If the installation of the advanced grounding system is not possible due to physical constraints of the location or other extenuating factors, the TRIMARC Systems Engineer or Traffic Engineer may allow for a standard ground installation. The standard installation would be with ground wiring consisting of solid bare copper #4 AWG and securely connected inside enclosures with #4 AWG copper clamp connectors. Nuts and washers securing the wire are not acceptable. All grounding shall meet the National Electric Code. Ground wires shall be exothermically welded to the ground rods. Ground rod clamps are not acceptable. The following devices shall be grounded to an array of two or three, 10' X 1" copper coated steel ground rods:

- Model 334/336 Enclosures (two ground rods required)
- Camera Poles (three ground rods required)
- Side-mounted VMS(two ground rods required)
- Service Locations(two ground rods required)

All ground rods in arrays shall have a minimum of 6' separation.

The resistance to ground shall be less than 10 Ohms as measured with an AEMC clamp on ground resistance meter or equivalent. The Contractor shall leave all exothermic welds exposed for inspection by the TRIMARC Systems Engineer or Traffic Engineer before backfilling.

INSTALLATION

All grounding shall be according to standards shown on "Advanced Grounding System Details". If contractor needs help with installation, they can contact Alltec Corporation for further assistance at 800-203-2658.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Advanced Grounding System will be measured for payment per each. The Department will make payment for complete, functioning, inspected, and accepted

quantities. The Department will consider payment as full compensation for all work required under this section.

Section 4:
POLE BASE

DESCRIPTION

Furnish and install Pole Base in accordance with the plans, specifications and Standard Drawings.

MATERIALS

Pole Base includes concrete, anchor bolts, reinforcing steel, and conduit within base. The Contractor shall submit to material testing at the discretion of the Engineer.

INSTALLATION

The Contractor shall stake all proposed pole base locations and obtain approval before excavation. The Traffic Engineer (District 5) will approve locations for pole bases in their districts. Any poles bases in Bullitt shall be approved by the TRIMARC representative. The Contractor shall have utilities marked in the field prior to requesting approval. The Contractor shall allow two weeks to schedule the location approval. KYTC/TRIMARC approval of field device location does not relieve the contractor from his responsibility to avoid utilities and repair any damage to buried infrastructure. The Contractor shall grade and re-seed all disturbed areas and restore the area to the satisfaction of the Engineer. Poles located behind guardrail shall have a minimum 5' spacing from edge of pole to face of guardrail. Otherwise, poles shall be located as according to the plans sheets or a minimum of 30' from all driving lanes. This item includes all excavation including any special equipment required to install the base in rock. This item shall include a vented rodent barrier furnished and installed by the contractor. See Vented rodent barrier detail.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Pole Base/Pole Base-High Mast will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 5: POLE WITH LOWERING DEVICE

General Description

The camera lowering system shall be designed to support, lower and raise an Ethernet fed IP CCTV Camera, housing, and PTZ mechanism without damage or causing degradation of camera operations. The camera lowering system and the pole are interdependent; and thus, must be considered a single unit or system. The lowering system shall consist of a pole, adjustable plate mounted pole top tenon,

tenon adapter for lowering device attachment to the pole top tenon, suspension contact unit, divided support arm, pole top junction box, conduit mount adapter, camera junction box, external mounted stabilization weights, and a permanently mounted winch on the interior of the pole. The divided support arm and receiver brackets shall be designed to self-align the contact unit with the pole center line during installation and ensure the contact unit cannot twist under high wind conditions. For maximum arm strength, round support arms are not acceptable. The camera-lowering device shall withstand wind forces of 100mph with a 30 percent gust factor using a 1.65 safety factor. The lowering device manufacturer, upon request, shall furnish independent laboratory testing documents certifying the device's adherence to the stated wind force criteria utilizing, as a minimum effective projected area, the actual EPA or an EPA greater than that of the camera system to be attached. The camera lowering system to be furnished shall be the product of manufacturers with a minimum of 5 years of experience in the successful manufacturing of camera lowering systems. The camera lowering device shall be the [MG]² Model CLDMG2-HYPIP6(2)-XXX(ST)-PERM or pre-bid approved equal. (The requirements for submitting alternative devices for approval prior to the bid opening date are found in the project documents.)

The lowering device manufacturer shall furnish an authorized factory representative to oversee the installation contractor's assembly and testing of the first lowering system onto the pole assembly for each project. The manufacturer shall furnish the applicable DOT engineer documentation certifying that the installation contractor has been instructed on the installation, operation, maintenance and safety features of the lowering device for the particular project. Thereafter, the contractor shall be responsible for providing applicable maintenance personnel "on site" operational instructions.

Suspension Contact Unit and Contact Block

The suspension contact unit shall have a minimum load capacity of 600 lbs. with a 4 to 1 safety factor. There shall be a locking mechanism between the fixed and moveable components of the lowering device. The movable assembly shall have a minimum of 2 latches. This latching mechanism shall securely hold the device and its mounted equipment. The latching mechanism shall operate by alternately raising and lowering the assembly using the winch and lowering cable. When latched, all weight shall be removed from the lowering cable. The fixed unit shall have a heavy duty cast tracking guide and means to allow latching in the same position each time. The contact unit housing shall be weatherproof with a gasket provided to seal the interior from dust and moisture. The entire unit shall have a minimum temperature rating of -40 degrees F to +190 degrees F (-40C to 90C).

The prefabricated components of the lift unit support system shall be designed to preclude the lifting cable from contacting the network and/or power cabling of the CCTV or any other device mounted upon the pole. The lowering device manufacturer shall provide a conduit mount adapter for housing the stainless steel lowering cable. This adapter shall have an interface to allow the connection of a contractor provided 1.25 inch PVC conduit and be located just below the cable stop

block at the back of the lowering device. The Contractor shall supply internal conduit in the pole as directed by the Camera Lowering Device (CLD) provider. The only cable permitted to move within the pole or lowering device during lowering or raising operations shall be the stainless steel lowering cable. All other cables must remain stable and secure during lowering and raising operations.

ETHERNET CONTACT BLOCK

The CLD must be properly equipped with a multiple contact connector designed and tested specifically for Ethernet devices or equipment utilizing Gigabit communications with or without POE. The Contact Connectors shall be designed for extreme environmental outdoor use per the technical requirements in the specifications and plans. Each Lowering Device shall be equipped with TWO distinct Shielded Ethernet contact connector blocks providing TWO separate individual Ethernet feeds regardless of whether one or two Ethernet devices is mounted upon the CLD. In the instance where only one Ethernet device being mounted, a second completed installed and readied Ethernet feed shall remain available for future equipment or as a back-up to the initial Ethernet feed.

Each Ethernet contact block shall consist of a female and male half. For environmental durability, the female and male socket contact halves shall be made of an outdoor rated thermosetting synthetic rubber. The female barrel contacts and the male pin contacts shall be permanently and integrally encased in this rubber material to ensure optimum protection against moisture and the environment. For optimum weatherproofing, each male pin shall be self-wiping with a shoulder or "O" ring at the base of each male contact so that it will recess into the female block, thereby giving a rain-tight seal to each individual contact when mated. Further, the wire leads from both the male and female rubber contact blocks shall be permanently and integrally molded in the overall synthetic rubber contact block body.

For optimum electrical conductivity and durability, all signal carrying male pin and female socket/barrel contacts shall be copper alloy and Gold plated per ASTM B-488. To ensure pins are not easily bent, the Male contact sizing shall be a minimum of 0.09 inches O.D., while the female contacts shall be at least 0.09 inches I.D. at the contact area. All contacts shall be a minimum of 0.09 inches in diameter at the contact area. Each individual female barrel contact shall have a sleeve which prevents foreign particles from entering the contact area as well as preclude the possibility of the tines of the female contact from opening beyond allowable limits and ensure a snug fit around the respective male pins. The contact block shall have a spring loaded design that provides constant pressure on the contact block enabling consistent electrical and data performance during moderate shaking conditions.

For proper and complete performance, each Ethernet/IP Male-Female connector shall be equipped with a total of (14) specifically designed contacts. Nine (9) of the (14) male contacts shall be silver soldered to Cat6a High Flex Shielded Industrial Ethernet Cable and end terminated with a RJ45 (shielded) male connector, and Five (5) of the (14) male contacts shall be silver soldered to (5) individual #18/1 UL lead wires – bare and numbered 1-5, which may be used for additional camera/equipment

requirements including but not limited to power, alarms or grounds. Nine (9) of the (14) female contacts shall be silver soldered to Cat6a High Flex Shielded Industrial Ethernet Cable and end terminated with a 10Gbps rated M12 8-position, shielded connector which will interface and provide a minimum IP65 rated connection with the Ethernet cable fed from the pole (or ground mounted) equipment cabinet. Five (5) of the (14) female contacts shall be silver soldered to (5) individual #18/1 UL lead wires – bare and numbered 1-5, which may be used for additional camera/equipment requirements including but not limited to power, alarms or grounds. These leads shall be factory or field terminated with an applicable AMP type circular connector as an interface with the applicable wire leads on the cable fed from the pole (or ground mounted) equipment cabinet. The installation of the M12 and AMP connector shall either be done at the CLD factory or in the field by the installation contractor. All connections and terminations must have field verifiable continuity prior to each pole's erection. All cable jackets shall be outdoor rated. All silver soldering shall be per IPC J STD-001E. Each individual contact shall be rated for up to 600v and 7A but de-rated according to the wire used in the application.

Each Ethernet connector block must be tested & verified for Ethernet Data Transmission speeds of up to 1000Base-T (1 GigaBit per Second). If requested, a copy of the verified connector test report showing 1000Base-T compliance shall be provided.

CAMERA JUNCTION BOX

The camera junction box is essential for proving both a mounting location for the CCTV as well as an interface compartment for wire leads from the lowering device to the CCTV or applicable switches or surge suppression modules. The camera junction box shall be of two piece clamshell design with one removable hinge side and one latch side with single toggle bolt to facilitate easy access. The general shape of the box shall be cylindrical to minimize the effective projected area. The Camera Junction Box shall be cast aluminum with stabilizing weights on the outside of the box to increase room on the interior. The box shall be capable of having up to 40 pounds of stabilizing weights. The bottom of the Camera Junction Box shall be drilled and tapped with a 1-1/2" NPT/Female thread to accept industry standard dome housings and be able to be modified to accept a wide variety of other camera mountings. The junction box shall be gasketed to prevent water intrusion. The bottom of the box shall incorporate a screened and vented hole to allow airflow and reduce internal condensation.

LOWERING WINCH

The camera lowering device (CLD) shall be operated by use of a permanently mounted winch. This winch shall be securely bolted on the interior of the pole as designed and shown on the plans. The winch shall operate by use of an included manual hand crank. The winch shall have the ability to operate (raise and lower but not latch) electrically by use of additional equipment noted in the provisions. The winch shall be designed to spool the required amount of stainless steel lowering cable

to lower and raise the CCTV camera and shall be accessed and operated through the handhole approximately 30-36 inches from ground level. This handhole shall be sized according to the requirements of the lowering device provider. The winch and stainless steel cable shall support the load during lowering/raising operations. The winch assembly shall include an integrated automatic braking system that prevents freewheeling when loaded and shall have a reduction gear to reduce the manual effort required to operate the lifting handle to raise and lower a capacity load. The lowering winch shall be made of durable and corrosion resistant materials or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment. The unit shall have a Thern model winch with a 2.85 to 1 gear ratio.

(e.1) Electrical Operation of the CLD Winch

If required, a quantity (as designated by the provisions and plans) of Electric Drill Assemblies & Custom Clutch Adapters can be provided to interface with the standard permanently mounted winch.

One complete set of Electric Drill Assembly & Custom Clutch Adapter is not required for EACH Pole, but rather a certain quantity shall be required per project and noted on the plans or otherwise herein. All Electrical Drill Assemblies shall be a CLD Manufacturer authorized LOW RPM, Variable Speed, Reversible, ½ inch chuck, Corded Electric Drill. Each Drill shall be provided with an attachable factory tensioned adjustable clutch adapter which will serve as the attachment mechanism of the drill to the winch. The clutch adapter will be factory tensioned to prohibit over-torqueing of the winch during the electric operation. All Electric drill assemblies and clutch adapters shall be delivered to the applicable DOT engineer upon project completion.

MATERIALS

All pulleys for the camera lowering device shall have sealed, self-lubricated bearings, oil tight bronze bearings, or sintered- oil impregnated, bronze bushings. The lowering cable shall be a minimum 1/8-inch diameter stainless steel aircraft cable with a minimum breaking strength of 1740 pounds with (7) strands of 19 wire each.

The fixed and lowerable portion of the contact block and the individual contacts shall be protected from exposure to the weather by both a gasket on the bottom side of the bell housing enclosure as well as the "O" ring shoulders at the base of each male contact pin.

The interface and locking components shall be made of stainless steel and/or aluminum. All external components of the lowering device shall be made of corrosion resistant materials, powder coated, galvanized, or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment.

In the event the mounted camera is a non-dome or otherwise not centrally weight balanced and plumb, the Camera Manufacturer shall provide weights and /or counterweights and/or brackets as necessary to assure that the alignment of pins and

connectors are plumb when tethered on the cable to allow the camera to be raised and locked into position without binding.

The Camera Manufacturer or integrator shall provide any alternate power/signal connectors and weatherproof interface couplers for attachment to the 1-5 bare leads and Ethernet cable in the pole top and/or camera junction boxes in a manner acceptable to the project engineer.

The Camera Manufacturer, camera supplier or integrator shall provide appropriate length (Per camera location) of outdoor rated Ethernet cable and any additional power/signal cables in one continuous run from the respective equipment cabinet to the pole top junction box of each lowering device pole.

The contractor shall demonstrate to the Engineer the proper and repeated operation of the lowering device. Proper camera operation and electrical connections shall be verified after each lowering/raising cycle.

CAMERA LOWERING SYSTEM POLE

DESIGN: Design shall be in accordance with the 2013 edition of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals including all addendums. Minimum Loading requirements shall be based on an isotach wind velocity for the area of installation according to the current AASHTO isotach wind chart. PE Stamped Calculations and detailed drawings for each height pole shall be submitted demonstrating compliance with the AASHTO specifications and any additional performance requirements herein.

Loading shall be based on:

- basic wind speed of 90 mph
- 30 percent gust factor / 1.65 safety factor
- design life/recurrence interval of 50 years
- fatigue category I.
- a total mounted weight of 130 LBS. and an Effective Projected Area (EPA) of 3.0ft² for the CLD & Camera

To avoid vortex shedding, the steel pole members shall have a taper of 0.14 in/ft. All structures shall be designed to natural wind gust conditions. The yearly mean wind speed for natural wind gusts will be assumed to be 11.2 per hour. Design for galloping and truck induced gust fatigue is not required for these structures.

Poles up to 50’ in length shall be one-piece construction. Poles greater than 50’ in length shall be of two-piece construction. Poles shall conform to ASTM A595, Grade A minimum yield strength of 55 ksi, or ASTM A572 minimum yield strength of 65 ksi. Pole, base plate, and all associated hardware shall be galvanized per ASTM A123 or A153. Poles greater than 50’ in length shall be of multi-piece slip-fit construction. The shaft shall be round or 16 sided with a four inch corner radius and contain only one longitudinal seam weld. Circumferential welded tube butt splices and laminated tubes are not permitted. Longitudinal seam welds within 6

inches of complete penetration pole to base plate welds shall be complete penetration welds. The shaft shall be hot dip galvanized per the requirements of the contract documents. The interior diameter of any top shaft at the point of Tenon attachment, regardless of pole height, shall be at least 5.5 inches to accommodate lowering device requirements. The interior diameter of the pole at the location of the permanent winch must be satisfactory to allow the installation, operation and maintenance of the winch. The winch shall be equipped with a winch mount plate or shelf for the permanent attachment of the winch mechanism.

The pole top deflection shall not exceed one inch in a 30-mph (non-gust) wind. The calculations shall include a pole, base plate, and anchor bolt analysis. The pole detail analysis shall be analyzed at the pole base, at 5-ft. pole intervals, and at each slip joint splice.

A detail analysis of the pole shall be submitted. The detailed analysis shall include, but not be limited to, the following calculations:

1. Provide Group I, II, III, IV load combinations as listed in Table 3-1 Group Load Combinations in AASTHO.

2. Provide dimensions and weights for all attachments. This includes areas used for wind, ice and fatigue loads, drag coefficients, projected areas, velocity pressures and wind force for each segment.

3. For Group Loads II, III, and IV, which have wind loads, provide calculations for each controlling "worst case" wind direction that controls any aspect of the design (anchor bolts, pole sizing, ect.)

4. Anchor Bolts shall be designed for the orientation that would provide the maximum stress on any individual bolt.

5. Provide all structural properties for poles, anchor bolts and base plates. This includes the poles diameter, thickness, section modulus, moment of inertia, and cross sectional area.

6. Calculations for each member shall include loads, section properties, member forces (axial, shear and bending), member deflections (angular and linear), member stresses (actual and allowable), and the combined stress ratio (CSR).

7. Fatigue calculations should be shown for all fatigue related connections. Provide the corresponding detail, stress category and example from Table 11-2 in AASHTO.

8. In fatigue calculations, the effective throat thickness of a complete joint penetration groove weld shall be the thickness of the thinner part joined per AISC J2.1a.

Each pole shall be equipped with a permanently affixed label/tag - 6 feet from the bottom of the base plate on the outside with the following information:

manufacturer

height

minimum stringing tension at yield

order number, and

maximum deflection rate.

ALL detailed calculations shall be stamped & certified by current licensed Professional Engineer.

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 prior to bid opening to ensure that the fabricator has the personnel, organization, experience, procedures, knowledge, equipment, capability and commitment to fabricate quality pole structures.

WELDING: All welding shall be in accordance with Sections 1 through 8 of the American Welding Society (AWS) D1.1 Structural Welding Code. Tackers and welders shall be qualified in accordance with the code. Tube longitudinal seam welds shall be free of cracks and excessive undercut, performed with automatic processes, and be visually inspected. Longitudinal welds suspected to contain defects shall be magnetic particle inspected. All circumferential butt-welded pole and arm splices shall be ultrasonically or radiographically inspected.

MATERIAL CERTIFICATIONS: All materials and products shall be manufactured in the United States of America, and comply with ASTM or AASHTO specifications. Mill certifications shall be supplied as proof of compliance with specifications.

HAND HOLE for PERMANENT WINCH: The hand hole opening shall be reinforced with a minimum 2-inch wide hot rolled steel rim and be of a size that allows proper and safe installation, operation and maintenance of the permanent winch. Unless otherwise noted on the plans, the bottom lip of the handhole shall be located on the shaft between 30”-36” from the baseplate. The handhole shall have a HINGED and Gasketed cover plate. The hinge shall provide adjustability to insure a weather-tight fit for the cover. On the frame side opposite the hinge, provide a mechanism on the handhole cover/frame to place the Department's standard padlock. The handhole cover shall be manufactured from 0.25 inch thick galvanized steel (ASTM 153) and have a neoprene rubber gasket that is permanently secured to the handhole frame to insure weather-tight protection.

POLE TOP TENON: The pole shall have a custom plate mounted adjustable tenon that allows the field modification of the arm/camera orientation up to 360 degrees. With this design, the DOT engineer can make slight orientation modifications to the camera mount to allow optimum viewing in case of future road development, change in terrain or a change in the viewing needs priority. The tenon shall have mounting holes and slot as required by the CLD manufacturer for the mounting of the camera-lowering system. The tenon shall be of dimensions necessary to facilitate camera lowering device component installation. The CLD mounting slot shall be parallel to the pole centerline for mounting the lowering device. There shall be a mounting slot for each required camera lowering device.

Unless otherwise noted, when DUAL mount lowering devices, the mounting slots shall be 180 degrees apart.

CABLE SUPPORTS / Electrical Cable Guides and Parking Stand (Eyebolts): Top and bottom electrical cable guides shall be located within the pole aligned with each other as referenced in the drawings. One cable guide-strain relief ring shall be positioned 2 inches below the winch operation handhole and the other shall be positioned 1 inch directly below the top of tenon. A parking stand ring shall be welded directly to the center and inner portion of the upper handhole frame. Note drawings for applicable details.

BASE PLATE: Provide base plates that conform to ASTM A36 for grade 36 or ASTM 572 for grade 50.

Ensure transverse plates have a thickness ≥ 2 inches. Provide a base plate for the vertical pole that fits inside a 48 in diameter concrete base. Plates shall be integrally welded to the tubes with a telescopic welded joint or a full penetration butt weld with backup bar. Plates shall be hot dip galvanized per the requirements of the contract documents.

ANCHOR BOLTS: The anchor bolt design shall follow the NCHRP Report 494 Section 2.4 and NCHRP 469 Appendix A Specifications. Use anchor bolts that conform to the requirement of ASTM F 1554 grade 55 for hooked smooth bars or grade 105 for headed. Anchor bolts shall conform to AASHTO M 314 grade 55. Anchor bolts and all associated hardware shall be fully galvanized per ASTM A 153. . Each anchor bolt shall be supplied with two hex nuts and two flat washers. The strength of the nuts shall equal or exceed the proof load of the bolts. For anchor bolt design, pole forces shall be positioned in such a manner to maximize the force on any individual anchor bolt regardless of the actual anchor bolt orientation with the pole. There shall be two steel templates (one can be used for the headed part of the anchor bolt when designed in this manner) provided per pole. Templates shall be contained within a 26.5 inch diameter. All templates shall be fully galvanized (ASTM A 153). Anchor bolt lengths should be based on NCHRP Report 494 Section 2.4.5.5 using #8 bars for the foundation reinforcing steel. The headed anchor bolt assembly shall be contained within 26.5 inch diameter. Minimum edge distance for bolt holes shall follow Table J3.4 of AISC Steel Construction Manual. NCHRP Report 494:

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_494.pdf

NCHRP Report 469:

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_469-a.pdf

INSTALLATION POLE

POLE

Pole shall be installed in the correct orientation and plumb. Pole shall be grounded in accordance with the plans and specifications. Damaged galvanizing shall be repaired with a paint approved by the Engineer. The pole shall have a 3' L x3' W x4" D concrete pad installed for each door. Concrete for the pad is incidental to the

cabinets. The Contractor shall grade and re-seed all disturbed areas to the satisfaction of the Engineer. This item includes the furnishing and installing of Fastrac bait bag in each pole for rodent control.

Pole shall be installed in the correct orientation and plumb. The anchor bolt orientation may be critical to provide the correct orientation. Authorized personnel shall be consulted to ensure the proper alignment of the anchor bolts and also consulted on the positioning of the lowering device arm. Pole shall be grounded in accordance with the plans and specifications found in this document and the project drawings. Damaged galvanizing shall be repaired with a paint or "cold galvanization" approved by the Engineer.

MEASUREMENT AND BASIS OF PAYMENT

Pole with Lowering Device will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 6: WEB CAMERA ASSEMBLY (CCTV)

DESCRIPTION

Furnish and install Web Camera Assembly in accordance with the plans, specifications and Standard Drawings.

MATERIALS

The Web Camera Assembly shall be an Axis Network Dome Model P5655-E or approved equivalent. This item shall include the color camera, zoom lenses, environmental enclosure, pan/tilt unit, housing, dome, parapet mount, and all mounting hardware, power cable, connections, and incidentals necessary to complete the work.

Proposed alternates shall be commercially available. The Contractor shall identify an installed site where the proposed alternate Web Camera Assembly has been operating for a period of at least one year in a similar climate region.

INSTALLATION

Web Camera Assembly shall be installed on a steel strain pole as specified in the plans and in accordance with the manufacturer's instructions. Installation shall comply with all warranty provisions and warranty contract maintenance services. Installation shall comply with all local, state, and federal building, electrical and construction codes, and Motorola R-56 requirements. All wiring access to the Web Camera Assembly shall be through watertight fittings. Wiring access points shall be on the side or underneath components; no exposed top access is permitted. The Web

Camera Assembly shall be installed so that the assembly is located on the side of the pole closest to the roadway when the camera is in its fixed position at the top of the pole. The contractor is responsible to verified all functions of the web camera through a laptop interface.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Web Camera Assembly will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 7: RACK MOUNT UPS

DESCRIPTION

Furnish and install Uninterruptible Power Supply in accordance with the plans, specifications and Standard Drawings.

MATERIALS

The Uninterruptible Power Supply shall be provided emergency power to the load when the input power sources fails. The Uninterruptible Power Supply shall be APC UPS 1500VA USB RM 2U (networkable card AP9630) or approved equal. The Uninterruptible Power Supply shall be networkable and have the following technical specifications:

Output Power Capacity: 980 Watts/ 1440 VA

Nominal Output/Input voltage: 120 Volts

Efficiency at Full Load: 95%

Waveform Type: Sine Wave

Output/Input Connections: (6) NEMA 5-15R

Battery Type: Maintenance-free sealed Lead-Acid Battery with suspended electrolyte:leakproof

Interface Ports: DB-9 Rs 232, USB

Surge Energy Rating: 459 Joules

Filtering: Meets UL 1449

Mounting: shall be able to mount in 19" rack

Operating Environment: 0-40 degrees Celsius

Regulatory Approvals: CSA, FCC Part 15 Class A, UL 1778

Warranty: At least 3 year for repair or replace

Network card shall have the following:

Protocols: HTTP, HTTPS, IPv4, SMTP, SNMP v1, SNMP v3, SSH V1, SSH V2, SSL, TCP/IP, Telnet

Network Interface Connections: RJ-45 10/100 Base-T

Regulatory Approvals: AS/NZS 3548 (C-Tick) Class A, EN 55022 Class A, En 55024, FCC Part 15 Class A, GOST, ICES-003, VCCI Class A

Warranty: At least 3 year for repair or replace

INSTALLATION

Uninterruptible Power Supply shall be installed in 334/336 Cabinet as specified in the plans sheets. It shall be securely mounted the 19" frame which is included in supplied 334/336 cabinet. All cables, rack Mounting Brackets, Rack Mounting support rails shall be incidental to the item.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Uninterruptible Power Supply will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 8: COMMUNICATIONS CABLE

DESCRIPTION

Furnish and install Communications Cable in accordance with the plans, specifications and Standard Drawings.

MATERIALS

Communications cable shall be General Cable GenSpeed 5000 CAT 5e Outside Plant Cable 8 wire PN: 5136100 or approved equal. The cable shall meet or exceed the following specifications:

Performance:

- ANSI/TIA/EIA 568B (Category 5e)
- MIL-C-24640A Water Penetration
- Propagation Delay: 583 ns @ 100 MHz
- Return Loss @ 100 MHz: 20.1 DB
- Frequency Range: 1-350 MHz

Physical characteristics:

- Nominal Outside Diameter: 0.230 in

- Insulation Type: Polyolefin
- Maximum Pulling Tension: 25 lbs
- Maximum DC Resistance: 9.38 Ohms/100m
- Mutual Capacitance @ 1kHz: 17 pF/100m
- Operating Temperature: -45° C to 80° C

All connectors, terminators, fittings, etc. shall be incidental to the cost of installing the Communications Cable and no separate payment will be made.

INSTALLATION

The Contractor shall install all cable and wire splice-free from the controller/service location to each cabinet, VMS sign, or CCTV camera the cable or wire is feeding. The Contractor shall not use excessive force when pulling wire through duct. The Contractor shall replace all wire damaged during installation. The Contractor shall submit to material testing at the discretion of the Engineer.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Communications Cable will be measured for payment per unit linear foot The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 9:
CONDUIT

DESCRIPTION

Furnish and install Conduit in accordance with the plans, specifications and Standard Drawings.

MATERIALS

Conduit shall be rigid steel, schedule 80 PVC, or flexible, non-metallic conduit as specified. This item includes fittings, connectors, clamps, caps and other materials necessary for proper installation. The Contractor shall submit to material testing at the discretion of the Engineer.

INSTALLATION

All conduit installed above ground or below ground under pavement shall be rigid steel. All conduits installed below ground, not under pavement shall be PVC. Flexible, non-metallic conduit shall be used as required and shall be incidental to the project. Unused conduits shall be capped on both ends. Conduit containing wire or cable shall be sealed with a piece of steel wool and capped off with duct seal putty. All conduits shall be accessible inside junction boxes. All conduits shall have bushings included. If rigid steel conduit, the bushings shall be bonded together with other similar types of conduits.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Rigid Steel and PVC Conduit will be measured for payment per unit linear foot. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section. A direct measurement will not be made for flexible, non-metallic conduit. All flexible, non-metallic conduits shall be incidental to the project.

Section 10:

ELECTRICAL SERVICE

DESCRIPTION

Furnish and install Electrical Service in accordance with the plans, specifications and Standard Drawings.

MATERIALS

The Contractor shall coordinate with the local power company to determine the exact materials for the service. This includes but is not limited to conduit, meter base, stainless steel disconnect, fused cutout, ground rod, wire, 35 foot wood pole, 2 anchors, connectors, fittings and all associated hardware required to construct the service.

The Contractor shall coordinate with the local power company (coordinate with TRIMARC representative) for the exact location of the service. This item also includes all electrical inspection and other fees required to provide electrical service.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Electrical Service will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 11:

MODEL 334 AND 336 ENCLOSURES

DESCRIPTION

Furnish and install Enclosure in accordance with the plans, specifications and Standard Drawings.

MATERIALS

The two types of enclosures are Model 336 (36" H x 24" W x 22" D) and Model 334 (66" H x 24" W x 30" D). All enclosures shall be NEMA 3R rated/UL Listed. All components in the cabinet shall be designed according to the NEC 2017/UL Listed. The enclosures shall include: all mounting accessories, access doors (minimum of two doors), ventilation, locking system, handles, door stops, rack assembly, light(s), shelves, drawer, and all required peripherals per the requirements of the contract documents and per the

equipment submitted by the Contractor. **The contractor shall provide a cabinet, wiring, and all components that are approved as an assembly. This approved assembly shall be incidental to this item. Verification that the cabinet, wiring, and all components are an approved assembly shall be submitted to Central Office Traffic Operations. This shall be stamped by an electrical engineer that it is in compliance with the NEC 2017.**

This item includes all excavation and any special equipment required to install the enclosure on a pole for a Model 336 enclosure or construct the concrete base for a Model 334 enclosure.

The Contractor shall provide a terminal facility harness by means of mating "MS" type connectors for interconnections of the field equipment specified. All cabinets of the same type shall be identical in size, shape and quality. In addition, the cabinets shall be equipped internally as specified herein and as required to suit the specific equipment specified on the plans.

Cabinets shall be of welded construction, using 0.125" minimum thickness 5052H32 or equivalent sheet aluminum. The equipment design shall utilize the latest available techniques, minimum number of different parts, subassemblies, circuits, cards and/or modules to maximize standardization and commonality.

Cabinets shall be provided with fully wired back and side panels with all necessary terminal boards, wiring harnesses, connectors and attachment hardware. All equipment shall be shelf or 19" rack mounted. Terminals and panel facilities shall be installed on the lower portion of the cabinet walls below all shelves.

Each field cabinet shall, at a minimum, be supplied with the following:

- Fan and Thermostat
- Left Side Power Distribution Panel
- Air Filter
- Adjustable Shelves (1-4 as needed for equipment submitted by the Contractor)
- Back Panel
- Right Side Panel
- Locking System
- Ground Bus (2)
- Terminal Blocks
- Duplex power outlet (weather resist)
- Surge Protector (See spec in surge section)
- Drawer that slides out for supporting a laptop computer
- All necessary installation and mounting hardware

All external screws, nuts and locking washers shall be stainless steel; no self-tapping screws are permitted unless specifically approved by the Engineer. All screws, nuts and locking washers used internally shall be manufactured from corrosion resistant materials.

All parts of the cabinet shall be cleaned, smoothed and free from flaws, cracks, dents and other imperfections. The cabinet shall be rigidly constructed to provide vibration free operation of the field equipment when installed. The cabinets shall be dust and rain tight and capable of maintaining a dry internal condition when subject to rain and wind gusts.

All components shall be made of corrosion resistant materials such as plastic, stainless steel, aluminum or brass; or shall be treated with corrosion resistance such as cadmium plating or galvanizing. All materials shall be resistant to fungus growth and moisture deterioration.

Individual cabinet components shall be pre-assembled upon installation in the cabinet such that the components can be easily replaced in the field. Modules of unlike function shall be mechanically keyed to prevent insertion into the wrong socket or connector.

Panels shall be designed to mount in the cabinet on mounting studs. It shall not be necessary to remove the panel to replace any panel-mounted equipment. The panels shall be capable of supporting specified equipment mounted on the panel. A lower input termination panel shall be provided to terminate all input field wires.

Electronic components shall meet the requirements contained herein and shall, at a minimum, comply with EIA Specifications. No component shall be of such design, fabrication, nomenclature or other identification as to preclude the purchase of said component from a wholesale electronics distributor or from the component manufacturer.

Components shall be down-rated by 50 percent with regard to ambient temperature, applied voltage, and power dissipation. All circuits shall be designed for reliability and maximum performance.

The design life of all components, under continuous operating conditions in their circuit application, shall be a minimum of ten years.

Each component shall meet all of its specified performance requirements when the input power is AC, 60 Hz, single phase, 120 volts +/- 20 volts. The equipment shall be designed such that the failure of a particular piece of equipment will not cause the failure of any other.

The cabinets shall be furnished with a power distribution panel mounted on the lower left hand inside wall when facing the front of the cabinet. This panel shall include a 115 VAC, convenience, dual outlet with integral ground fault interrupt protected by a circuit breaker. The left panel shall have:

- Circuit Breaker(s)
- Radio Interference Suppressor
- Power Cable Input and Junction Terminals

Circuit breakers shall be approved and listed by UL. Each cabinet shall have, at a minimum, a circuit breaker to protect the lamp, vent fan, and dual outlet. In addition, a properly rated equipment circuit breaker(s) shall be provided for the equipment shown on the plans. At each cabinet that houses VMS control equipment, a 220 VAC circuit breaker, sized to suit the cables that provide power to the VMS pixels shall be furnished and installed. Breakers shall have a minimum interrupt capacity of 50 amperes.

Each cabinet shall be equipped with a radio interference suppressor installed at the circuit breaker. The suppressor shall provide a minimum attenuation of 50 dB over a frequency range of 200 kHz to 75 MHz. The suppressor shall be hermetically sealed in a case filled with a suitable insulation compound.

The suppressor terminals shall be nickel-plated, with brass studs of sufficient external length to provide space for connection of two appropriately sized conductors and shall be mounted such that the terminals cannot be turned in the case. The suppressors shall be designed for operation at the proper current ampere rating as determined by the Contractor per the equipment specified on the plans and shall be approved by UL and EIA.

Power distribution blocks suitable for use as a power feed and junction points shall be furnished and installed for two and three wire circuits. The line side of each circuit shall be capable of handling the specified number of and size of all wires.

Each cabinet shall include a fully wired equipment panel mounted on the lower rear inside of the wall of the cabinet. The back panel shall be utilized to distribute and properly interconnect all cabinet wiring related to the specific equipment. Each piece of equipment specified shall have its cable harness properly connected at terminal boards on the back panel. All functions available at the equipment connector shall be carried in the connector cable harness to a terminal board point on the back panel.

Wiring shall be provided for the equipment specified. All cabinet wiring, where connected to terminal strips, switches, radio interference suppressor, etc., shall be identified by the use of insulated pre-printed sleeving (wire markers) slipped over the wire before attachment of the lug or terminating the connection. The wire markers shall have a text label with sufficient detail so that a translating sheet is not required.

All wires shall be cut to the proper length before assembly. No wires shall be doubled back to take up slack. Wires shall be neatly secured with nylon lacing or cable ties. Cables shall be secured with nylon cable clamps.

The grounded side of the electric service shall be carried throughout the cabinet to the ground bus without a break.

All electrical connections in the cabinet shall have sufficient clearance between each terminal and the cabinet to prevent a leakage path or physical contact under stress. Where these distances cannot be maintained, barriers must be provided. All equipment grounds shall run directly and independently to the ground bus. The lay of the interconnect cable between the components must be such that when the door is closed, it does not press against the cables or force the cables against the various components inside the cabinet. Sufficient length of cable harnesses shall be provided to easily reach the electronic equipment placed anywhere on the shelves.

All wiring containing line voltage AC shall be routed and bundled separately and/or shielded from all low voltage (i.e. control) circuits. All conductors and live terminals or parts, which could be hazardous to maintenance personnel, shall be covered with suitable insulating materials.

All conductors used in the cabinet wiring shall be 22 AWG or larger with a minimum of 19 strands. The insulation shall have a minimum thickness of 10 MILS. All wiring containing line voltage shall be 14 AWG or larger.

The AC+, AC-, and equipment ground wiring shall be electrically isolated from the other by an insulation resistance of at least 10 Megohms when measured at 250 VAC. Return and equipment grounding wiring shall be color-coded white and green respectively.

Terminal blocks located on the panels shall be accessible such that it shall not be necessary to remove the electronic equipment from the cabinet to make a connection or perform an inspection.

Terminal blocks shall be two-position, multiple-pole, and barrier type. Shorting bars, along with integral marking strip, shall be provided. Terminal blocks shall be arranged such that they do not impede the entrance, training, or connection of incoming field conductors. All terminals shall be identified by legends permanently attached to the terminal blocks. Not more than three conductors shall be brought to any one terminal screw. No electrically live parts shall extend beyond the protection afforded by the barriers. All terminal blocks shall be located below the shelves.

AC terminal blocks shall be Underwriter's Laboratory approved for 600 volts AC minimum and shall be suitable for outdoor use. Terminals used for field connections or interwiring connections shall secure conductors by means of a nickel or cadmium plated brass binder head screw.

All connections to and from the electronic equipment shall terminate at an interwiring block. These blocks shall act as intermediate connection points for all electronic equipment inputs and outputs.

A varistor shall be installed across the thermostat used to control the fan to act as a surge and transient noise suppressor. The varistor shall be GE VI5OLAIOA, Stetron 250NRO7-1, Siemens SIOK150, or approved equal.

MOUNTING

Model 336 cabinets shall be pole mounted or mounted to an existing concrete wall as specified. Model 334 cabinets shall be mounted on a poured concrete base or on existing concrete surfaces as specified. All holes drilled into existing concrete surfaces shall penetrate the concrete no more than 4 inches unless otherwise approved by the Engineer. Bolts inserted into any concrete surface shall be properly secured and epoxied, per manufacturer’s recommendations. Prefabricated fiberglass bases used in lieu of poured concrete bases must be approved by the Engineer. Cabinet installation shall conform to the details shown. All cabinets shall be furnished with stainless steel mounting plates, nuts, bolts, washers and all other necessary hardware to mount the cabinet as shown or described.

DOORS

All cabinets shall be provided with doors in the front and back. Doors shall have secure gaskets to prevent the entrance of dust and moisture. Doors shall be sized to encompass the full area of the cabinet opening. Doors shall be provided with two stop positions to hold the door open at 90 degrees and 135 degrees. The stops shall hold the door securely open until released manually. The front door shall be hinged on the right-hand side by means of three butt hinges with 1/4" minimum stainless steel hinge pins.

VENTILATION

Cabinets shall be furnished with louvers properly designed to provide natural ventilation to the interior. The louver area shall be of sufficient size to permit the free flow of air corresponding to the rated capacity of the associated cabinet fan. A pleated media fiber filter shall be provided and shall cover all louvers.

Cabinets shall be furnished with an electric, thermostatically-controlled ventilation fan or fans mounted in the cabinet. The fan(s) shall have a rated capacity of at least 200 cubic feet per minute. The fan and cabinet ventilation louvers shall be located with respect to each other so as to direct the bulk of the air flow throughout the entire cabinet and, in particular, over the field equipment units. The thermostat shall be adjustable to turn on between 90 degrees and 120 degrees Fahrenheit.

LOCKING SYSTEM

Each door shall be furnished with a 3-point positive locking system. The lock for the door shall be a self-locking, heavy-duty, five-pin tumbler cylinder rim type. The handles shall be made of stainless steel and shall be provided with a padlock feature. Locks shall be keyed identically to Corbin #2. Two keys shall be provided for each cabinet.

LIGHT

A fluorescent light shall be provided in front for all cabinets and also in the back for Model 334 cabinets. A panel mounted 40-Watt weatherproof incandescent lamp with an on-off switch shall be positioned to provide light to the face of the equipment installed in the cabinet.

SHELF/DRAWER/RACK

A removable 19” EIA rack shall be provided for mounting sub-assemblies in Model 334 cabinet. Adjustable shelves shall be provided to hold the equipment. Vertical shelf adjustment intervals shall be 2” maximum. The shelves shall be positioned from the top of the cabinet in accordance with the actual equipment configuration of the particular cabinet. All devices/sub-assemblies shall be mounted on the rack if possible. Otherwise, they shall be placed on the shelves.

A sliding drawer shall be provided in each cabinet. The drawer shall be installed below the shelves in a suitable position for placement of a laptop computer. The drawer shall have a nominal depth of 1” and a hinged lid.

LABELING

The letters "KYTC ITS" shall be permanently displayed along the top of each door on the outside of each cabinet. The letters shall be a minimum of 1” tall. The letters shall be die-cut or engraved into the metal before galvanizing and shall be readable after

galvanizing. All excess galvanizing shall be brushed off. The location and description of the label must be shown on the shop plan submittal for the cabinets. Stenciling with paint or other markers is not permitted. If required information is placed on a steel plate, the plate must match the surface profile of the cabinet. The plate must then be welded completely around the plate before galvanizing.

SPECIAL NOTE FOR THE DISCONNECT/Cabinet:

Only connect one side of the 120 volt in the disconnect at the camera only location. The other side of the 120 Volt shall still be install in meter, but not feed down to the disconnect.

Furnish a shock hazard warning sticker on

Disconnect with the following information:

Voltage (120 volt)

Glove class (0)

Limited approach boundary (42 in)

Restricted approach boundary (contact)

See nfpa 70e for additional ppe required

QUALITY ASSURANCE PROVISIONS

The following water spray test shall be performed on each empty cabinet: Water shall be sprayed from a point directly overhead at an angle of 60° from the vertical axis of the cabinet. This procedure shall be repeated for each of eight equally spaced positions around the cabinet for a period of not less than five minutes in each position. The water shall be sprayed using a domestic type-sprinkling nozzle at a rate of not less than one gallon per minute per square foot of the cabinet's surface area. The cabinet shall then be inspected for leakage. Evidence of water leakage shall be cause for rejection.

A manufacturer's certification of successful completion of the water spray test and that the cabinet conforms to these specifications shall be the basis of acceptance of the cabinet. Separate submission of test cabinets shall not be required.

MAINTENANCE

All components and assemblies shall be clearly identified with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

All equipment shall be designed for ease of installation and maintenance. Location, accessibility, serviceability and features that will lead to simplified maintenance shall be a prime consideration. All component parts shall be readily accessible for inspection and maintenance. The only tools and test instruments required by maintenance personnel shall be simple hand tools and basic meters.

After the wiring is complete, all conduit penetrations into the cabinets shall be sealed in such a manner as to prevent rodents and insects from entering the cabinet. The conduit sealants and insect traps used shall be approved by the Engineer prior to installation.

DOCUMENTATION

Each field cabinet shall be supplied with three copies of the final cabinet wiring diagram. One copy shall be placed in a clear plastic envelope and left in the cabinet drawer. Two sets of Mylar plans shall be delivered to the Engineer.

INSTALLATION

Model 334/336 enclosure shall be installed in accordance with the plans and specifications. The Contractor shall stake all proposed enclosure locations and shall obtain approval of staked locations before excavation. A representative from the KYTC Division of Traffic Operations, Design Services Branch or the Traffic Engineer, District 5, TRIMARC representatives will approve locations for all field devices. The Contractor shall have all utilities marked in the field prior to requesting approval. The Contractor shall allow two weeks to schedule this location approval with KYTC. KYTC approval of field device locations does not relieve the contractor from his responsibility to repair any damage incurred during construction. Enclosures located behind guardrail shall have minimum 5 foot spacing from edge of pole to face of guardrail. Otherwise, enclosures shall be located as specified on the plan sheets or a minimum of 30' from all driving lanes. All materials shall be installed in a neat and professional manner. All pole mount cabinets shall be mounted approximately 42" from the ground. All 336 pole mounted cabinets shall a 3' L x3' W x4" D concrete pad install for each door. Concrete for the pad is incidental to the cabinets. The Contractor shall grade and re-seed all disturbed areas to the satisfaction of the Engineer. This item includes the furnishing and installing of Fastrac bait bag in each cabinet for rodent control.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Model 334/336 Enclosure will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 12: JUNCTION BOX

DESCRIPTION

Furnish and install Junction Box in accordance with the plans, specifications and Standard Drawings.

MATERIALS

Junction box shall meet or exceed ANSI/SCTE 77-2002, tier 15. Junction box covers shall be marked "ITS." Covers shall be attached with a minimum of two 3/8" stainless steel hex bolts.

INSTALLATION

Where required, junction box shall be oriented such that the dimensions comply with the NEC. Junction boxes used as pull boxes along a conduit run shall be spaced at a maximum of 250'. Junction boxes shall not be placed in ditch lines or in areas where standing water may accumulate. Junction box covers shall be flush with the finished surface. The Contractor shall restore all disturbed areas to the satisfaction of the Engineer. This item includes the furnishing and installing of Fastrac bait bag in each junction box for rodent control.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Junction Box will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 13:

SURGE DEVICES

DESCRIPTION

Furnish and install video surge device, data surge device, power surge device, and RF surge device in accordance with the plans, specifications and Standard Drawings.

MATERIALS

GENERAL

Each surge device shall be compatible with the equipment it is protecting. Each surge device shall include cables, connectors, power supplies, and all incidentals required for operation.

VIDEO SIGNAL COAX CONDUCTOR SURGE DEVICE

Video Signal Coax Conductor Surge Device shall be EDCO CX12-BNC-Y or approved equal. This surge protector shall:

- Have a clamping voltage response time of less than one nanosecond
- Have a maximum clamping voltage of 12 volts when subjected to a 3 kA, 8x20 microsecond wave
- Have a peak surge current of 20kA with 8x20 microsecond wave
- Have BNC connectors
- Pass signals from DC to 80 MHz with less than 3 dB insertion losses
- Be UL 497B listed

DATA SIGNAL CONDUCTOR SURGE DEVICE

Data Signal Conductor Surge Device shall be for RS 422 and RS 485 Communication conductors shall be EDCO PC642C-015 or approved equal. This surge protector shall:

- Have a clamping voltage response time of less than one nanosecond
- Have a maximum clamping voltage of 12 volts when subjected to a 1 kA 8x20 microsecond wave
- Have a peak surge current per wire of 10 kA with 8x20 microsecond wave
- Have a maximum inline resistance of 6 ohms
- Have a maximum attenuation of -3db at 50MHz

RS 232 COMMUNICATION DATA SIGNAL CONDUCTOR SURGE DEVICE

Data Signal Conductor Surge Device for RS 232 Communication conductors shall be EDCO PC642C-015 or approved equal. This surge protector shall:

- Have a clamping voltage response time of less than one nanosecond
- Have a maximum clamping voltage of 30 volts when subjected to a 1 kA 8x20 microsecond wave
- Have a peak surge current per wire of 3kA with 8x20 microsecond wave
- Have a maximum inline resistance of 6 ohms
- Have a maximum attenuation of -3 db at 0.5 MHz

100 BASE-T AND 10 BASE-T COMMUNICATION DATA SIGNAL CONDUCTOR SURGE DEVICE

Data Signal Conductor Surge Device for 100BaseT and 10BaseT Communication conductors shall be EDCO LCDP-30 or approved equal. This surge protector shall:

- Have a clamping voltage response time of less than one nanosecond
- Have a maximum clamping voltage of 30 volts when subjected to a 0.5 kA 8x20 microsecond wave
- Have a peak surge current per wire shall be 1kA with 8x20 microsecond wave
- Have a maximum attenuation shall be -3db at 100 MHz
- Have a N.E.X.T. worst pair of better than -40 db at 100 MHz
- Have a maximum attenuation of -3db at 0.5 MHz

POWER CONDUCTOR SURGE DEVICE

Conductor Surge Device for power carrying conductors shall be UL Listed Commercial rated. This surge protector shall meet or exceed the following specifications:

- Nominal Line Voltage 120 V

- Peak Current 20,000 Amps
- Clamp Voltage 280 volt typical @ 20kA
- Response time <5ns
- Continuous Service Current 10 Amps max. 120 VAC, 60 Hz

RF ANTENNA COAX CONDUCTOR SURGE DEVICE

RF Antenna Coax Conductor Surge Devices shall meet all manufacturer recommendations for the particular use of the radio antenna coax conductors.

INSTALLATION

The Contractor shall supply surge devices in model 334/336 enclosures, VMS signs, on poles, and on sign trusses as specified on layout sheets. Surge devices shall be located in said equipment such that they are easily accessible for maintenance activities.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Surge Device will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 14:

SMART WORK ZONE TRAILER

DESCRIPTION

DBT shall acquire and provide for KYTC/TRIMARC to use and potentially share a minimum of 4 Smart Work Zone Trailers at the beginning of the project. Smart Work Zone Trailer is the project name for portable changeable message signs that also include a telescoping pole system with a CCTV camera. Portable changeable message signs are commonly used on high-visibility construction projects and the video component improves monitoring and response capabilities by allowing remote-monitoring. The DBT shall provide Smart Work Zone Trailers in accordance with the scope and requirements for this project and included in the plans, specifications and Standard Drawings.

MATERIALS

GENERAL

Each Smart Work Zone Trailer shall be a Wanco PN 229734-C1 with the designated upgrades, or approved functional equivalent. Each device shall include the trailer, display panels, cables, connectors, solar panels and charger, batteries, software capable of being remotely controlled, and all incidentals required for turn-key operation. Requirements include:

Below are some of the standard features of the Wanco PN: 229734-C1. This list is not all-inclusive.

FULL MATRIX TRAILER: 3500LBS IDLER AXLE SIGN, TELESCOPING OUTRIGGERS,
4 POLE TRAILER PLUG,
TOWER: HYD. LIFT W/ STD SIGN SUPPORT FRAME
FULL MATRIX SIGN LENSED CHAR.,
CONTROLLER: STD. ICC COMPUTER BOX W/RJ-45 PORT, LOCKING HASP ON DOOR
CAMERA TOWER ASSY: 1) Electric winch operated 23 ft tall three section mast
CAMERA: AXIS P5624E HD720P, 12VDC 30W POE
MODEM: RV-50X 4G, NETWORK SWITCH 5 PORTS
Modem ANTENNAS: MULTI FUNCTION, 3- in -1
SOLAR: FLAT 400W OFFSET ARRAY
BATTERIES: 8 - 6VDC FLOODED BATTERIES,STD BOX
CHARGER: 55A 120VAC CHRGR,
CONSPICUITY TAPE ON ALL TRAILER SIDES

The DBT shall provide a 4G CELLULAR DATA PLAN SHALL provide a 1 frame per second update rate for the HD720P camera indicated above.

REQUIRED UPGRADES to the standard equipment list above include:

Wanco Part Number : 229734-C1 with the following optional upgrades added:

-Electric Brakes

-Replace standard battery box with secure battery box.

-Replace standard battery charger with optional charger capable of 75-amp, 12V

-Replace standard solar battery charger with a minimum of the 390W option.

-Replace standard deep-cycle batteries with AGM and upgrade to a minimum of four 4D AGM 12Vdc batteries, 800Ah total capacity.

INSTALLATION

The DBT shall supply a minimum of four Smart Work Zone Trailers with requirements as described above. The DBT is required to coordinate the delivery of the devices with KYTC District Office and with the KYTC/TRIMARC TOC to determine where the units will be located and the message to relay to motorists. The DBT shall be responsible for unit relocations based on the outcomes of weekly coordination meetings between KYTC and the designated DBT contact or traffic management. KYTC/TRIMARC maintains location responsibility for all devices and will make the final determination for unit locations based on the coordination

meetings. Devices shall be delivered to the local district office located in said equipment such that they are easily accessible for maintenance activities.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Smart Work Zone Trailers will be measured for payment per unit each. The Department will make payment for complete, functioning, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 15: Dynamic Message Sign (DMS/VMS – Overhead – Single Pole Mount)

This document contains sample procurement specifications for a full matrix, walk-in access dynamic message sign (DMS) also referred to as a variable message sign (VMS) capable of displaying multiple lines of full-color text and graphics with multiple characters per line. This unit specified for this project will function providing a full-matrix graphics display with the capability to display 3 rows of 21 alphanumeric characters 18" tall with 23x15_3 font characters with character spacing of 4 as well as the capability to display graphics.

The DBT shall provide a single pole mount designed for roadside installation, hence the description DMS/VMS – Overhead- Single Pole Mount used to describe this specific installation. Plans and suggested designs, calcs, etc. shall be submitted by the DBT for review by KYTC/TRIMARC, the Project team and the appropriate departments at KYTC for approval prior to construction and installation.

These specifications describe major DMS/VMS system components, including:

- DMS
- DMS sign controller
- Sign controller enclosures
- DMS control software
- NTCIP communications protocol

The Specifications also address other key DMS project needs:

- DMS manufacturer qualifications
- Product testing
- Product documentation

15.1 How to Use This Document

This section describes how to use this procurement specification document. This document is intended to assist you in developing your own project specifications.

If you have any questions regarding these specifications or how to use them, please contact Daktronics.

15.2 Model Definition

The Daktronics Vanguard® DMS/VMS model numbers are read as:

VF-2020-RRxCCC-20-RGB

VF-2020	Vanguard DMS Full Matrix, 30-degree viewing cone, Walk-In Signs
RR	Number of Pixel Rows High
CCC	Number of Pixels Columns Wide
20	20-mm Pixel Pitch
RGB	Full-Color LED

The DMS special provisions describe attributes common to all sizes full matrix Walk-in DMS. For features and data that are unique to different DMS sizes, please refer to the DMS Spec sheets and shop drawings. **The DMS/VMS model required for this project is**

VF-2020-96-400-20-RGB. Or if KYTC/TRIMARC approve a similar Daktronics model and size can be used if it is agreed that a different style unit is the best fit for the approved mounting structure.

15.3 Glossary

The following abbreviations and definitions shall govern this specification:

- **AASHTO –** American Association of State Highway and Transportation Officials
- **AlInGaP –** Aluminum Indium Gallium Phosphide. Refers to the chemical composition of a red or amber LED dye.
- **ANSI –** American National Standards Institute
- **AWS –** American Welding Society
- **Bin –** Group of LEDs categorized and sorted by intensity or color. Each "bin" has upper and lower intensity or color specifications and contains only LEDs that are measured to be within that range. LED manufacturers sort LEDs into bins to ensure consistent intensity and color properties.
- **Control Computer –** A desktop or laptop computer used in conjunction with DMS control software to communicate with DMS sign controllers. The control computer

can instruct a DMS sign controller to program and control the DMS, monitor DMS status, and run DMS diagnostic tests. A control computer can be used for remote control of one of more DMS, as well as for local control of a single DMS

- **DMS –** Dynamic message sign. An industry term that applies to various types of changeable sign technology. Also known as Changeable Message Signs (CMS) and Variable Message Signs (VMS)
- **Font –** The style and shape of alphanumeric characters that are displayed on the DMS matrix to create messages viewed by motorists and travelers
- **Frame –** see *Page*
- **FSORS –** An NTCIP term meaning "Full, Standardized Object Range Support." See the NTCIP standards for additional information.
- **InGaN –** Indium Gallium Nitride. Refers to the chemical composition of green and blue LED dye.
- **GUI –** Graphical User Interface
- **IPC –** Association Connecting Electronics Industries
- **ISO –** International Organization for Standardization
- **ITE –** Institute of Transportation Engineers
- **ITS –** Intelligent Transportation System
- **LED –** Light Emitting Diode
- **Message –** Information displayed on the DMS for the purpose of visually communicating with motorists. A DMS message can consist of one or more pages of data that are displayed consecutively
- **MIB –** NTCIP Management Information Base
- **Module –** Assembly consisting of a two-dimensional LED pixel array, pixel drive circuitry, and mounting hardware. Modules are installed in the display adjacent to each other to form the display matrix.
- **NEMA –** National Electrical Manufacturers Association
- **NCHRP –** National Cooperative Highway Research Program
- **NTCIP –** National Transportation Communications for ITS Protocol
- **Object –** This is a NTCIP term referring to an element of data in an NTCIP-compatible device that can be manipulated to control or monitor the device.
- **OSHA –** Occupational Safety And Health Administration
- **Page –** This is a NTCIP term referring to the data that is displayed on the DMS display matrix at a given moment in time. Also referred to as a "frame."
- **Pixel –** Picture element. The smallest changeable (programmable) portion of a DMS display matrix
- **PMPP –** Point to Multi-Point Protocol

- **PPP –** Point to Point Protocol
- **PWM –** Pulse Width Modulation
- **Schedule –** A set of data that determines the time and date when a DMS sign controller will cause a stored message to be displayed on the DMS
- **Sign Controller –** A stand-alone computer that is located at a DMS site, which controls a single or multiple DMS. A sign controller received commands and sends information to a control computer
- **Stroke –** Refers to the vertical and horizontal width of the lines and curves of a display font. “Single stroke” denotes character segments that are one pixel wide. “Double stroke” denotes character segments that are two pixels wide.
- **WYSIWYG –** What You See Is What You Get. More specifically, what you see on the DMS control computer monitor is a scaled representation of how a message will appear when it is being displayed on the DMS. Similarly, after a pixel diagnostic test routine has been run, what you see on the control computer monitor is a scaled representation of the functional status of each pixel in the DMS display matrix.

Section 16: DMS/VMS Manufacturer Contract Requirements

This section describes the minimum qualifications required for a dynamic message sign manufacturer to be selected under this contract. A DMS manufacturer must meet these minimum qualifications prior to bidding. This section also details the product documentation that must be provided by the contractor.

16.2 DMS Manufacturer Qualifications

The dynamic message sign manufacturer for this contract shall:

- Have been in the business of manufacturing large outdoor permanently mounted LED DMS, which are used to manage vehicular roadway traffic, for minimum period of ten (10) years prior to the contract bid date. An "LED" DMS contains display pixels constructed solely of high-intensity discrete LEDs.
- Have in operation a minimum of one thousand (1000) large outdoor permanently mounted LED DMSs in North America as defined above. Each of these DMS shall have successfully operated for a minimum period of one (1) year prior to the contract bid date.
- Have in operation as of the contract bid date a minimum of ten (10) independently owned and operated LED DMS systems. Each of the ten (10) systems shall contain a minimum of ten (10) permanently mounted DMS that use the National Transportation Communications ITS Protocol (NTCIP) as their primary communication protocol. Each of the DMS signs shall be communicating over dial-up telephone, cellular telephone, spread spectrum radio, or fiber optic networks.
- The DMS manufacturer must have an in house Quality Management System (QMS) in place certified by an approved registrar to the latest standard of ISO 9001.
- Utilize a documented certified welding procedure in accordance with the latest version of AWS D1.2.

Experiences with manufacturing other types of electronic sign products will not satisfy the requirements of this DMS specification such as:

- Indoor signs of any size or type
- Portable or mobile signs of any size or type
- Neon signs
- Back-lit signs
- Rotating drum or plank signs
- LED lens Displays
- Blank out signs
- Any type of sign that is not pixilated and cannot be programmed to display a nearly infinite quantity of messages
- DMS that have a pixel technology comprised of something other than high-intensity light emitting diodes (LED). Examples of unacceptable technologies are incandescent lamp, liquid crystal, fiber optic, flip disk, flip-fiber combination, and flip-LED combination

- Outdoor electronic signs that are used for purposes other than roadway/motorway traffic management

16.3 Material, Manufacturing, and Design Standards

DMS provided for this contract must comply with the following standards. If no revision date is specified, the most recent revision of the standard applies:

- **General DMS Requirements –** The DMS must be designed in accordance with *NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements*.
- **Aluminum Welding –** The DMS housing must be designed, fabricated, welded, and inspected in accordance with the latest revision of *ANSI/AWS D1.2 Structural Welding Code-Aluminum*.
- **Electrical Components –** High-voltage components and circuits (120 VAC and greater) must be designed, wired, and color-coded per the National Electric Code.
- **Environmental Resistance –** The DMS housing must be designed to comply with type 3R enclosure criteria as described in the latest revision of *NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum)*
- **Product Electrical Safety –** The DMS and all associated equipment and enclosures must be listed by the Underwriters Laboratories (UL) and will bear the UL mark on the outside of the DMS enclosure. Control equipment and enclosures shall be listed as conformant to *UL 1433 Standard for Control Centers for Changing Message Type Electric Signs*. Failure to meet conformance will be cause for rejection.
- **Radio Frequency Emissions –** All equipment must be designed in accordance with Federal Communications Commission (FCC) Part 15, Subpart B as a "Class A" digital device.
- **Maintenance Access and Safety –** The DMS equipment provided must be compliant with all relevant OSHA requirements. The DMS must be equipped with OSHA compliant safety rails and fall arrest system at each entrance location.
- **Structural Integrity –** The DMS housing must be designed and constructed to comply with all applicable sections of *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, as* well as the fatigue resistance requirements of *NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports*.
- **Communication Protocols –** The sign controller hardware/firmware and DMS control software must conform to the applicable National Transportation Communication for ITS Protocol (NTCIP) standards. Refer to the NTCIP section of this specification for detailed NTCIP requirements for this contract.

16.4 Quality Management System (ISO 9001 Certified)

The DMS manufacturer must have an in house Quality Management System (QMS) in place that is certified by an approved registrar to ISO 9001:2008 or the latest released standard of ISO 9001. ISO 9001 certification is a means of ensuring the DMS organization conforms to specific requirements through quality planning in accordance to the latest standard of ISO 9001.

The manufacturer's pre-build technical submittal must provide a copy of the company's ISO 9001 certification.

16.5 Customer Service Department

The DMS manufacturer must have a customer service department that provides technical support and services for the manufacturer's DMS systems.

The manufacturer's customer service department must have technical support help desk that may be contacted via telephone, e-mail and fax. The help desk must be staffed from 8 am to 5 pm Central Time (CT) at a minimum. The manufacturer must also offer bench level repair services for failed components and stocking of most parts for replacement.

The manufacturer must include a description of its available customer support services in the pre-build technical submittal.

16.5 Manufacturing Automation Systems

The DMS manufacturer must utilize automated equipment in the manufacturing process. Automated systems shall be used for the following processes at a minimum: component insertion, soldering, circuit board washing, and conformal coating application.

16.6 Product Testing

The DMS manufacturer must provide documentation indicating that the DMS product has been tested to the following standards. It must be acceptable for the testing to be performed on scale-sized versions of the actual DMS provided that the test unit is functionally and structurally equivalent to the full size DMS.

Failure to conform to these testing requirements will be grounds for rejection. Rejected equipment may be offered for test or retest provided all non-compliant items have been corrected and tested or retested by the DMS manufacturer. Any corrections deemed necessary by the Engineer must be made by the DMS manufacturer, at no additional cost to the Department.

Product Testing

Product test reports shall be submitted for the following testing:

- *NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements* – Section 2, Environmental Requirements. Test report shall detail results of mechanical vibration and shock, electrical noise and immunity, temperature, and humidity.
- Underwriters Laboratories (UL), *UL 1433 Standard for Control Centers for Changing Message Type Electric Signs*. The UL report number(s) for all DMS and control equipment manufactured by the DMS manufacturer shall be submitted and the products shall bear the UL mark.

The supplier must provide a record of each test performed including the results of each test. The report must include a record of the product test report and the test lab's representative that witnessed the tests, including the signature of the lab's representative. The test reports must be provided to the Engineer for review as part of the technical submittal.

Self-Certification

The DMS manufacturer must provide self-certification, including a statement of conformance and copies of test reports, indicating that the following tests have been performed and passed.

Product test reports must be submitted for testing of the following National Transportation Communication for ITS Protocol (NTCIP) standards:

- *NTCIP 1201: NTCIP Global Object Definitions*
- *NTCIP 1203: Object Definitions for Dynamic Message Signs* (including Amendment 1)
- *NTCIP 2101: Point to Multi-Point Protocol Using RS-232 Subnetwork Profile.*

The NTCIP testing must have been completed using industry accepted test tools such as the NTCIP Exerciser, Trevilon's NTester, Intelligent Devices' Device Tester, and/or Frontline's FTS for NTCIP. The NTCIP test report(s) must include testing of sub-network communications functionality, all mandatory objects in all mandatory conformance groups, and a subset of the remaining objects.

16.7 DMS Housing Structural Certification

A Professional Engineer registered in the state of **Kentucky / United States** must analyze the DMS/VMS structural design and shall certify that the DMS/VMS:

- Will withstand the temporary effects of being lifted by the lifting eyebolts provided
- Will comply with the applicable requirements of *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*
- Complies with the fatigue resistance requirements of *NCHRP Report 412, Fatigue-Resistant Design of Cantilevered Signal, Sign, and Light Supports.*

The Professional Engineer must analyze the complete DMS structural design. This includes the housing, mounting brackets, and lifting eyebolts, as well as the bracket-to-housing mounting hardware (nuts, bolts, washers, direct tension indicators, etc.) provided by the DMS manufacturer. Analysis must include, but shall not be limited to:

- The quantity and type of lifting eyebolts to be provided
- The quantity and type of mounting brackets to be provided
- The quantity and type of hardware (nuts, bolts, washers) used to attach the mounting brackets to the DMS
- Verification that no dissimilar metals problem will exist and/or affect the structural integrity of the DMS-to-bracket attachment points
- A recommendation of the number of attachment points, as well as the attachment locations, that the installing contractor should use when mounting the DMS to its support structure

The DMS manufacturer must include a signed and sealed copy of this P.E. certification, including all supporting calculations, within thirty days of submittal approval. Failure to provide P.E. calculations will be cause for rejection.

16.8 Pre-Build Technical Submittal

The DMS manufacturer must provide a complete pre-build technical submittal within 60 days of contract award and shall not proceed with DMS manufacture until the Engineer has approved the submittal. The DMS manufacturer shall provide one (1) copy of the submittal in electronic format delivered via FTP site.

The submittal must include:

- All DMS manufacturer qualification information, as specified herein
- DMS shop drawing, including an illustration of the recommended installation method
- AC site power requirements, including the number of legs, current draw per leg, and typical site power consumption
- Major DMS schematics in block diagram form, including AC power distribution inside and outside the DMS, DC power distribution within the DMS, and control signal distribution inside and outside the DMS
- Drawings of major DMS components, including LED display modules, driver boards, control/logic components, environmental control assemblies, DMS sign controller, control equipment cabinet assembly, and control cabinet mounting footprint
- Catalog cut sheets for major DMS components, including front face paint material, polycarbonate face material, LEDs, regulated DC power supplies, circuit board conformal coating material, hookup wire, signal cable, surge suppression devices, panel board, circuit breakers, utility outlets, sign controller, ventilation/cooling fans, heaters, ventilation filter, thermostats, and any other major system components
- Test reports and certification for all items identified in the “Product Testing” specifications herein

Documentation that proves the DMS manufacturer complies with these specifications must be provided with the DMS manufacturer’s pre-build technical submittal.

This submittal shall also include five (5) references from states that have had NTCIP-compliant DMS from the manufacturer installed for a minimum of five (5) years and project information for all of the manufacturer’s DMS customers of the last five (5) years, including:

- Equipment owner/operator agency name
- Contact person name, telephone number, fax number, and email address
- DMS system name and location of operations control center (project name/number, roadway name/number, state, county, and country)
- DMS commissioning date (first date of successful on-site operation)
- DMS quantity
- DMS display pixel technology (LED, fiber optic, flip disk, etc.)

- DMS display matrix size (pixel rows by pixel columns) and type (full matrix, line matrix, or discrete character)
- DMS housing access type (walk-in, front, rear, or other specific access type)
- Communications protocol used (NTCIP or proprietary; if proprietary, provide a name or description)
- Type of communications backbone used (telephone, fiber optic, direct, etc.)
- NTCIP compliance test reports prepared by independent testing companies, including contact information

The pre-build submittal shall also include the following background information about the DMS manufacturer:

- Full corporate name
- Corporate address
- Contact person name, telephone number, fax number, and email address
- Names and qualifications of the primary project team members, including the following: sales person, project manager, product manager, application engineer, and manufacturing manager
- Number of years in business under the current corporate name
- Copy of the DMS manufacturer's in-house quality management system
- Copy of the DMS manufacturer's certified welding procedure
- General corporate literature
- DMS product literature

Failure to provide complete and accurate submittal information, as specified herein, will be cause for rejecting the DMS manufacturer.

Section 17: DMS/VMS Construction and Operation

This section describes the minimum construction and operational functionality requirements for the dynamic message signs (DMS) to be supplied under this contract. The contractor shall provide all the materials, software, and services necessary to install DMS and associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

17.1 Intent Disclaimer

The Department acknowledges there may be alternative methods to meet the intent of the specification without meeting the exact wording of the specification. The Department encourages DMS Manufacturers to propose advances in technology and alternates to meet the Department's intent. Each deviation of the written specification must be clearly shown and the benefits explained. The Department reserves the right to reject any specification alternate without reason to the DMS Manufacturer.

17.2 General Specifications

The DMS housing shall provide walk-in service access for all LED display modules, electronics, environmental control equipment, air filters, wiring, and other internal DMS components.

The DMS shall contain a full display matrix measuring a minimum of 96 rows high by 512 pixel columns wide. The matrix shall display messages that are continuous, uniform, and unbroken in appearance to motorists and travelers.

Each display pixel shall be composed of red, green, and blue LEDs. Other pixel technologies, such as fiber optic, flip disk, combination flip disk-fiber optic, combination flip disk-LED, liquid crystal, LED Lenses and incandescent lamp will not be accepted.

The pixel matrix shall be capable of displaying at a minimum alphanumeric 6” high characters in accordance with the definition defined by NEMA TS 4 Hardware Standards for Dynamic Message Signs Standards.

The DMS shall be able to display messages composed of any combination of alphanumeric text, punctuation symbols, and graphic images across multiple frames.

Legibility

DMS messages shall be legible within a distance range of 75 ft. (22.9 m) to 300 ft. (137 m) from the DMS display face under the following conditions:

- When the DMS is mounted so its bottom side is positioned between five feet (1.524 m) and 20 feet (6.096 m) above a level roadway surface
- Whenever the DMS is displaying alphanumeric text
- 24 hours per day and in most normally encountered weather conditions
- During dawn and dusk hours when sunlight is shining directly on the display face or when the sun is directly behind (silhouetting) the DMS
- When viewed by motorists and travelers that have 20-20 corrected vision
- When the motorist eye level is 3 feet (.914 m) to 12 feet (3.658 m) above the roadway surface.

Dimensions

DMS housing dimensions shall not exceed 8' high by 30' wide. The front-to-back housing depth shall not exceed 4'4" at its widest point, including the rear ventilation hoods.

DMS weight shall not exceed 4000 pounds.

Power Requirements

Maximum AC power shall not exceed 12,000 Watts, when the following circuits are operational and fully loaded:

- LED display pixel matrix, with 100% of the pixels operating at their maximum possible drive current
- DMS environmental control system
- Utility outlet circuit
- DMS sign controller

Typical DMS AC operating power shall not exceed 3000 Watts with the following circuit loadings:

- LED display pixel matrix, with 38% of the pixels operating at their maximum possible drive current
- DMS sign controller and ventilation system

DMS shall operate from a 120/240 VAC, 60Hz, single-phase power source, including neutral and earth ground (3 wire plus ground).

Sign Construction

The DMS housing shall be constructed to have a neat, professional appearance. The housing shall protect internal components from rain, ice, dust, and corrosion in accordance with NEMA enclosure Type 3R standards, as described in *NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum).*

The DMS housing bottom side shall contain small weep holes for draining any water that may accumulate due to condensation. Weep holes and ventilation/exhaust hoods shall be screened to prevent the entrance of insects and small animals.

DMS and sign controller components shall operate in a minimum temperature range of –30ºF to +165ºF (-34ºC to +74ºC) and a relative humidity range of 0 to 99%, non-condensing. DMS and sign controller components shall not be damaged by storage at or temporary operational exposure to a temperature range of –40ºF to +185ºF (-40ºC to +85ºC).

External DMS component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from hot dipped or mechanically galvanized steel, stainless steel, aluminum, nylon, or other durable corrosion-resistant materials suitable for the roadway signage application.

DMS and sign controller components shall be 100% solid-state, except for the environmental control fans and thermostats. All high voltage electrical components (exceeding 24 VDC) used in the DMS and the sign controller shall be UL (Underwriter's Laboratory) listed and meet all local NEC codes applicable to DMS applications.

The presence of ambient radio signals and magnetic or electromagnetic interference, including those from power lines, transformers, and motors, shall not impair the performance of the DMS system. The DMS system shall not radiate electromagnetic signals that adversely affect any other electronic device, including those located in vehicles passing underneath or otherwise near the DMS and its sign controller.

17.3 DMS Sign Housing

The DMS housing structural frame shall consist of aluminum extrusions made from 6061-T6 and/or 6063-T6 aluminum alloy. All sides of the DMS housing exterior, except the front, shall be covered with thick aluminum sheets made from 5052-H32 aluminum alloy. This external aluminum skin shall be attached to the structural framework using a proven method of attachment.

DMS housing right, left, and rear walls shall be vertical. The top and bottom sides shall be horizontal. The front DMS wall shall be built with a permanent forward tilt angle of three (3) degrees, so that the top of the DMS housing is deeper than its bottom. LED display modules shall be mounted parallel to the front wall, so they are tilted three (3) degrees forward toward the viewing motorists and use of the legible LED viewing area is optimized. The use of tilting brackets to achieve the 3 degree requirements will not be acceptable, as this will cause the walkway floor to be unlevel and hazardous to general maintenance personnel.

DMS structural assembly hardware (nuts, bolts, washers, and direct tension indicators) shall be galvanized A325 high-strength steel and shall be appropriately sized for the application.

Chemical Bonding

An alternate method of attaching the aluminum sheet to the cabinet extrusion shall be the use of a two-part chemically bonding structural adhesive. The adhesive shall be applied in a continuous bead on all cabinet extrusion surfaces that contact the aluminum sheet. The adhesive shall provide the necessary structural bond between the aluminum sheet and the cabinet extrusion as required by the contract specifications and other pertinent standards and codes. The adhesive shall ensure a watertight seal is obtained around the entire perimeter of the cabinet and where any aluminum sheets are spliced.

To ensure that appropriate procedures are followed to bond the aluminum sheet and cabinet extrusion, the structural adhesive manufacturer shall certify the DMS manufacturer. The DMS manufacturer is responsible for performing all necessary testing of the adhesive to meet all requirements of the contract specifications

Welding

The aluminum skin shall be welded to the DMS cabinet frame. All exterior sheet seams shall be continuously seam welded to the DMS frame to form a single structure. Stitch welding shall be used on the interior of the cabinet to attach the aluminum skin sheets to the aluminum extrusion frame. The DMS housing shall be welded and inspected in accordance with the requirements of *ANSI/AWS D1.2Structural Welding Code-Aluminum.* Compliance with this standard shall include, but shall not be limited to, the following:

- Welding shall be performed according to documented in-house welding procedures
- Personnel who perform welding on the DMS housing shall be certified to *AWS D1.2* for all weld types required for housing fabrication
- A Certified Welding Inspector (CWI) shall inspect DMS welding on a daily basis and shall complete written reports that document welding progress, weld integrity, and any corrective action taken. The DMS manufacturer shall archive these reports and make them available for review, upon request of the Engineer

17.4 Mounting Brackets

Multiple mounting brackets in the form of Z-bar extrusions shall be bolted to the DMS housing exterior rear wall to facilitate attachment of the DMS to the support structure. Mounting brackets shall be:

- Extruded from aluminum alloy number 6061-T6
- Attached to the DMS structural frame members, not just the exterior sheet metal
- Installed at the DMS manufacturer's factory
- Attached to the DMS using mechanically galvanized A325 high-strength steel bolts
- Attached to the DMS using direct tension indicators to verify that mounting hardware is tightened with the proper amount of force
- Installed such that all bracket-to-DMS attachment points are sealed and water-tight
- Designed and fabricated such that the installing contractor can drill into them without penetrating the DMS housing and compromising the housing's ability to shed water

17.5 Lifting Hardware

For moving and installation purposes, multiple galvanized steel lifting eyebolts shall be attached to the top of the DMS housing. Eyebolt hardware shall attach directly to the DMS housing structural frame and be installed at the DMS factory. All mounting points for eyebolts shall be sealed to prevent water from entering the DMS housing. Lifting hardware, as well as the

housing frame, shall be designed such that the DMS can be shipped and handled without damage or excessive stress being applied to the housing prior to or during DMS installation on its support structure.

The lifting eyebolts shall be easily removed by one individual without opening or entering the display and without any risk of compromising water-tightness. Special tools shall not be required. Removal of the eyebolts shall not create holes and no replacement bolts or other hardware shall be necessary to seal the cabinet.

17.6 Front Face Construction

The DMS front face shall be constructed with multiple rigid panels, each of which supports and protects a full-height section of the LED display matrix. The panels shall be fabricated using aluminum sheeting on the exterior and polycarbonate sheeting on the interior of the panel.

Front face panels shall provide a high-contrast background for the DMS display matrix. The aluminum mask of each panel shall be painted black and shall contain an opening for each pixel. Openings shall be large enough to not block any portion of the viewing cones of the LEDs.

Face panels shall be attached to each other using stainless steel hardware. Seams that separate adjacent panels shall be sealed. Panels shall not be welded or otherwise permanently mounted to the DMS housing.

Each panel shall have a single polycarbonate sheet attached securely to the inside of the aluminum panel. The polycarbonate sheet shall cover all of the pixel openings. The polycarbonate shall be sealed to prevent water and other elements from entering the DMS. The polycarbonate shall contain UV inhibitors that protect the LED display matrix from the effects of ultraviolet light exposure and prevent premature aging of the polycarbonate itself. The use of a plastic lens system will not meet the requirements and will be cause for rejection.

LED display modules shall mount to the inside of the DMS front face panels. No tools shall be needed for removal and replacement of LED display modules.

DMS front face borders (top, bottom, left side, and right side), which surround the front face panels and LED display matrix, shall be painted black to maximize display contrast and legibility.

In the presence of wind, the DMS front face shall not distort in a manner that adversely affects LED message legibility.

17.7 Exterior Finish

DMS front face panels and front face border pieces shall be coated with semi-gloss black polyvinylidene fluoride (PVDF) applied in accordance to American Architectural Manufacturers Association (AAMA 2605) which has an expected outdoor service life of 10 to 15 years.

All other DMS housing surfaces, including the access doors and DMS mounting brackets, shall be natural mill-finish aluminum.

17.8 Service Access

The DMS housing shall provide safe and convenient access to all modular assemblies, components, wiring, and subsystems located within the DMS housing. All of those internal components shall be removable and replaceable by a single technician.

Two (2) 80" vertically hinged door shall be provided. Each access door shall be mounted to an integral doorframe. A vertical stainless steel hinge shall support each door, and all doors shall open outward. In the closed position, each door shall latch to its frame with a three-point draw-roller mechanism. The latching mechanism shall include an internal handle and release lever. Door release levers shall be located so that a person with no key and no tools cannot become trapped inside the housing.

Access doors, when open at a 90-degree angle from the DMS housing end wall, shall not extend more than 38-inches (965 mm) from the housing. The bottom edge of each door shall be at least 3.5-inches (89mm) from the bottom edge of the DMS housing. This will provide clearance for the doors to swing open over external access platform.

Doorframes shall be double flanged on all sides to shed water. Each door shall close around its flanged frame and compress against a closed-cell foam gasket, which adheres to the door. All doors shall contain a stop that retains the door in a 90-degree open position. When a door is open, the door and its stop shall not be damaged by a 40 mph (64 km/h) wind.

Each door shall be furnished with a lock that is keyed to a Corbin #2 lock.

The DMS must be equipped with an OSHA compliant safety rail assembly, which prevents service personnel from falling out of the DMS when closed across an open access door. A rail assembly must be provided for each door in the display. The safety rail shall consist of a top rail that extends 42-inches (1,067 mm) above the interior walkway, and a mid-rail that extends 21-inches (533 mm) above the interior walkway. The rail assembly shall require no tools to open and close.

The DMS cabinet shall be equipped with an OSHA compliant anchor point at each entrance location for the connection of a personal fall arrest system. These anchorages integrated to the support structure must be strong enough to withstand a force of 5,000 pounds (22.2 kilonewtons) as required by OSHA. The anchorages must be located such that they will not allow a person to free-fall for more than 6 feet when a 6 foot lifeline is used. The anchorages must be located just inside each access door within easy reach from the outside.

17.9 Interior Work Area

Minimum headroom of 72-inches (1,829mm) shall be provided. This free space shall be maintained across the entire width of the DMS housing, with the exception of structural frame members. Structural members shall be designed not to obstruct the free movement of maintenance personnel throughout the DMS interior.

A level aluminum walkway shall be installed in the bottom of the DMS housing. The walkway shall be a minimum of 24-inches (610 mm) wide, and it shall run the entire length of the housing, from one side to the other side . The walkway's top surface shall be non-slip and shall be free of obstructions that could trip service personnel. The walkway shall support a load per AASHTO STA specifications for Highway Signs section 3.6, Live Loads, and it shall be constructed of multiple aluminum removable panels.

17.10 Internal Lighting

The DMS housing shall contain lighting that meets NEAM TS4-2016 section3.2.8.3 Nighttime Service Lighting.

A timer switches shall be located near each cabinet access door. Each timer switch shall be adjustable from 15-minutes to 4-hours of on time.

17.11 LED Display Modules

The DMS shall contain LED display modules that include an LED pixel array and LED driver circuitry. These modules shall be mounted adjacently in a two-dimensional array to form a continuous LED pixel matrix. Each LED display module shall be constructed as follows:

- All LED modules shall be manufactured and designed to IPC Standards
- Each LED display module shall be mounted to the rear of the display's front face panels using durable non-corrosive hardware. No tools shall be required for module removal and replacement. The modules shall be mounted such that the LEDs emit light through the face panel's pixel holes and such that the face panel does not block any part of the viewing cone of any of the LEDs in any pixels. The use of light enhancing lenses to achieve defined viewing cone shall be cause for rejection.
- LED display module power and signal connections shall be a quick-disconnect locking connector type. Removal of a display module from the DMS shall not require a soldering operation.
- All exposed metal on both sides of each printed circuit board, except connector contacts, shall be protected from water and humidity exposure by a thorough application of conformal coating. Bench level repair of individual components, including discrete LED replacement and conformal coating repair, shall be possible.

- Individual addressing of the each LED display module shall be configured via the communication wiring harness and connector. No on-board addressing jumpers or switches shall be allowed.
- Removal or failure of single LED module shall not affect the operation of any other LED module or sign component. Removal of one or more LED modules shall not affect the structural integrity of any part of the sign.
- It shall not be possible to mount an LED display module upside-down or in an otherwise incorrect position within the DMS display matrix.
- All LED display modules, as well as the LED pixel boards and driver circuit boards, shall be identical and interchangeable throughout the DMS.

17.12LED Pixels

Each LED module shall contain a printed circuit board to which LED pixels are soldered. The LED pixel matrix shall conform to the following specifications:

- The distance from the center of one pixel to the center of all adjacent pixels, both horizontally and vertically, shall be .81-inches (~20 mm).
- Each pixel shall consist of a minimum of one (1) independent string of discrete LEDs for each color. All pixels shall contain an equal quantity of LED strings.
- The failure of an LED string or pixel shall not cause the failure of any other LED string or pixel in the DMS.
- Each pixel shall contain the quantity of discrete LEDs needed to output white colored light at a minimum luminous intensity of 12,400 candelas per square meter when measured using a photometric meter through the DMS front face panel assembly. Failure to conform to the requirements will be cause for rejection.
- The base of the discrete LEDs shall be soldered so that they are parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs shall be perpendicular to the circuit board.

17.13Discrete LEDs

DMS pixels shall be constructed with discrete LEDs manufactured by a reputable manufacturer such as Avago Technologies (formerly Agilent Technologies), Nichia Corporation, OSRAM, CREE or EOI. Discrete LEDs shall conform to the following specifications:

- All LEDs shall have a nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer's product specifications and shall not exceed +/- 5 degrees. Using optical enhancing lenses with 15 degree LED's

will not conform to 30 degree half-power viewing cone specifications and will be cause for rejection.

- Red LEDs shall utilize AlInGaP semiconductor technology and shall emit red light that has a peak wavelength of 618-630nm
- Green LEDs shall utilize InGaN semiconductor technology and shall emit green light that has a peak wavelength of 519-539nm
- Blue LEDs shall utilize InGaN semiconductor technology and shall emit blue light that has a peak wavelength of 460-480nm
- The LED packages shall be fabricated from UV light resistant epoxy.
- The LED manufacturer shall perform color sorting of the bins. Each color of LEDs shall be obtained from no more than two (2) consecutive color "bins" as defined by the LED manufacturer.
- The LED manufacturer shall perform intensity sorting of the bins. LEDs shall be obtained from no more than two (2) consecutive luminous intensity "bins" as defined by the LED manufacturer.
- The various LED color and intensity bins shall be distributed evenly throughout the sign and shall be consistent from pixel to pixel. Random distribution of the LED bins shall not be accepted.
- The LED manufacturer shall assure color uniformity and consistency on the LED display face within the 30 degree cone of vision. Inconsistent color shifts or intensity will be cause for rejection.
- All LEDs used in all DMS provided for this contract shall be from the same manufacturer and of the same part number, except for the variations in the part number due to the intensity and color.
- The LEDs shall be rated by the LED manufacturer to have a minimum lifetime of 100,000 hours of continuous operation while maintaining a minimum of 50% of the original brightness.

17.14 Pixel Drive Circuitry

Driver circuitry shall be provided for each LED pixel module and shall individually control all pixels on that module. The display modules shall conform to the following specifications:

- Each LED driver board shall be microprocessor-controlled and shall communicate with the sign controller on a wire or fiber optic communication network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostic tests, and report pixel and diagnostic status.
- Constant current LED driver ICs shall be used to prevent LED forward current from exceeding the LED manufacturer's recommended forward current whenever a forward voltage is applied. To maximize LED service life, LED drive currents will not be allowed

that exceed the manufacturer's recommendations for the 100,000-hour lifetime requirement.

- 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.
- Each LED driver circuit shall be powered by 24 VDC from external regulated DC power supplies.
- The LED driver circuitry shall be able to detect that individual LED strings or pixels are stuck off and shall report the pixel status to the sign controller upon request.

17.15Regulated DC Power Supplies

The LED pixel display modules shall be powered with auto-ranging regulated switching power supplies that convert the incoming AC to DC at a nominal voltage of 24 volts DC. Power supplies shall be wired in a redundant configuration that uses multiple supplies for the DMS display matrix.

Power supplies shall be redundant and rated such that if one supply fails, the remaining supply(s) shall be able to operate 100% of the pixels in that display region at 100% brightness when the internal DMS air temperature is +140ºF (60ºC) or less.

Each power supply shall receive 120VAC power from separate circuits on separate circuit breakers, such that a single tripped breaker will not disconnect power from more than one supply.

The power supplies shall be sufficient to maintain the appropriate LED display intensity throughout the entire operating input voltage range.

The power supplies used to power the LED pixel modules shall be identical and interchangeable throughout the DMS.

The power supplies used to power the LED pixel modules shall have an application of conformal coating to protect from the environmental elements, and must be either UL listed or recognized.

The regulated DC power supplies shall conform to the following specifications:

- Nominal output voltage of 24 VDC +/- 10%
- Nominal maximum output power rating of 1000 watts
- Operating input voltage range shall be a minimum of 90 to 264 VAC
- Operating temperature range shall be a minimum of –30ºF to +165ºF (-34ºC to +74ºC)

- Maximum output power rating shall be maintained over a minimum temperature range of –30ºF to +140ºF (-34ºC to +60ºC)
- Power supply efficiency shall be a minimum of 80%
- Power factor rating shall be a minimum of 0.95
- Power supply input circuit shall be fused
- Automatic output shut down and restart if the power supply overheats or one of the following output faults occurs: over-voltage, short circuit, or over-current
- Power supplies shall be UL listed
- Printed circuit boards shall be protected by an acrylic conformal coating

17.16 Control Systems

The DMS shall include a DMS controller and/or auxiliary control panel as specified in the Requirements for DMS Controllers section herein.

17.17 Environmental Monitoring Systems

The DMS shall include sensors that monitor and report ambient (external) light level and temperature, as well as the internal temperature and humidity.

Ambient Light Measurement

Sensors that measure the outdoor ambient light level at the DMS site shall be mounted in-line with the DMS housing walls. This ambient light measurement system shall consist of three (3) electronic light sensors.

Two of the light sensors shall be placed such that they measure the ambient light levels striking the front and rear of the DMS. The third light sensor shall be mounted to the floor of the DMS housing and shall face the ground. The DMS sign controller shall continuously monitor the light sensors and adjust the LED display matrix intensity to a level that creates a legible message on the DMS face.

Ambient Temperature Measurement

A minimum of one (1) ambient temperature sensor shall be mounted to the rear wall or bottom of the DMS housing. The sensor shall be placed such that it is never in direct contact with sunlight. The external temperature sensor reading shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

Internal Temperature Measurement

The DMS shall contain a minimum of one (1) temperature sensor. The sensor(s) shall measure the temperature of the air in the cabinet over a minimum range of -40°F to +176ºF (-40°C to +80°C). The internal temperature sensor output shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

Internal Humidity Measurement

The DMS shall contain one (1) sensor that measures the relative humidity of the air inside the DMS cabinet. The sensor shall monitor the humidity from 0 to 100%. The humidity sensor

output shall be continuously monitored by the DMS sign controller and shall be reported to the DMS control software upon request.

17.18 Interior DMS Environmental Control

The DMS shall contain systems for cabinet ventilation, face panel fog prevention, and safe over-temperature shutdown.

Housing Ventilation System

The DMS shall contain an electronically controlled ventilation system and a failsafe thermostat designed to keep the internal DMS components safe when the outdoor ambient temperature is +115°F (+46°C) or less.

The ventilation system shall consist of two or more air intake ports. Each intake port shall be covered with a filter that removes airborne particles measuring 500 microns in diameter and larger. One or more ball bearing-type fans shall be mounted at each intake port. These fans shall positively pressure the DMS cabinet.

Fans and air filters shall be removable and replaceable from inside the DMS housing.

Each primary ventilation fan shall contain a sensor to monitor its rotational speed, measured in revolutions per minute and shall be reported to the sign controller upon request with an indication of a pass or fail status.

One exhaust port shall be provided for each air intake port. All exhaust port openings shall be screened to prevent the entrance of insects and small animals.

An aluminum hood attached to the rear wall of the DMS shall cover each air intake and exhaust port. All intakes and exhaust hoods shall be thoroughly sealed to prevent water from entering the DMS.

For regions identified that experience regular high ambient temperatures, the addition of pixel fans shall be incorporated into the design to prevent thermal dimming of the modules.

A manual override timer switch shall be located just inside the access door to manually activate the ventilation system. The switch shall be adjustable from zero (0) to four (4) hours. If doors are located at both ends of the cabinet, one override switch shall be located at each door.

Front Face Panel Defog System

The DMS shall contain an automatically controlled defog system that warms the DMS front face when the internal DMS relative humidity is near condensation levels. This system shall keep the front face polycarbonate panel free of fog and condensation. The heat generated by the defog system shall not damage any part of the DMS.

Over Temperature Safety Shutdown

The DMS shall automatically shut down the LED modules to prevent damaging the LEDs if the measured internal cabinet air temperature exceeds a maximum temperature threshold.

17.19 Sign Controller Signal Interface

In situations where the sign controller is located in a ground-mounted or pole-mounted traffic cabinet, the communication signals from the external sign controller to the DMS shall use fiber optic cable with the following specifications:

- 50.0/125 µm diameter
- LC-style connectors
- Rated for indoor/outdoor use
- UL-rated
- PVC outer jacket
- Tight buffer inner jacket
- Operating temperature range: –40ºF to +185ºF (-40ºC to +85ºC)

A minimum of six (6) fibers shall be provided with one (1) for controller to sign commands, one (1) for sign to controller responses, and four (4) spares.

17.20 Wiring and Power Distribution

Power and Signal Entrances

Two threaded conduit hubs shall be located on the rear wall of the DMS housing. One hub shall be for incoming AC power and the other shall be for incoming DMS signal cabling or a communications line.

Panel Board

The DMS shall contain a power panel board and circuit breakers that meet the following minimum requirements:

- Service entrance-rated
- Minimum of 20 circuit breaker mounting positions
- Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
- UL listed panel board and circuit breakers

Internal Wiring

Wiring for LED display module control, environmental control circuits, and other internal DMS components shall be installed in the DMS housing in a neat and professional manner. Wiring shall not impede the removal of display modules, power supplies, environmental control equipment, and other sign components. Wires shall not make contact with or bend around sharp metal edges. All wiring shall conform to the National Electrical Code.

Earth Grounding

The DMS manufacturer shall provide one earth ground lug that is electrically bonded to the DMS housing. The lug shall be installed near the power entrance location on the DMS housing's rear wall. The DMS installation contractor shall provide the balance of materials and services needed to

properly earth ground the DMS. All earth grounding shall conform to the National Electrical Code.

17.21 Convenience Outlets

The DMS housing shall contain a utility outlet circuit consisting of a minimum of one (1) 15-A NEMA 15-R, 120 VAC duplex outlets, with ground-fault circuit interrupters. One outlet shall be located at the end of DMS housing interior by the control equipment.

17.22 Transient Protection

The DMS and sign controller signal and power inputs shall be protected from electrical spikes and transients as follows:

Sign AC Power

The AC power feed for all equipment in the sign cabinet shall be protected at the panel board by a parallel-connection surge suppresser rated for a minimum surge of 40 kA. This device shall conform to the following requirements:

- Withstand a peak 100,000-ampere surge current, 40kA L-N, 40kA L-G
- Designed, manufactured, & tested consistent with: ANSI/IEEE C62.41.1-2002, C62.42.2-2002C62.45-2002, and C62.72-2016, NEC 285, and IEC 61643, CE
- Less than 1 nanosecond response time
- Temperature range of -40ºF to +185°F (-4000ºC to +140ºC)
- Approximate dimensions of 3.67 inches (93 mm) wide by 8.28 inches (210 mm) long by 3-inches (76 mm) high
- High Energy Parallel Deign for Category C3 & C-High Application, plus B & A
- UL listed to: UL 1449 Fourth Edition, CSA 22.2 No 269.2

Section 18: DMS/VMS Controller Requirements

This section describes the minimum specifications for the dynamic message sign (DMS) controllers and auxiliary control panels to be provided with this contract. Each DMS shall include a sign controller, auxiliary control panel, and associated equipment. The contractor shall provide all the materials, software, and services necessary to install DMS controllers, auxiliary control panels, and associated equipment that fully comply with the functional requirements specified herein, including incidental items that may have been inadvertently omitted.

18.1 General Requirements

Each DMS shall be controlled and monitored by its own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with DMS control software in order to perform most DMS control functions.

The sign controller shall meet the following operational requirements:

- Communicate using embedded NTCIP protocol
- Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation
- Include a front panel user interface with graphical LCD and keypad for direct operation and diagnostics as described herein
- Contain a minimum of three (3) NTCIP-compliant RS232 communication ports
- Contain a minimum of two (2) NTCIP-compliant Ethernet port with RJ45 connector
- Have the ability to play volatile messages
- Contain DMS-specific control firmware (embedded software) that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel interface

NTCIP shall be natively supported in the DMS controller. External protocol converter or translator devices shall not be allowed.

18.2 Controller Location

The sign controller and associated communication equipment shall be installed in one of the following locations:

- The sign controller will be installed inside the DMS housing.
- An auxiliary controller with laptop enclosure will be installed in a ground mounted 334 cabinet located near the sign on the truss ladder side. **The contractor shall provide a cabinet, wiring, and all components that are approved as an assembly. This approved assembly shall be incidental to this item. Verification that the cabinet, wiring, and all components are an approved assembly shall be submitted to Central Office Traffic Operations. This shall be stamped by an electrical engineer that it is in compliance with the NEC 2017.**

18.3 Environmental

The sign controller shall meet the following environmental requirements defined in *NEMA Standards Publication TS 4, Hardware Standards for Dynamic Message Signs (DMS), with NTCIP Requirements.*

18.4 Mechanical and Electrical

The sign controller shall meet the following electrical and mechanical requirements:

- Mount in a standard EIA 19-inch (480 mm) equipment rack with a maximum 4U space requirement
- Weigh no more than 12 pounds, including its enclosure
- Consume no more than 30 watts of power
- Powered by an internal regulated DC power supply capable of operating on 120VAC or 240VAC at both 50Hz and 60Hz

18.5 Operational Requirements

Front Panel User Interface

The sign controller's front panel shall include a menu driven architecture, 16-button keypad, and a minimum of a 480x272 graphical LCD screen. These devices shall be used to perform the following functions with the sign controller and DMS:

- Monitor the current status of the sign controller, including the status of all sensors and a monochromatic what-you-see-is-what-you-get (WYSIWYG) representation of the message visible on the display face including the use of graphical messages.
- Perform all diagnostics testing of various system components including pixels, power systems, sensors, and more
- Activate, create, preview, and delete messages stored in memory
- Blank the sign
- Start and stop the schedule
- Configure display parameters, including display size and color technology
- Configure date and time
- Configure communications port settings and NTCIP options
- Configurable level of password protection per user
- Select automatic or manual brightness mode of operation

Memory

The sign controller shall have non-volatile electronically changeable memory. This memory shall be formed by flash or battery-backed static RAM integrated circuits that retain the data in memory for a minimum of 30 days following a power loss. This changeable memory shall be used to store messages and schedules. The controller memory shall be a minimum of 2G RAM and 8GB storage.

Internal Clock

The DMS sign controller shall contain a computer-readable clock that has a battery backup circuit. The battery shall keep the clock operating properly for at least 30 days without external power, and the clock shall automatically adjust for daylight savings time and leap year using hardware, software, or a combination of both. The clock shall be set electronically by the sign controller microprocessor and shall be accurate to within one (1) minute per month.

18.6 Communications

All remote communication ports shall be NTCIP-compatible as defined in the "Requirements for NTCIP Compatibility" section of these specifications.

Communication Modes

The DMS sign controller shall be able to receive instructions from and provide information to a computer containing DMS control software using the following communication modes:

- Remotely via direct or dial-up communications with a remotely located computer. The system communications backbone, as well as all field modems or signal converters, shall provide the DMS sign controller with an RS232 signal.
- Locally via direct connection with a laptop computer that is connected directly to the sign controller using an RS232 null modem connection.

Serial Communication Ports

The DMS sign controller shall contain a minimum of three (3) NTCIP-compatible RS232 communication ports. These ports shall support multiple communication interfaces, including, but not limited to, direct null-modem (for local laptop control), dial-up and leased-line modems, radio systems, cellular modems, and fiber optic modems. The RS232 ports shall all have standard DB9M connectors.

The baud rate, connection type, and NTCIP communication protocol shall be configurable. Each port must support all typical serial baud rates ranging from 1200 to 115,200 baud. All three ports shall be capable of supporting either of the following sub network profiles: NTCIP 2101 (PMPP). They shall also be capable of supporting either NTCIP 2201 (Null) or NTCIP 2202 (Internet) transport profiles. Only one each of the transport and sub network profiles shall be active at any time on each port.

Ethernet Port

The DMS sign controller shall contain a minimum of one (1) 10/100Base-T Ethernet communication port. This port shall be available for optional use for communicating from the central control system to the DMS sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.

Communications on the Ethernet port shall be NTCIP-compatible using the NTCIP 2202 Internet transport profile and the NTCIP 2104 Ethernet sub network profile. This shall permit the controller to be operated on any typical Ethernet network using the TCP/IP and UDP/IP protocols.

Controller Addressing

The DMS sign controller shall use whatever addressing scheme is appropriate for the NTCIP network types used for communications. The controller addressing shall be configurable through the front panel user interface.

NTCIP 2101 (PMPP) networks shall be configured with an address in the range 1 to 255 with a default address of 1. NTCIP 2104 (Ethernet) networks shall use a static IP address. Both the IP address and subnet shall be configurable.

Transient Protection

The Ethernet communication ports in the DMS sign controller shall be protected with surge protection between each signal line and ground. This surge protection shall be integrated internally within the controller.

18.7 DMS Control Outputs

The DMS sign controller shall transmit and receive data packets to and from the DMS via dedicated fiber optic cables. This network will communicate with all sensors, drivers, and other devices utilizing a CAN (controller area network) bus network running throughout the DMS.

Data transferred shall include pixel states, sensor values, and I/O readings from various devices, such as door sensors and power supply monitors. Pixel data shall include the states to be displayed on the sign face as well as diagnostic data retrieved from the LED drivers.

18.8 Messaging

The DMS controller shall have the ability to display messages on the DMS display face as required herein.

Message Presentation on the DMS Display Matrix

The sign controller shall control the LED drivers in a manner that causes the desired message to display on the DMS sign. At a minimum, the sign controller shall support the following features as described in the DMS specification:

- *Display of alpha numeric characters, including letters, numbers, and punctuation*
- Selection of particular character fonts style

- Horizontal alignment of text on the display, including left, center, and right justification
- Vertical alignment of text on the display, including top, middle, and bottom justification
- Adjusting the spacing horizontally between characters or vertically between lines of text
- Alternating between pages of a multiple-page message
- Display of graphic bitmaps of various sizes ranging to very small to the size of the entire DMS matrix

Message Effects

The DMS shall be able to display messages using the following types of effects:

- **Static Message –** The selected message is displayed continuously on the sign face until the sign controller blanks the sign or causes the display of another message
- **Flashing Message –** All or part of a message is displayed and blanked alternately at rates between 0.1 seconds and 9.9 seconds. The flash rate is user programmable in increments of 0.1 seconds
- **Scrolling Message –** The message moves across the display face from one side to the other. The direction of travel is user selectable as either left-to-right or right-to-left
- **Multiple-Page Message –** A message contains up to six different pages of information, with each page filling the entire pixel matrix. Each page's display time is user programmable from 0.1 seconds to 25.5 seconds, and adjustable in increments of 0.1 seconds.

Message Activation

Messages shall be activated on a DMS in three ways:

- **Manual –** An operator using the front panel LCD/keypad interface or NTCIP-compatible control software manually instructs a particular message to be activated.
- **Schedule –** The internal time-based scheduler in the DMS may be configured to activate messages at programmable times and dates. Prior to activation, these messages and their activation times and dates shall be configured using the control software.
- **Events –** Certain events, like a power loss, may trigger the activation of pre-configured messages when they occur. These events must be configured using the control software.

A displayed message shall remain on the sign until one of the following occurs:

- The message's duration timeout expires
- The controller receives a command to change the message
- The controller receives a command to blank the sign

- The schedule stored in the controller's memory indicates that it is time to activate a different message
- A special event, such as a loss of communication, occurs that is linked to message activation

It shall be possible to confer a "priority" status onto any message, and a command to display a priority message shall cause any non-priority message to be overridden.

Schedule Activation

The DMS sign controller shall support the activation of messages based on a time/date-based schedule. The format and operation of the message scheduler shall be per the NTCIP 1201 and NTCIP 1203 standards.

Display of Alphanumeric Text

The DMS sign controller shall support the storage and use of a minimum of twelve (12) font sets with which messages can be formatted and displayed. Each font shall support up to 255 characters. All text font files shall include the following characters:

- The letters "A" through "Z", in both upper and lower case
- Decimal digits "0" through "9"
- A blank space
- Eight (8) directional arrows
- Punctuation marks, such as: . , ! ? – ‘ ’ “ ” : ;
- Special characters, such as: # & * + / ( ) [ ] < > @

The DMS supplier shall provide the DMS controller with the at least 20 fonts preinstalled. The controller shall support changing or replacing these fonts from the central software using NTCIP.

18.9 DMS Intensity Control

The DMS controller shall provide means to change the brightness of the display matrix manually or automatically. The manual control will allow the user to select one of at least 100 intensity levels, which will be communicated to the LED drivers in the DMS. The brightness shall remain at that level until the user changes the level or sets the controller to automatic mode.

The automatic intensity control mode will monitor the ambient light sensors of the DMS and will use a mathematical algorithm to automatically select one of the 100 or more intensity levels. The intensity level will then be transmitted to the LED drivers in the DMS. The algorithm used to calculate the intensity level shall be determined by the manufacturer and tested under real-world lighting conditions.

The intensity control mode, manual or automatic, shall be settable via NTCIP using the control software or via the front panel interface. The manual brightness level shall be settable via the software or front panel. The mode and brightness level shall be monitored from both the software or front panel interfaces.

18.10 System Status Monitoring and Diagnostic Testing

The DMS controller shall be capable of monitoring the status of many of the DMS components and subsystems in real-time and/or manual modes, depending on the component or system. The following sections detail the status and diagnostic information that shall be provided by the controller. All of this status and diagnostic data shall be available via the front panel LCD screen and shall be transmitted via NTCIP to control software upon request.

Message Display Status

The DMS controller shall be capable of monitoring and displaying the currently active message (if any) including graphical messages on the controller's front panel LCD display. This display shall be in a WYSIWYG format.

LED Pixel Testing

Upon command from either the front panel control interface or via NTCIP from remote control software, the sign controller shall direct all of the LED modules to perform diagnostic tests of all their pixels. The controller shall then collect and report the results of the pixel testing.

The controller shall also be capable of automatically detecting in real-time the status of each of the display's pixels and reporting their on/off status. This monitoring shall take place without interfering with the display of data on the DMS face.

Power Supply Operation

The sign controller shall monitor and report the functional status of regulated DC power supplies located in the DMS by monitoring diagnostic outputs located on the supplies. The controller shall monitor the output voltage of each power supply and the status of each output. The power supply voltages shall be measured and the status shall be indicated as pass or fail.

Door States

If the DMS or control equipment cabinet is equipped with access doors and sensors to monitor their open status, the controller shall monitor the status of those doors.

Fan Operation

Intake fans shall be monitored by the controller and report the status of the fans.

Environmental Conditions

The DMS controller shall monitor the readings of all light, temperature, and humidity sensors installed in the DMS housing.

18.11 Error Notification

The DMS sign controller shall be capable of automatically informing a maintenance operator (via the local LCD panel) and a central control system (via NTCIP communication) of the occurrence of important events and subsystem failures.

All major component and subsystem errors shall be indicated on the controller's LCD front panel.

The controller shall be capable of sending event notifications to the central control system via SNMP "traps" as allowed by NTCIP. When one of these events occurs, the sign controller shall create a data packet for transmission to the central controller that shall contain details about the event. The transmission of traps shall be governed by the NTCIP standards. The controller shall be configurable to enable or disable the transmission of traps for each event or error type. This configuration will include the automatic initiation of these traps, including establishing telephone modem connections if appropriate, when the NTCIP network permits transmission initiation by the sign controller.

The following sections list errors and events that the controller shall report as defined above.

Over Temperature Shutdown

The DMS controller shall continuously monitor the DMS housing's temperature sensors and shall automatically shut down the DMS if the internal cabinet temperature exceeds a safety threshold.

If the temperature approaches the threshold the controller shall reduce the brightness of the sign face. If the temperature continues to increase and exceeds that threshold, the controller shall trigger a warning notification event and blank the face of the sign. The sign face will remain blank until the temperature begins to drop. As the temperature drops, the controller will gradually increase the brightness of the display face, eventually returning to full brightness.

The sign controller shall employ an algorithm to control the above brightness reductions and increases utilizing hysteresis to ensure that the display face does not visibly flicker as the temperature changes.

The event notifications sent for over temperature situations will include visual indication on the controller's front panel LCD, as well as a trap notification sent to the central control system.

Controller Restart

When the DMS controller detects that it has been restarted due to a manual reset or error condition, it shall send a trap notification to the central system. It shall also automatically activate the NTCIP reset message if it is configured to do so.

Power Loss

When the DMS controller detects that it has lost power, it shall automatically indicate that on the front panel LCD. It shall also send a trap notification to the central system and activate the NTCIP power loss message if configured to do so.

Power System Failure

The DMS controller shall automatically monitor the major power systems in the sign and detect when one of them has failed. These failures will be reported on the front panel LCD and transmitted to the central system in the form of a trap.

Door Opened

When the sign controller detects that one of the sign cabinet or control cabinet doors has been opened, it will transmit a trap to the central system indicating which door has opened.

Communication Loss

The DMS controller shall monitor the frequency of communication packets from the central system. If the controller detects that communication has not occurred between the controller and central system for longer than a configurable timeout, then the controller will automatically activate a communication loss message as defined by NTCIP. This communication loss message shall be configurable and may be disabled as allowed by NTCIP.

18.12 Auxiliary Control Panel

The DMS may include an auxiliary control panel if specified that will provide a secondary user interface panel for DMS control, configuration, and maintenance. The auxiliary control panel shall meet the same electrical, mechanical, and environmental specifications as the DMS controller.

Interface Panel

The auxiliary control panel shall have a graphical LCD panel and keypad identical to those found on the DMS controller. It shall also contain a local/remote mode, status LEDs, and one NTCIP compatible RS232 communication port that meet the same specifications as the DMS controller.

DMS Control Interface

The auxiliary control panel shall include an identical menu system to the DMS controller with all of its features and functionality.

Location & Signal Interface

The auxiliary control panel shall be located and shall interface to the DMS sign controller in one of the following locations:

- Mount the DMS controller in the DMS cabinet, the auxiliary control panel shall be mounted inside a ground-mounted 334 cabinet for maintenance access from the ground. The auxiliary control panel shall interface over multi-mode fiber optic cable and shall allow operation up to 1640 feet from the DMS sign controller.

Section 19: DMS/VMS Requirements for Control Equipment Cabinets

This section describes the requirements of the metal cabinet(s) used to house the auxiliary sign controller and associated equipment separately from the sign cabinet.

19.1 Ground-Mounted Controller Cabinet

The ground-mounted control equipment cabinet shall be a 334-type cabinet. It shall be designed to mount on a concrete pad near the DMS. A rebar enforced concrete slab, 3'x3'x4" shall be installed on both sides of the cabinet, in front of the doors to provide a standing spot for technicians working at the cabinet. The cabinet shall enclose the sign auxiliary controller, panel board, 120 VAC electrical outlets, and remote communication devices, such as a modem. **The contractor shall provide a cabinet, wiring, and all components that are approved as an assembly. This approved assembly shall be incidental to this item. Verification that the cabinet, wiring, and all components are an approved assembly shall be submitted to Central Office Traffic Operations. This shall be stamped by an electrical engineer that it is in compliance with the NEC 2017.**

General Specifications

The ground-mounted controller cabinet shall be 66" (1,676 mm) +/- 1" (25.4 mm) high by 24" (610 mm) +/- 0.5" (12.7 mm) wide by 30" (762 mm) +/- 0.5" (12.7 mm) deep. The front-to-back cabinet dimensions shall not exceed 36" (914 mm) at its widest point, including the door handles, and louvers.

The controller cabinet weight shall not exceed 200 pounds (45.5 kg) when the cabinet is empty.

Cabinet Construction

The controller cabinet shall be constructed to have a neat, professional appearance. The cabinet shall protect all internal components from rain, ice, dust and corrosion in accordance with NEMA enclosure Type 3R standards, as described in *NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum)*.

Internal component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from hot dipped galvanized steel, stainless steel, aluminum, nylon or other durable corrosion-resistant materials suitable for roadway signage applications.

The DMS controller cabinet shall be constructed using 0.125-inch thick aluminum alloy 5052-H32. The exterior of the controller cabinet shall be natural mill-finish aluminum.

Serviceability

The controller cabinet shall provide safe and convenient access to all modular assemblies, components, wiring and other materials located within the

cabinet. All internal components shall be removable and replaceable by a single technician.

Two (2) vertically hinged doors shall be mounted on the cabinet for interior access. One door shall be located on the front face and one door shall be located on the rear face of the cabinet. Each of the door openings shall not be less than 54" (1,372 mm) high by 21" (533 mm) wide. Each opening shall be sealed with a 0.5" x 2" closed cell foam gasket.

Each door shall be attached to the cabinet by a full-length stainless steel hinge and mounting hardware. Both doors shall open outward. In the closed position, each door shall latch to a double-flanged door opening with a three-point draw-roller mechanism. The door handle shall be stainless steel. Each door shall have a doorstop to hold the door in the open position. The doors shall each be equipped with a Corbin #2 lock.

One (1) lamp for each door shall be located at the top of the controller cabinet to illuminate the cabinet interior. A switch mounted near the front and rear doors shall automatically turn on the light when the door is opened.

Equipment Rack

The cabinet shall contain a full-height standard EIA 19-inch rack. The rack shall be secured within the cabinet by mounts at the top and bottom.

The rack shall contain a minimum of one (1) pullout drawer. The drawer shall be suitable for storing manuals and small tools, such as screwdrivers. The drawer shall be able to latch in the out position to function as a laptop/utility shelf.

Electrical Systems

The cabinet shall contain a power panel board and circuit breakers that meet the following minimum requirements:

- Service entrance-rated
- Minimum of 12 circuit breaker mounting positions
- Short circuit ratings of 22,000 amps and 10,000 amps for the main and branch circuits, respectively
- UL listed

The panel board shall be mounted in the equipment rack.

The cabinet shall contain a utility outlet circuit consisting of a minimum of two (2) 15-A NEMA 15-R, 120 VAC duplex outlets, with a minimum of one (1) ground-fault circuit interrupter. The outlets shall be mounted inside the cabinet and located near the panel board.

The cabinet shall include one (1) earth ground lug that is electrically bonded to the cabinet. The lug shall be installed near the power entrance. The installation contractor shall provide the balance of materials and services needed to properly connect to earth ground. All earth grounding shall conform to the National Electrical Code.

Environmental Systems

At least one (1) thermostatically controlled 100 cfm exhaust fan shall be mounted near the top of the control cabinet.

Filtered air intake ports shall be located on the bottom third of each access door. The fan and air filters shall be removable and replaceable from inside the cabinet.

19.2 Laptop Interface Enclosure

A pole-mounted control interface cabinet shall be provided. It shall be provided with two (2) mounting brackets suitable for use with pole-mount straps. The cabinet shall enclose an auxiliary control panel, 120 VAC electrical outlets, and a laptop shelf.

General Specifications

The pole-mounted cabinet shall be 20" (508 mm) +/- 1" (25.4 mm) high by 24" (610 mm) +/- 0.5" (12.7 mm) wide by 10" (254 mm) +/- 0.5" (12.7 mm) deep. The front-to-back cabinet dimensions shall not exceed 12" (305 mm) at its widest point, including the door handle and roof overhang.

The cabinet weight shall not exceed 50 pounds (22.7 kg) when the cabinet is empty.

Cabinet Construction

The controller cabinet shall be constructed to have a neat, professional appearance. The cabinet shall protect all internal components from rain, ice, dust and corrosion in accordance with NEMA enclosure Type 3R standards, as described in *NEMA Standards Publication 250, Enclosures for Electrical Equipment (1000 Volts Maximum)*.

Internal component hardware (nuts, bolts, screws, standoffs, rivets, fasteners, etc.) shall be fabricated from hot dipped galvanized steel, stainless steel, aluminum, nylon or other durable corrosion-resistant materials suitable for roadway signage applications.

The cabinet shall be constructed using 0.125-inch thick aluminum alloy 5052-H32. The exterior of the controller cabinet shall be natural mill-finish aluminum.

Serviceability

The controller cabinet shall provide safe and convenient access to all modular assemblies, components, wiring and other materials located within the cabinet. All internal components shall be removable and replaceable by a single technician.

One (1) vertically hinged door shall be mounted on the cabinet for interior access. The door shall be located on the front face of the cabinet. The door opening shall not be less than 17" (432 mm) high by 21" (533 mm) wide. The opening shall be sealed with a 0.5" x 2" closed cell foam gasket.

The door shall be attached to the cabinet by a full-length stainless steel hinge and mounting hardware. The doors shall open outward. In the closed position, the door shall latch to a double-flanged door opening. The door handle shall be stainless steel. The door shall be equipped with a Corbin #2 lock.

Equipment Mounting

The auxiliary control panel shall be mounted to the interior rear wall of the cabinet.

The cabinet shall contain a fold-down shelf suitable for supporting a laptop computer during maintenance operations. The shelf shall be a minimum of 15" (381 mm) wide by 12" (305 mm) deep.

Electrical Systems

The cabinet shall contain a utility outlet circuit consisting of a minimum of two (2) 15-A NEMA 15-R, 120 VAC duplex outlets, with a minimum of one (1) ground-fault circuit interrupter.

The installation contractor shall provide the balance of materials and services needed to properly connect to earth ground. All earth grounding shall conform to the National Electrical Code.

Section 20: DMS Control Software Requirements

This section describes the minimum specifications for the DMS sign control software. The contractor shall provide all software, software media, licenses, and documentation necessary to install and operate a dynamic message sign (DMS) control system that fully complies with the functional requirements herein, including incidental items that may have been inadvertently omitted.

20.1 General Specifications

DMS control software shall:

- Operate on desktop and laptop computers with the following minimum hardware requirements: 1.5GHz processor, 1 GB RAM, and 2GB of free hard drive space.
- Support the following operating systems: Windows 7, Windows Server 2003, Windows Server 2008 with all critical updates installed .
- Support 32 bit or 64 bit processors and operating systems
- Provide a user-friendly multi-color graphical user interface
- Be written using Microsoft-certified software development tools (compilers, etc.)
- Be able to support at least 250 dynamic message signs
- Utilize a client-server architecture with the server handling sign communications and the clients connecting to the server via local and wide area networks
- Support DMS communications via any combination of dedicated hardwired serial network, fiber-optic network, dial-up telephone lines, leased phone lines, dialup cellular modem, Cellular IP modem,, spread spectrum radio, Ethernet, or other as specified herein
- Support DMS control, monitoring, and diagnostic functions as specified herein
- Control DMS both remotely from a central location, and locally at the DMS site using a laptop computer
- Be accompanied by an easy-to-use software installation utility
- Contain an on-line help system that includes documentation for each feature or present in the software. It shall also be context sensitive such that pressing the help button or [**F1**] key on any screen will launch the help page for that particular function.
- Be fully compliant with the communications protocol requirements of the NTCIP Special Provision specified herein

20.2 Software Security

DMS control software shall support the creation of user IDs and passwords for up to 100 system users. Only a “System Administrator” shall assign user creation.

The DMS control software shall support different level of rights and authorizations to control DMS, to create and modify messages within software, configuration of control software, and ability to modify DMS settings or running content on DMS.

DMS control software shall require the use of passwords and ability to modify requirements for user passwords to ensure user passwords are secure. These include requiring setting minimum password lengths and include support for minimum alpha-numeric combinations.

Before a system operator can use the DMS control software, the software shall request a "user name" and user "password." If the correct user name and password are not provided, access to the software shall be declined.

20.3 Client-Server Architecture

The software shall be of a modular design including a server and multiple client modules. The server shall handle all DMS communication and shall store all configuration data, messages, schedules, communications settings, DMS status, and other data. The client software modules shall send requests to and receive responses from the server over any TCP/IP-based network, including LANs and WANs. Client applications shall include the following functionality:

- Login application to provide user access to system with username and password
- Central software to manage display communications, monitoring system status, and various DMS diagnostics.
- Message creation application for creating DMS messages
- Message scheduler client for creating time and date schedules for activating messages
- Administration client for DMS system configuration and administration

20.4 DMS Control

The DMS control software shall provide a user interface that presents the system's DMS in both list and graphical (map) formats. The software will allow the DMS to be organized into groups as defined by the end user to allow for separating displays by region, roadway, and or any user specified category as needed by the administrator. The DMS list and map interfaces will include only the signs for the group currently selected.

List, Map, and Display Monitor Interfaces

The DMS list shall clearly display the following information about each DMS:

- DMS ID number, as the numerical ID of the display
- DMS name, in a descriptive text format
- Message name or description of the message being displayed on the DMS
- Date and time of last communication between the control software and the DMS sign controller
- Error and warning status, including pixel errors, power failures, communication error, etc.
- Graphical representation (WYSIWYG) of current message displayed

The graphical map interface shall include the following:

- Configurable bitmaps that may be used to show all or parts of the system geographically
- Message name or description of message being displayed on DMS
- Icons for each sign located anywhere on the map
- Icon color changes to indicate the status of the DMS (i.e., yellow for warnings or red for errors)
- Date and time of last communication between the control software and the DMS sign controller
- Sign name is visible if mouse is placed over a DMS icon
- Graphical representation (WYSIWYG) of current message displayed when hovering over the sign icon.

The display monitor interface shall display the following information:

- DMS name, in a descriptive text format
- Message name or description of message being displayed on DMS
- Date and time of last communication between the control software and the DMS sign controller
- Graphical representation of messages running on DMS
- Ability to select the DMS visible by sign name, running messages

Direct Control Operations

The user interface shall provide a means for users to directly perform the following tasks for each sign:

- Send and activate stored messages from the libraries
- Blank the display
- Activate an ad-hoc quick message that is created immediately, not loaded from a library
- Send and activate schedules
- Retrieve messages from the sign
- Perform diagnostics of DMS subsystems, such as power supplies, sensors, climate control devices, etc.
- Perform pixel testing and report coordinates of any failed pixels with failure detection

Polling

The software shall have a feature to poll all or a set of DMS at predefined intervals or at a specific time-of-day. During this poll, the software shall retrieve the most recent status information from the sign and present it to the user as appropriate in the list and map interfaces.

Scenarios

The administrator shall have the ability to create scenarios that act like macros or scripts to automate a series of often repeated tasks. These scenarios shall have the ability to perform the following actions:

- Send and activate stored messages from the libraries
- Blank the display
- Send and activate schedules
- Perform diagnostics of DMS subsystems, such as power supplies, sensors, climate control devices, etc.
- Perform tests of pixels

The scenarios shall be saved to libraries where system operators may activate them through the graphical user interface. The scenarios shall also be scheduled to automatically run at predetermined times and dates.

System Monitoring

The software shall be capable of monitoring and displaying to the operator the contents of any communications in progress with DMS. The status of all outgoing and incoming data packets will be visible.

Multi-Vendor Sign Control

The software shall be capable of controlling any NTCIP-compatible DMS regardless of the manufacturer. Functionality supported shall be limited to NTCIP standard MIB objects only. Other manufacturer support many require proof of NTCIP compliance of controller to verify compatibility. The software shall be configurable to enable or disable support for any standard optional NTCIP objects.

20.5 Message Creation and Editing

A DMS system operator shall be able to use the DMS control software to create, edit, name, and store message files.

The message editor GUI shall present a scaled image of the DMS display matrix, including a complete and accurate representation of the display matrix type (character, line or full matrix) and the number of display pixels. The DMS editor image shall actively show message content in a WYSIWYG format, while a new message is being created or an existing message is being edited.

The message editor shall provide the operator with the following capabilities:

Text Editing Capabilities:

- Be able to type in message text as if typing in any word processor
- Text entry shall be directly in message editing area, external input windows to enter text then displayed on a graphic representation is not a true WYSIWYG editor
- Text entry includes but is not limited to text input, modification, removal, or insertion

- Ability to select font per character
- Ability to set flashing text and variable flashing rates per character
- Character map functionality to insert special characters such as arrows
- Support for many different fonts ranging in size and boldness for improved legibility of message
- Adjustable interline spacing in number of pixels for improved legibility of message (full matrix only)
- Horizontal message justification on the DMS display matrix including left, center, and right
- Vertical message justification on the DMS display matrix including top, middle, and bottom (full matrix only)
- Ability to make text scrollable per line, including direction and scroll rate
- Ability to change inter-character spacing between individual characters (line and full matrix only)
- Ability to change text foreground and background color per character based on color depth capabilities of display
- Support for inserting NTCIP standard real time fields

Graphics Editing Capabilities:

- Be able to insert text and locate anywhere on matrix display
- Be able to insert graphic images files into message editing area
- Be able to move the graphic text and images around within message editing area
- Support for inserting true type font text
- Support for enabling anti-aliasing of font text
- Be able to resize images when inserted
- Be able to layer images and text and change the z-order (top to bottom)
- Be able to move shapes to the front or back within the z-order
- Be able to insert shapes include lines, rectangles, ellipse, triangles, spheres, and diamonds
- Be able to support drawing tools include shape fill, line color, fill color, and brush width
- Support at least color depth of 32k for full RGB color displays
- Time with AM/PM or am/pm (NTCIP 1203 v3)

Message Properties:

- The number of pages that the message is to contain (shall be a maximum of six)
- Ability to turn on and off beacon per message
- Page on and off times for each page

- Ability to adjust message priority status per message stored in library

Editor Capabilities:

- Include a spell checker to verify against misspelled words
- Ability to adjust message priority status per message stored in library
- Include a list of prohibited words and prevent from being used in message text
- Include a library of common MUTCD symbols for easy insertion of graphic images
- Support clip board operations of cut, copy, and paste
- Support undo/redo actions
- Ability to rearrange page order for multiple page messages
    - Ability to duplicate pages
    - Be able to preview message as would run on display
    - Be able to zoom in/out editing area
    - Messages shall be able to be sent to any NTCIP DMS using standard NTCIP 1203 MULTI tags
    - Include a most recent list of last messages edited for quick access.
    - Support default options when creating new messages including page time on and off, line and page justification, and default font

Message Library Capabilities:

- Top level folders shall be organized by DMS type and size
- Be able to create folders to store messages
- Be able to rename files and folders
- Be able to delete files and folders
- Be able to create multiple levels of folders
- Be able to save the message for future use
- Be able to edit a saved message for future changes
- Be able to open an existing message and save as a new message

20.6 Schedule Creation and Editing

DMS control software shall support the creation of message schedules, which instruct the DMS sign controller to run specific messages at pre-determined times and dates.

Software shall contain an editor, which allows messages to be scheduled via:

- Month of the year (January, February, etc.)
- Day of the week (Monday, Tuesday, etc.)
- Day of the month (1,2, ….31)
- Time of the day

The schedule editor shall provide a convenient means for the operator to:

- Create a new schedule
- Rename an existing schedule
- Delete a schedule
- Save all new changes

The schedule editor shall contain a calendar view to see the scheduled day plans. The view shall be able to view by week, month, or year.

When adding a message to a schedule, the software shall provide a visual representation of the messages. The verification ensures the user is adding the correct message to the displays schedule.

It shall be possible to store schedule files in both the DMS control computer memory and the DMS sign controller memory.

20.7 Display Fonts

The software shall support a minimum of twenty (20) fonts for each model of DMS. These fonts shall be configurable by the system administrator. The fonts used shall be selectable from a library containing a minimum of 20 fonts provided by the software vendor. Each sign model shall be capable of using a different set of fonts. The software shall automatically adjust the available fonts in the message editor based on the DMS model configuration.

The software shall include a font editor to allow the operator to create custom fonts. The font editor shall allow the DMS system operator to create new fonts or modify existing fonts. The operator shall have the capabilities to graphically edit each character within a font in a pixel-by-pixel manner.

Any of the fonts provided by the software vendor or created/modified by the administrator shall be downloadable to the DMS.

20.8 Event Logging

The software shall include an event logging system that logs all significant system events. Each logged events shall include the following fields at a minimum:

- Event ID number
- Operator that initiated the event
- Time and date that the event occurred
- Description of the event (i.e., “Diagnostic Test Performed”)
- Source of the event (i.e., DMS sign name)
- Additional data relevant to the event (i.e., “Failed pixel: (4, 73)”)

The events logged shall include, but not be limited to, the following:

- User login/logout
- Communication failures
- Configuration changes
- Message and schedule activation or display blanking
- Diagnostics test results

- Warning events sent from the sign
- Other system errors

The system operators will have the ability to view, sort by category, and print the log file at any time.

20.9 System Configuration

The DMS control software shall allow system administrators, and other users with correct security access right, to configure many system parameters and functions. The basic sets of configurable settings include the following:

- Sign models and individual signs
- Communication networks
- NTCIP profiles to enable/disable MIB objects
- System error/warning alarms
- User security rights
- System maps and sign icon placement
- Default system option settings
- Default message parameters
- Message priority settings
- Prohibited word list

Sign Configuration

Each sign in the DMS control software shall be configured with the following parameters:

- Sign viewing area height and width (for full-matrix signs)
- Number of lines and each line's height and width (for line-matrix signs)
- Number of lines and characters size for character matrix signs
- Color capabilities (amber, tricolor, full-color)
- Site name
- DMS ID number
- Network address
- Communication parameters
- Time zone and daylight savings time settings

Communication Settings

Communication network configuration shall include the ability to configure and modify sign communication networks with the following parameters:

- Network type (direct serial, dial-up, Ethernet)
- Communication port (i.e., COM4)

- Baud rate (ranging from 1200 to 115,200)
- Hardware handshaking
- NTCIP subnetwork and transport protocols
- Communication retries and timeouts
- IP address and port

User Administration

The access rights shall be capable of at least four (4) levels of security including but not limited to:

- *Limited*- access to only view information
- *Standard*- simple control of running messages and content
- *Power*-modify display settings and configuration
- *Administrator*- full rights to all software commands including adding, removing, modifying user access rights.

System Maps

It shall be possible to configure each sign group to appear on a map within the software. The administrator shall be able to use the software to select the map, identified as a bitmap file, which can then be imported into the software. Each sign shall have an icon that may be placed anywhere on the map.

Message Editor Defaults

The message editor shall automatically utilize the following default settings during the creation of new message files:

- Pixel spacing between adjacent lines of text
- Pixel spacing between adjacent text characters
- Display duration of a given message page
- Beacon activation status (for DMS that contain flashing beacons)
- Effect to be applied to text (i.e., static, scrolling, etc.)
- Message priority classification
- Horizontal text justification supporting left, center, or right
- Vertical text justification supporting top, middle, and bottom
- Default font
- Spell check on message save
- Force text to uppercase
- Disable scrolling

Message Priorities

User-definable defaults shall allow messages to be assigned a priority classification of:

- Emergency
- High
- Normal
- Low
- Minimal

A numeric priority range shall be assigned to each of these five priority classifications. The priority shall allow two different message files to be assigned the same classification, but within that classification, one message can be identified as having higher priority.

20.10 Software Use and Reproduction Rights

Software shall support a licensing key to prevent unauthorized or unlicensed copies of the software to be installed on non-agency computers or personal machines. The license shall apply to the server machine, and authorize client use from server machine. The DMS manufacturer shall provide a DMS control software license for this contract. A copy of the DMS control software shall be provided to the engineer on CD-ROM within thirty (30) days of contract award.

Section 21: DMS/VMS Requirements for NTCIP Conformance

This section describes the minimum specifications for the NTCIP communication capabilities of the DMS controller and DMS control software. The contractor shall provide all the software, firmware, and services necessary to operate a dynamic message sign (DMS) system that fully complies with the NTCIP functional requirements specified herein, including incidental items that may have been inadvertently omitted.

21.1 References

Each NTCIP device covered by these project specifications shall implement the latest version of the standard. Refer to the NTCIP library at www.ntcip.org for information on the current status of NTCIP standards.

21.2 Subnetwork Profiles

Each serial or modem port on each NTCIP device shall be configurable to support NTCIP 2101. Only one of these profiles shall be active at any given time. Serial ports shall support external dial-up modems.

Each Ethernet port on the NTCIP device shall comply with NTCIP 2104.

The NTCIP device(s) may support additional Subnet Profiles at the manufacturer's option. At any one time, only one subnet profile shall be active on a given port of the NTCIP device. All response datagram packets shall use the same transport profile used in the request. The NTCIP device shall be configurable to allow a field technician to activate the desired subnet profile and shall provide a visual indication of the currently selected subnet profile.

21.3 Transport Profiles

Each serial or modem port on each NTCIP device shall be configurable to support both NTCIP 2201 and NTCIP 2202.

Each Ethernet port on the NTCIP device shall comply with NTCIP 2202.

The NTCIP device(s) may support additional transport profiles at the manufacturer's option. Response datagrams shall use the same transport profile used in the request. Each NTCIP device shall support the receipt of datagrams conforming to any of the supported transport profiles at any time.

21.4 Application Profiles

Each NTCIP device shall comply with NTCIP 2301 and shall meet the requirements for Conformance Level 1.

An NTCIP device may support additional application profiles at the manufacturer's option. Responses shall use the same application profile used by the request. Each NTCIP device shall support the receipt of application data packets at any time allowed by the subject standards.

21.5 Object Support

Each NTCIP device shall support all mandatory objects of all mandatory conformance groups as defined in NTCIP 1201 and NTCIP 1203.

Each NTCIP device shall support all mandatory objects in all optional conformance groups required herein. All optional objects listed in these specifications shall be supported.

21.6 MULTI Tags

Each NTCIP device shall support the following message formatting MULTI tags. The manufacturer may choose to support additional standard or manufacturer-specific MULTI tags.

21.7 Acceptance Testing

The vendor will provide certification of NTCIP-compliance as part of the vendor's pre-build submittal documentation. This certification shall be in the form of a comprehensive test plan and completed test report as performed by either the vendor or a third-party testing agency. The testing shall have been completed using industry accepted test tools such as the NTCIP Exerciser, Trevilon's NTester, Intelligent Devices' Device Tester, and/or Frontline's FTS for NTCIP. Data capture files from the FTS software during the performance of the above testing shall be furnished upon request of the Engineer.

The Engineer can elect to perform additional NTCIP testing if desired. This testing shall be conducted on a production DMS in the vendor's facility during the factory acceptance test. The vendor shall provide a written NTCIP test procedure to the Engineer a minimum of 30 days prior to the NTCIP testing.

21.8 Interpretation Resolution

If the Engineer or DMS manufacturer discovers an ambiguous statement in the standards referenced by this procurement specification, the issue shall be submitted to the NTCIP DMS Working Group for resolution. If the Working Group fails to respond within 90 days, the engineer shall provide an interpretation of the specification for use on the project.

Section 22: TRENCHING AND BACKFILLING

DESCRIPTION

Trenching and Backfilling shall be performed in accordance with the plans, specifications and Standard Drawings.

MATERIALS

All trenches shall be marked with underground utility warning tape.

INSTALLATION

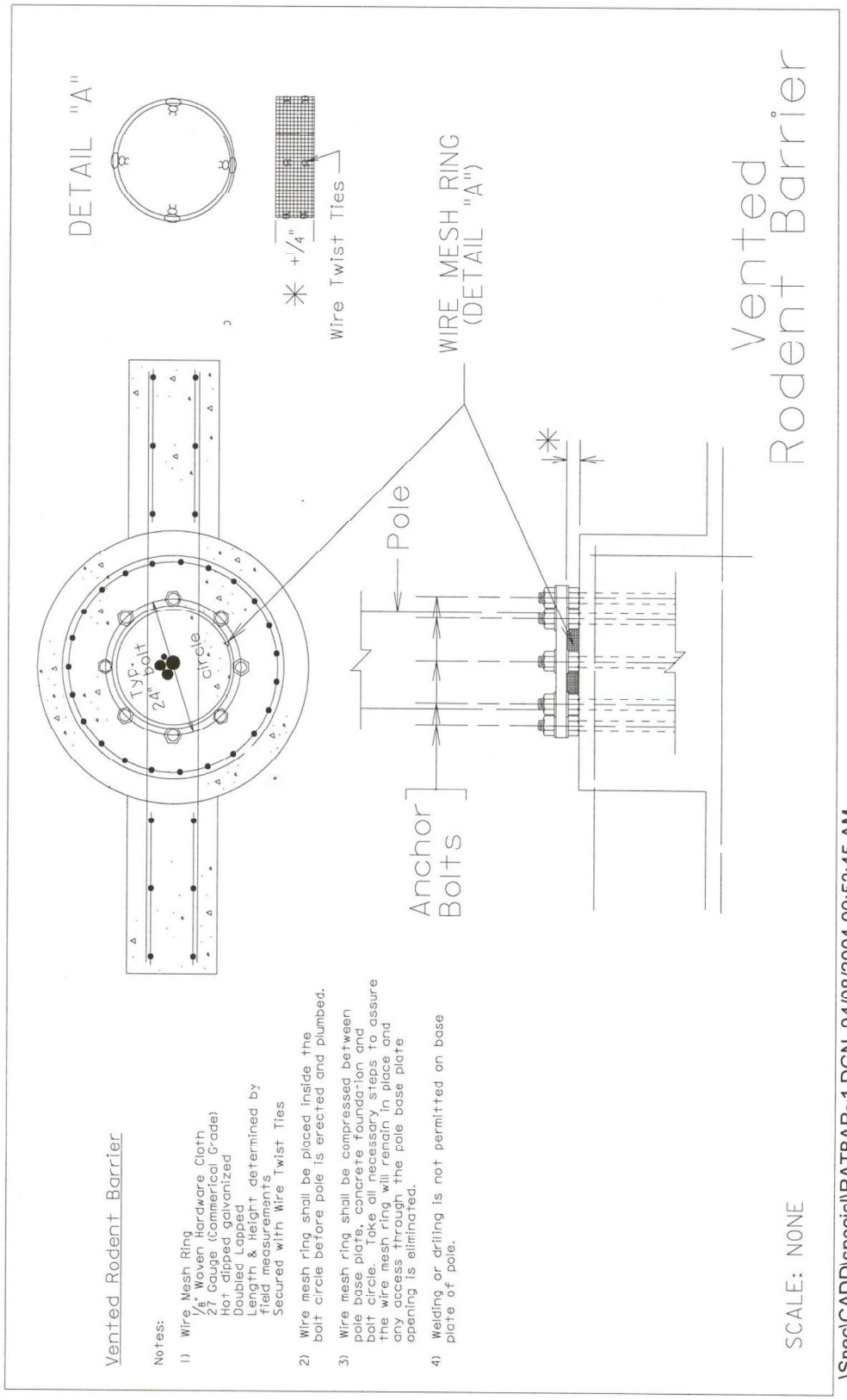
The Contractor shall be responsible for locating all underground utilities prior to excavation. The Contractor shall excavate the trench, place warning tape above the conduit, backfill the trench and restore all disturbed areas to the satisfaction of the Engineer. Backfill material shall be placed and compacted in lifts of 9 inches or less.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Trenching and Backfilling will be measured for payment per unit linear foot. The Department will make payment for complete, inspected, and accepted quantities. The Department will consider payment as full compensation for all work required under this section.

Section 23: Vented Rodent Barrier Detail

Vented rodent barrier – Prior to erecting tubular structures and poles on concrete foundations formed with conduit sweeps, a double lapped ring barrier of standard commercial grade 27 gauge hot dipped galvanized 1/8 inch woven wire mesh shall be placed inside the foundations bolt circle. The height of the wire mesh ring barrier shall be from the concrete foundation to the top of the leveling nuts and washers plus 1/4 inch. The Contractor shall take all necessary steps to assure the wire mesh ring will remain in place to eliminate any access through the base plate opening of the tubular structure or pole when erected and plumbed. The Contractor shall not weld or drill to the base plate of the pole. Optional vented rodent barrier designs and materials may be used when approved by the Engineer and at no additional cost to the Department.


Vented Rodent Barrier
Notes:
1) Wire Mesh Ring
1/8" Woven Hardware Cloth
27 Gauge (Commerical Grade)
Hot dipped galvanized
Doubled Lapped
Length & Height determined by field measurements
Secured with Wire Twist Ties
2) Wire mesh ring shall be placed inside the bolt circle before pole is erected and plumbed.
3) Wire mesh ring shall be compressed between pole base plate, concrete foundation and bolt circle. Take all necessary steps to assure the wire mesh ring will remain in place and any access through the pole base plate opening is eliminated.
4) Welding or drilling is not permitted on base plate of pole.
Typ. 24" bolt circle
DETAIL "A"
+/-1/4"
Wire Twist Ties
WIRE MESH RING (DETAIL "A")
Pole
Anchor Bolts
Vented Rodent Barrier
SCALE: NONE
...\Spec\CADD\special\RATBAR~1.DGN 04/08/2004 09:52:45 AM

Section 24: GLOSSARY

The following acronyms, abbreviations, and definitions shall govern this specification:

- AASHTO – American Association of State Highway and Transportation Officials
- ABS - Acrylonitrile Butadiene Styrene
- AC – Alternating Current
- AlInGaP – Aluminum Indium Gallium Phosphide (refers to the chemical composition of an LED).
- ANSI – American National Standards Institute
- ASCII – American Standard Code for Information Interchange
- ASN.1 – Abstract Syntax Notation 1
- ASTM – American Society for Testing and Materials
- AWG - American Wire Gauge
- AWS – American Welding Society
- BCD – Binary Coded Decimal
- B frames – Bi-directional Predicted Frames
- BGP – Border Gateway Protocol
- Bin – Group of LEDs categorized and sorted by intensity or color. Each bin has upper and lower intensity or color specifications and contains only LEDs that are measured to be within that range. LED manufacturers sort LEDs into bins to ensure consistent intensity and color properties.
- BOOTP – Bootstrap Protocol
- CALTRANS – California Department of Transportation
- CAN – Control Area Network
- CCTV – Closed Circuit Television
- CDPD – Cellular Digital Packet Data
- CLI – Command Line Interface
- CNC – Computer Network Control
- Control Computer – A desktop or laptop computer used in conjunction with VMS control software to communicate with VMS sign controllers. The control computer can instruct a VMS sign controller to program and control the VMS, monitor VMS status, and run VMS diagnostic tests. A control computer can be used for remote

control of one of more VMS, as well as for local control of a single VMS

- DC – Direct Current
- DHCP – Dynamic Host Configuration Protocol
- DMS – Dynamic Message Sign. Synonymous and interchangeable with Variable Message Sign (VMS). An industry term that applies to various types of variable or changeable message sign technology
- DVI-D – Digital Visual Interface - Digital
- EIA – Electronic Industries Association
- ELFEXT – Equal Level Far End Crosstalk
- EPA – Effective Projected Area
- FCC – Federal Communications Commission
- FDA – Food and Drug Administration
- Font – The style and shape of alphanumeric characters that are displayed on the VMS matrix to create messages viewed by motorists and travelers
- Frame – see *Page*
- FSORS – Full, Standardized Object Range Support – an NTCIP term. See the NTCIP standards for additional information.
- GUI – Graphical User Interface
- HDPE – High Density Polyethylene
- HHR – Half Horizontal Resolution
- HTTP – Hypertext Transfer Protocol
- IEEE – Institute of Electrical and Electronic Engineers
- I frames – Intra-frames
- IC – Integrated Circuit
- IGMP
- InGaAlP – Indium Gallium Aluminum Phosphide
- I/O – Input/Output
- IP – Internet Protocol – in transceivers
- IRE – Institute of Radio Engineers
- ISO – International Organization for Standardization
- ITE – Institute of Transportation Engineers

- ITS – Intelligent Transportation System
- Kbps – Kilobits per second
- KYTC – Kentucky Transportation Cabinet – May also be referred to as the or The Department in this document.
- LAN – Local Area Network
- LCD – Liquid Crystal Display
- LED – Light Emitting Diode
- MDPE – Medium Density Polyethylene
- Message – Information displayed on the VMS for the purpose of visually communicating with motorists. A VMS message can consist of one or more pages of data that are displayed consecutively
- MIB – Management Information Base
- Module – Assembly consisting of a two-dimensional LED pixel array, pixel drive circuitry, and mounting hardware. Modules are installed in the display adjacent to each other to form the display matrix.
- MTBF – Mean Time Between Failures
- MPEG – Moving Picture Experts Group
- NEC – National Electrical Code
- NEMA – National Electrical Manufacturers Association
- NESC – National Electrical Safety Code
- NEXT – Near End Crosstalk
- NCHRP – National Cooperative Highway Research Program
- NRZ – Non Return to Zero
- NRZI – Non Return to Zero Inverted
- NTCIP – National Transportation Communications for ITS Protocol
- NTSC - National Transmission Standards Committee
- Object – An NTCIP term referring to an element of data in an NTCIP-compatible device that can be manipulated to control or monitor the device.
- OER – Octet Encoding Rules
- OSHA – Occupational Safety and Health Administration
- OTDR – Optical Time Domain Reflectometer
- Page – An NTCIP term referring to the data that is displayed on the VMS display

matrix at a given moment in time. Also referred to as a frame.

- P frames – Forward Predicted Frames
- PCB – Printed Circuit Board
- Pixel – Picture element. The smallest changeable (programmable) portion of a VMS display matrix
- PMPP – Point to Multi-Point Protocol
- PPP – Point to Point Protocol
- PSELFEXT – Power Sum Equal Level Far End Cross Talk
- PSNEXT – Power Sum Near End Crosstalk
- PTZ – Pan/Tilt/Zoom
- PVC – Polyvinyl Chloride
- PWM – Pulse Width Modulation
- QSIF – Quarter Source Input Format
- RAM – Random Access Memory
- RARP – Reverse Address Resolution Protocol
- RGB – Red-Green-Blue
- Schedule – A set of data that determines the time and date when a VMS sign controller will cause a stored message to be displayed on the VMS
- SDRAM – Synchronous Dynamic Random Access Memory
- SIF – Source Input Format
- SNMP – Simple Network Management Protocol
- STMP – Simple Transportation Management Framework
- Stroke – Refers to the vertical and horizontal width of the lines and curves of a display font. Single stroke denotes character segments that are one pixel wide. Double stroke denotes character segments that are two pixels wide.
- TFTP – Trivial File Transfer Protocol
- TIA - Telecommunications Industry Association
- TMA – Truck Mounted Attenuator
- TOC – Traffic Operations Center
- UL – Underwriters Laboratories
- UPS – Uninterruptible Power Supply

- USB – Universal Serial Bus
- VLAN – Virtual Local Area Network
- VMS – Variable Message Sign. Synonymous with DMS. A type of VMS that is fully programmable such that the content of its messages are fully changeable remotely and electronically.
- VMS Controller – A stand-alone computer that is located at a VMS site, which controls up to 8 VMS or LCS units. A sign controller receives commands from and sends information to a control computer
- WAN – Wide Area Network
- WYSIWYG – What You See Is What You Get. More specifically, what you see on the VMS control computer monitor is a scaled representation of how a message will appear when it is being displayed on the VMS. Similarly, after a pixel diagnostic test routine has been run, what you see on the control computer monitor is a scaled representation of the functional status of each pixel in the VMS display matrix.