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Development of a Risk-Based Approach for KDOT Construction Inspection: Implementation Guidelines

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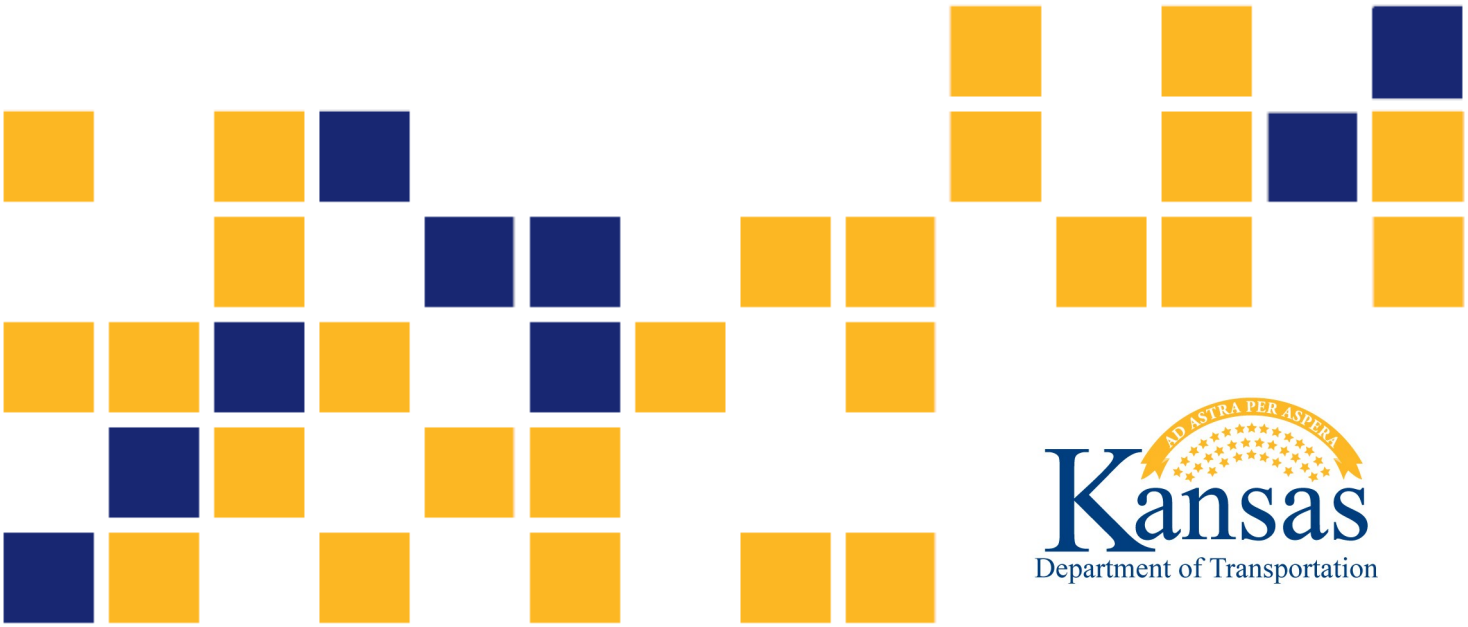

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16 Abstract

State departments of transportation (DOTs) routinely face the challenges of shrinking budgets and substantial reductions in the numbers and experience levels of inspectors. Many experienced construction inspection staff have left state DOTs, including the Kansas DOT (KDOT), while the number of projects and the levels of required inspections have increased. Consequently, DOTs often rely on costly strategies such as the utilization of contractor's quality control and outsourcing for third-party testing and inspection. K-TRAN: KU-19-3, *Development of Risk-Based Approach for KDOT Construction Inspection: An Assessment*, successfully identified and evaluated the level of risk of KDOT construction activities associated with section numbers from the KDOT Standard Specifications and the KDOT Construction Manual.

The overarching goal of this research project was to develop implementation guidelines to incorporate risk-based approaches into current KDOT construction inspection practices. An empirical dataset of 169 KDOT construction projects completed between 2017 and 2021 was used to analyze inspection risk activities and develop an inspection checklist. The inspection checklist includes 35 primary activities associated with six common construction operations from the KDOT quality assurance (QA) documents, including (1) earthwork and embankment; (2) subgrade, base, and shoulders; (3) Portland cement concrete pavement (PCCP) and hot-mix asphalt (HMA) pavement; (4) structures; (5) incidental construction; and (6) roadside improvement. Eighteen KDOT experts provided input to create heat maps of risk levels, inspection frequency, and required inspection staff associated with each inspection activity in the checklist. Results from this study will help KDOT managers effectively and efficiently allocate inspection resources for highway construction projects.

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Final Report

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PREFACE

The Kansas Department of Transportation's (KDOT) Kansas Transportation Research and New-Developments (K-TRAN) Research Program funded this research project. It is an ongoing, cooperative and comprehensive research program addressing transportation needs of the state of Kansas utilizing academic and research resources from KDOT, Kansas State University and the University of Kansas. Transportation professionals in KDOT and the universities jointly develop the projects included in the research program.

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Abstract

State departments of transportation (DOTs) routinely face the challenges of shrinking budgets and substantial reductions in the numbers and experience levels of inspectors. Many experienced construction inspection staff have left state DOTs, including the Kansas DOT (KDOT), while the number of projects and the levels of required inspections have increased. Consequently, DOTs often rely on costly strategies such as the utilization of contractor's quality control and outsourcing for third-party testing and inspection. K-TRAN: KU-19-3, *Development of Risk-Based Approach for KDOT Construction Inspection: An Assessment*, successfully identified and evaluated the level of risk of KDOT construction activities associated with section numbers from the KDOT Standard Specifications and the KDOT Construction Manual.

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Acknowledgments

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Chapter 1: Introduction

1.1 Background

The Federal Regulations 23 CFR 637, Subpart B: Quality Assurance Procedures for Construction, requires each state's department of transportation (DOT) to develop and implement a Quality Assurance (QA) program to ensure that the materials and workmanship incorporated into federal-aid highway construction projects meet the requirements (Quality Assurance Procedures for Construction, 2011). Subpart B of 23 CFR 637 defines the six core elements of a QA program as follows:

- Quality control (QC): All operational techniques and activities performed by the contractor vendor are to fulfill contract requirements;
- Acceptance: All factors that comprise state DOT's determination of product quality are as specified in the contract requirements, including verification sampling, testing, inspection, and possibly QC sampling and testing results;
- Independent assurance (IA): Activities that are an unbiased and independent evaluation of all sampling and testing procedures used in the acceptance program;
- Dispute resolution: A system administered entirely within the DOT that addresses the resolution of discrepancies between the verification sampling and testing and the QC sampling and testing;
- Personnel qualifications: Personnel capability defined by appropriate programs established by the DOT with sampling and testing by qualified personnel; and
- Laboratory accreditation/qualification: Laboratory capability defined by appropriate programs established by the DOT, minimally including provisions for checking test equipment and records of calibration checks.

In the Kansas DOT (KDOT), the Bureau of Construction and Materials develops standards and specifications for materials, establishes sampling procedures and frequencies, and creates

testing procedures used in the laboratory and the field to ensure specification compliance. Part V of the KDOT Construction Manual and KDOT's Standard Specifications include provisions for the Department's QC/QA program (KDOT, 2018). The current QC/QA Specifications procedure requires the contractor to conduct QC testing, the results of which can be used to determine if KDOT's QA verifies the results. However, for each relevant test group, all technicians must demonstrate qualifications, such as certificate types, to complete a training program or demonstrate test procedures and complete written exams over the test methods (KDOT, 2014; KDOT, 2018). All contractors conducting QC/QA sampling and testing for KDOT projects are responsible for the annual calibration and verification of their equipment by the American Association of State Highway and Transportation Officials (AASHTO) accredited laboratory using the National Institute of Standards and Technology (NIST) traceable equipment (KDOT, 2018).

1.2 Research Problem

State DOTs and the Federal Highway Administration (FHWA) have spent substantial efforts on inspection to provide transportation facilities and systems that meet or exceed specified quality standards. Typically, state DOTs have specified quality standards based on detailed descriptions of the required materials and construction methods. Historically, DOT construction inspection was often based on pass/fail standards or engineering experience and judgment. Although these standards appeared to be sufficient, DOTs currently face the challenge of an ever-growing gap between the demand for inspection and available inspection resources. Many state DOTs, including KDOT, have lost experienced construction inspection staff, while the number of projects requiring a high level of inspection has increased. In fact, KDOT currently lacks sufficient staff to fully inspect all aspects of various highway construction projects.

K-TRAN: KU-19-3, *Development of Risk-Based Approach for KDOT Construction Inspection: An Assessment*, successfully identified and evaluated the risk level of construction activities associated with the *KDOT Standard Specification and Construction Manual*. Results from K-TRAN: KU-19-3 emphasize the importance of incorporating risk-based approaches into current KDOT construction inspection practices (Tran & Mohamed, 2021).

1.3 Objectives

The primary objective of this research was to develop implementation guidelines for KDOT risk-based construction inspection. The proposed guideline provides KDOT with inspection forms and checklists, including critical construction inspection items associated with risk impact, inspection priorities, inspection tasks, and appropriate inspector staffing. The inspection checklist is expected to help KDOT project and program managers effectively and efficiently allocate their limited resources while mitigating risk impact. The secondary objectives include the following:

- Conduct a quantitative review of existing material QA practices via empirical data collection and analysis;
- Identify and assess tasks of each risk-based inspection activity, including inspection stages (e.g., pre-construction, during construction, and post-construction) and levels of inspection (e.g., continuous, intermittent, or end product inspection);
- Develop a risk-based inspection checklist for different construction processes and related material testing;
- Create inspection staff guidance that allows KDOT project managers to estimate the project needs of inspection staff given project types and budget; and
- Document the results of this research in a concise and comprehensive research report.

1.4 Report Organization

This report is comprised of six chapters. Chapter 1 introduces the subject area, including the scope and objectives. Chapter 2 provides a literature review to highlight existing inspection methodologies and relevant issues related to construction inspections and briefly discusses state-of-practice by examining current state DOT inspection using five QA programs. Chapter 3 presents study methodology; data used in the methodology implementation were obtained via a questionnaire survey sent to 18 KDOT experts. Chapter 4 presents key findings related to

prioritization of QA inspections, development of 35 checklists, and assessment of inspection items in terms of risk level, frequency of inspection, and number of inspectors and inspector experience. Chapter 5 presents key findings related to the development of inspection guidance for estimating project staff size. Finally, Chapter 6 briefly summarizes the information presented in previous chapters and offers conclusions and suggestions for future research.

Chapter 2: Literature Review

2.1 Introduction

The literature review for this study highlights risk-based inspection practices using FHWA reports, Transportation Research Board (TRB) reports, academic literature, professional engineering publications, and state DOT websites. The literature search specifically focused on documents that support the development of risk-based inspection for highway construction activities. Typical keywords and terms for these searches included *inspection*, *risk and uncertainty*, *material testing*, *QC/QA processes*, *risk-based inspection*, *qualitative assessment*, *quantitative assessment*, and *risk impact and consequences*.

To develop a risk-based inspection checklist for KDOT, the research team reviewed and synthesized relevant documents from state DOTs with experience in risk-based inspection. A web-based search was conducted to evaluate relevant documents and procedures used for construction inspection prioritization as well as QC/QA throughout all 50 state DOTs. Literature regarding Mississippi (MDOT), Ohio (ODOT), Pennsylvania (PennDOT), South Carolina (SCDOT), and Wisconsin (WisDOT) were reviewed and analyzed in detail. Key findings from existing and newly identified risk-based strategies from these five state DOTs are presented in this chapter.

2.2 Mississippi DOT Critical Inspection Guide

To optimize inspection resources and improve efficiency, MDOT uses a risk-based inspection approach for local public agency (LPA) projects. Risk-based inspection allows MDOT to adjust the inspection level designated to a pay item (MDOT, 2020). The level of required construction inspection and material testing in MDOT risk-based inspection methodology is determined based on three project risk categories: high, moderate, and low. Typically, the low-risk category involves projects off roadway, while the high-risk category involves the National Highway System, as well as roadway and bridge projects (MDOT, 2021). Table 2.1 shows MDOT's project risk levels for LPA projects.

Table 2.1: MDOT Project Risk Levels (MDOT, 2021)

LPA Project Components		Risk Level
Roadway and Bridge	New Construction	High
	Reconstruction	High
	Pavement Preservation	Moderate
	Mill and Overlay	Moderate
	Full-Depth Pavement Rehabilitation	High
	Interchange Modifications	High
	Trench Widening	Moderate
	Drainage Improvements	Moderate
	Bridge Construction/Replacement	High
	Bridge Repair	Moderate
Traffic	Traffic Signal Installation	Moderate
	ITS Implementation	Moderate
	Signing	Low

MDOT specifically defines three levels of inspection. Full time inspection refers to construction activities that require inspection during a majority of the time that work is ongoing, while part time inspection applies to construction items that require monitoring for compliance with specifications and quantity measurements but do not meet the above criteria for full time inspection. Finally, intermittent inspection pertains to items that should be randomly inspected during the construction operation or during other inspection downtime to be accepted via certification and end-product inspection (MDOT, 2021).

Based on the risk-based inspection methodology, MDOT developed a critical inspection guide to help inspectors determine the amount of inspection required for a pay item based on risk

and strengthen inspection procedures throughout the life of a project. Figure 2.1 shows an example of MDOT critical inspection for sealing and filling joints and cracks. As shown in the figure, the risk level of this inspection ranges from low to moderate, and inspector experience required for this inspection is 1–3 years.

SEALING AND FILLING JOINTS AND CRACKS

Specification Section Reference(s):	413
Inspection Level:	High Risk – **Part Time (Daily)**
	Moderate Risk – **Part Time (Daily)**
	Low Risk – **Part Time (Daily)**
Priority:	Low to Medium
Inspector Experience (min):	1 to 3 years
Inspection Objective:	Observe the routing, sawing and/or cleaning, sealing joints and cracks in existing pavement

Before Work Begins

- Verify that all traffic control signs are up and they meet the contract requirements
- Familiarize yourself with the Plans and Specifications to determine the materials being incorporated and the testing requirements

Inspection During Work Activity

- Ensure that temporary traffic control is in place and is operating sufficiently per the Plans, Specifications and MUTCD
- Verify that joints and cracks to be sealed have been cleaned/sawed to the minimum dimensions specified
- Ensure the surface to receive the new joint material is dry and free of all lubricants, tar, asphalt, discoloration and stains as well as other forms of contamination
- Verify the joint sealant material is dry enough to prevent tracking before allowing traffic to travel over it
- Inspect, document for payment and collect samples for testing on all items installed per the Plans and Specifications

Figure 2.1: MDOT Critical Inspection Guide
Source: MDOT (2020)

2.3 Ohio DOT Risk-Based Inspection Prioritization

ODOT employs a programmatic approach to risk-based inspection prioritization in its construction projects, including a risk assessment of more than 7000 items to determine the relative inspection priorities and appropriate documentation levels for these items. As shown in Figure 2.2, which illustrates ODOT's priority ratings for standard pay items, the rating of the 7000 items is generally based on the consequences of failure and the need for more intensive or continuous inspection and documentation to avoid failures, quality issues, and rework. Further review of the inspection ratings for the 7000 items revealed that the inspection priority levels were as expected for many items (e.g., asphalt and structures generally require full time inspection); whereas, a large number of items were the lowest priority inspection and documentation categories.

PLN	Item	Item No	UNITS	Description - Item Master	Unit Accuracy for DWR Entry	Code	Inspection Priority	Doc Priority	Tickets Rqd?	Spec Chair	Quality Form	Quantity Form	Worksheet1	Worksheet 2
1	201E11000	201	LS	CLEARING AND GRUBBING	lump sum	LS-1	2	2	0	Geotechnical	CA-Q-0201	CA-D-2 Multi	0	0
2	202E20010	202	EACH	HEADWALL REMOVED	each	U-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Multi	0	0
3	202E23000	202	SY	PAVEMENT REMOVED	0.1 yd2	A-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Area	0	0
4	202E23500	202	SY	WEARING COURSE REMOVED	0.1 yd2	A-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Area	0	0
5	202E30000	202	SF	WALK REMOVED	0.1 ft2	A-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Area	0	0
6	202E30600	202	SY	CONCRETE MEDIAN REMOVED	0.1 yd2	A-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Area	0	0
7	202E30700	202	FT	CONCRETE BARRIER REMOVED	0.1 foot	L-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Length	0	0
8	202E32000	202	FT	CURB REMOVED	0.1 foot	L-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Length	0	0
9	202E35100	202	FT	PIPE REMOVED, 24" AND UNDER	1 foot	L-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Length	0	0
10	202E35200	202	FT	PIPE REMOVED, OVER 24"	1 foot	L-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Length	0	0
11	202E38000	202	FT	GUARDRAIL REMOVED	1 foot	L-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Length	0	0
12	202E42206	202	EACH	ANCHOR ASSEMBLY REMOVED	each	U-3	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Multi	0	0
13	202E42206	202	EACH	ANCHOR ASSEMBLY REMOVED	each	U-3	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Multi	0	0
14	202E58300	202	EACH	CATCH BASIN OR INLET REMOVED	each	U-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Multi	0	0
15	202E98200	202	FT	REMOVAL MISC.:	1 foot	L-1	3	3	0	Geotechnical	CA-Q-0202	CA-D-2 Length	0	0
16	203E10000	203	CY	EXCAVATION	1 yd3	V-4	2	1	0	Geotechnical	CA-Q-0203	CA-D-2 Volume	CA-EW-9	CA-EW-10
17	203E20000	203	CY	EMBANKMENT	1 yd3	V-4	2	1	0	Geotechnical	CA-Q-0203	CA-D-2 Volume	CA-EW-5	CA-EW-6
18	204E10000	204	SY	SUBGRADE COMPACTION	1 yd2	A-2	2	1	0	Geotechnical	CA-Q-0204	CA-D-2 Area	CA-EW-5	CA-EW-6
19	204E13000	204	CY	EXCAVATION OF SUBGRADE	1 yd3	V-4	2	1	0	Geotechnical	CA-Q-0204	CA-D-2 Volume	CA-EW-12	0
20	204E30010	204	CY	GRANULAR MATERIAL, TYPE B	1 yd3	V-4	2	1	X	Geotechnical	CA-Q-0204	CA-D-2 Volume	CA-EW-5	CA-EW-13
21	204E30020	204	CY	GRANULAR MATERIAL, TYPE C	1 yd3	V-4	2	1	X	Geotechnical	CA-Q-0204	CA-D-2 Volume	CA-EW-5	CA-EW-13
22	204E45000	204	HOUR	PROOF ROLLING	0.1 hour	M-1	2	1	0	Geotechnical	CA-Q-0204	CA-D-2 Multi	CA-EW-2	CA-EW-3
23	204E50000	204	SY	GEOTEXTILE FABRIC	0.1 yd2	A-2	2	2	0	Geotechnical	CA-Q-0204	CA-D-2 Area	CA-EW-12	0
24	606E15050	606	FT	GUARDRAIL, TYPE MGS	0.1 foot	L-5	2	1	0	Traffic	CA-Q-0606	CA-D-2 Length	0	0
25	606E17350	606	FT	GUARDRAIL, TYPE MGS, 25' LONG-SPAN	0.1 foot	L-5	2	1	0	Traffic	CA-Q-0606	CA-D-2 Length	0	0
26	606E26150	606	EACH	ANCHOR ASSEMBLY, MGS TYPE E	each	U-1	2	1	0	Traffic	CA-Q-0606	CA-D-2 Multi	0	0
27	606E26550	606	EACH	ANCHOR ASSEMBLY, MGS TYPE T	each	U-1	2	1	0	Traffic	CA-Q-0606	CA-D-2 Multi	0	0
28	606E35002	606	EACH	MGS BRIDGE TERMINAL ASSEMBLY, TYPE 1	each	U-1	2	1	0	Traffic	CA-Q-0606	CA-D-2 Multi	0	0
29	608E10001	608	SF	4" CONCRETE WALK, AS PER PLAN	0.1 ft2	A-1	2	2	0	Pavements	CA-Q-0608	CA-D-2 Area	TE-45	0
30	608E52000	608	SF	CURB RAMP	0.1 ft2	A-1	2	2	0	Pavements	CA-Q-0608	CA-D-2 Area	0	0
31	608E53020	608	SF	DETECTABLE WARNING	0.1 ft2	A-1	2	2	0	Pavements	CA-Q-0608	CA-D-2 Area	0	0
32	622E25001	622	EACH	CONCRETE BARRIER END SECTION, TYPE D, AS	each	U-1	2	2	0	Traffic	CA-Q-0622	CA-D-2 Multi	TE-45	0
33	623E39500	623	EACH	MONUMENT BOX ADJUSTED TO GRADE	each	U-1	2	3	0	Geotechnical	CA-Q-0623	CA-D-2 Multi	0	0
34	626E00100	626	EACH	BARRIER REFLECTOR	each	U-1	3	3	0	Traffic	CA-Q-0626	CA-D-2 Multi	0	0
35	861E10000	861	SY	GEOGRID FOR SUBGRADE STABILIZATION	0.1 yd2	A-1	2	1	X	Geotechnical	CA-Q-0861	CA-D-2 Area	0	0

Figure 2.2: ODOT Inspection and Documentation Priority Ratings
Source: ODOT (2017)

Risk-based prioritization documentation has improved the quality of the inspection process because it focuses inspection on items that require the most attention and documentation. Ideally, ODOT would enter inspection data for item inspection attributes directly into a database to be sorted and analyzed. However, no connection currently exists in the ODOT system between risk-based inspection priority and inspection resource planning, such as determining staffing needs and experience based on risk level. Inspection resourcing is currently based on construction engineering and inspection (CEI) costs calculated as a percentage of the contract value for each project based on historic needs (ODOT, 2017).

ODOT uses a hierarchical rating system with three levels of inspection frequency and documentation with short and long descriptions of priority levels for inspection and documentation. ODOT inspection frequency levels include full time inspection, intermittent inspection, and end product inspection. The full-time inspection level, which is performed continuously while the item is actively under construction, is required for items in which the consequence of failure could result in a catastrophic, life-threatening safety hazard. The intermittent inspection level is performed daily as needed with a focus on initial setups and critical attributes when the item is actively under construction. This level of inspection is specified for items in which the consequence of failure would directly affect environmental compliance or when repair would delay the project or cause safety considerations. This priority level also includes items that require multi-activity construction processes. Inspection may occur as interim activities during the construction process that are completed before being covered or hidden by subsequent operations. Finally, the end product inspection level does not require inspection and construction quality documentation while the item is actively under construction, but inspection must be completed before the project is accepted. This level of inspection is specified for items in which the consequence of failure is minimal in terms of project performance. Typically, inspection may be completed by observing the end product.

Table 2.2 shows three levels of ODOT documentation, including high, moderate, and low either per day, per item, or per group of items. The descriptions of documentation levels are generally defined based on the consequences of failure and the need for more intensive or continuous inspection and documentation to avoid failures, quality issues, and rework. For

example, as shown in the table, the high documentation level is daily with 30%–50% of inspector time, while the low documentation level is conducted one per group of similar items.

Table 2.2: ODOT Documentation Priorities (ODOT, 2017)

Level	Short Description	Level of Effort	Long Description
High	Daily/Per Segment	30%–50% of inspector time	Construction quality documentation frequency is typically required daily during active work specific to the item.
Moderate	Once per item	10%–30% of inspector time	Construction quality documentation frequency is required at major intervals in the construction process (e.g., prior to being covered by subsequent work) and shall not occur less than once during the project.
Low	Once per group	<10% of inspector time	Construction quality documentation is required once per project for all similar items (e.g., all shrubs, all traffic symbols…).

2.4 Pennsylvania DOT Risk-Based Inspection Procedures

The *Project Office Manual* for PennDOT includes a risk-based inspection procedure that establishes a decision-making process with guidelines for managing construction inspection forces based on risk factors and cost, specifically safety, environmental impact, quality of construction related to durability and performance, and the cost of reworking an item or future early failure of an item. The risk-based procedure was not intended to eliminate project inspection but to provide a tool for evaluating specific project factors to maximize inspection resources. As shown in Figure 2.3, the PennDOT risk-based system focuses on operations within the shaded quadrant of Low Cost/Low Risk. These operations are potential opportunities to reduce or eliminate the need for full-time inspection. Operations that fall in the two hatched quadrants of High Cost/Low Risk and High Risk/Low Cost are also possible candidates; however, PennDOT guidance suggests that care and discretion should be used to properly assess and analyze the impact of risk on the project. Operations that fall in the white quadrant are not recommended for consideration because they are High Risk/High Cost and would have the most potential impact on the project (PennDOT, 2023). Table 2.3 lists inspection items associated with Low Risk/Low Cost, High Risk/Low Cost, High Cost/Low Risk, and High Cost/High Risk categories.

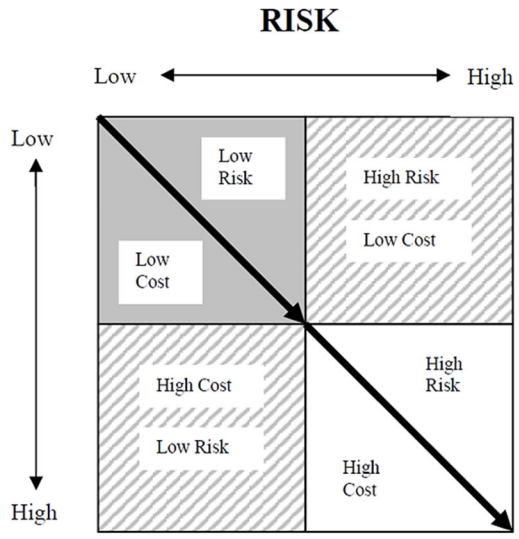

Figure 2.3: Risk Assessment Categories
Source: PennDOT (2023)

Table 2.3: Inspection Items With Cost/Risk Categories (PennDOT, 2023)

LOW RISK/LOW COST • Clearing & Grubbing • Bulk Excavation • Gabions • Misc. Seeding, Mulching, Planting • Office Trailer & Equipment Package • Waterproofing • Downspouting	LOW RISK/HIGH COST • Rebuilt Misc. Structures • Random Stone Slope Walls • Temporary Concrete Barrier
HIGH RISK/LOW COST • Embankment • Sub grade • Slab Stabilization • Flowable Fill • Geotextiles • Drainage • Sidewalks • Survey • Delineation Devices • Pavement Markings • Guide Rail • Scarification of Existing Bridge Decks • Rebar Downspouting	HIGH RISK/HIGH COST • Drainage Items Under Roadway • Base Courses • Flexible Pavement • Rigid Pavement • Curb Ramps/ADA-Associated items • Impact Attenuating Devices • Concrete Median Barrier • Blasting • Lead Paint Removal • Bridge Demo • Beam Erection • Structural Concrete • Piling • Retaining Walls • Sound Walls • Box Culverts • Bridge Painting • Spot Zone Maintenance Painting of Existing Structural Steel • Highway Signing and Lighting • Permanent Traffic Control Items • Overhead Sign Structures • Environmental Commitments

PennDOT asserted that, instead of using their risk-based procedures as standard practice, they are utilized as a tool to allocate department resources for specific purposes at the discretion of project managers or assistant district executives for construction (ACE). Because ACE and project managers determine seasonal staffing requirements for in-house and consultant staff, the risk-based procedure can be used to optimize resources, particularly when staff shortages occur (PennDOT, 2023).

2.5 South Carolina DOT Risk-Based Inspection

SCDOT recently conducted research to explore the use of risk-based inspection to effectively allocate limited resources to most-critical areas. The primary goals of the SCDOT research were to identify and assess risks associated with construction activities, develop inspection strategies that correspond to risk level, identify quality requirements and inspection activities associated with construction activities, and design and implement a digital, risk-based inspection system (Cai et al., 2022). As shown in Table 2.4, which summarizes the top 11 risk factors for each main construction operation in SCDOT, the most common risk factors are inadequate training, improper equipment operation, and weather conditions. A main deliverable of the project was to produce an inspection summary document and checklist (Table 2.5), including risk level, inspection objectives, and inspection activities during construction.

Table 2.4: SCDOT Top 11 Risk Factors (Cai et al., 2022)

Risk rank	Earthwork	Bases/Pavements	Traffic control	Structures	Incidental Construction
1	Inadequate training	Inadequate training	Inadequate training	Inadequate training	Inadequate training
2	Improper equipment operation	Improper equipment operation	Inadequate traffic control	Failure to follow design/specification	Failure to follow design/specification
3	Weather conditions	Weather conditions	Improper removal of signs and traffic control devices	Improper equipment operation	Irrational construction schedules
4	Irrational construction schedules	Improper equipment calibration/condition	Interactions of work and customer vehicles	Irrational construction schedules	Improper equipment operation
5	Not timely stabilization of disturbed areas	Failure to follow design/specification	Work not consistent with plan	Weather conditions	Weather conditions
6	Failure to follow design/specification	Improper timing and temperature at mixing, placement, curing, and finishing	Failure to follow design/specification	Inadequate fall protection	Work not consistent with plan
7	Damage to utilities	Irrational construction schedules	Irrational construction schedules	Unclear and defective designs	Unclear and defective designs
8	Work not consistent with plan	Inadequate traffic control	Weather conditions	Work not consistent with plan	Not enough materials
9	Improper equipment calibration/condition	Work not consistent with plan	Unclear floor plan of the workplace	Improper materials	Funding availability
10	Improper materials	Variable material quality	Improper choice of equipment entrance, routes, and parking	Improper timing and temperature at mixing, placement, curing, and finishing	Improper materials
11	Inadequate traffic control	Inadequate moisture in materials	Improper equipment operation	Improper handling and storage of materials	Not timely on cleaning waste and unused materials

Table 2.5: SCDOT Inspection Summary and Checklist (Cai et al., 2022)

Work Activity Groups	Sections	Section Titles	Risk Level (H/M/L)	Inspection Objectives	Inspection Activities during Construction
Excavation and Embankment *(High risk, continuous inspection)*	203 204 205 206 207 208 209	ROADWAY AND DRAINAGE EXCAVATION STRUCTURE EXCAVATION EMBANKMENT CONSTRUCTION EMBANKMENT IN-PLACE OVERHAUL SUBGRADE SHOULDERS AND SLOPES		Ensure proper environmental controls are in place. Ensure area to be excavated as per plans, limit disturbed areas to minimize erosion and siltation. Ensure depth of fill embankment layers as per specifications. Verify contractor's effort in obtaining desired density and moisture content as defined in the specifications. Ensure cut and fill slopes are constructed on the specified ratio. Ensure slopes intercept ditch line or shoulder line at correct location.	• Before staring the excavation, review with the contractor the contract plans and specifications, verify permits and agreements (e.g., SCDHEC), verify NPDES lines, BCA lines and right-of-way lines have been staked and the construction lines have been established. • Verify borrow pit material and embankment material have been sampled and tested by the contractor and reset items have been reset properly. • Verify the contractor is limiting the erodible area and has in place proper erosion and sediment control checks. • Remove all soft, unstable, or unsuitable material that does not compact readily. • Verify that 1) excavation achieves the proper grade and slope required by the Contract Plans; 2) the resulting excavated areas are backfilled with suitable material compacted as required; 3) the deviation of pre-split face is within the tolerance.

2.6 Wisconsin DOT Construction Critical Inspection Guide

WisDOT utilizes the Construction Critical Inspection Manual to prevent high-risk consequences while providing minimal inspection to ensure a safe and successful project. The objectives of the manual are to provide guidance and strengthen the application of critical inspection throughout the life of a construction project (WisDOT, 2017). WisDOT notes that, although many construction activities (e.g., removal of existing structures and roadways) are not critical inspection items, certain aspects of these activities may need intermittent review and monitoring. For example, environmental commitments such as archaeology, bridge netting, erosion/sediment control, and debris are inspection activities that require monitoring during critical and non-critical work operations. Table 2.6 shows an example of a WisDOT critical construction inspection item.

Table 2.6: Example of WisDOT Critical Construction Inspection (WisDOT, 2017)

TRAFFIC CONTROL	
Specification Reference: 643	
Inspection Level: Continuous, Intermittent (Daily)	
Priority: Medium	
Inspector Experience: 1–3 years of Traffic Control inspection	
Before Work Begins	**Inspection During Work Activity**
• Ensure a copy of Transportation Management Plan (TMP) is available in the field office. • Review and be familiar with the TMP requirements. • Verify Lane Closure System (LCS) requirement for the project. • Ensure the contractor has staked each sign location and that sign location meets field conditions.	• Monitor and manage work zone impacts on traffic during the initial setup. (Continuous) Monitor and manage work zone impacts on traffic during stage changes. (Daily-as needed) • Monitor and manage work zone impacts on pedestrians during construction. (Daily-as needed) • Monitor and manage work zone impacts on traffic safety and mobility during construction. (Daily-as needed) • Perform and document daytime and nighttime inspection to verify proper illumination. (Daily-as needed) • Verify the retroreflective sheeting on drums, barricades, and other devices are clean. (Daily-as needed) • Ensure the contractor repairs scratches, rips, and tears in the sheeting. (Daily-as needed) • Ensure contractor replaces devices that have large areas of abrasion, missing reflective sheeting, asphalt splatter, concrete slurry, or other residue. (Daily-as needed) • Ensure contractor removes devices from the project when they are no longer needed. (Continuous) Measure and document traffic control item quantities. (Daily-as needed)

Recommendations for construction critical inspection are minimal inspection requirements to prevent high-risk consequences of failure (WisDOT, 2017). The inspection level, priority, inspector experience, inspection objective, and activities before/during work are included for each construction operation and are reflective of a typical size or complexity of a construction project. For continuous inspection, WisDOT requires inspection during the entire construction process, while intermittent inspection requires inspection only at critical times in the construction. End-product inspection requires inspection only after the operation is complete and during the construction operation when time permits. The priority level (e.g., low, medium, high) is determined based on risk resulting from insufficient inspection (WisDOT, 2017).

2.7 Summary of Literature Review

Several state DOTs have explored the use of risk-based inspection for their highway construction projects. Current risk-based inspection approaches evaluate material testing and workmanship inspection based on criticality, and the results can beneficially influence field inspection and laboratory tests by increasing construction quality, leading to lower overall life cycle costs. This chapter briefly summarized key findings from the utilization of risk-based inspection methodology from five state DOTs. These DOTs use guidance, charts, or checklists to link inspection activities with the required inspection frequency and inspection standards. Priority or risk levels for each critical activity inspection are often assigned using a matrix or professional surveys, and checklists include guidance for inspector experience and documentation requirements. The findings from this chapter were used to develop a risk-based inspection checklist for KDOT.

Chapter 3: Methodology

3.1 Introduction

The main objective of this research was to create inspection checklists and develop inspection strategies for KDOT to optimize resource allocation for transportation construction projects. The checklists provide critical construction inspection items associated with risk impact, inspection priorities, and inspection tasks, and the inspection strategies help KDOT project managers effectively and efficiently allocate limited inspection resources based on project needs of inspection staff. To achieve this objective, the research team performed six integrated research tasks over three phases.

3.2 Research Approach

As illustrated in Figure 3.1, this research approach was conducted in three phases: (1) empirical data collection on highway construction inspection staffing from KDOT database and construction QA documents, (2) assessment and evaluation of KDOT inspection items/checklists, and (3) development of final risk-based checklists and guidance to consider staff size, staff experience, inspection frequency, and item risk level.

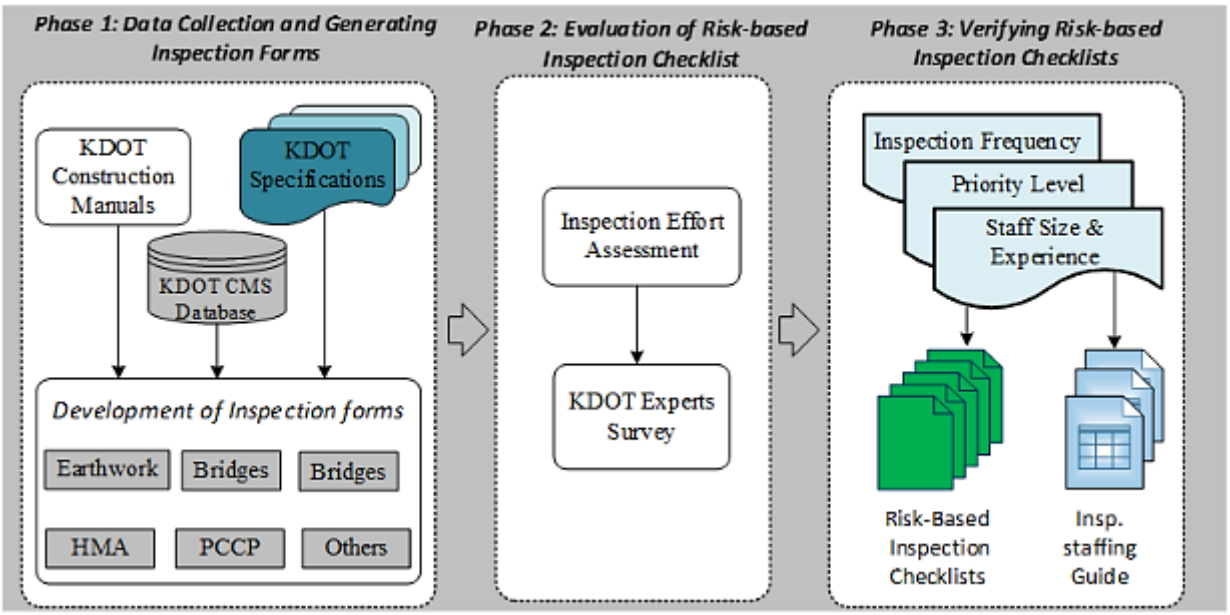

Figure 3.1: Overview of Research Framework

3.2.1 Phase 1: Data Collection and Generation of Inspection Forms/Checklists

Building on results from K-TRAN: KU-19-3, this phase involved data collection from past and current KDOT projects. Although K-TRAN: KU-19-3 identified a core list of inspection risk activities at the programmatic level based on qualitative assessment of surveys and structured interviews with KDOT experts (Tran & Mohamed, 2021), this phase sought to identify typical KDOT construction operations and pertinent inspection items and then generate construction inspection forms, as well as analyze relevant data retrieved from the KDOT Construction Management System (CMS) database regarding staffing for various construction operations and projects. This stage included two main tasks (Tasks 1 and 2).

- **Task 1 – Develop Inspection Forms/Checklists:** This task comprehensively reviewed inspection manuals and relevant documents from KDOT and state DOTs with experience in conducting risk-based inspection to identify and develop inspection forms. Emphasis was placed on the KDOT construction manual and the current practices of QC/QA from other state DOTs. The research team specifically focused on the acceptance of materials, QA practices, impact of sample size, and material certification. The first step of this task was to identify inspection forms related to core construction operation and inspection tasks. The research team examined these forms rigorously to determine common features associated with acceptance criteria and inspection methods described in the KDOT Specification and Construction Manual, Special Provisions, and Supplemental Technical Specifications. The second step of this task was to develop the content of the inspection forms. Each form details the level of inspection for each construction inspection activity and its corresponding level of risk, number of inspectors, inspector experience, and inspection frequency. This step also compiled a pay item list from KDOT construction documentation to categorize pay items and connect these pay items to related inspection tasks.

- **Task 2 – Examine Inspection Staff from the KDOT Database:** This task examined and created an inspection staffing dataset for KDOT highway construction projects. The dataset was extracted from the KDOT CMS database (Figure 3.2). The research team rigorously analyzed the relevant material testing and construction inspection reports, construction documentation, and maintenance records. A total of 169 construction projects completed by KDOT between 2017 and 2021 were analyzed to create the dataset. The research team worked with KDOT to identify the most common types of construction projects in Kansas and extract data that focused on project size, project complexity, and other factors. Table 3.1 summarizes project types, common construction work, duration, and budgets associated with inspection staff.

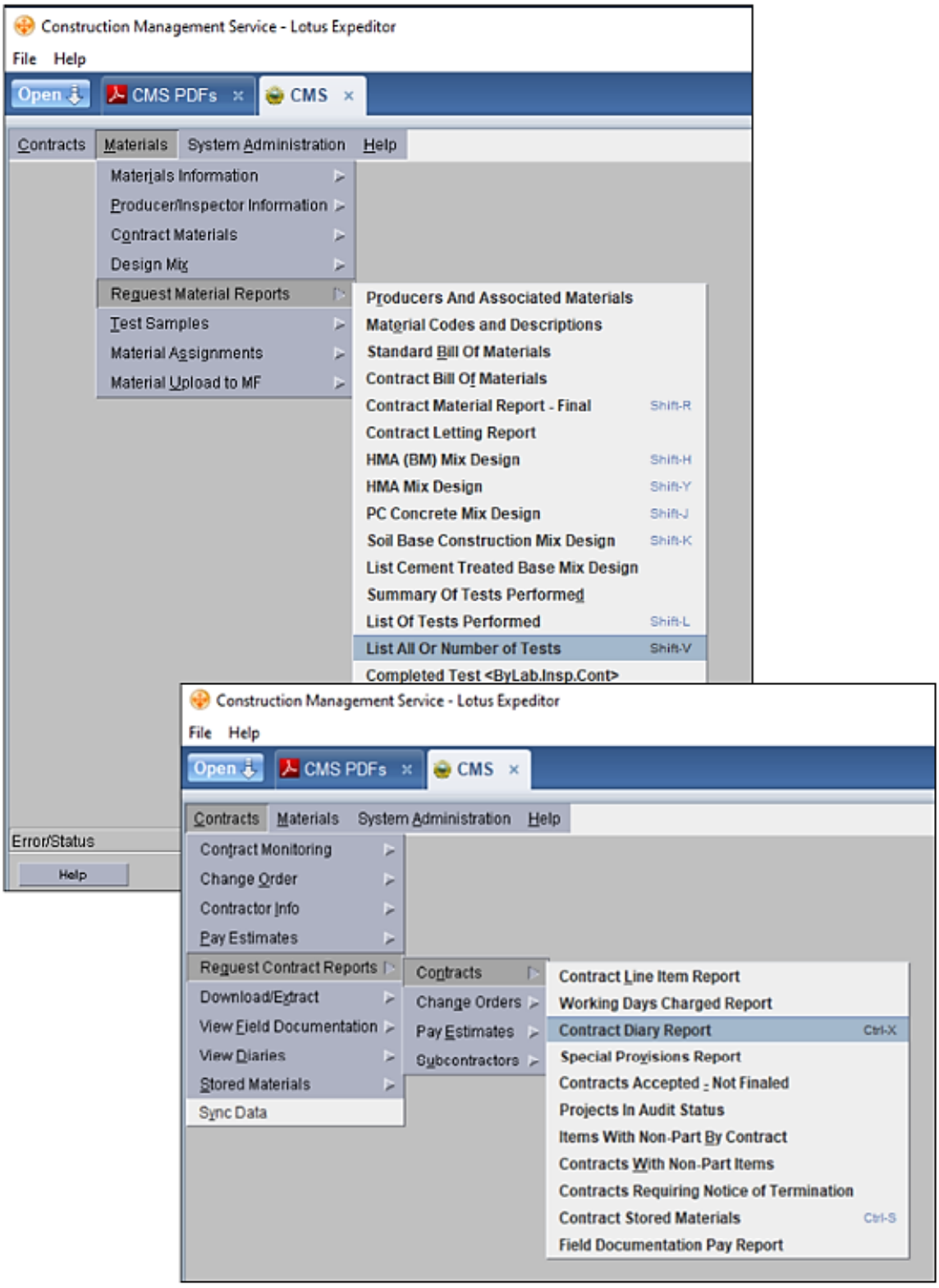

Figure 3.2: KDOT CMS Database

Table 3.1: Inspection Staff Information from the KDOT Database

Project Type	Typical Construction Work	Budget ($)	Duration (day)	Number of Inspectors		
				KDOT	Consultant	Total
Chip Sealing	Roadway is sealed with the application of a surface treatment film of heated asphalt material, followed by the placement of cover material.	618,791.40	15	2	1	3
Surface Recycle and Overlay	Recycling surface by heating the surface, hot milling and mixing and placing the recycled material. An overlay operation consists of placing HMA mixture and relevant construction activities.	169,289.73	25	2	2	4
Grading and Surfacing	Including activities such as compaction of earthwork, sidewalk construction, base, and pavement layer.	8,037,094.12	185	7	1	8

3.2.2 Phase 2: Evaluation of Inspection Checklists

The purpose of this phase was to evaluate the risks associated with inspection items from the inspection forms/checklists developed in Phase 1. Phase 2 also determined inspection frequency as well as staff size and inspector experience required to inspect critical activities in the inspection forms/checklists. This phase included two main tasks (Tasks 3 and 4).

- **Task 3 – Develop Evaluation Systems:** Based on the findings from Phase 1, this task developed evaluation systems for each inspection form/checklist associated with inspection/risk level priority, inspection frequency, number of inspectors, and inspector experience. A five-point scale was used for the priority level of inspection (1 = Low; 2 = Low to Moderate; 3 = Moderate; 4 = Moderate to High; and 5 = High). Three main categories (End product, Intermittent, and Continual) were used for the inspection frequency, as summarized in Table 3.2. For the

number of required inspectors, three main categories (one inspector, two inspectors, or three or more inspectors) were used to rate each construction inspection activity in the inspection forms/checklists. Finally, KDOT experts were asked to rate inspector experience based on three categories: junior, intermediate, and senior. The junior level describes an inspector with less than two years of construction inspection experience, the intermediate level describes an inspector with 2–5 years of construction inspection experience, and the senior level describes an inspector with more than five years of construction inspection experience.

Table 3.2: Inspection Frequency

Category		Description
0	N/A	Not applicable
1	End product	Requires inspection after completion of the operation and during the operation when time permits (< 30% of the time work)
2	Intermittent	Requires inspection at critical times in the operation (30%–80% of the time work)
3	Continual	Requires inspection during the entire operation (80%–100% of the time work)

- **Task 4 – Evaluate Inspection Items in Checklists:** The purpose of this task was to evaluate and determine the priority for inspection/risk levels, inspection frequency, number of inspectors, and inspector experience of each item in the inspection forms/checklists from Phase 1. Based on the evaluation system from Task 3, a questionnaire was distributed to a variety of KDOT experts, including the FHWA representative, state material engineer, district engineers, project manager, and field engineer. The KDOT experts were asked to rate each of 35 checklists in terms of risk or priority level of inspection and inspection resource allocation associated with four main types of projects: new

road/pavement construction or expansion, roadway/pavement rehabilitation and resurfacing, new or replaced bridge, and bridge rehabilitation. Figure 3.3 shows a portion of the risk-based inspection assessment questionnaire; the complete questionnaire is included in Appendix B. A total of 18 KDOT experts completed the questionnaire, and the responses were summarized and analyzed, as presented in Chapter 4.

DIVISION	No.	Inspection Items	Risk Level/ Priority for Inspection				Inspection Level/ Frequency				Number of Inspectors				Inspector Experience			
			New Road Construction	*Roadway Rehabilitation*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction*	*Roadway Rehabilitation*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction*	*Roadway Rehabilitation*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction*	*Roadway Rehabilitation*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
EARTHWORK AND EMBANKMENT	1	Clearing and grubbing																
	2	Demolition and removal of existing structures																
	3	Excavation and backfill for structures																
	4	Excavation and embankment for highways																
	5	Geofoam lightweight embankment fill																
STRUCTURES	1	Falsework and form construction																
	2	Cast-in-place box culvert																
	3	Bridge substructure																

Figure 3.3: Sample of the KDOT Risk-Assessment and Inspection Staffing Questionnaire

3.2.3 Phase 3: Development of Final Risk-Based Inspection Checklists and Guidance

The purpose of this phase was to analyze the data collected from Phase 2 and finalize the inspection checklists to help KDOT inspectors implement the risk-based approaches. This stage includes two main tasks (Tasks 5 and 6).

- **Task 5 – Finalize Inspection Checklists:** This task analyzed the results of expert evaluation in terms of the priority level for inspection, inspection frequency, number of inspectors, and inspector experience associated with each inspection item in the checklists, including the correlation between the risk level and the inspection frequency and inspector experience for each inspection item. In addition, heat maps associated with priority level for inspection, inspection frequency, number of inspectors, and inspector experience were created based on the survey information and inspection checklists. The outcome of this task produced a total of 35 checklists associated with specific construction inspection items based on risk, including inspection methods, inspection frequency, and number and experience of inspectors.
- **Task 6 – Develop Guidance for Risk-Based Inspection:** This task analyzed the data collected from Phases 1 and 2 and developed guidance by assigning an appropriate level of inspection effort and resources to inspection items in the checklists. The outcome of Task 6 was expected to provide an optimal inspection workload level for different types of construction projects, including new road/pavement construction or expansion, roadway/pavement rehabilitation and resurfacing, new or replaced bridges, and bridge rehabilitation.

3.3 Summary

This chapter discussed the six integrated research tasks employed to develop inspection checklists for KDOT to optimize resource allocation for the inspection of transportation construction projects. These six tasks were conducted via three research phases: (1) empirical data collection on highway construction inspection staffing from KDOT database and construction QA documents, (2) assessment and evaluation of KDOT inspection items/checklists, and (3) development of final risk-based checklists and guidance. The risk evaluation process in this chapter was a mix of qualitative and quantitative. The qualitative risk evaluation approach was used to screen and prioritize risks and develop inspection checklists, while the quantitative approach used historical KDOT construction projects to evaluate project needs of inspection staff. Both the qualitative and quantitative evaluations provided appropriate risk mitigation and staff allocation strategies for highway construction projects.

Chapter 4: Development of Risk-Based Inspection Checklists

4.1 Introduction

This chapter describes the process of developing and evaluating the inspection checklists for KDOT. The checklists were developed by reviewing, synthesizing, and evaluating a variety of KDOT documents. For each inspection checklist, the research team rigorously analyzed the *KDOT Construction Manual*, the *KDOT Bridge Construction Manual*, KDOT Specifications, QA Inspection Acceptance, and other relevant documents. The initial forms were verified by KDOT experts, and the inspection items in the final KDOT inspection checklists were evaluated by priority for inspection/risk levels, inspection frequency, number of inspectors, and inspector experience.

4.2 Development of Initial Risk-Based Inspection Checklists

Certain types of construction components are known to considerably enhance the quality of highway construction projects. For example, FHWA (1979) indicated that earthwork and embankment, base course and subbase, bridge deck and structural concrete, bituminous pavement, and rigid pavement are critical operations that substantially impact the quality of highway construction projects. Figure 4.1 shows common construction operations of highway projects.

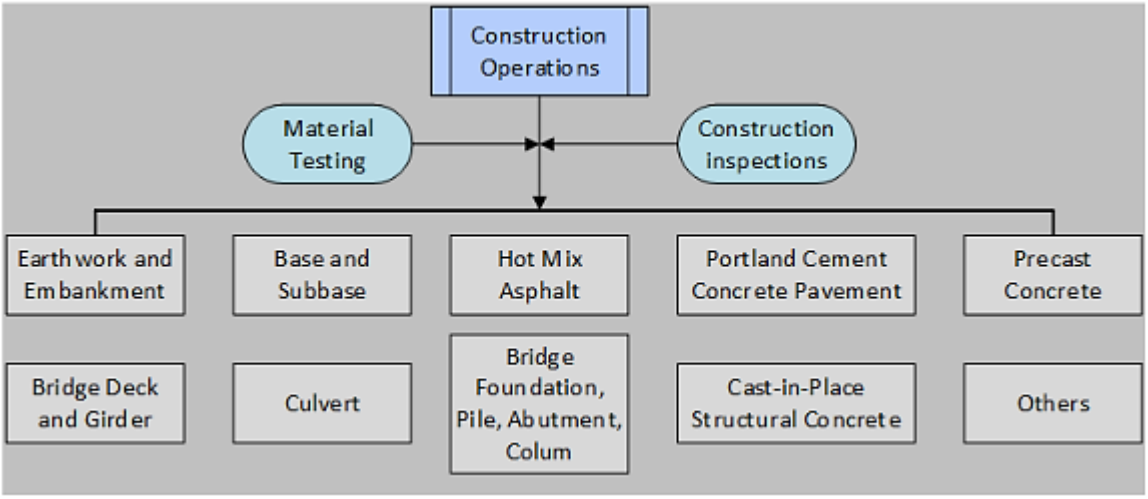

Figure 4.1: Common Operations of Highway Construction Projects

To develop the inspection checklists, the research team conducted a comprehensive review of relevant documents from KDOT, FHWA, and other state DOTs. Results of the review process indicated that KDOT currently has 11 checklists for highway construction inspection, as summarized in Table 4.1.

Table 4.1: KDOT Current Checklists for Construction Inspection

No.	Checklist Description
1	Compaction of Earthwork Construction
2	QC/QA Concrete Pavement Construction Checklist
3	HMA Construction Checklist
4	Asphalt Chip Seal Construction
5	Structures Construction Checklist
6	Drainage Pipes Checklist (merged with culvert)
7	Signals Checklist
8	Erosion Control Project Guide
9	Traffic Control/Signing/Pavement Marking
10	Lighting Checklist
11	Seeding Checklist

Figure 4.2 shows a sample of the Compaction of Earthwork Construction checklist. For the daily field data, this checklist includes three main sections: daily diary items, miscellaneous data, and testing. KDOT also noted that the checklist should be used in conjunction with Part IV of the *KDOT Construction Manual* (KDOT, 2018).

Compaction of Earthwork Construction Checklist
"DAILY FIELD DATA"

Use this check list in conjunction with Part IV of the KDOT Construction Manual

An equipment spread is defined as collection of equipment including at least each one of the following pieces, a hauling machine, a motor grader, and a compaction machine.

Daily Diary Items

- ☐ 1 Record reason for **NOT** charging a working day.
- ☐ 2 Record what work is being done by contractor or sub-contractor.
- ☐ 3 Record weather and site conditions.
- ☐ 4 Record controlling Item of Work.
- ☐ 5 Record equipment and Personnel listed.
- ☐ 6 Record length and cause of delays.
- ☐ 7 Record disputed items. (Not a place for personal opinions)
- ☐ 8 Record all visitors on site and their purpose (Area Engineer, District Engineer, City or County Engineer, Topeka Personal/Representatives, etc)
- ☐ 9 Record daily pay quantities for items
- ☐ 10 Record location of fill/cut and where material coming from (contractor furnished)

Miscellaneous Data (Record necessary data in field book, anything measured needs to be recorded)

- ☐ 11 Record volume of hauling equipment (calibration of loaders bucket and trucks)
- ☐ 12 Record daily load count and type (Rock, soil)
- ☐ 13 Make sure the haul road is not blowing dust onto traffic, contractor will need to water if necessary
- ☐ 14 Motograder leveling the fill
- ☐ 15 Lifts are proper thickness
  - ☐ 8" for soil loose
  - ☐ 10" loose for rock/soil mix
  - ☐ 24" for rock
- ☐ 16 Compaction equipment keeping up with the fill
- ☐ 17 Project has liquidated damages record whether damages are Type A or Type B

Testing

- ☐ 18 Check construction manual for frequency for Type of Compaction
- ☐ 19 Proctors and soil samples on hand?
- ☐ 20 When different types of soils are used, combine proctors numbers to ensure an representative standard density/moisture for testing
- ☐ 21 Check moisture using speedy or other approved method
- ☐ 22 Check density using nuclear density gauge or other approved method
  - ☐ Does the spread have stability?
- ☐ 23 Record results from test
  - ☐ If test fail have contractor correct by adding water or aerating soil
- ☐ 24 At the end of the day is the embankment properly compacted and cut to drain properly

Figure 4.2: Sample of Earthwork Construction Checklist
Source: KDOT (2018)

The research team examined each of the 11 checklists in detail and observed the following limitations:

- Several core pavement construction elements were not included in the checklist.
- There was a lack of instruction on detailed field inspection.

- There was a lack of guidance on the priority for field inspection items.
- Inspection frequency for each item was not provided.
- The checklists did not link inspection activities to pay items.
- Requirements for the size of inspection staff and inspector experience were not provided.
- There was a lack of guidance on related material inspection for construction inspection items.
- The inspection documentation requirements and the level of documentation were not provided.
- The checklists primarily focused on administrative and project management tasks with less focus on inspector tasks.

Table 4.2 summarizes 35 inspection checklists focused on field construction inspection for KDOT highway construction across seven construction operations. For the core list of QA inspection activities related to construction materials, the previous research project K-TRAN: KU-19-3, *Development of Risk-Based Approach for KDOT Construction Inspection: An Assessment*, already identified 108 critical inspection activities associated with five main KDOT construction specifications, including Earthwork; Subgrade, Base, and Shoulder; Concrete Bridge Deck; Rigid (PCCP) Pavement; and Flexible (HMA) Pavement (Tran & Mohamed, 2021).

Table 4.2: Proposed Inspection Checklists for KDOT Highway Construction

Construction Operation	No.	Checklist Description
Earthwork and Embankment	1	Clearing and grubbing
	2	Demolition and removal of existing structures
	3	Excavation and backfill for structures
	4	Excavation and embankment for highways
	5	Geofoam lightweight embankment fill
	6	Mechanically stabilized earth (MSE) fill
	7	Granular drainage blanket
	8	Prefabricated vertical drain
Subgrade, Base, and Shoulders	9	Sub-grade
	10	Subbase and base course
PCCP and HMA Pavement	11	Concrete pavement (PCCP)
	12	PCCP pavement patching
	13	HMA prime and tack coats
	14	Asphalt pavement (HMA)
	15	Asphalt surface treatment by chip seal
Structures	16	Falsework and form construction
	17	Cast-in-place box culvert construction
	18	Bridge substructure
	19	Bridge deck
	20	Bridge painting
	21	Precast and pipe culverts, erosion pipe, storm, and sanitary sewers
	22	Retaining wall
Incidental Construction	23	Traffic control
	24	Construction staking
	25	Incidental concrete items
	26	Erosion control
	27	Riprap
	28	Guardrail
	29	Fencing
	30	Pavement marking
	31	Underdrains
	32	Traffic signs
	33	Electric lighting systems and traffic signals
Roadside Improvement, Planting, and Seeding	34	Roadside topsoil, mulching, and seeding
	35	Trees and shrubs planting

Figure 4.3 shows the process of developing the Portland Cement Concrete (PCCP) Pavement checklist. This checklist was specified and retrieved from Sections 401, 403, 502, and 503 of the KDOT Standard Specifications. The pay item related to this inspection item was determined based on the *KDOT Construction Manual: Parts I–V*. The inspection tasks were organized into three main phases: preconstruction, during construction, and post construction.

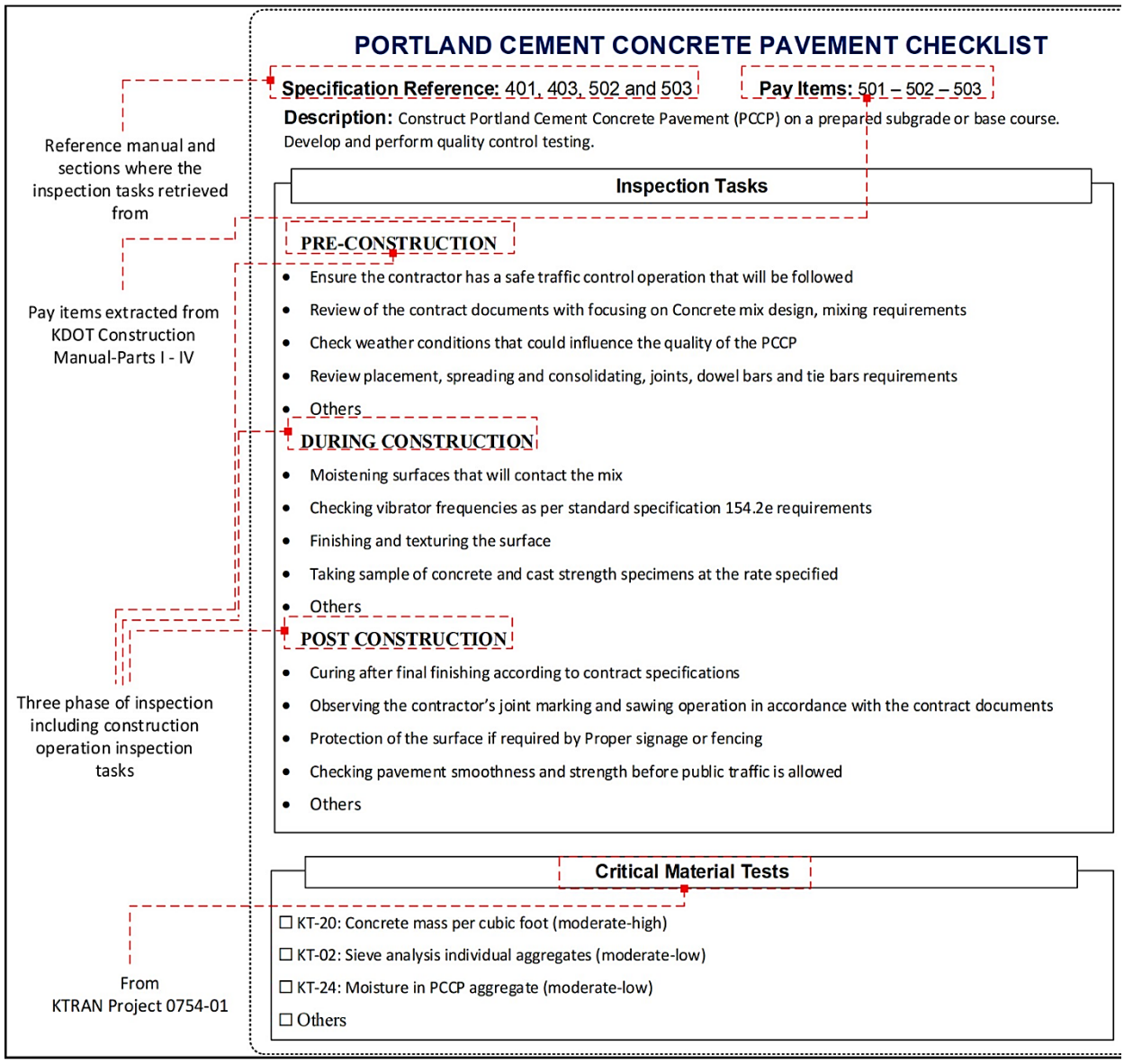

Figure 4.3: Development Process of PCCP Pavement Construction Checklist

The PCCP checklist in Figure 4.3 also highlights critical material tests required for PCCP pavement construction as identified from previous research project K-TRAN: KU-19-3. By checking core construction items and considering material tests, a construction inspector ensures a complete inspection process that covers both field construction inspections and material tests. The following sections present the evaluation results of the 35 checklists regarding the risk level/inspection priority, frequency of inspection, number of inspectors, and inspector experience required for each construction item.

4.3 Checklist Evaluation Results

This section presents the analysis and evaluation results of the 35 checklists in terms of risk levels/priority for inspection, frequency of inspection, number of inspectors, and inspector experience. Heat maps were created based on input from 18 KDOT experts. Figure 4.4 shows the legends used to construct the heat maps for inspection priority, inspection frequency, number of inspectors, and inspector experience.

a. *Priority for Inspection/Risk Level*

Level	Mean/Median	Heat Map
5. High	4< Score ≤ 5	
4. Moderate to High	3< Score ≤ 4	
3. Moderate	2< Score ≤ 3	
2. Low to Moderate	1< Score ≤ 2	
1. Low	0< Score ≤ 1	

b. *Inspection Frequency*

Level	Mean/Median	Heat Map
3. Continual	2.5< Score ≤ 3	
2. Intermittent	1.5< Score ≤ 2.5	
1. End product	0< Score ≤ 1.5	

c. *Number of inspectors*

Level	Mean/Median	Heat Map
3. Three or more	2.5< Score ≤ 3	
2. Two inspectors	1.5< Score ≤ 2.5	
1. One inspector	0< Score ≤ 1.5	

d. *Inspector experience*

Level	Mean/Median	Heat Map
3. Senior	2.5< Score ≤ 3	
2. Intermediate	1.5< Score ≤ 2.5	
1. Junior	0< Score ≤ 1.5	

Figure 4.4: Heat Map Legend for Risk Level, Inspection Frequency, and Inspection Resources

As shown in Figure 4.4, based on the risk score associated with the mean or median of 18 KDOT experts, the five levels of inspection priority were Low (0–1), Low to Moderate (1–2), Moderate (2–3), Moderate to High (3–4), and High (4–5). The color-coded heat map was based on these levels. Similar color-coded heat maps were constructed for inspection frequency, number of inspectors, and inspector experience.

4.3.1 Priority for Inspection/Risk Level

Table 4.3 shows a heat map of the risk level or inspection priority of 35 inspection checklists across four main types of projects: New Road Construction or Expansion, Roadway Rehabilitation and Resurfacing, Bridge - New or Replacement, and Bridge Rehabilitation. The risk heat map was displayed in both mean and median scores. As shown, the risk level varies among the six divisions and 35 items. Although the risk levels (e.g., color-coded cells in the heat map) are similar between mean and median scores, the user should use the mean score. The median score of each inspection item is a useful value to understand the ratings distribution among the 18 experts.

Table 4.3: Heat Map of Risk-Based Construction Inspection Checklist

Division	No.	Inspection Items	Risk Level/ Priority for Inspection							
			New Road Construction or Expansion		*Roadway Rehab & Resurfacing*		*Bridge - New or Replacement*		*Bridge Rehab*	
			Median	Mean	Median	Mean	Median	Mean	Median	Mean
Earthwork & Embankment	1	Clearing and grubbing	1.00	1.44	1.00	1.33	1.00	1.39	1.00	1.33
	2	Demolition of existing structures	1.00	1.89	2.00	2.00	2.00	2.44	3.00	2.67
	3	Excavation and backfill for structures	3.00	2.76	3.00	2.73	3.00	2.83	3.00	2.94
	4	Excavation and embankment	4.00	3.50	3.00	3.06	3.50	3.44	3.00	3.00
	5	Geofoam lightweight embankment fill	3.00	3.31	4.00	3.36	3.00	3.08	3.00	2.91
	6	Mechanically stabilized earth (MSE) fill	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
	7	Granular drainage blanket	2.00	2.60	2.00	2.54	2.50	2.69	2.00	2.50
	8	Vertical drain	2.00	2.47	2.00	2.54	2.00	2.50	2.50	2.58
Subgrade & Base	9	Subgrade	4.00	3.67	4.00	3.28	4.00	3.57	3.50	3.25
	10	Subbase and base course	4.00	3.72	4.00	3.39	4.00	3.64	3.50	3.33
PCCP & HMA Pavement	11	Concrete pavement (PCCP)	5.00	4.44	5.00	4.17	4.50	4.00	5.00	4.08
	12	Patching concrete pavement	3.00	3.19	3.00	3.50	3.00	3.27	3.50	3.67
	13	HMA prime and tack coats	3.00	2.93	3.00	2.93	3.00	2.90	3.00	2.90
	14	Asphalt pavement (HMA)	5.00	4.39	5.00	4.39	4.00	4.27	4.00	4.27
	15	HMA surface treatment by chip seal	3.50	3.50	4.00	3.61	3.00	3.43	3.00	3.43
Structures	16	Falsework and form construction	3.00	2.64	3.00	2.75	3.00	2.94	3.00	2.73
	17	Cast-in-place box culvert	3.00	3.13	3.00	2.93	3.00	3.15	3.00	2.83

Division	No.	Inspection Items	Risk Level/ Priority for Inspection							
			New Road Construction or Expansion		*Roadway Rehab & Resurfacing*		*Bridge - New or Replacement*		*Bridge Rehab*	
			Median	Mean	Median	Mean	Median	Mean	Median	Mean
	18	Bridge substructure	4.00	3.80	4.00	3.50	5.00	4.24	4.00	3.93
	19	Bridge deck	4.50	3.90	4.50	3.60	5.00	4.24	5.00	4.06
	20	Bridge painting	2.00	2.20	2.00	2.20	3.00	2.71	3.00	2.65
	21	Precast and pipe culverts, sewers, etc.	3.00	2.82	3.00	2.63	3.00	2.83	3.00	2.67
	22	Retaining walls	3.50	3.50	3.00	3.33	4.00	3.53	4.00	3.38
Incidental Construction	23	Traffic control	4.00	3.61	4.00	3.67	4.00	3.56	4.00	3.72
	24	Construction staking	2.00	1.94	1.50	1.72	2.00	2.06	1.50	1.88
	25	Incidental concrete structures	2.00	2.22	2.00	2.22	2.00	2.12	2.00	2.18
	26	Erosion control	3.50	3.28	3.00	2.89	3.00	3.29	3.00	2.79
	27	Riprap	2.00	2.00	2.00	1.88	2.00	1.94	2.00	1.93
	28	Guardrail	3.00	2.76	3.00	2.56	3.00	2.76	3.00	2.56
	29	Fencing	1.00	1.65	1.00	1.69	1.00	1.71	1.00	1.71
	30	Pavement marking	3.00	3.18	3.00	3.18	3.00	3.18	3.00	3.00
	31	Underdrain	3.00	2.63	2.00	2.40	2.50	2.50	2.00	2.33
	32	Traffic signs	3.00	2.94	3.00	2.94	3.00	2.72	3.00	2.75
	33	Electric lighting and traffic signals	3.00	2.53	2.50	2.50	2.50	2.50	2.00	2.43
Roadside	34	Roadside topsoil, mulching, and seeding	3.00	2.59	2.00	2.50	3.00	2.69	2.00	2.31
	35	Trees and shrubs planting	1.00	1.59	1.00	1.56	1.00	1.53	1.00	1.54

As shown in Table 4.3, the high-risk inspection activities are in the PCCP and HMA Pavements, Structures, and Earthwork & Embankment categories. For example, construction inspections of PCCP pavement (checklist #11), HMA pavement (checklist #14), and bridge deck (checklist #19) were rated as high risk, with a score above 4.0 for New Road Construction or Expansion, Roadway Rehabilitation & Resurfacing, Bridge - New or Replacement, and Bridge Rehabilitation projects. In contrast, the clearing and grubbing item has the lowest risk level with an average of 1.44, 1.33, 1.39, and 1.33 for those same projects, respectively.

4.3.2 Frequency of Inspection

Using both mean and median scores, Table 4.4 shows a heat map of the inspection level/frequency for 35 inspection checklists for the four main types of projects. As shown, the inspection frequency varies among the 35 items in six divisions. Although the mean score should be used to estimate the inspection frequency for each inspection, the median score of each inspection item is a useful value to understand the ratings distribution among the 18 experts. Three levels of inspection frequency were used: the end-product level (score of 0–1.5), the intermittent level (score of 1.5–2.5), and the continual level (score of 2.5–3).

Table 4.4: Heat Map of Inspection Frequency

Division	No.	Inspection Items	Inspection Level/ Frequency							
			New Road Construction or Expansion		*Roadway Rehab & Resurfacing*		*Bridge - New or Replacement*		*Bridge Rehab*	
			Median	Mean	Median	Mean	Median	Mean	Median	Mean
Earthwork & Embankment	1	Clearing and grubbing	1.00	1.44	1.00	1.47	1.00	1.39	1.00	1.38
	2	Demolition of existing structures	2.00	1.61	2.00	1.65	2.00	1.83	2.00	2.00
	3	Excavation and backfill for structures	2.00	2.41	2.50	2.44	2.50	2.44	3.00	2.50
	4	Excavation and embankment	3.00	2.67	3.00	2.61	3.00	2.63	3.00	2.64
	5	Geofoam lightweight embankment fill	3.00	2.62	3.00	2.64	3.00	2.58	3.00	2.64
	6	Mechanically stabilized earth (MSE) fill	3.00	2.93	3.00	3.00	3.00	2.93	3.00	3.00
	7	Granular drainage blanket	2.00	2.27	2.00	2.23	2.00	2.27	2.00	2.33
	8	Vertical drain	2.00	2.33	2.00	2.46	2.00	2.33	2.50	2.50
Subgrade & Base	9	Subgrade	3.00	2.72	3.00	2.61	3.00	2.64	3.00	2.75
	10	Subbase and base course	3.00	2.78	3.00	2.67	3.00	2.71	3.00	2.83
PCCP & HMA Pavement	11	Concrete pavement (PCCP)	3.00	3.00	3.00	2.89	3.00	2.87	3.00	3.00
	12	Patching concrete pavement	2.00	2.38	2.00	2.39	2.00	2.42	2.50	2.50
	13	HMA prime and tack coats	3.00	2.40	3.00	2.40	3.00	2.50	3.00	2.50
	14	Asphalt pavement (HMA)	3.00	2.94	3.00	2.94	3.00	2.83	3.00	2.91
	15	HMA surface treatment by chip seal	3.00	2.92	3.00	2.94	3.00	2.88	3.00	2.88
Structures	16	Falsework and form construction	2.00	1.86	2.00	1.92	2.00	1.82	2.00	1.87
	17	Cast-in-place box culvert	2.00	2.25	2.00	2.27	2.00	2.38	2.00	2.33
	18	Bridge substructure	3.00	2.60	3.00	2.60	3.00	2.53	3.00	2.53

Division	No.	Inspection Items	Inspection Level/ Frequency							
			New Road Construction or Expansion		*Roadway Rehab & Resurfacing*		*Bridge - New or Replacement*		*Bridge Rehab*	
			Median	Mean	Median	Mean	Median	Mean	Median	Mean
	19	Bridge deck	3.00	2.80	3.00	2.80	3.00	2.59	3.00	2.59
	20	Bridge painting	2.00	2.10	2.00	2.20	2.00	2.18	2.00	2.18
	21	Precast and pipe culverts, sewers, etc.	2.00	2.24	2.00	2.19	2.50	2.33	2.50	2.33
	22	Retaining walls	2.50	2.44	3.00	2.47	3.00	2.47	3.00	2.54
Incidental Construction	23	Traffic control	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	24	Construction staking	1.00	1.41	1.00	1.41	1.00	1.47	1.00	1.47
	25	Incidental concrete structures	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.06
	26	Erosion control	2.00	1.89	2.00	1.94	2.00	1.88	2.00	1.86
	27	Riprap	2.00	1.71	2.00	1.69	2.00	1.71	2.00	1.71
	28	Guardrail	2.00	1.94	2.00	2.00	2.00	1.94	2.00	1.94
	29	Fencing	2.00	1.75	2.00	1.80	2.00	1.79	2.00	1.85
	30	Pavement marking	3.00	2.71	3.00	2.71	3.00	2.65	3.00	2.71
	31	Underdrain	2.00	2.19	2.00	2.20	2.00	2.31	2.50	2.33
	32	Traffic signs	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	33	Electric lighting and traffic signals	2.00	2.06	2.00	2.06	2.00	2.07	2.00	2.07
Roadside	34	Roadside topsoil, mulching, and seeding	2.00	2.35	2.00	2.38	2.00	2.38	2.00	2.46
	35	Trees and shrubs planting	1.00	1.47	1.50	1.50	1.00	1.47	2.00	1.54

According to Table 4.4, the PCCP & HMA Pavement, Subgrade & Base, and Earthwork & Embankment divisions contain items that require the highest frequency of inspection. For

example, in the Earthwork & Embankment division, excavation and backfill for structures, excavation and embankment, geofoam lightweight embankment fill, and mechanically stabilized earth (MSE) fill rank at the continual level for inspection frequency (score of 2.5–3). Similarly, both items in the Subgrade & Base division require continual inspection, as well as concrete pavement (PCCP), asphalt pavement (HMA), and HMA surface treatment by chip seal in the PCCP & HMA Pavement division. Bridge structure and bridge deck inspection checklists under the Structures division also require a continual level of inspection. Finally, Table 4.4 indicates that clearing and grubbing, construction staking, and trees and shrubs planting inspection items require the lowest frequency of inspection (scores less than 1.5).

4.3.3 Number of Inspectors

Using both mean and median scores, Table 4.5 shows a heat map from an analysis of the number of inspectors required for 35 inspection checklists for the four main types of projects. Although use of mean values is recommended, the median score of each inspection item is a useful value to understand the ratings distribution among the 18 surveyed experts.

Table 4.5: Heat Map of Number of Inspectors

Division	No.	Inspection Items	Number of Inspectors							
			New Road Construction or Expansion		*Roadway Rehab & Resurfacing*		*Bridge - New or Replacement*		*Bridge Rehab*	
			Median	Mean	Median	Mean	Median	Mean	Median	Mean
Earthwork & Embankment	1	Clearing and grubbing	1.00	1.06	1.00	1.00	1.00	1.00	1.00	1.00
	2	Demolition of existing structures	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	3	Excavation and backfill for structures	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	4	Excavation and embankment	1.00	1.07	1.00	1.00	1.00	1.00	1.00	1.00
	5	Geofoam lightweight embankment fill	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	6	Mechanically stabilized earth (MSE) fill	1.00	1.21	1.00	1.17	1.00	1.13	1.00	1.17
	7	Granular drainage blanket	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	8	Vertical drain	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Subgrade & Base	9	Subgrade	1.00	1.13	1.00	1.06	1.00	1.09	1.00	1.11
	10	Subbase and base course	1.00	1.19	1.00	1.13	1.00	1.08	1.00	1.10
PCCP & HMA Pavement	11	Concrete pavement (PCCP)	3.00	2.50	3.00	2.50	2.00	2.20	2.00	2.11
	12	Patching concrete pavement	1.00	1.69	2.00	1.81	2.00	1.86	2.00	1.88
	13	HMA prime and tack coats	1.00	1.36	1.00	1.47	1.00	1.57	1.00	1.57
	14	Asphalt pavement (HMA)	3.00	2.94	3.00	2.94	3.00	2.75	3.00	2.33
	15	HMA surface treatment by chip seal	2.00	2.00	2.00	2.00	2.00	2.25	2.00	2.25
Structures	16	Falsework and form construction	1.00	1.20	1.00	1.22	1.00	1.13	1.00	1.13
	17	Cast-in-place box culvert	1.00	1.29	1.00	1.31	1.00	1.33	1.00	1.42

Division	No.	Inspection Items	Number of Inspectors							
			New Road Construction or Expansion		*Roadway Rehab & Resurfacing*		*Bridge - New or Replacement*		*Bridge Rehab*	
			Median	Mean	Median	Mean	Median	Mean	Median	Mean
	18	Bridge substructure	1.50	1.50	1.50	1.50	1.00	1.44	1.50	1.50
	19	Bridge deck	2.00	2.00	2.00	2.00	2.00	2.13	2.00	1.88
	20	Bridge painting	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	21	Precast and pipe culverts, sewers, etc.	1.00	1.19	1.00	1.20	1.00	1.10	1.00	1.10
	22	Retaining walls	1.00	1.07	1.00	1.07	1.00	1.07	1.00	1.08
Incidental Construction	23	Traffic control	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	24	Construction staking	1.00	1.25	1.00	1.08	1.00	1.25	1.00	1.10
	25	Incidental concrete structures	1.00	1.19	1.00	1.06	1.00	1.20	1.00	1.07
	26	Erosion control	1.00	1.06	1.00	1.00	1.00	1.00	1.00	1.00
	27	Riprap	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	28	Guardrail	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	29	Fencing	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	30	Pavement marking	1.00	1.25	1.00	1.25	1.00	1.19	1.00	1.19
	31	Underdrain	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	32	Traffic signs	1.00	1.13	1.00	1.00	1.00	1.00	1.00	1.00
	33	Electric lighting and traffic signals	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Roadside	34	Roadside topsoil, mulching, and seeding	1.00	1.06	1.00	1.07	1.00	1.07	1.00	1.08
	35	Trees and shrubs planting	1.00	1.06	1.00	1.07	1.00	1.07	1.00	1.08

Among the six divisions of inspection items in Table 4.5, items in the PCCP & HMA Pavement division require the highest number of inspectors (i.e., 3 or more with a mean score of 2.5–3). For example, HMA construction inspection requires the highest number of inspectors, with average scores of 2.94, 2.94, and 2.75 for New Road Construction or Expansion, Roadway Rehabilitation & Resurfacing, and Bridge - New or Replacement, respectively, and 2.33 for Bridge Rehabilitation projects. Similarly, the PCCP construction inspection item requires an average of 2.50 inspectors each for New Road Construction or Expansion and Roadway Rehabilitation & Resurfacing projects and 2.20 and 2.11 inspectors for Bridge - New or Replacement and Bridge Rehabilitation projects, respectively. Bridge substructure and bridge deck checklists in the Structures division each require two inspectors (average score of 1.5–2). Overall, Table 4.5 also indicates that a majority of construction inspections in the checklists require only one inspector in the field.

4.3.4 Inspector Experience

Using both mean and median scores, Table 4.6 shows a heat map from an analysis of required inspector experience for 35 inspection checklists for the four main types of projects. Although use of the mean values is recommended, the median score of each inspection item is a useful value to understand the distribution of ratings among the 18 surveyed experts. Three levels of inspector experience were used: (1) junior level (score of 0–1), (2) intermediate level (score of 1–2), and (3) senior level (score of 2–3).

Table 4.6: Heat Map of Inspector Experience

Division	No.	Inspection Items	Inspector Experience							
			New Road Construction or Expansion		*Roadway Rehab & Resurfacing*		*Bridge - New or Replacement*		*Bridge Rehab*	
			Median	Mean	Median	Mean	Median	Mean	Median	Mean
Earthwork & Embankment	1	Clearing and grubbing	1.00	1.07	1.00	1.08	1.00	1.00	1.00	1.00
	2	Demolition of existing structures	1.00	1.21	1.00	1.23	1.00	1.47	1.00	1.42
	3	Excavation and backfill for structures	1.00	1.33	1.00	1.36	1.00	1.38	1.00	1.36
	4	Excavation and embankment	1.00	1.44	1.00	1.44	1.00	1.29	1.00	1.33
	5	Geofoam lightweight embankment fill	1.00	1.43	1.00	1.46	1.00	1.33	1.00	1.36
	6	Mechanically stabilized earth (MSE) fill	2.00	2.07	2.00	2.23	2.00	2.07	2.00	1.92
	7	Granular drainage blanket	1.00	1.27	1.00	1.31	1.00	1.27	1.00	1.33
	8	Vertical drain	1.50	1.50	2.00	1.58	1.50	1.50	2.00	1.64
Subgrade & Base	9	Subgrade	2.00	1.81	2.00	1.81	1.00	1.45	2.00	1.56
	10	Subbase and base course	2.00	1.88	2.00	1.88	2.00	1.67	2.00	1.80
PCCP & HMA Pavement	11	Concrete pavement (PCCP)	2.50	2.44	3.00	2.50	2.00	2.09	2.00	2.00
	12	Patching concrete pavement	2.00	1.54	2.00	1.75	1.00	1.38	1.50	1.63
	13	HMA prime and tack coats	1.00	1.43	1.00	1.53	2.00	1.57	2.00	1.57
	14	Asphalt pavement (HMA)	2.00	2.06	2.00	2.06	2.00	1.89	2.00	1.89
	15	HMA surface treatment by chip seal	1.00	1.45	1.00	1.44	2.00	2.00	2.00	2.00
Structures	16	Falsework and form construction	2.00	2.20	2.00	2.20	2.00	2.19	2.00	2.21
	17	Cast-in-place box culvert	1.50	1.57	2.00	1.62	2.00	1.64	2.00	1.67
	18	Bridge substructure	2.50	2.50	2.00	2.44	2.00	2.38	2.00	2.36

Division	No.	Inspection Items	Inspector Experience							
			New Road Construction or Expansion		*Roadway Rehab & Resurfacing*		*Bridge - New or Replacement*		*Bridge Rehab*	
			Median	Mean	Median	Mean	Median	Mean	Median	Mean
	19	Bridge deck	3.00	2.63	3.00	2.67	3.00	2.69	2.50	2.44
	20	Bridge painting	2.00	1.86	2.00	1.88	2.00	1.60	2.00	1.60
	21	Precast and pipe culverts, sewers, etc.	1.00	1.38	1.00	1.33	1.00	1.40	1.00	1.40
	22	Retaining walls	2.00	1.87	2.00	1.93	2.00	1.87	2.00	1.92
Incidental Construction	23	Traffic control	1.00	1.53	1.00	1.60	1.00	1.53	1.00	1.53
	24	Construction staking	2.00	1.83	2.00	1.75	2.00	1.83	1.50	1.70
	25	Incidental concrete structures	1.00	1.31	1.00	1.31	1.00	1.33	1.00	1.27
	26	Erosion control	1.00	1.50	1.50	1.63	1.00	1.53	1.00	1.54
	27	Riprap	1.00	1.07	1.00	1.07	1.00	1.07	1.00	1.08
	28	Guardrail	1.00	1.53	1.50	1.57	1.00	1.53	1.00	1.50
	29	Fencing	1.00	1.20	1.00	1.14	1.00	1.15	1.00	1.17
	30	Pavement marking	1.00	1.25	1.00	1.25	1.00	1.19	1.00	1.19
	31	Underdrain	1.00	1.40	1.00	1.36	1.00	1.33	1.00	1.27
	32	Traffic signs	2.00	1.53	1.50	1.50	1.00	1.40	1.00	1.46
	33	Electric lighting and traffic signals	2.00	1.67	2.00	1.71	2.00	1.69	2.00	1.67
Roadside	34	Roadside topsoil, mulching, and seeding	1.00	1.19	1.00	1.20	1.00	1.13	1.00	1.17
	35	Trees and shrubs planting	1.00	1.06	1.00	1.07	1.00	1.07	1.00	1.08

According to Table 4.6, items in the PCCP & HMA Pavement and the Structures divisions require the highest inspector experience. In fact, most construction inspection items in these divisions require intermediate- or senior-level inspectors. For example, the bridge deck checklist in the Structures division requires a senior level of experience for New Road Construction or Expansion, Roadway Rehabilitation & Resurfacing, and Bridge - New or Replacement projects, with mean scores of 2.63, 2.67, and 2.69, respectively, while the PCCP pavement construction inspection checklist shows average scores of 2.44, 2.50, 2.09, and 2.00, respectively, for the same projects. Table 4.6 also indicates that most construction inspections in the Roadside Improvement, Incidental Constructions, and Earthwork & Embankment divisions require the junior level of inspection experience.

4.4 Final Risk-Based Inspection Checklists

To develop the final risk-based inspection checklists, the research team integrated the evaluation results of the 18 KDOT experts into an initial checklist. The results presented in Tables 4.3–4.6 were combined using the average of scores across four types of projects (New Road Construction or Expansion, Roadway Rehabilitation & Resurfacing, Bridge - New or Replacement, and Bridge Rehabilitation). Table 4.7 summarizes the scores of the 35 checklists for the risk level/priority for inspection, inspection frequency, number of inspectors, and inspector experience.

Table 4.7: Combined Evaluation Results of Risk-Based Inspection Checklist

Division	No.	Inspection Items	Risk Level		Inspection Frequency		Number of Inspectors		Inspector Experience	
			Median	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*	*Mean*
Earthwork & Embankment	1	Clearing and grubbing	1.00	1.38	1.00	1.42	1.00	1.02	1.00	1.04
	2	Demolition of existing structures	2.00	2.25	2.00	1.77	1.00	1.00	1.00	1.33
	3	Excavation and backfill for structures	3.00	2.82	2.50	2.45	1.00	1.00	1.00	1.36
	4	Excavation and embankment	3.38	3.25	3.00	2.64	1.00	1.02	1.00	1.37
	5	Geofoam lightweight embankment fill	3.25	3.16	3.00	2.62	1.00	1.00	1.00	1.40
	6	Mechanically stabilized earth (MSE) fill	4.00	4.00	3.00	2.97	1.00	1.17	2.00	2.07
	7	Granular drainage blanket	2.13	2.58	2.00	2.27	1.00	1.00	1.00	1.29
	8	Vertical drain	2.13	2.52	2.13	2.41	1.00	1.00	1.75	1.55
Subgrade & Base	9	Subgrade	3.88	3.44	3.00	2.68	1.00	1.10	1.75	1.66
	10	Subbase and base course	3.88	3.52	3.00	2.75	1.00	1.12	2.00	1.80
PCCP & HMA Pavement	11	Concrete pavement (PCCP)	4.88	4.17	3.00	2.94	2.50	2.33	2.38	2.26
	12	Patching concrete pavement	3.13	3.41	2.13	2.42	1.75	1.81	1.63	1.57
	13	HMA prime and tack coats	3.00	2.92	3.00	2.45	1.00	1.49	1.50	1.53
	14	Asphalt pavement (HMA)	4.50	4.33	3.00	2.91	3.00	2.74	2.00	1.98
	15	HMA surface treatment by chip seal	3.38	3.49	3.00	2.90	2.00	2.13	1.50	1.72
Structures	16	Falsework and form construction	3.00	2.77	2.00	1.87	1.00	1.17	2.00	2.20
	17	Cast-in-place box culvert	3.00	3.01	2.00	2.31	1.00	1.34	1.88	1.62
	18	Bridge substructure	4.25	3.87	3.00	2.57	1.38	1.48	2.13	2.42

Division	No.	Inspection Items	Risk Level		Inspection Frequency		Number of Inspectors		Inspector Experience	
			Median	*Mean*	*Median*	*Mean*	*Median*	*Mean*	*Median*	*Mean*
	19	Bridge deck	4.75	3.95	3.00	2.69	2.00	2.00	2.88	2.60
	20	Bridge painting	2.50	2.44	2.00	2.16	1.00	1.00	2.00	1.73
	21	Precast and pipe culverts, sewers, etc.	3.00	2.74	2.25	2.27	1.00	1.15	1.00	1.38
	22	Retaining walls	3.63	3.44	2.88	2.48	1.00	1.07	2.00	1.90
Incidental Construction	23	Traffic control	4.00	3.64	2.00	2.00	1.00	1.00	1.00	1.55
	24	Construction staking	1.75	1.90	1.00	1.44	1.00	1.17	1.88	1.78
	25	Incidental concrete structures	2.00	2.18	2.00	2.02	1.00	1.13	1.00	1.31
	26	Erosion control	3.13	3.06	2.00	1.89	1.00	1.02	1.13	1.55
	27	Riprap	2.00	1.94	2.00	1.70	1.00	1.00	1.00	1.07
	28	Guardrail	3.00	2.66	2.00	1.95	1.00	1.00	1.13	1.53
	29	Fencing	1.00	1.69	2.00	1.80	1.00	1.00	1.00	1.17
	30	Pavement marking	3.00	3.13	3.00	2.69	1.00	1.22	1.00	1.22
	31	Underdrain	2.38	2.46	2.13	2.26	1.00	1.00	1.00	1.34
	32	Traffic signs	3.00	2.84	2.00	2.00	1.00	1.03	1.38	1.47
	33	Electric lighting and traffic signals	2.50	2.49	2.00	2.06	1.00	1.00	2.00	1.68
Roadside	34	Roadside topsoil, mulching, and seeding	2.50	2.52	2.00	2.39	1.00	1.07	1.00	1.17
	35	Trees and shrubs planting	1.00	1.56	1.38	1.49	1.00	1.07	1.00	1.07

Table 4.8 shows the score conversions of the mean values of the risk level/priority for inspection, inspection frequency, number of inspectors, and inspector experience to the terms defined in Figure 4.4. For example, the clearing and grubbing checklist, with a risk level mean value of 1.38, was designated as a Low to Moderate risk level, and the inspection level mean score of 1.42 was designated as an Intermittent level. The inspector experience mean score of 1.04 was assigned to the Junior level.

Table 4.8: Evaluation Results for KDOT Risk-Based Inspection Final Checklist

Division	No.	Inspection Items	Risk Level	Inspection Frequency	Number of Inspectors	Inspector Experience
Earthwork & Embankment	1	Clearing and grubbing	Low to moderate	Intermittent	2.0	Junior
	2	Demolition of existing structures	Moderate	Intermittent	1.0	Junior
	3	Excavation and backfill for structures	Moderate	Continual	1.0	Junior
	4	Excavation and embankment	Moderate to high	Continual	2.0	Junior
	5	Geofoam lightweight embankment fill	Moderate to high	Continual	1.0	Junior
	6	Mechanically stabilized earth (MSE) fill	Moderate to high	Continual	2.0	Intermediate
	7	Granular drainage blanket	Moderate	Continual	1.0	Junior
	8	Vertical drain	Moderate	Continual	1.0	Intermediate
Subgrade & Base	9	Subgrade	Moderate to high	Continual	2.0	Intermediate
	10	Subbase and base course	Moderate to high	Continual	2.0	Intermediate
PCCP & HMA Pavement	11	Concrete pavement (PCCP)	High	Continual	3	Senior
	12	Patching concrete pavement	Moderate to high	Continual	2.0	Intermediate
	13	HMA prime and tack coats	Moderate	Continual	2.0	Intermediate
	14	Asphalt pavement (HMA)	High	Continual	3	Intermediate
	15	HMA surface treatment by chip seal	Moderate to high	Continual	3	Intermediate
Structures	16	Falsework and form construction	Moderate	Intermittent	2.0	Intermediate
	17	Cast-in-place box culvert	Moderate to high	Continual	2.0	Intermediate
	18	Bridge substructure	Moderate to high	Continual	2.0	Senior
	19	Bridge deck	Moderate to high	Continual	2.0	Senior
	20	Bridge painting	Moderate	Continual	1.0	Intermediate
	21	Precast and pipe culverts, sewers, etc.	Moderate	Continual	2.0	Junior
	22	Retaining walls	Moderate to high	Continual	2.0	Intermediate

Division	No.	Inspection Items	Risk Level	Inspection Frequency	Number of Inspectors	Inspector Experience
Incidental Construction	23	Traffic control	Moderate to high	Intermittent	1.0	Junior
	24	Construction staking	Low to moderate	Intermittent	2.0	Intermediate
	25	Incidental concrete structures	Moderate	Continual	2.0	Junior
	26	Erosion control	Moderate to high	Intermittent	2.0	Intermediate
	27	Riprap	Low to moderate	Intermittent	1.0	Junior
	28	Guardrail	Moderate	Intermittent	1.0	Intermediate
	29	Fencing	Low to moderate	Intermittent	1.0	Junior
	30	Pavement marking	Moderate to high	Continual	2.0	Junior
	31	Underdrain	Moderate	Continual	1.0	Junior
	32	Traffic signs	Moderate	Intermittent	2.0	Intermediate
	33	Electric lighting and traffic signals	Moderate	Continual	1.0	Intermediate
Roadside	34	Roadside topsoil, mulching, and seeding	Moderate	Continual	2.0	Junior
	35	Trees and shrubs planting	Low to moderate	Intermittent	2.0	Junior

Based on the results summarized in Table 4.8, the research team developed the final risk-based checklists by adding relevant information on inspection priority, inspection frequency, numbers of inspectors, and inspector experience to the initial checklists. As shown in Figure 4.5, the complete checklist for PCCP construction shows the risk level/inspection priority as High, the inspection frequency as Continual, the number of inspectors as High (three or more inspectors), and inspector experience as Senior. Appendix A provides all 35 checklists for KDOT risk-based inspection.

PORTLAND CEMENT CONCRETE PAVEMENT CHECKLIST

Specification Reference: 501-502-503-504-505 **Pay Item**: 501 – 502 – 503

Inspection Level/Frequency: Continual **Priority**: High

Inspector Experience: Senior (plant inspector, field testers, placement inspector, curing inspector, sawed joint cutting and sealing inspector)

Number of Inspectors: 3-5

Description: Construct Portland Cement Concrete Pavement (PCCP) on a prepared subgrade or base course. Develop and perform quality control testing.

INSPECTION TASKS
Pre-Construction
☐ Ensure the contractor has a safe traffic control operation that will be followed
☐ Review of the contract documents with focusing on Concrete mix design, mixing requirements
☐ Check weather conditions that could influence the quality of the PCCP
☐ Review placement, Spreading and consolidating, Joints, dowel bars and tie bars requirements.
☐ Plant inspector monitors batch weights, water, and admixture amounts
☐ Materials Division reviews the mix design for approval.
☐ Approval of the base course and related tests, and grades and surface tolerance requirements are in accordance with the contract documents
☐ Confirming stakeout requirements with survey crew
☐ Plant inspector reviews aggregate gradation test result
☐ Field testers obtain samples of the mixed concrete from the hauling vehicle before it leaves the plant area
During Construction
☐ Moistening surfaces that will contact the mix
☐ Checking Alignment and grade control
☐ Placing dowel bars and tie bars when required
☐ Checking vibrator frequencies as per standard specification 154.2e requirements
☐ Finishing and texturing the surface
☐ Taking sample of concrete and cast strength specimens at the rate specified
Post Construction
☐ Curing after final finishing according to contract specifications
☐ Observing the contractor's joint marking and sawing operation in accordance with the contract documents
☐ Protection of the surface if required by Proper signage or fencing
☐ Checking pavement smoothness and strength before public traffic is allowed
☐ Profile measurement testing of the PCCP surface using profiler by contractor
☐ Measurement and payment

CRITICAL MATERIAL TESTS (risk level)	
☐ KT-20: Concrete mass per cubic foot (moderate-high)	☐ KT-24: Moisture in PCCP aggregate (moderate-low)
☐ KT-02: Sieve analysis individual aggregates (moderate-low)	☐ KT-49: Cored PCCP thickness (moderate-low)
☐ KT-17: PCCP temperature (moderate-low)	☐ KT-38: Density of fresh PCCP (moderate-low)
☐ KT-21: PCCP slump (moderate-low)	☐ KT-73: PCCP permeability (moderate-low)
☐ KT-20: air content (moderate-high)	☐ KT-05: Unit weight of individual aggregate (moderate-low)

Figure 4.5: Complete PPCP Pavement Construction Checklist

4.5 Summary

This chapter summarizes the development and evaluation results of 35 inspection checklists for various construction items in KDOT projects. The checklists were developed by synthesizing and evaluating a wide range of KDOT documents, including the *KDOT Construction Manual*, *KDOT Bridge Construction Manual*, KDOT Specifications, and QA Inspection Acceptance. Inspection tasks for preconstruction, during construction, and post construction were created for each checklist, and KDOT pay items and KDOT specifications were connected and incorporated into each checklist. The construction inspection item in each checklist was evaluated by 18 KDOT experts in terms of the risk level and priority for inspection, frequency of inspection, number of inspectors, and inspector experience required. Four types of projects (New Road Construction or Expansion, Roadway Rehabilitation & Resurfacing, Bridge - New or Replacement, and Bridge Rehabilitation) were used in the evaluation process. Evaluation results were integrated into the final 35 checklists, which could provide a useful reference for KDOT risk-based inspection for highway construction projects.

Chapter 5: Construction Inspection Staffing Strategies

5.1 Introduction

This chapter presents the estimation results of inspection staff sizes for four types of projects based on project data from KDOT's CMS database. Four common KDOT project types include (1) grading and surfacing, (2) sealing, (3) surface recycling and overlay, and (4) bridge repair projects. Inspection staff size was estimated based on projects cost, duration, and number of inspectors for a total of 169 projects. The following sections present inspection staff estimation results based on project cost and time for the four type projects.

5.2 Data Extraction Process

The research team conducted diligent data extraction from the KDOT CMS, including thorough examination of the Contracts and Materials reports from the database. From the Contracts report, the research team analyzed the contract line-item report, the working days-charged report, the contract diary report, field documentation, change orders, and pay estimates. From the Materials report, the research team analyzed the material codes and descriptions, HMA mix design, PCCP mix design, soil-based construction mix design, summary of tests performed, samples received, the density analysis report, and inspector maintenance reports. Figures 5.1 and 5.2 show samples from the Contracts and Materials reports, respectively.

DTCO004 STATE OF KANSAS - DEPARTMENT OF TRANSPORTATION PAGE: 1
DATE: 08 16 21 TIME: 10:52 AM CONTRACT DIARY REPORT

CONTRACT : 518102303 E STATUS : NOTAC PROJECT ID : U083 020 KA 4981 01
WORK TYPE : RCYLE RECYCLE & O-LAY LENGTH : 12.398 MI
LOCATION : 2.0 SURFACE RECYCLE AND 1.50 HMA OVERLAY. US83 FR N END OF P
CONTRACTOR : 00817 VENTURE CORPORATION

BEGIN DATE: 09/17/2019 END DATE : 01/15/2020
DIARY TYPE : ALL - All Diaries

DATE: 11/14/2019 DAY: Thursday TEMP MAX: 55.0 MIN: 29.0
WEATHER: Clear CIOW: Overlay
WORK DAY CHARGED: 1 CLEANUP DAYS : 0 STATES DELAY: 0
LIQUID DAMAGES (A): 0 LIQUID DAMAGES (B): 0
INSPECTOR: Derek TYPE: A - PROJECT DIARY

Venture started milling in curb & gutter section at 9:00 am. Milled in the right lane from sta. 0+00 to sta. 17+50. Waited on the test strip results for 1:30 pm to 2:00 pm. Test strip was paved on shoulder of curb and gutter. Started laying asphalt @ 2:30pm. Off the road at 5:20 pm, sta. 38+00.

Figure 5.1: Sample of Contract Diary Report from the KDOT CMS Database

DTMT284 STATE OF KANSAS - DEPARTMENT OF TRANSPORTATION PAGE 4
09/16/2021 TIME 10:07 AM REPORT OF SELECTED TESTS - LIST ALL TESTS

SELECTION CRITERIA:
CONTRACT: 518102303 E RESP LOCN:
TYPE INSP: TYPE TEST: TEST RESULT:
PRODUCER: MTRL CODE: INSPECTOR:
SAMPLED DATE RANGE: 09/17/2019 TO 01/15/2020

TYPE INSP: ACC LOCATION: 32

TYPE TEST	SAMPLE ID	SI-IND	MTRL CODE	INSPECTOR	QUANTITY ASSIGNED	PRODUCER
10	01104311A	E	002070610	000321022	576.700	CC081700
	01104313A	E	002070610	000321022	1,893.280	CC081700
	01104316A	E	002070610	000321022	853.800	CC081700

ID to count number of Project inspectors

Figure 5.2: Sample of Materials Report from the KDOT CMS Database

The scanning results from 169 projects were then coded in a master Excel spreadsheet. Spreadsheet information included the project description, such as CMS description; major work types (e.g., bridge repair, grading and surfacing); project cost; project duration; and liquidated damages. HMA test results, emulsified asphalt test results, asphalt binder, HMA mix analysis, HMA density analysis, field gradation test results, concrete-air slump test, concrete strength, concrete density test results, soil/base density, aggregate quality test results, number of inspectors, and comments and notes from inspectors were also included in the spreadsheet.

The following sections present estimated inspection staff sizes for grading and surfacing, sealing, surface recycling and overlay, and bridge repair projects.

5.3 Grading and Surfacing Projects

Table 5.1 shows the inspection staff sizes for grading and surfacing projects associated with six categories of project cost: less than $1.0 million, $1.0 million to $3.0 million, $3.0 million to $5.0 million, $5.0 million to $10.0 million, $10.0 million to $20.0 million, and $20.0 million to $40.0 million. For each project, the inspection staff (e.g., KDOT inspectors or consultants) was recorded from the database. On average, Table 5.1 indicates that grading and surfacing projects costing less than $1.0 million required four KDOT inspectors and one consultant inspector, while projects costing $1.0 million to $3.0 million and projects costing $3.0 million to $5.0 million each required eight KDOT inspectors and two consultant inspectors. Projects costing $5.0 million to $10.0 million required 12 KDOT inspectors and two consultant inspectors, projects costing $10.0 million to $20.0 million required 13 KDOT inspectors and three consultant inspectors, and projects costing $20.0 million to $40.0 million required eight KDOT inspectors and two consultant inspectors. The project duration measured by workday was also included for each category. Results shown in Table 5.1 may help KDOT construction managers initially estimate the number of inspectors required for any given grading and surfacing project. However, because the samples of grading and surfacing projects costing $10.0 million to $20.0 million and projects costing $20.0 million to $40.0 million were relatively small (less than five projects), additional data is needed to verify inspection staff estimation results for these project sizes.

Table 5.1: Inspection Staff Size for Grading and Surfacing Projects (n = 48)

Budget (B)	Staff Source	Number of Inspectors		
		Min	Max	Average
B < $1M (n = 11)	KDOT	1.0	7.0	4.0
	Consultant	0.0	3.0	0.9
	Total	2.0	7.0	4.9
	Duration: workdays	45.0	135.0	71.4
$1M ≤ B < $3M (n = 14)	KDOT	2.0	15.0	7.8
	Consultant	0.0	7.0	2.4
	Total	3.0	18.0	10.2
	Duration: workdays	30.0	200.0	135.4
$3M ≤ B < $5M (n = 9)	KDOT	5.0	22.0	10.9
	Consultant	0.0	5.0	1.6
	Total	7.0	22.0	12.5
	Duration: workdays	65.0	255.0	172.2
$5M ≤ B < $10M (n = 7)	KDOT	6.0	19.0	12.3
	Consultant	0.0	7.0	2.0
	Total	7.0	22.0	14.3
	Duration: workdays	111.0	255.0	200.2
$10M ≤ B < $20M (n = 3)	KDOT	12.0	14.0	13.0
	Consultant	3.0	4.0	3.5
	Total	16.0	17.0	16.5
	Duration: workdays	177.0	387.0	282.0
$20M ≤ B < $40M (n = 4)	KDOT	14.0	28.0	19.3
	Consultant	1.0	8.0	3.5
	Total	18.0	32.0	22.8
	Duration: workdays	442.0	593.0	518.3

5.4 Sealing Projects

Table 5.2 shows inspection staff sizes for sealing projects associated with three categories of project cost: less than $0.5 million, $0.5 million to $1.0 million, and $1.0 million to $4.0 million. KDOT sealing projects are typically small in terms of project cost. Table 5.2 indicates that, on average, sealing projects costing less than $0.5 million required two KDOT inspectors for an average duration of 15 workdays, while projects costing $0.5 million to $1.0 million required three KDOT inspectors and one consultant inspector for an average duration of 20 workdays. Projects costing $1.0 million to $4.0 million required four KDOT inspectors and two consultant inspectors for an average duration of 115 workdays. These results may help KDOT construction managers initially estimate the number of inspectors required for any given sealing project. However, because the sample of KDOT sealing projects costing $1.0 million to $4.0 million was small (only two projects available), additional data is needed to verify inspection staff results for sealing projects that cost $1.0 million to $4.0 million.

Table 5.2: Inspection Staff Size for Sealing Projects (n = 22)

Budget (B)	Staff Source	Min	Max	Average
B < $0.5M (n = 10)	KDOT	1.0	6.0	2.4
	Consultant	0.0	0.0	0.0
	Total	1.0	6.0	2.4
	Duration: workdays	10.0	20.0	14.5
$0.5M ≤ B < $1M (n = 10)	KDOT	1.0	7.0	3.0
	Consultant	0.0	3.0	0.3
	Total	1.0	7.0	3.3
	Duration: workdays	10.0	35.0	20.0
$1M ≤ B < $4M (n = 2)	KDOT	3.0	5.0	4.0
	Consultant	0.0	3.0	1.5
	Total	5.0	6.0	5.5
	Duration: workdays	70.0	160.0	115.0

5.5 Surface Recycle and Overlay Projects

Table 5.3 shows inspection staff sizes for surface recycle and overlay projects associated with four categories of project cost: less than $1.0 million, $1.0 million to $2.0 million, $2.0 million to $5.0 million, and $5.0 million to $10.0 million. According to Table 5.3, on average, surface recycle and overlay projects costing less than $1.0 million required three KDOT inspectors and one consultant inspector for an average duration of 27 workdays, while projects costing $1.0 million to $2.0 million required four KDOT inspectors and two consultant inspectors for an average duration of 34 workdays. Projects costing $2.0 million to $5.0 million required four KDOT inspectors and two consultant inspectors for an average duration of 50 workdays, and projects costing $5.0 million to $10.0 million required seven KDOT inspectors and two consultant inspectors for an average duration of 131 workdays. The results in Table 5.3 may help KDOT construction managers initially estimate the number of inspectors required for any given surface recycle and overlay project. However, because the sample of KDOT surface recycle and overlay projects costing $5.0 million to $10.0 million was relatively small (only six projects available), additional data is needed to verify the inspection staff size for this category of surface recycle and overlay projects.

Table 5.3: Inspection Staff Size for Surface Recycling and Overlay Projects (n = 61)

Budget (B)	Staff Source	Min	Max	Average
B < $1M (n = 15)	KDOT	0.0	10.0	2.9
	Consultant	0.0	6.0	1.1
	Total	1.0	11.0	4.0
	Duration: workdays	5.0	65.0	27.0
$1M ≤ B < $2M (n = 22)	KDOT	0.0	12.0	3.7
	Consultant	0.0	8.0	2.3
	Total	1.0	14.0	6.0
	Duration: workdays	20.0	100.0	34.1
$2M ≤ B < $5M (n = 18)	KDOT	1.0	8.0	3.8
	Consultant	0.0	8.0	2.2
	Total	2.0	10.0	6.0
	Duration: workdays	30.0	100.0	50.3
$5M ≤ B < $10M (n = 6)	KDOT	3.0	15.0	6.8
	Consultant	1.0	3.0	1.6
	Total	5.0	17.0	8.4
	Duration: workdays	65.0	190.0	131.3

5.6 Bridge Repair Projects

Table 5.4 shows the inspection staff sizes for bridge repair projects associated with four categories of project cost: less than $0.5 million, $0.5 million to $1.0 million, $1.0 million to $2.0 million, and $2.0 million to $8.0 million. According to Table 5.4, on average, bridge repair projects costing less than $0.5 million required five KDOT inspectors for an average duration of 64 workdays, while projects costing $0.5 million to $1.0 million required six KDOT inspectors for an average duration of 101 workdays. Projects costing $1.0 million to $2.0 million required seven KDOT inspectors and one consultant inspector for an average duration of 109 workdays, and projects costing $2.0 million to $8.0 million required eight KDOT inspectors and one consultant

inspector for an average duration of 301 workdays. The results in Table 5.4 may help KDOT construction managers initially estimate the number of inspectors required for any given bridge repair construction project. However, because the sample of KDOT bridge repair projects costing $1.0 million to $2.0 million and $2.0 million to $8.0 million was relatively small (only four projects available), additional data is needed to verify the inspection staff size for these two categories of bridge repair construction projects.

Table 5.4: Inspection Staff Size for Bridge Repair Projects (n = 38)

Budget (B)	Staff Source	Min	Max	Average
B < $0.5M (n = 17)	KDOT	0.0	15.0	4.9
	Consultant	0.0	2.0	0.1
	Total	2.0	15.0	5.0
	Duration: workdays	20.0	110.0	64.1
$0.5M ≤ B < $1M (n = 12)	KDOT	2.0	10.0	6.0
	Consultant	0.0	1.0	0.1
	Total	2.0	10.0	6.1
	Duration: workdays	45.0	180.0	101.3
$1M ≤ B < $2M (n = 5)	KDOT	5.0	10.0	7.0
	Consultant	0.0	4.0	0.7
	Total	5.0	10.0	7.8
	Duration: workdays	85.0	150.0	109.0
$2M ≤ B < $8M (n = 4)	KDOT	5.0	11.0	7.5
	Consultant	0.0	3.0	0.6
	Total	5.0	11.0	7.5
	Duration: workdays	180.0	382.0	301.0

5.7 Summary

This chapter summarized analysis results of the empirical data (years 2017–2021) from the KDOT CMS database to determine inspection staff sizes for four types of construction projects, including 48 grading and surfacing projects, 22 sealing construction projects, 61 surface recycle and overlay projects, and 22 bridge repair construction projects. Each project type was classified into different project sizes in terms of cost and project duration. Project costs varied from less than $0.5 million to $40 million, with durations between 14 days and 518 workdays. The inspection staff was comprised of in-house and consultant inspectors. The results presented in this chapter may help KDOT project managers determine inspection staff requirements during the early stages of any given project and identify inspection staff shortages and subsequent outsourcing needs for inspection items.

Chapter 6: Conclusions and Recommendations

6.1 Summary

State DOTs and the FHWA are constantly seeking to ensure that all highway construction projects are of the highest quality and durability. Therefore, state DOTs allocate resources for their inspection processes to guarantee quality, safety, and fiscal responsibility of their construction projects. However, the current challenge of limited construction inspector resources for transportation infrastructure encapsulates a broader issue of prolonged construction workforce shortages. Leveraging inspection resources, such as staff and finances, is a challenging task, and the decrease in the number of inspectors and technicians for all construction operations, the allocation of less experienced inspectors for complex construction operations, and the decrease of inspection frequency for all construction operations due to staff shortages enhance the risk of decreased safety, functional failures, and lack of oversight. Consequently, construction inspection efforts should be appropriately allocated by prioritizing inspection based on the criticality of construction operations.

Building upon the previous K-TRAN: KU-19-3, *Development of Risk-Based Approach for KDOT Construction Inspection: An Assessment*, the main objective of this research was to develop implementation guidelines for KDOT risk-based construction inspection. The research approach included three phases: (1) empirical data collection on highway construction inspection staffing from the KDOT database and construction QA documents, (2) assessment and evaluation of KDOT inspection items/checklists, and (3) the development of final risk-based checklists and guidance that consider staff size, staff experience, frequency of inspection, and item risk level. A mix of qualitative and quantitative research approaches was applied during these phases. Due to the shortage of data regarding risk levels of various construction operations, the qualitative risk evaluation approach was used to screen and prioritize inspection items and develop inspection checklists. A total of 18 KDOT experts evaluated the 35 checklists in terms of risk level and priority for inspection, inspection frequency, number of inspectors, and inspector experience. Based on the data extracted from 169 KDOT highway construction projects between 2017 and 2021, the quantitative approach was used to evaluate inspection staffing needs. Both the qualitative

and quantitative evaluations provided appropriate risk mitigation and staff allocation strategies for highway construction projects with minimal inspection risks.

Each checklist includes inspection tasks that cover core inspection items before, during, and after construction operations. Critical QA tests of each construction operation were also added from a previous research project (K-TRAN: KU-19-3) to consider field inspections and material testing of each construction operation. Priority for inspection, expressed as the risk level of each checklist, was evaluated based on input from the 18 KDOT experts. In addition, the evaluation process for each checklist included frequency of inspection, number of inspectors, and inspector experience. Furthermore, KDOT inspection staffing needs for four types of construction projects (grading and surfacing, sealing, surface recycling and overlay, and bridge repair) were determined using historical data from KDOT construction projects.

6.2 Findings and Recommendations

K-TRAN: KU-19-3, *Development of Risk-Based Approach for KDOT Construction Inspection: An Assessment,* successfully identified and evaluated the risk levels of KDOT construction activities according to KDOT Standard Specifications and the *KDOT Construction Manual*. Findings from K-TRAN: KU-19-3 confirmed the need to incorporate risk-based approaches into current KDOT practices for construction inspection. As described in Chapter 2, several state DOTs implement risk-based inspection approaches to evaluate material testing and workmanship inspection based on criticality. The findings of this study are intended to enhance the inspection of highway construction projects by utilizing less inspection resources. The following key findings are emphasized:

- The *KDOT Construction Manual* explicitly regulates the sample size, sampling process, testing methods, and acceptance criteria for all materials, while KDOT's Standard Specifications include materials and construction requirements for transportation projects. However, no guidance exists for effective and efficient construction inspections.
- The proposed 35 risk-based inspection checklists include eight checklists for the Earthwork & Embankment division, two checklists for

the Subgrade, Subbase, & Base Course division, five checklists for the PCCP and HMA Pavement divisions, seven checklists for the Structures division, 11 checklists for the Incidental Construction division, and two checklists for the Roadside Improvement division. Appendix A provides the complete 35 inspection checklists for KDOT QA inspections.

- Each checklist includes relevant sections from KDOT's Standard Specifications, KDOT pay items, the inspection level/frequency, inspection priority, number of inspectors, and inspector experience required. Additionally, each checklist includes core inspection tasks before construction, during construction, and after construction. The critical material tests are included at the end of each checklist to ensure that an inspector inspects field construction and verifies the construction material tests. Figures 4.3 and 4.5 show examples of the PCCP checklist, including specification references, pay items, risk item, risk levels/priority for inspection, inspection frequency, number of inspectors, and inspector experience requirements.
- The heat map of inspection risk levels/priority for the 35 checklists (Table 4.3) may help KDOT project managers determine when and where to inspect New Road Construction or Expansion, Roadway Rehabilitation and Resurfacing, Bridge - New or Replacement, or Bridge Rehabilitation projects.
- The heat map of inspection frequency for the 35 checklists (Table 4.4) may help KDOT project managers determine how frequently construction inspection should be conducted for each of the four project types.
- The heat map of the number of inspectors and inspector experience required for the 35 checklists (Tables 4.5 and 4.6, respectively) may

help KDOT project managers determine the demand for inspectors and required inspection experience for each of the four project types.

- Because KDOT inspections lack formal guidelines for inspection staffing of construction projects, staffing is dependent upon construction project characteristics, such as project type and size. Therefore, this study developed a guideline to specify average inspection staffing (in-house and outsourced) for any given project based on the records of 169 KDOT construction projects completed between 2017 and 2021. Results presented in Tables 5.1–5.4 may help KDOT determine the demand for inspection staff according to project cost and duration for grading and surfacing, sealing, surface recycling and overlay, and bridge repair projects.
- The lack of knowledge transfer from seasoned inspectors to new inspectors is the primary reason for knowledge loss, especially when experienced QA staff members retire. The developed checklists may help KDOT determine inspector experience and the number of required inspectors for each construction operation, as well as a detailed description of inspection tasks and tests.
- The utilization of digital technologies could improve construction inspection processes and reduce inspection resources and effort. These technologies help fill the gap between an increasing number of highway construction projects and decreasing inspection resources.

Based on the study findings, this research presents the following recommendations:

- The risk-based inspection protocol from K-TRAN: KU-19-3 and the 35 checklists and construction inspection strategies presented in this study should be used to guide the allocation of inspection staff.
- Risk-based inspection methodologies should be employed to evaluate the risks of other construction inspection activities beyond the 35 checklists presented in this study.

- A digital risk-based inspection system should be developed by considering potential efficiencies using evolving technologies for inspection practices.

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Appendix A: Inspection Checklists for Highway Construction

CLEARING AND GRUBBING

Specification Reference: 201

Pay Item: 201 (Lump Sum)

Inspection Level/Frequency: Intermittent

Priority: Low to moderate

Inspector Experience: Junior

Number of Inspectors: 2

Description: Clearing involves ground clearing of trees, trash, and debris. Grubbing involves additional clearing of stumps, roots, bushes, and undergrowth.

INSPECTION TASKS
Pre-Construction ☐ Review staking and layout of special locations, such as environmentally sensitive areas and other specified avoidance areas ☐ Check disposal and location of material outside highway right-of-way according to contract and regulations and contractor's submittal of copies of disposal permits ☐ Ensure that the necessary temporary pollution control measures and environmental requirements are in place ☐ Verify that the survey is completed to ensure clearing and grubbing operations are confined to proposed construction limits and with staking areas
During Construction ☐ Document any hazards and ensure that safety measures have been safely implemented ☐ Monitor that the contractor's operations do not damage the adjacent property and environmentally sensitive areas ☐ Confirm debris does not block drainage and organic materials are not buried within the right-of-way when the contract documents allow burying debris ☐ Check that the grade is cut to the required tolerance
Post Construction ☐ Keep accurate records when disposing of solid wastes adjacent to the roadway and show this information on the as-built plans ☐ Measure and pay (if paid separately in the contract)

CRITICAL MATERIAL TESTS
☐ N/A

DEMOLITION AND REMOVAL OF EXISTING STRUCTURES

Specification Reference: 202

Pay Item: 202

Inspection Level/Frequency: Intermittent

Priority: Moderate

Inspector Experience: Junior

Number of Inspectors: 1.0

Description: Remove and dispose of the existing structures as identified in the contract for removal and man-made structures not specifically identified in the contract that are in conflict with the new construction.

INSPECTION TASKS
Pre-Construction ☐ Ensure the work to be performed, including resolving issues regarding limits of removal, salvage, storage, and disposal of obstructions and materials, with the contractor ☐ Inspect all building structures that are scheduled for removal and determine if asbestos is present; then remove in compliance with all federal and state regulations ☐ Ensure that all stakeout or marking of structures designated for removal are complete prior to removal ☐ Take sufficient measurements and color photographs of the existing structures, if required, so the reconstruction duplicates the original ☐ Review safety plan if the removal includes bridge deck or blasting work
During Construction ☐ Ensure materials are disposed outside the right-of-way according to the standard specifications and regulations ☐ Check the backfilling of cavities created by removing existing structures using granular material or loose friable soil from the project ☐ Ensure materials are disposed in a manner that does not alter existing drainage patterns
Post Construction ☐ Check backfilling to the level of the surrounding ground ☐ Check the compaction of all cavities ☐ Measure and pay (lump sum)

CRITICAL MATERIAL TESTS
☐ N/A

EXCAVATION AND BACKFILL FOR STRUCTURES

Specification Reference: 204

Pay Item: 204

Inspection Level/Frequency: Continual

Priority: Moderate

Inspector Experience: Junior

Number of Inspectors: 1.0

Description: Excavate for the structures as shown in the contract documents. Unless otherwise specified, backfill the completed structures to the original ground line.

INSPECTION TASKS
Pre-Construction ☐ Confirm the safety plan with the contractor to comply with contract documents and Occupational Safety and Health Administration (OSHA) regulations ☐ Check locations and areas to be excavated or backfilled as per plans ☐ Verify with the testers that the backfill material meets requirements before use ☐ Confirm the source for backfill material has received source acceptance from the Materials division
During Construction ☐ Observe safety procedures during excavation and throughout the installation process ☐ Observe excavation operations as they progress so that alterations or changes can be made without causing delays ☐ Check the maximum allowable backfill placement depth of each layer ☐ Monitor the compaction operations of the backfilling
Post Construction ☐ Inspect excavation depth and verify that the compaction of the excavation floor meets the requirements of the contract documents before the contractor constructs or installs the structures ☐ Measure and pay (CUYD)

CRITICAL MATERIAL TESTS	
☐ Field density of compacted backfilling works (moderate-high)	☐ Moisture content for structure backfilling (moderate-low)

EXCAVATION AND EMBANKMENT FOR HIGHWAYS

Specification Reference: 205

Pay Item: 205

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Junior (Field Tester, Field Inspector)

Number of Inspectors: 2.0

Description: Excavate, haul, place, remove, and dispose of the specified materials. Construct the embankments as specified in the contract. Compact the earthwork according to the requirements for the type of compaction and moisture range specified in the contract.

INSPECTION TASKS
Pre-Construction ☐ Confirm with the contractor and surveyor about the area to be graded ☐ Ensure proper environmental controls are in place, borrow and waste sites are cleared for environmental impact, and Form 219 for storm water pollution is used ☐ Before placement of borrow pits, ensure material has been tested and approved ☐ Ensure area to be excavated as per plans; limit disturbed areas to minimize erosion and siltation ☐ Check construction manual for testing frequency and type of compaction
During Construction ☐ Verify proper elevations, depth of excavations, and conformance to the typical sections shown in the project plans ☐ Verify removal and disposal of any unsuitable materials, if encountered ☐ Ensure that existing open ditches are properly connected to new construction and are able to pass runoff when an open ditch exists ☐ Monitor construction of the embankment foundation to verify proper compaction of the original ground and drainage seepage ☐ Monitor the thickness of the compacted layer to verify that the contractor does not exceed thicknesses allowed by the specifications ☐ Verify that the material delivered to the job site conforms to the requirements and is placed according to specifications when geotextiles are specified to address unsuitable soil conditions ☐ Ensure slopes intercept ditch line or shoulder line at correct locations ☐ Check placement and compaction of granular drainage blanket
Post Construction ☐ Perform and document checks of line and grade, slope ratio, and slope texture ☐ Measure and pay (CUYD for excavation and embankment work)

EXCAVATION AND EMBANKMENT FOR HIGHWAYS (Cont.)

CRITICAL MATERIAL TESTS	
☐ Field density for compacted earth works (moderate-high) ☐ Field density of MSE fill (moderate-high)	☐ Moisture content of earthwork (moderate-low) ☐ Field density of foundation of MSE walls (moderate-low)

GEOFOAM LIGHTWEIGHT EMBANKMENT FILL

Specification Reference: 211, 1732

Pay Item: 205

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Junior

Number of Inspectors: 1.0

Description: Provide and install the geofoam lightweight expanded polystyrene (EPS) fill at the embankment locations shown in the contract documents.

INSPECTION TASKS
Pre-Construction ☐ Confirm with the contractor the fill embankment locations shown in the contract documents ☐ Check approval of materials that comply with the applicable testing requirements ☐ Check fabrication of the expanded polystyrene in standard sizes that are typically 4-ft wide by 2.5-ft thick by 8–16-ft long blocks
During Construction ☐ Verify construction of the geofoam-fill in successive layers of blocks with the block's long axis alternating by 90° and offsetting blocks by half their widths to prevent the continuation of joints within the polystyrene mass ☐ Monitor the connection of the polystyrene blocks with gripper plates and place gripper plates between horizontal layers of geofoam as required ☐ Check that geofoam lightweight EPS is not exposed to direct sunlight and that it is covered with a light-colored opaque tarp
Post Construction ☐ Final check of line and grade and depth ☐ Measure and pay (CUYD) ☐ Payment for Geofoam-Fill at the contract unit price is full compensation for the specified work

CRITICAL MATERIAL TESTS	
☐ Test in accordance with ASTM D 6817 (KDOT Specification 1732.3) ☐ Receipt and approval of a Type B certification as specified in DIVISION 2600	☐ Perform random sampling and testing for compressive strength and density in accordance with KDOT specifications TABLE 1732-2

MECHANICALLY STABILIZED EARTH FILL

Specification Reference: 214, 853

Pay Item: 200, 204, 205

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Intermediate (Field Tester, Field Inspector)

Number of Inspectors: 2.0

Description: Install a complete MSE system as specified in the contract, including excavation, grading, and compaction of the MSE fill foundation, dewatering as required for execution of the work, erection of welded-wire facing elements, placement of soil reinforcing, and placement and compaction of select backfill material within the reinforced soil volume.

INSPECTION TASKS

Pre-Construction

☐ Confirm the safety plan with the contractor to comply with contract documents and Occupational Safety and Health Administration (OSHA) regulations

☐ Check excavating, grading for a width equal to or exceeding the length of the geogrid plus 6 inches, compaction of the MSE fill foundation, and general and local dewatering as required for proper execution

☐ Verify with the testers that the backfill material and aggregate meet the requirements before use

☐ Confirm the source for backfill material has received source acceptance from the Materials division

☐ Verify that the complete MSE fill system (engineering design, geogrid, welded-wire facing, and all necessary accessories) is from an approved manufacturer and in accordance with the contract documents

☐ Obtain approval of the shop drawings, calculations, and construction manuals by the engineer before construction begins

During Construction

☐ Check the plumbness and tolerances of each facing row prior to erection of the next facing row

☐ Verify vertical and horizontal alignment of the MSE fill face as shown in the plans and specifications

☐ Verify the overall vertical tolerance (plumbness) of the MSE fill

☐ Check placement of connectors from the dimensions shown on the contract documents or approved shop drawings

☐ At each reinforcing level, roughly level backfill before placing and/or attaching the reinforcement

☐ Check placement of reinforcement as shown in the contract documents

☐ Verify drawings of the reinforcing against the connections at the connectors and stake the end of the geogrid sheet at the retained soil limit before backfilling

☐ Check compaction of the entire retained earth volume to 95% of maximum laboratory dry density and at a moisture requirement

☐ Confirm that sampling and testing have been performed in accordance with contract requirements

☐ Maintain the maximum allowable backfill placement depth of each layer

Post Construction

☐ Verify that the last level of backfill is shaped to permit runoff of rainwater away from the wall face
☐ Check construction of traffic barriers, copings, or attachment of other appurtenances to the wall
☐ Measure and pay (CUYD)
☐ Payment for MSE fill at the contract unit price is full compensation for the specified work

CRITICAL MATERIAL TESTS	
☐ Field density of compacted backfilling works (moderate-high) ☐ Moisture content for the backfilling (moderate-low)	☐ The designated soil reinforcing geogrid will be accepted on the basis of a Type A Certification

GRANULAR DRAINAGE BLANKET

Specification Reference: 215, 1114

Pay Item: 200

Inspection Level/Frequency: Continual

Priority: Moderate

Inspector Experience: Junior

Number of Inspectors: 1.0

Description: Excavate for and place aggregate to provide a drainage pathway to consolidate embankments and foundation soil as detailed in the contract documents.

INSPECTION TASKS

Pre-Construction

☐ Ensure clearing and grubbing and foundation treatment of the embankment by bringing the embankment to grade at the bottom of the granular drainage blanket
☐ Confirm that the aggregate for the granular drainage blanket has been approved

During Construction

☐ Check placement of the drainage blanket in 24-inch maximum lifts
☐ Verify that the drainage blanket is extended under the embankment footprint behind the abutment to the end slope face and across the width of the embankment, or as shown in the contract documents
☐ Check compaction of the drainage blanket by routing construction equipment across the drainage blanket until no further consolidation is evident

Post Construction

☐ Verify that the nominal thickness of the drainage blanket at each location is specified in the contract documents
☐ Measure and pay (square yard)
☐ Payment for the various thicknesses of the Granular Drainage Blanket at the contract unit price is full compensation for the specified work

CRITICAL MATERIAL TESTS

☐ Confirm with the material tester that the aggregate for the granular drainage blanket complies with SECTION 1114

PREFABRICATED VERTICAL DRAIN

Specification Reference: 213, 1700

Pay Item: 200

Inspection Level/Frequency: Continual

Priority: Moderate

Inspector Experience: Intermediate

Number of Inspectors: 1.0

Description: Excavate for and place geosynthetics to provide a drainage pathway to consolidate embankments and foundation soils as shown in the contract documents.

INSPECTION TASKS
Pre-Construction ☐ Verify approval of prefabricated vertical drain that complies with DIVISION 1700 ☐ Verify that KDOT's Bureau of Structures and Geotechnical Services, Geotechnical Unit will approve the contractor's qualifications ☐ Before installing drains, confirm satisfactory installation of three test prefabricated vertical drains to the maximum anticipated depth shown in the contract documents at locations designated by the engineer
During Construction ☐ Check that installation and alignment is per plans and specifications, and then survey, number, and stake the drains within 6 inches of the locations indicated in the contract documents ☐ Verify drain installation from the working surface to the depth shown in the contract documents, and confirm that the installed drains do not vary from the vertical by more than 1 inch per 4 ft Splice or connect the drain material for continuity of drain material, leaving a 4–8-inch length of drain material protruding above the natural ground surface at each drain location
Post Construction ☐ Measure and pay (Linear Foot) ☐ Payment for Prefabricated Vertical Drain at the contract unit price is full compensation for the specified work

CRITICAL MATERIAL TESTS
N/A

STABILIZED/MODIFIED SUBGRADE

Specification Reference: 301, 302, 303, 304

Pay Item: 301, 302, 303, 304

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Intermediate

Number of Inspectors: 2.0

Description: Modify the subgrade using the materials and methods shown in the contract documents. When the contract documents specify, realign the shoulders and clean and reshape the ditches. Mix subgrade soil and treatment materials to construct a uniformly treated subgrade as shown in the contract.

INSPECTION TASKS

Pre-Construction

☐ Verify that the subgrade will not be on a frozen roadbed

☐ Check for scarifying or trim the existing roadbed to the depth and width shown in the contract documents

☐ Verify the existence of proper drainage if required by contract

During Construction

If subgrade modification is required:

☐ Monitor the mixing process, check depth per the contract documents and verify use of the materials and methods shown in the contract documents

☐ Before incorporating the additive in the subgrade, blade the roadway to allow uniform distribution of the additive

☐ Monitor subgrade, additive, and water mixing until a homogeneous, friable mixture is obtained

If application of lime is required:

☐ Apply the lime treatment to the specified depth for in-place areas as designated in the contract documents

☐ Test the concentration of lime suspension at a minimum rate of 1 per day or 1 per mixed batch

☐ Check the lime application, such as pH testing

☐ Measure the moisture content (KT-11) immediately after mixing is completed and before sealing or compacting

If cement or fly ash treatment is required:

☐ Scarify with positive depth control equipment

☐ Verify the scarified subgrade within the specified moisture content (KT-11) before adding cement or fly ash

☐ Check the application rate of cement or fly ash on a flat area in the path of the cement or fly ash application

☐ Monitor the mixing of the scarified subgrade and cement or fly ash and continue mixing and adding water until a homogeneous, friable mixture is achieved that complies with contract specifications

If crushed stone subgrade is required:

☐ Obtain a sample of the crushed stone for backfill from materials stockpiled at the project site and submit to MRC where the relative density will be determined using KT-69

☐ Mix the crushed stone with a sufficient quantity of water to provide satisfactory compaction

☐ If the thickness is greater than 6 inches, spread and compact the crushed stone subgrade in multiple lifts and verify the relative density using a nuclear gauge (KT-41)

Post Construction

☐ Verify compaction to a minimum of 95% of the combined materials dry density using a vibratory roller as specified in the contract documents

☐ After compacting the modified subgrade, trim the surface to the specified lines and grades

☐ Verify the curing process to protect the finished subgrade from drying for 7 days after completion or until the subgrade is covered with the base or surfacing if covered before 7 days

☐ Measure and pay (various)

CRITICAL MATERIAL TESTS	
☐ Sieve analysis of aggregate for subgrade KT-02 (moderate-low)	☐ Sieve analysis for acceptance subgrade KT-42 (moderate-low)
☐ Material passing the no. 200 (75 µm) sieve by the wash method for subgrade aggregate KT-03 (moderate-low)	☐ Percent solids of lime slurry in lime-treated subgrade KT-62 (moderate-low)
☐ Plasticity of aggregate of subgrade KT-10 (moderate-low)	☐ Field density of subgrade KT-13 (moderate-low)
☐ Moisture content for lime-treated subgrade KT-11 (moderate-low)	☐ Sample of subgrade KT-29 (low)
	☐ Relative density of crushed stone subgrade KT-69 (moderate-low)

SUBBASE AND BASE COURSE

Specification Reference: 305, 306, 307, 308

Pay Item: 305, 306, 307

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Intermediate (Field Inspector and Tester)

Number of Inspectors: 2.0

Description: Construct a base on a prepared subgrade as shown in the contract documents. Mix base and any required treatment materials as shown in the contract documents.

INSPECTION TASKS
Pre-Construction ☐ Ensure subgrade and typical section are within specified tolerances and that uniform density has been attained ☐ Ensure that compacting and finishing operations are completed within the specified time ☐ Ensure that the moisture content of the surface material is maintained at not less than specified optimum during all finishing operations ☐ If a cement-treated base (CTB) is used, check approval and documentation of mix design and test results
During Construction ☐ Check and document grade and depth of each layer before placing subsequent layers ☐ Ensure that the maximum compacted thickness of any layer of aggregate base or shoulder is 6 inches ☐ Select and obtain sampled CTB material at the plant and cure compression test specimens to represent each sublot ☐ Check the application rate of cement or fly ash to CTB ☐ Perform and record density tests, check that the surface is smooth and free of compaction planes, cracks, ridges, or loose material ☐ Notify Materials division of ensuing placement ☐ After compacting the aggregate base, trim the surface to the specified lines and grades
Post Construction ☐ Ensure that curing operations are in accordance with specifications to achieve required strength and durability ☐ Measure and pay - use a percent within limit (PWL) for CTB

SUBBASE AND BASE COURSE (Cont.)

CRITICAL MATERIAL TESTS	
☐ KT-02: Sieve analysis for aggregate of base course (moderate-low) ☐ KT-02: Sieve analysis for aggregate of binder material of base course (low) ☐ KT-10: Plasticity for aggregate of binder material of base course (low) ☐ KT-02: Sieve analysis for combined aggregate of base course (moderate-low) ☐ KT-10: Plasticity of combined aggregate of base course (moderate-low) ☐ KT-11: Moisture test for combined aggregate of base course (moderate-low) ☐ KT-13: Field density of completed aggregate base course (moderate-low) ☐ KT-02: Sieve analysis for aggregate of cement-treated base (CTB) (moderate-low) ☐ KT-11 or KT-41: Moisture of cement-treated base (CTB) (moderate-low) ☐ KT 37 or KT 20: Density of cement-treated base (CTB) (moderate-low) ☐ KT 37 or KT 20: Compressive strength of cement-treated base (CTB) (moderate-high)	☐ KT-13 or KT-41: Field density of completed cement-treated base (CTB) (moderate-low) ☐ KT-11: Moisture of completed granular base (moderate-low) ☐ KT-11 or KT-41: Moisture of completed cement-treated base (CTB) (moderate-low) ☐ KT-02: Sieve analysis for aggregate of granular base (moderate-low) ☐ KT-10: Plasticity of aggregate of granular base (moderate-low) ☐ KT-02: Sieve analysis for aggregate of binder material of granular base (low) ☐ KT-10: Plasticity of binder material of granular base (moderate-low) ☐ KT-02: Sieve analysis for pulverized aggregate of granular base (moderate-low) ☐ KT-02: Sieve analysis for combined aggregate of granular base (moderate-low) ☐ KT-10: Plasticity of combined aggregate of granular base (moderate-low) ☐ KT-11: Moisture of combined aggregate of granular base (moderate-low) ☐ KT-13 or KT-41: Field density of completed granular base (moderate-low)

PORTLAND CEMENT CONCRETE PAVEMENT

Specification Reference: 501-502-503-504-505

Pay Item: 501 – 502 – 503

Inspection Level/Frequency: Continual

Priority: High

Inspector Experience: Senior (plant inspector, field testers, placement inspector, curing inspector, sawed joint cutting and sealing inspector)

Number of Inspectors: 3-5

Description: Construct Portland cement concrete pavement (PCCP) on a prepared subgrade or base course. Develop and perform quality control testing.

INSPECTION TASKS
Pre-Construction ☐ Ensure that the contractor will follow a safe traffic control operation ☐ Review the contract documents, focusing on concrete mix design and mixing requirements ☐ Check weather conditions that could influence PCCP quality ☐ Review placement, spreading and consolidating, joints, dowel bars, and tie bar requirements ☐ Ensure that the plant inspector monitors batch weights, water, and admixture amounts ☐ Ensure that the Materials division reviews the mix design for approval ☐ Approve the base course and related tests; ensure that the grades and surface tolerance requirements are in accordance with the contract documents ☐ Confirm stakeout requirements with the survey crew ☐ Ensure that the plant inspector reviews aggregate gradation test results ☐ Verify that field testers obtain samples of the mixed concrete from the hauling vehicle
During Construction ☐ Moisten surfaces that will contact the mix ☐ Check alignment and grade control ☐ Place dowel bars and tie bars when required ☐ Check vibrator frequencies as per standard specification 154.2e requirements ☐ Finish and texture the surface ☐ Take samples of concrete and cast strength specimens at the rate specified
Post Construction ☐ Cure after the final finishing according to contract specifications ☐ Observe the contractor's joint marking and sawing operation in accordance with the contract documents ☐ Protect the surface, if required, using proper signage or fencing ☐ Check pavement smoothness and strength before public traffic is allowed ☐ Implement profile measurement testing of the PCCP surface using profiler ☐ Measure and pay

CRITICAL MATERIAL TESTS	
☐ KT-20: Concrete mass per cubic foot (moderate-high) ☐ KT-02: Sieve analysis individual aggregates (moderate-low) ☐ KT-17: PCCP temperature (moderate-low) ☐ KT-21: PCCP slump (moderate-low) ☐ KT-20: Air content (moderate-high)	☐ KT-24: Moisture in PCCP aggregate (moderate-low) ☐ KT-49: Cored PCCP thickness (moderate-low) ☐ KT-38: Density of fresh PCCP (moderate-low) ☐ KT-73: PCCP permeability (moderate-low) ☐ KT-05: Unit weight of individual aggregate (moderate-low)

PATCHING CONCRETE PAVEMENT

Specification Reference: 833, 1716

Pay Item: 833

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Intermediate (Field Inspector and Tester)

Number of Inspectors: 2.0

Description: Patch the existing PCCP pavement as shown in the contract documents or at locations directed by the engineer. Patches will be full depth or partial. The purpose of patching is to repair surface spalls at joint and cracks or repair joints and slabs that are cracked or shattered.

INSPECTION TASKS
Pre-Construction ☐ Ensure all failed pavement has been defined and locate and mark all areas of repair ☐ Ensure the contractor has a safe traffic control operation that will be followed, especially the operation of trucks through the work zone ☐ Check and document that the grade, density, surface of underlying material, and the subgrade are structurally sound, all delaminated concrete is removed, and approve and document the contractor's equipment
During Construction ☐ Check and document size, location, and grade of reinforcing steel and dowel assemblies ☐ Check and document type of mix, truck delivery operation, and placing, consolidation, texturing, curing, and protecting operations ☐ Check that the saw cutting operations are not spalling or tearing the concrete
Post Construction ☐ Saw cut as soon as the concrete has hardened sufficiently to prevent spalling or tearing ☐ Verify that curing operations are in accordance with specifications to achieve required strength and durability ☐ Perform joint sealing prior to opening to traffic and after the curing period as is practical ☐ Measure and pay

CRITICAL MATERIAL TESTS
☐ Sample concrete and cast strength specimen beams at the rate specified ☐ KT-21: PCCP slump (moderate-low) ☐ KT-17: PCCP temperature (moderate-low) ☐ KT-18: Air content (moderate-high)

HMA PRIME AND TACK COATS

Specification Reference: 607, 1200

Pay Item: 607

Inspection Level/Frequency: Continual

Priority: Moderate

Inspector Experience: Intermediate

Number of Inspectors: 2.0

Description: Treat a previously prepared surface with asphalt material and apply coat material when required, as specified in the contract documents.

INSPECTION TASKS
Pre-Construction ☐ Blade the surface of the roadbed to a smooth, uniform cross-section, booming off all loose materials to ensure the surface is free from dust to receive the prime coat ☐ Check that the roadbed is sufficiently dry before applying prime coat ☐ Verify that the grade and type of emulsified asphalt is in accordance with the contract documents and refinery material certification received for the delivery ☐ Verify that the distributor truck is in accordance with KDOT equipment specifications
During Construction ☐ Ensure that the temperature of the asphalt material matches the specifications and the producer's bill of lading ☐ Use a distributer to uniformly apply the asphalt material at the rate shown in the contract documents ☐ Inspect a sample from each load of emulsified asphalt
Post Construction ☐ For prime coat, verify if application of blotting material on specific areas is required to prevent damage from traffic (after 48 hours) ☐ Apply a light application of tack coat the next day if the tacked surface is not covered with an HMA surface ☐ Measure and pay

CRITICAL MATERIAL TESTS	
☐ Determine the amount of emulsified asphalt applied to the roadway by the weighting method	

ASPHALT PAVEMENT & ASPHALT SURFACE

Specification Reference: 601 to 615

Pay Item: 602 to 614 & 07-06002 & 07-06004 & 0706010

Inspection Level/Frequency: Continual

Priority: High

Inspector Experience: Intermediate (Plant Inspector, Field Tester, Placement Inspector)

Number of Inspectors: 3

Description: Mix and place one or more courses of plant-produced HMA mixture on a prepared surface as shown in the contract documents.

INSPECTION TASKS

Pre-Construction

☐ Ensure that the contractor has an effective and safe traffic control operation through the work zone
☐ Verify that the engineer's testers obtain and test aggregate samples from stockpiles
☐ Confirm that the job mix formula has been approved be the engineer
☐ Check and document grade, density, and surface of underlying material
☐ Review all surfaces, especially milled areas, for cleanliness prior to placement
☐ Apply liquid or emulsified asphalt before HMA placement
☐ Discuss equipment and labor for spreading and compacting HMA material, width and depth, and longitudinal and transverse joints placement with contractor during the pre-pave conference
☐ After the equipment is on-site, verify that the equipment is in accordance with specifications and that the grade-sensing device of the paver is in good working order
☐ The contractor furnishes a profiling system and a pavement core-drilling machine for coring samples of compacted HMA

During Construction

☐ The plant inspector monitors and records a variety of operations that affect the quality of the HMA such as bitumen ratio, aggregate moisture tests, and aggregate and asphalt feed rates
☐ The plant inspector confirms that the load weight of haul trucks and the truck beds are clean
☐ Verify the availability of an appropriate number, types, and weight of rollers prior to HMA placemen
☐ Record the amount of material incorporated into the work by haul tickets
☐ Record information at the paver, such as temperatures, stationing and thickness of pavement, and weather conditions
☐ Observe the surface of the unconsolidated layer produced by the paver for irregularities and cross slope uniformity
☐ Frequently check the depth the paver produced and the uncompacted layer
☐ Conduct density and air void tests with the tester after compaction by rollers
☐ For the coring samples, verify that the drill is able to drill the required cores without distorting or tearing the pavement and is of the correct size

Post Construction

☐ Check the pavement smoothness after final rolling, both longitudinally and transversely
☐ Check for proper depth and construction joint operations
☐ Measure and pay

CRITICAL MATERIAL TESTS	
☐ KT-05: Sieve analysis of individual aggregate (low) ☐ KT-26: Sampling and storage for testing (low) ☐ KT-31: Percentage of crushed particles in crushed gravel (low) ☐ KT-50: Uncompacted void content of fine aggregate (low) ☐ KT-02: Sieve analysis for the aggregate of mineral filler supplement (low) ☐ KT-10: Plasticity of mineral filler supplement (low) ☐ KT-02: Sieve analysis of combined aggregate (low) ☐ KT-31: Coarse aggregate angularity for combined aggregate (low) ☐ KT-55: Sand equivalent of combined aggregate (low) ☐ KT-11: Moisture content of combined aggregate (low) ☐ KT-14: Density of mixtures (field lab) (moderate-high) ☐ KT-14: Voids of mixtures (field lab) (low) ☐ KT-11: Moisture content of mixtures (field lab) (low) ☐ KT-26: Asphalt binder sampling for testing at plant (low) ☐ KT-14: Density of mixtures (district lab) (low) ☐ KT-34: Gradation of mixtures (district lab) (low) ☐ KT-57: Asphalt content of HMA mixtures (district lab) (low)	☐ KT-39: Maximum specific gravity of uncompacted plant mix asphalt (field lab) (low) ☐ KT-11: Moisture content of uncompacted plant mix asphalt (field lab) (low) ☐ KT-15 and KT-58: Air voids of plant mix asphalt (district lab) (low) ☐ KT-39: Maximum specific gravity of uncompacted plant mix asphalt (district lab) (low) ☐ KT-34: Gradation of plant mix asphalt (district lab) (low) ☐ KT-57: Asphalt content of plant mix asphalt (district lab) (low) ☐ KT-15: Field density (cores or nuclear) of completed HMA road work (low) ☐ KT-15 and KT-6: Voids in mineral aggregate (VMA) (low) ☐ SPECS 602: Mix gradation (low) ☐ KT-57: Binder content (low) ☐ KT-39: Theoretical maximum specific gravity of asphalt paving mixtures-HMA (field lab) (low) ☐ KT-15, KT-39, and KT-58: Voids filled with asphalt (VFA) (low) ☐ KT-15 & KT-6: Voids in mineral aggregate (VMA) (low) ☐ SPECS 602: Dust to effective binder content (d/b) ratio (low)

SURFACE TREATMENT BY CHIP SEAL

Specification Reference: 608, 1206

Pay Item: 608

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Intermediate

Number of Inspectors: 3

Description: Apply asphalt material to the existing surface, followed by an application of cover material, as specified in the contract documents.

INSPECTION TASKS
Pre-Construction ☐ Clean all foreign material from the surface to be treated and broom the surface to remove dust before applying the asphalt material ☐ Check that the roadway surface is repaired and cleaned: potholes are filled, ruts are leveled, cracks are sealed, and broken edges are repaired before chip sealing a paved surface ☐ Verify that the temperature is as shown on the producer's bill of lading before applying the asphalt material
During Construction ☐ Verify that the distributor applies the asphalt material at the rate shown in the contract documents ☐ Verify that the self-propelled aggregate spreader spreads the cover material in quantities designated in the contract documents immediately following application of the asphalt material ☐ The field inspector or tester observes the contractor taking samples of the emulsified asphalt from each load delivered ☐ Conduct embedding using a roller immediately following the application of cover material
Post Construction ☐ Verify that the asphalt material is cured according to the contract documents before opening the roadway ☐ Broom loose cover material from the surface of the traveled way as soon as the asphalt material has cured enough ☐ Measure and pay

CRITICAL MATERIAL TESTS
☐ Test the emulsified asphalt viscosity before it is applied to the roadway

FALSEWORK AND FORM CONSTRUCTION

Specification Reference: 708

Pay Item: 708

Inspection Level/Frequency: Intermittent

Priority: Moderate

Inspector Experience: Intermediate

Number of Inspectors: 2.0

Description: Design and construct a safe, adequate temporary structure to provide the necessary rigidity, support the loads imposed, and produce the final structure to the lines and grades shown in the contract documents.

INSPECTION TASKS

Pre-Construction

☐ Verify the contractor's submission of three copies of detailed falsework plans designed and sealed by a professional engineer

☐ Check approval of falsework design according to the KDOT bridge design manual, falsework design, and analysis

During Construction

☐ Verify that falsework piling is driven to a satisfactory depth and bearing value to support all falsework that is not founded on rock, shale, or thick deposits

☐ Verify the number and spacing of falsework piling, the adequacy of sills, caps and stringers, and the amount of bracing in the falsework framing

☐ Check that construction of the falsework provides only sufficient camber to prevent final settlement below the finish grades, as shown in the contract documents

☐ Check the condition of the materials used for piling, cross bracing, beams, plywood decking, shims, and jacks

☐ Check the condition and compliance of all splices to the submitted falsework plan

Post Construction

☐ Upon completion, remove all forms and falsework

☐ Pull or cut off falsework piling 12 inches below low water level or the natural ground

☐ Measure and pay

CRITICAL MATERIAL TESTS

N/A

CAST-IN-PLACE BOX CULVERT

Specification Reference: 203, 1900

Pay Item: 203

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Intermediate (Field Tester, Placement Inspector) **Number of Inspectors: 2.0**

Description: Cast-in-place culvert elements include foundation, location and staking, walls and slab with steel reinforcement.

INSPECTION TASKS
Pre-Construction
☐ Check foundation, bedding material, and grades for conformance with specifications and proper sampling
☐ The Materials division reviews the mix design for approval
☐ Confirm stakeout requirements with the survey crew
☐ Check and document line, grade, elevation, dimensions, condition of forms, bracing, and ties
☐ Check the placement of reinforcement and tie bars according to contract plans and specifications
During Construction
☐ Identify weather conditions that could influence the quality of concrete casting
☐ Verify that the delivery time of each concrete load meets the specifications
☐ Verify that the field tester casts strength specimens and performs required field tests of the slump, temperature, and air content
☐ Oversee the spreading and consolidating of concrete
Post Construction
☐ Ensure that the proper curing method is applied in accordance with the contract
☐ Ensure uniform backfill compaction
☐ Measure and pay

CRITICAL MATERIAL TESTS	
☐ KT-21: Slump of concrete	☐ KT-24: Moisture in aggregate
☐ KT-29: Portland cement approval for concrete	☐ KT-36: Density of fresh concrete
☐ KT-17: Concrete temperature measurement	☐ KT-73: Permeability of concrete
☐ KT-20: Concrete mass per cubic foot	☐ KT-22 and KT-76: Concrete strength (cylinders)
☐ KT-18: Concrete air content	

CONCRETE BRIDGE SUBSTRUCTURE

Specification Reference: 858, Bridge Construction Manual

Pay Item: 000

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Senior

Number of Inspectors: 2

Description: Cast-in-place substructure elements include foundation, location and staking, temporary formwork and abutment with steel reinforcement.

INSPECTION TASKS
Pre-Construction ☐ Ensure the contractor obtains all necessary permits ☐ The plant inspector monitors batching and admixture amounts ☐ The Materials division reviews the mix design for approval ☐ Confirm stakeout requirements, levels, and dimensions of the bridge foundation, abutment, pier, and column with the survey crew ☐ Check foundation bedding material and grades for conformance with specifications ☐ Check and document line, grade, elevation, dimensions, condition of forms, bracing, and ties ☐ The plant inspector reviews aggregate gradation test results ☐ Check the placement of reinforcement and tie bars according to contract requirements
During Construction ☐ Identify weather conditions that could influence the quality of concrete casting ☐ For underwater concrete placement, ensure that the operation follows specification requirements ☐ Verify that the delivery time of each concrete load meets the specifications ☐ Verify that the field tester casts strength specimens and performs required field tests of the slump, temperature, and air content ☐ The specialty inspector checks any required drain, sleeve, mechanical, electrical, or other installations ☐ Oversee the spreading and consolidating of concrete
Post Construction ☐ Ensure that the proper curing duration and the method applied are in accordance with the contract ☐ Verify that required concrete strength has been obtained based on test results ☐ Contact the KDOT bridge engineer for final inspection if required ☐ Measure and pay

CONCRETE BRIDGE SUBSTRUCTURE (Cont.)

CRITICAL MATERIAL TESTS	
☐ KT-21: Slump of concrete (moderate-low) ☐ KT-29: Portland cement approval for concrete (moderate-low) ☐ KT-17: Concrete temperature measurement (moderate-low) ☐ KT-20: Concrete mass per cubic foot (moderate-low) ☐ KT-18: Concrete air content (moderate-low)	☐ KT-24: Moisture in aggregate (moderate-low) ☐ KT-36: Density of fresh concrete (moderate-low) ☐ KT-73: Permeability of concrete (moderate-high) ☐ KT-22 and KT-76: Concrete strength (cylinders) (moderate-low)

CONCRETE BRIDGE DECK

Specification Reference: 731, 732, 733, Bridge Construction Manual

Pay Item: 732

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Senior

Number of Inspectors: 2.0

Description: Cast-in-place superstructure elements include bridge deck, location and leveling, temporary formwork, supporting girders, with steel reinforcement.

INSPECTION TASKS

Pre-Construction

☐ Ensure that the contractor obtains all necessary permits
☐ The plant inspector monitors batching and admixture amounts
☐ The Materials division reviews the mix design for approval
☐ If existing girders are to remain in place, verify that no damage is occurring to the girders
☐ Confirm stakeout requirements, levels, and dimensions of the bridge deck with the survey crew
☐ Check and document line, grade, elevation, dimensions, condition of forms, bracing, and ties
☐ The plant inspector reviews aggregate gradation test results
☐ Check the placement of reinforcement and tie bars according to contract requirements

During Construction

☐ Identify weather conditions that could influence the quality of concrete casting
☐ Verify that the delivery time of each concrete load meets the specifications
☐ Verify that the field tester casts strength specimens and performs required field tests of the slump, temperature, and air content
☐ Verify that the specialty inspector checks any required drain, sleeve, mechanical, electrical, or other installations
☐ Oversee the spreading and consolidating of concrete
☐ Ensure that the concrete deck thickness is per contract requirements
☐ Finish and texture the surface per specifications

Post Construction

☐ Ensure the proper curing method is applied in accordance with the contract
☐ Verify that required concrete strength has been obtained based on test results
☐ Contact the KDOT bridge engineer for final inspection if required
☐ Measure and pay

CONCRETE BRIDGE DECK (Cont.)

CRITICAL MATERIAL TESTS	
☐ KT-21: Slump of concrete (moderate-low)	☐ KT-24: Moisture in aggregate (moderate-low)
☐ KT-29: Portland cement approval for concrete (moderate-low)	☐ KT-36: Density of fresh concrete (moderate-low)
☐ KT-17: Concrete temperature measurement (moderate-low)	☐ KT-73: Permeability of concrete (moderate-high)
☐ KT-20: Concrete mass per cubic foot (moderate-low)	☐ KT-22 and KT-76: Concrete strength (cylinders) (moderate-low)
☐ KT-18: Concrete air content (moderate-low)	

BRIDGE PAINTING

Specification Reference: 705, 714

Pay Item: 714

Inspection Level/Frequency: Continual

Priority: Moderate

Inspector Experience: Intermediate

Number of Inspectors: 1.0

Description: Clean and prepare all surfaces to be painted and protect the structure against damage that could occur. Paint all required surfaces and other exposed metal surfaces, including handrails, guardrails, cables, wire fences, light fixtures, metal flooring, and other metal appurtenances.

INSPECTION TASKS
Pre-Construction
☐ Check and document materials requirements, sandblasting, collection of waste materials, and paint
☐ Ensure that the paint removal and waste handling meet contract requirements
☐ Ensure the proper cleaning and painting of haunches, expansion devices, bearings, floor drains, and railings
☐ Verify the removal of rust, mill scale, dirt, oil, grease, and other foreign substances
During Construction
☐ Notify the Bureau of Structures of any steel or structural defects
☐ Verify and record field conditions of temperature, humidity, and wind
☐ Ensure that paint thickness meets contract requirements
Post Construction
☐ Paint all required areas
☐ Measure and pay

CRITICAL MATERIAL TESTS
☐ Verify that paint materials are in accordance with contract specifications

PRECAST AND PIPE CULVERTS, EROSION PIPE, STORM AND SANITARY SEWERS

Specification Reference: 736, 817, 1900

Pay Item: 817

Inspection Level/Frequency: Continual

Priority: Moderate

Inspector Experience: Junior

Number of Inspectors: 2.0

Description: Install the size and type of pipe culvert, erosion pipe, storm sewer, sanitary sewer, end section and concrete headwall specified in the contract documents.

INSPECTION TASKS
Pre-Construction ☐ Check foundation, bedding material, and grades for conformance with specifications before placing a precast element ☐ Approve all materials and working drawings, including the supplier's manufacturing specifications, as well as details of all phases of construction, including layout, joint details, lifting devices ☐ Confirm any stakeout requirements with the survey crew
During Construction ☐ Inspect the precast elements for any delivery or loading defects and cracks ☐ Seal all joints with approved materials ☐ Check dimensions and grades of the precast element
Post Construction ☐ Verify that the backfill materials conform to KDOT specifications and contract documents ☐ Ensure uniform backfill compaction if required ☐ Measure and pay

CRITICAL MATERIAL TESTS	
☐ KT-36: Field density of compacted backfilling works (moderate-high)	☐ KT-24: Moisture content for structure backfilling (moderate-low)

RETAINING WALL SYSTEM

Specification Reference: 853, 854

Pay Item: 07-08005

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Intermediate

Number of Inspectors: 2.0

Description: Construct a standard gravity, cast-in-place reinforced concrete (CIP), or gabion retaining wall as specified in the contract. The contractor is responsible for excavating the retaining walls and crib walls as shown on the plans.

INSPECTION TASKS
Pre-Construction ☐ Verify that shop drawings of MSEW or MBW segments have been submitted and approved ☐ Confirm that foundation, bedding material, and grades conform to specifications and contract documents ☐ Confirm stakeout requirements with the survey crew ☐ Review checklist #8: MECHANICALLY STABILIZED EARTH FILL
During Construction ☐ Inspect wall segments for any defect or cracking before placement ☐ Ensure wall segments, location, and alignment are as per contract documents ☐ Ensure that wall segments are connected properly
Post Construction ☐ Ensure uniform backfill compaction ☐ Measure and pay

CRITICAL MATERIAL TESTS
☐ Verify approval of the wall system materials and elements by the Materials division

TRAFFIC CONTROL

Specification Reference: 104, 805

Pay Item: 805

Inspection Level/Frequency: Intermittent

Priority: Moderate to high

Inspector Experience: Junior

Number of Inspectors: 1.0

Description: Monitor and manage work zone impacts on traffic during construction.

INSPECTION TASKS

Pre-Construction

☐ Ensure that a copy of the Traffic Control Plan is available in the field office

☐ Check that the contractor provided temporary surfacing when required

☐ Ensure that the quality and quantity of traffic control devices are accepted by the engineer and meet the most recent edition of the *Manual on Uniform Traffic Control Devices* (MUTCD) adopted by the ATSSA standards

☐ Verify that all traffic control devices have been tested and found acceptable using test methods compliant with MASH testing requirements

☐ Ensure that the contractor has staked each sign location and that the sign locations meet field conditions

During Construction

☐ Verify the erection of signs/traffic control devices as shown in the contract documents or traffic control plan

☐ Confirm with the engineer regarding the establishment of work zone speed limits

☐ Confirm that the contractor provided flaggers and equipped the flaggers

☐ Verify that the retroreflective sheeting on drums, barricades, and other devices are clean and that the contractor repairs scratches, rips, and tears in the sheeting

Post Construction

☐ Obtain the engineer's approval if project sections are open to traffic before the contractor has completed all work or before the contract time expires

☐ Ensure that the contractor removes devices from the project when they are no longer needed

☐ Document traffic control item quantities, measure, and pay (various)

CRITICAL MATERIAL TESTS

☐ Verify that materials shown in the contract documents comply with the following specifications:

DIVISION 2200: Retroreflective Sheeting

DIVISION 1700: Portable Changeable Message Signs

DIVISION 1700: Temporary Pavement Marking/Line Masking Tape

DIVISION 2200: Work Zone Warning Lights

DIVISION 2200: Traffic Line Paint

DIVISION 2200: Raised Pavement Markers

CONSTRUCTION STAKING

Specification Reference: 105.14, 802

Pay Item: 802

Inspection Level/Frequency: Intermittent

Priority: Low to moderate

Inspector Experience: Intermediate

Number of Inspectors: 2.0

Description: Carry out staking processes during the project for various construction operations.

INSPECTION TASKS
Pre-Construction ☐ Confirm that the contractor provided a land surveyor, trained and experienced in the construction staking and licensed by the Kansas State Board of Technical Professions ☐ Verify that the contractor provided surveying equipment that complies with KDOT standard specification 802.3 ☐ By visual inspection, ensure that the condition of the steel post, gage, bolt, steel bar, and monument box materials for the specified surveying services comply with specified requirements ☐ Verify the accuracy of existing benchmarks (bench loop) and their location ☐ Furnish data for the horizontal and vertical control points ☐ Verify protection of known property and survey markers and land monuments ☐ Ensure that the contractor provided the engineer with a written report of any errors or apparent discrepancies found in previous surveys or the contract documents
During Construction ☐ Randomly verify survey computations ☐ On a daily basis, randomly verify the accuracy of contractor's staking during the day ☐ Perform final checks, measurements, and surveys
Post Construction ☐ Set/reset all right-of-way survey monuments ☐ Measure and pay (lump sum)

CRITICAL MATERIAL TESTS
N/A

INCIDENTAL CONCRETE STRUCTURES

(Catch Basins, Inlets, Outlets, Manholes, Junction Boxes, Paved Ditch, Sidewalks, Steps, Median Barrier, Curb, Curb & Gutter, and Entrances)

Specification Reference: 815, 816, 825

Pay Item: 815, 816, 825

Inspection Level/Frequency: Continual

Priority: Moderate

Inspector Experience: Junior

Number of Inspectors: 2.0

Description: Construct catch basins, inlets, outlets, manholes, junction boxes, paved ditch, sidewalks, steps, median barrier, curb, curb and gutter, and entrances.

INSPECTION TASKS
Pre-Construction
☐ Ensure that the contractor has staked each structure location and that the structure alignment and grade are according to project plans and specifications
☐ Approve and submit shop drawings
☐ Verify that all environmental permit conditions will be met and that erosion and sediment control devices have been installed before excavations
☐ Ensure excavation for footing, bedding material or soil, and grades are in conformance with specifications
☐ Check and document line, grade, elevation, dimensions, condition of forms, bracing, and ties
☐ Verify that the placement of reinforcing steel is in accordance with the plans and specifications
During Construction
☐ Ensure that the concrete is placed according to plans and specifications
☐ Check and document discharging, conveying, spreading, consolidating, screeding, finishing, and texturing of placed concrete
Post Construction
☐ Verify and document that concrete strength has been obtained before commencing backfilling operations
☐ Verify that the curing duration and protecting operations are according to project specifications
☐ Ensure uniform backfill compaction and depth of layers if required
☐ Document quantities, measurement, and payment (various)

CRITICAL MATERIAL TESTS	
☐ KT-21: Slump of concrete	☐ KT-17: Concrete temperature
☐ KT-18: Concrete air content	☐ KT-20: Concrete mass per cubic foot

EROSION CONTROL

Specification Reference: 902, 2100

Pay Item: 901

Inspection Level/Frequency: Intermittent

Priority: Moderate to high

Inspector Experience: Intermediate

Number of Inspectors: 2.0

Description: Prevent erosion on the project and project-related borrow areas by installing and maintaining temporary erosion control measures.

INSPECTION TASKS
Pre-Construction ☐ Ensure that necessary temporary pollution control measures and environmental requirements are in place ☐ Ensure that any hazardous materials have been mitigated in accordance with contract documents ☐ Verify that erosion control devices, sediment barriers, fertilizers, seeds, soil erosion mix, erosion control materials and mulch comply with DIVISION 2100
During Construction ☐ Verify that berms, slope drains, and silt fences are constructed or installed as shown in the contract documents ☐ Install biodegradable logs, filter socks, and synthetic sediment barriers for slope barriers or ditch checks as shown in the Stormwater Pollution Prevention Plan (SWPPP) ☐ Construct temporary sediment basins ☐ Construct a temporary rock ditch as shown in the SWPPP or the contract ☐ Construct temporary inlet sediment barriers using the materials listed in the contract documents or the SWPPP ☐ Verify the soil erosion mix by preparing the seedbed, fertilizer, and seed according to DIVISION 900, and hand rake broadcasted seed before placing the erosion control ☐ Install erosion control according to the manufacturer's requirements for edge and junction overlaps, staple size, and staple pattern ☐ Install geotextile (erosion control) as a temporary measure to protect steep slopes and other areas where timely installation of the permanent (aggregate or concrete) slope protection is impractical ☐ Check erosion control measures prior to a major rainfall event, and document erosion control
Post Construction ☐ Verify that the effectiveness of the temporary erosion and pollution control devices are maintained as long as required to contain sediment runoff ☐ Monitor temporary erosion and pollution control devices daily ☐ Remove the temporary devices (by contractor) according to the SWPPP or when directed by the engineer ☐ Document erosion control item quantities, measure, and pay (various)

EROSION CONTROL (Cont.)

CRITICAL MATERIAL TESTS
☐ Verify that the materials shown in the contract documents comply with specification DIVISION 2100
☐ Verify that water for erosion control complies with DIVISION 2400
☐ Verify that geotextile or erosion control complies with DIVISION 1700

RIPRAP

Specification Reference: 829, 401, 402, 1102, 1100, 1400-1600

Pay Item: 829

Inspection Level/Frequency: Intermittent

Priority: Low to moderate

Inspector Experience: Junior

Number of Inspectors: 1.0

Description: Construct the designated type of riprap as shown in the contract documents.

INSPECTION TASKS
Pre-Construction
☐ Verify that the materials are approved and comply with applicable requirements
☐ Ensure that the base material is prepared according to plans and specifications
☐ Verify proper use and anchorage of geotextile fabric, if used
☐ Ensure that the appropriate class of riprap is utilized for the application
During Construction
☐ Ensure that appropriate riprap placing techniques are followed
☐ Ensure the placement and depth of bedding material as outlined in the specifications
☐ Ensure that the fabric is stored and installed properly and that the contractor overlaps the fabric in joints per specification
☐ If required, check the placement of steel reinforcement and concrete starting at the lower end and progressing to the upper end of the riprap, using grade 3.0 concrete, unless shown otherwise in the contract documents
☐ If required, check the placement of stone riprap and grouted stone riprap, filling the larger spaces between stones with spalls and grout
Post Construction
☐ If required, check the placement of cure liquid membrane-forming compound immediately after the concrete surface is finished
☐ Verify that the finished riprap does not have pockets of small stones and clusters of large stones

☐ Document, measure, and pay (various)

CRITICAL MATERIAL TESTS
☐ N/A

GUARDRAIL

Specification Reference: 827, 1618, 1723

Pay Item: 827

Inspection Level/Frequency: Intermittent

Priority: Moderate

Inspector Experience: Intermediate

Number of Inspectors: 1.0

Description: Install guardrails that conform to plans, standards, specifications, and contract requirements.

INSPECTION TASKS
Pre-Construction
☐ Ensure the guardrail conforms to plans, standards, specifications and contract requirements
☐ Review the post layout and location of each terminal
☐ Verify approval of all guardrail materials and working drawings, including layout and joint details
During Construction
☐ Inspect the prefabricated elements for any delivery or loading defects before installation
☐ Verify alignment, site grading, height, laps, post spacing, post embedment, bolting, and galvanization for each location
☐ Observe the placement of beams, posts, and any other hardware element
Post Construction
☐ Verify that the elements are not damaged after installation
☐ Record the location and quantities
☐ Measure and pay

CRITICAL MATERIAL TESTS
☐ Verify that guardrail materials are on the approved product list

FENCING

Specification Reference: 828, 1620

Pay Item: 828

Inspection Level/Frequency: Intermittent

Priority: Low to moderate

Inspector Experience: Junior

Number of Inspectors: 1.0

Description: Install fencing work that conforms to plans, standards, specifications, and contract requirements.

INSPECTION TASKS
Pre-Construction
☐ Ensure that the path of the fence line is cleared
☐ When necessary, excavate a trench to line and grade in areas of irregular ground to secure clearance between the ground line and the bottom of the fence fabric
☐ Verify type, size, and approval of fencing materials
☐ Verify that the construction of footings or bases of commercial grade concrete are in accordance with the contract documents
During Construction
☐ If required, remove the existing fence and store at locations as directed by the engineer and as shown in the contract documents
☐ Verify the alignment, gauge, type of wire, spacing of posts, depth of set, tightness and stability of posts, tightness of fabric, grounding and bracing at each location
Post Construction
☐ Record the location and quantity
☐ Document, measure, and pay (various)

CRITICAL MATERIAL TESTS
☐ N/A

PAVEMENT MARKING

Specification Reference: 806, 807, 808, 2207-2216

Pay Item: 806, 807, 808

Inspection Level/Frequency: Continual

Priority: Moderate to high

Inspector Experience: Junior

Number of Inspectors: 2.0

Description: Mark the pavement with markers to conform to contract requirements.

INSPECTION TASKS
Pre-Construction
☐ Remove existing pavement markings if required
☐ Verify that the pavement surface has been prepared to receive markings and markers
☐ Verify that pavement marking materials comply with DIVISION 2200
☐ Verify the use of equipment designed for the preparation and application of the appropriate type of pavement marking material
During Construction
☐ Verify the layout and install markings, messages, and markers
☐ On a daily basis, oversee the contractor's application thickness and bead rate testing, and document
☐ Verify that the application of the pavement marking complies with the manufacturer's application instructions
Post Construction
☐ Review and record a daily log for temporary and permanent markings and markers
☐ Document, measure, and pay (various)

CRITICAL MATERIAL TESTS
☐ Before beginning pavement marking operations, complete a 300-foot test section for epoxy, thermoplastic, sprayed thermoplastic, and multi-component pavement markings that meet specification requirements

UNDERDRAINS

Specification Reference: 822, 845, 1900

Pay Item: 822

Inspection Level/Frequency: Continual

Priority: Moderate

Inspector Experience: Junior

Number of Inspectors: 1.0

Description: Construct, install, and place underdrains that conform to plans, standards, specifications, and the contract.

INSPECTION TASKS
Pre-Construction
☐ Verify that the underdrain pipe and backfill materials comply with applicable requirements
☐ Verify that the elevation of the excavated trenches for all lateral and longitudinal interceptor drains are as shown in the contract documents
During Construction
☐ Visually inspect the underdrain to confirm that it is the appropriate type and that installation and alignment are per plans and specifications
☐ Verify that cleanouts are constructed at regular intervals and other locations, such as junctions, according to contract documents
☐ Construct the blanket underdrain with a minimum thickness of 12 inches and geotextile fabric if required by contract documents
Post Construction
☐ When specified in the contract documents, after installation, notify the materials engineer for a video camera inspection of underdrains and pavement edge drains
☐ Record locations and quantities before measurement and payment (LNFT)

CRITICAL MATERIAL TESTS
☐ N/A

PERMANENT TRAFFIC SIGNS

Specification Reference: 812

Pay Item: 812

Inspection Level/Frequency: Intermittent

Priority: Moderate

Inspector Experience: Intermediate

Number of Inspectors: 2.0

Description: Install and construct sign panels and support systems that are manufactured and assembled in accordance with the plans, standards, specifications, and shop drawings.

INSPECTION TASKS
Pre-Construction
☐ Ensure that the contractor has staked each sign location and that the sign locations meet field conditions and do not conflict with underground obstructions or other traffic signs
☐ Ensure that test borings and submission of shop drawings have occurred and that the regional traffic engineer has approved each sign location
☐ Ensure that the sign panels and support systems are manufactured and assembled in accordance with the plans, standards, specifications, and approved shop drawings
☐ Ensure that the conduit, wiring, electrical service, and illumination is in accordance with the plans, standards, specifications, and approved shop drawings
During Construction
☐ Inspect the excavation to ensure that the footing, bedding material, and grades conform to specifications
☐ Determine and record if weather conditions are conducive to concrete placement
☐ Ensure that the footing concrete is placed and compacted according to plans and specifications
☐ Verify and document that concrete strength has been obtained before commencing backfilling operations
☐ Before erection, inspect the condition of sign panels and supports and any allowable repairs that have been made
☐ Ensure that the bolts of any ground-mounted breakaway signs have been torqued as specified in the plans
Post Construction
☐ Perform and document nighttime inspection to verify that the signs have proper illumination
☐ Document quantities, measure, and pay (various)

CRITICAL MATERIAL TESTS
☐ KT-21: Slump of concrete
☐ KT-18: Concrete air content
☐ KT-17: Concrete temperature
☐ KT-20: Concrete mass per cubic foot

ELECTRIC LIGHTING SYSTEMS AND TRAFFIC SIGNALS

Specification Reference: 814, 1703 **Pay Item**: 814

Inspection Level/Frequency: Continual **Priority**: Moderate

Inspector Experience: Intermediate (Field Inspector and Specialty Inspector) **Number of Inspectors: 1.0**

Description: Install electric lighting systems and traffic signal items as shown in the contract documents.

INSPECTION TASKS
Pre-Construction ☐ Ensure that the contractor has staked each signal or electric pole location and that the signal location meets field conditions and does not conflict with underground obstructions or traffic signs ☐ Ensure that test borings and submission of shop drawings have occurred and the Regional Traffic Engineer has approved each signal pole location ☐ Ensure that the signal poles, cabinets, and signal heads are manufactured and assembled in accordance with the plans, standards, specifications, and approved shop drawings ☐ Ensure that the conduit, wiring, electrical service, and illumination is in accordance with the plans, standards, specifications, and approved shop drawings
During Construction ☐ Inspect the excavation to ensure that the footing, bedding material, and grades conform to specifications ☐ Determine and record if weather conditions are conducive to concrete placement ☐ Ensure that the footing concrete is placed and compacted according to plans and specifications ☐ Verify and document that concrete strength has been obtained before commencing backfilling operations ☐ Before erection, inspect the condition of the signal poles, cabinets, and signal heads ☐ Ensure that the bolts of ground-mounted poles and signals have been torqued as specified in the plans ☐ Cast concrete strength specimens at the rate specified
Post Construction ☐ Perform and document nighttime inspection to verify that the signal has proper illumination ☐ Document quantities, measure, and pay (various)

CRITICAL MATERIAL TESTS
☐ Temperature ☐ Concrete slump ☐ Concrete air content ☐ Concrete Strength

ROADSIDE TOPSOIL, MULCHING, AND SEEDING

Specification Reference: 904, 905, 906, 2101, 2103

Pay Item: 903, 904, 905

Inspection Level/Frequency: Continual

Priority: Moderate

Inspector Experience: Junior

Number of Inspectors: 2.0

Description: Provide and place topsoil at the locations shown in the contract. Provide and uniformly place mulching materials as shown in the contract. Prepare the seedbed, provide the seed, and plant at the rate and in the locations designated in the contract documents.

INSPECTION TASKS
Pre-Construction
☐ Verify that the seedbed and grade are within the contract tolerance prior to seeding and spreading topsoil and mulch
☐ Verify that the roughened surface is ready to receive topsoil or seed
During Construction
☐ Spread the topsoil at the locations and to the depths shown in the contract documents
☐ Using random samples, ensure the seed is drilled into the prepared seedbed at a maximum depth of 0.5 inch for grass seeds
☐ Place mulching materials as shown in the contract documents after an area is fertilized and seeded
Post Construction
☐ Check that topsoil is free of any stones, roots, large clods (greater than 6 inches)
☐ Punch the mulching material (except wood chips and excelsior material) approximately 2 inches into the ground
☐ Measure and pay

CRITICAL MATERIAL TESTS
☐ Verify that the seeds and nitrogen-fixing bacteria comply with DIVISION 2100
☐ Approve the mulching material

TREES AND SHRUBS PLANTING

Specification Reference: 908, 2102

Pay Item: 907

Inspection Level/Frequency: Intermittent

Priority: Low to moderate

Inspector Experience: Junior

Number of Inspectors: 2.0

Description: Provide and plant (or transplant) the designated plants as shown in the contract documents.

INSPECTION TASKS
Pre-Construction
☐ Verify plant locations and beds before digging pits and cultivating
☐ Verify that all plants have been approved by the region's environmental personnel if required
☐ Ensure that the plants are packed and protected against drying, freezing, breaking, or other injury
During Construction
☐ Stake the locations of all plants
☐ Clear a 10-ft radius area at each planting site by removing all weeds, brush, and other undesirable material
☐ Excavate the plant pit to the depth and diameter that comply with contract specifications before installing plants
☐ Verify placing plants and mulching materials as shown in the contract documents
Post Construction
☐ After the planting operations are completed, remove all debris from the planting areas, all labels from the plants, and all flags used to mark underground utilities
☐ Ensure that the plants, pits, and beds are maintained to achieve healthy growth until the end of the establishment period
☐ Measure and pay

CRITICAL MATERIAL TESTS
☐ Verify that the plants comply with DIVISION 2100

Appendix B: Checklist Evaluation Questionnaire

Development of Risk-Based Approach for KDOT Construction Inspection: Implementation Guidelines

CONTACT INFORMATION

(*Note: All information you provide will be kept confidential. The contact information is used for the purpose of checking data only*)

First Name: Job Title:

Last Name: Phone #:

District/Location: Email:

INSTRUCTIONS

The expert is asked to rate each of 35 checklists in terms of Risk or Priority Level of Inspection (***Tab 2 - Risk Assessment***) and Inspection Resource Allocation (***Tab 3 - Inspector Infor***) associated with four main types of projects:

1. New Road/Pavement Construction or Expansion
2. Roadway/Pavement Rehabilitation & Resurfacing
3. Bridge - New or Replacement
4. Bridge Rehabilitation

Table 1 shows the six categories of priority for inspection from "*N/A*" to "*High Risk*". Table 2 shows inspection frequency categories ranging from "*None*" to "*Continual inspection*." Table 3 shows the number of inspectors required. Table 4 shows the description of inspectors' experience.

Thank you very much for your time and effort!

Table 1. Risk level/priority for inspection		
0	No risk or N/A	Not applicable
1	Low	Low priority for inspection
2	Low to Moderate	Moderately low priority for inspection
3	Moderate	Medium priority for inspection
4	Moderate to High	Moderately high priority for inspection
5	High	High priority for inspection

Table 2. Inspection Frequency		
0	N/A	Not applicable
1	End product	Requires inspection after completion of the operation and during the operation
2	Intermittent	Requires inspection at critical times in the operation (30 - 80% of the time work)
3	Continual	Requires inspection during the entire operation (80 -100% of the time work)

Table 3. Number of Inspectors	
0	N/A
1	One inspector
2	Two inspectors
3	Three inspectors or more

Table 4. Inspector Experience		
0	N/A	Not applicable
1	Junior	< 2 years of construction inspection
2	Intermediate	2 to 5 years of construction inspection
3	Senior	> 5 years of construction inspection

B.1 Risk Assessment for Construction Inspection

DIVISION	No	Inspection Items	Description of inspected construction work	RISK LEVEL/ PRIORITY FOR INSPECTION				INSPECTION LEVEL/ FREQUENCY			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
EARTHWORK AND EMBANKMENT	1	CLEARING AND GRUBBING	Clearing involves just that, clearing the ground of trees, trash debris. Grubbing follows and involves additional clearing of stumps, roots, bushes and undergrowth.								
	2	DEMOLITION AND REMOVAL OF EXISTING STRUCTURES	Remove and dispose of the existing structures as identified in the contract for removal, and man-made structures not specifically identified in the contract that are in conflict with the new construction.								

DIVISION	No	Inspection Items	Description of inspected construction work	RISK LEVEL/ PRIORITY FOR INSPECTION				INSPECTION LEVEL/ FREQUENCY			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
	3	EXCAVATION AND BACKFILL FOR STRUCTURES	Excavate for the structures as shown in the contract documents. Unless specified otherwise, backfill the completed structures to the original ground line.								
	4	EXCAVATION AND EMBANKMENT FOR HIGHWAYS	Excavate, haul, place, remove and dispose of the specified materials. Construct the embankments, as specified in the contract. Compact the earthwork according to the requirements for the type of compaction and moisture range specified in the contract.								
	5	GEOFOAM LIGHTWEIGHT EMBANKMENT FILL	Provide and install the geofoam lightweight expanded polystyrene (EPS) fill at the embankment locations shown in the contract documents.								
	6	MECHANICALLY STABILIZED EARTH FILL (MSE)	Install a complete MSE system as specified in the contract. This includes excavation, grading, and compaction of the MSE fill foundation, dewatering as required for the execution of the work, erection of welded wire-facing elements, placement of soil reinforcing, and placement and compaction of select backfill material within the reinforced soil volume.								
	7	GRANULAR DRAINAGE BLANKET	Excavate for, and place aggregate to provide a drainage pathway for consolidating embankments and foundation soil as detailed in the contract documents.								

DIVISION	No	Inspection Items	Description of inspected construction work	RISK LEVEL/ PRIORITY FOR INSPECTION				INSPECTION LEVEL/ FREQUENCY			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
	8	PREFABRICATED VERTICAL DRAIN	Excavate for and place geosynthetics to provide a drainage pathway for consolidating embankments and foundation soils, as shown in the contract documents.								
SUBGRADE & BASE	9	SUBGRADE	Modify the subgrade using the materials and methods shown in the contract documents. When the contract documents specify, realign the shoulders and clean and reshape the ditches. Mix subgrade soil and treatment materials to construct a uniformly treated subgrade, as shown in the contract.								
	10	SUBBASE AND BASE COURSE	Construct a base on a prepared subgrade as shown in the contract. Mix base and any required treatment materials as shown in the contract.								
PCCP &HMA LAYERS	11	CONCRETE PAVEMENT (PCCP)	Construct Portland Cement Concrete Pavement (PCCP) on a prepared subgrade or base course. Develop and perform quality control testing.								
	12	PATCHING CONCRETE PAVEMENT	Patch the existing PCCP pavement as shown in the contract documents or at locations directed by the Engineer. Patches will be either full-depth or partial. The purpose is to repair surface spalls at joints and cracks or repair joints and slabs that are cracked or shattered.								
	13	HMA PRIME AND TACK COATS	Treat a previously prepared surface with asphalt material, and apply blotter material,								

DIVISION	No	Inspection Items	Description of inspected construction work	RISK LEVEL/ PRIORITY FOR INSPECTION				INSPECTION LEVEL/ FREQUENCY			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
			when required, as specified in the contract documents.								
	14	ASPHALT PAVEMENT (HMA)	Mix and place one or more courses of plant-produced HMA mixture on a prepared surface, as shown in the contract documents.								
	15	HMA SURFACE TREATMENT BY CHIP SEAL	Apply asphalt material to the existing surface, followed by an application of cover material, as specified in the Contract Documents.								
STRUCTURES	16	FALSEWORK AND FORM CONSTRUCTION	Design and construct safe, adequate temporary structure to provide the necessary rigidity, support the loads imposed and produce the final structure to the lines and grades shown in the contract documents.								
	17	CAST IN PLACE BOX CULVERT	Cast-in-place culvert elements, including foundation, location and staking, walls and slab, with steel reinforcement.								
	18	BRIDGE SUBSTRUCTURE	Cast-in-place substructure elements including foundation, location and staking, temporary form work, abutment, with steel reinforcement.								
	19	BRIDGE DECK	Cast-in-place superstructure elements, including bridge deck, location and leveling, temporary formwork, and supporting girders, with steel reinforcement.								

DIVISION	No	Inspection Items	Description of inspected construction work	RISK LEVEL/ PRIORITY FOR INSPECTION				INSPECTION LEVEL/ FREQUENCY			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
	20	BRIDGE PAINTING	Begin by cleaning and preparing all surfaces to be painted and protect the structure against damage that could occur. Paint all required surfaces and other exposed metal surfaces, including handrails, guardrails, cables, wire fences, light fixtures, metal flooring, and other metal appurtenances.								
	21	PRECAST AND PIPE CULVERTS, EROSION PIPE, STORM AND SANITARY SEWERS	Install the size and type of pipe culvert, erosion pipe, storm sewer, sanitary sewer, end section, and concrete headwall specified in the contract documents.								
	22	RETAINING WALLS	Construct a standard gravity, cast-in-place reinforced concrete (CIP), or gabion retaining wall as specified in the contract. The contractor is responsible for excavating the retaining walls and crib walls, as shown on the plans.								
INCIDENTAL CONSTRUCTION	23	TRAFFIC CONTROL	Monitor and manage work zone impacts on traffic during construction.								
	24	CONSTRUCTION STAKING	Carrying out staking processes during the project for different construction operations.								
	25	INCIDENTAL CONCRETE STRUCTURES	Construct catch basins, inlets, outlets, manholes, junction boxes, paved ditches, sidewalks, steps, median barriers, curb and gutter, and entrances.								

DIVISION	No	Inspection Items	Description of inspected construction work	RISK LEVEL/ PRIORITY FOR INSPECTION				INSPECTION LEVEL/ FREQUENCY			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
	26	EROSION CONTROL	Prevent erosion on the project and project related borrow areas by installation, and maintenance of temporary erosion control measures.								
	27	RIPRAP	Construct the designated type of riprap as shown in the contract documents.								
	28	GUARDRAIL	Install guardrail conforming to plans, standards, specifications, and contract requirements.								
	29	FENCING	Install fencing work conforming to plans, standards, specifications, and contract requirements.								
	30	PAVEMENT MARKING	Marking the pavement with markers conform to the contract requirements.								
	31	UNDERDRAIN	Construct, install, and place underdrain conforms to plans, standards, specifications, and contract.								
	32	TRAFFIC SIGNS	Install and construct sign panels and support systems that are manufactured and assembled in accordance with the plans, standards, specifications, and shop drawings.								
	33	ELECTRIC LIGHTING SYSTEMS AND TRAFFIC SIGNALS	Install electric lighting systems and traffic signal items as shown in the contract documents.								

DIVISION	No	Inspection Items	Description of inspected construction work	RISK LEVEL/ PRIORITY FOR INSPECTION				INSPECTION LEVEL/ FREQUENCY			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
ROADSIDE IMPROVEMENT	34	ROADSIDE TOPSOIL, MULCHING AND SEEDING	Provide and place topsoil at the locations shown in the contract. Provide and uniformly place mulching materials as shown in the contract. Prepare the seedbed, provide the seed, and plant at the rate and in the locations designated in the contract documents.								
	35	TREES AND SHRUBS PLANTING	Provide and plant (or transplant) the designated plants as shown in the contract documents.								

B.2 Inspector Information

DIVISION	No	Inspection Items	Description of inspected construction work	NUMBER OF INSPECTORS				INSPECTOR EXPERIENCE			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
EARTHWORK AND EMBANKMENT	1	CLEARING AND GRUBBING	Clearing involves just that, clearing the ground of trees, trash debris. Grubbing follows and involves additional clearing of stumps, roots, bushes and undergrowth.								
	2	DEMOLITION AND REMOVAL OF EXISTING STRUCTURES	Remove and dispose of the existing structures as identified in the contract for removal, and man-made structures not specifically identified in the contract that are in conflict with the new construction.								
	3	EXCAVATION AND BACKFILL FOR STRUCTURES	Excavate for the structures as shown in the contract documents. Unless specified otherwise, backfill the completed structures to the original ground line.								
	4	EXCAVATION AND EMBANKMENT FOR HIGHWAYS	Excavate, haul, place, remove and dispose of the specified materials. Construct the embankments, as specified in the contract. Compact the earthwork according to the requirements for the type of compaction and moisture range specified in the contract.								
	5	GEOFOAM LIGHTWEIGHT EMBANKMENT FILL	Provide and install the geofoam lightweight expanded polystyrene (EPS) fill at the embankment locations shown in the contract documents.								

DIVISION	No	Inspection Items	Description of inspected construction work	NUMBER OF INSPECTORS				INSPECTOR EXPERIENCE			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
	6	MECHANICALLY STABILIZED EARTH FILL (MSE)	Install a complete MSE system as specified in the contract. This includes excavation, grading, and compaction of the MSE fill foundation, dewatering as required for the execution of the work, erection of welded wire-facing elements, placement of soil reinforcing, and placement and compaction of select backfill material within the reinforced soil volume.								
	7	GRANULAR DRAINAGE BLANKET	Excavate for, and place aggregate to provide a drainage pathway for consolidating embankments and foundation soil as detailed in the contract documents.								
	8	PREFABRICATED VERTICAL DRAIN	Excavate for and place geosynthetics to provide a drainage pathway for consolidating embankments and foundation soils, as shown in the contract documents.								
SUBGRADE & BASE	9	SUBGRADE	Modify the subgrade using the materials and methods shown in the contract documents. When the contract documents specify, realign the shoulders and clean and reshape the ditches. Mix subgrade soil and treatment materials to construct a uniformly treated subgrade, as shown in the contract.								
	10	SUBBASE AND BASE COURSE	Construct a base on a prepared subgrade as shown in the contract. Mix base and any required treatment materials as shown in the contract.								

DIVISION	No	Inspection Items	Description of inspected construction work	NUMBER OF INSPECTORS				INSPECTOR EXPERIENCE			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
PCCP &HMA LAYERS	11	CONCRETE PAVEMENT (PCCP)	Construct Portland Cement Concrete Pavement (PCCP) on a prepared subgrade or base course. Develop and perform quality control testing.								
	12	PATCHING CONCRETE PAVEMENT	Patch the existing PCCP pavement as shown in the contract documents or at locations directed by the Engineer. Patches will be either full-depth or partial. The purpose is to repair surface spalls at joints and cracks or repair joints and slabs that are cracked or shattered.								
	13	HMA PRIME AND TACK COATS	Treat a previously prepared surface with asphalt material, and apply blotter material, when required, as specified in the contract documents.								
	14	ASPHALT PAVEMENT (HMA)	Mix and place one or more courses of plant-produced HMA mixture on a prepared surface, as shown in the contract documents.								
	15	HMA SURFACE TREATMENT BY CHIP SEAL	Apply asphalt material to the existing surface, followed by an application of cover material, as specified in the contract documents.								
STRUCTURES	16	FALSEWORK AND FORM CONSTRUCTION	Design and construct safe, adequate temporary structure to provide the necessary rigidity, support the loads imposed and produce the final structure to the lines and grades shown in the contract documents.								

DIVISION	No	Inspection Items	Description of inspected construction work	NUMBER OF INSPECTORS				INSPECTOR EXPERIENCE			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
	17	CAST-IN-PLACE BOX CULVERT	Cast-in-place culvert elements, including foundation, location and staking, walls and slab, with steel reinforcement.								
	18	BRIDGE SUBSTRUCTURE	Cast-in-place substructure elements including foundation, location and staking, temporary form work, abutment, with steel reinforcement.								
	19	BRIDGE DECK	Cast-in-place superstructure elements, including bridge deck, location and leveling, temporary formwork, and supporting girders, with steel reinforcement.								
	20	BRIDGE PAINTING	Begin by cleaning and preparing all surfaces to be painted and protect the structure against damage that could occur. Paint all required surfaces and other exposed metal surfaces, including handrails, guardrails, cables, wire fences, light fixtures, metal flooring, and other metal appurtenances.								
	21	PRECAST AND PIPE CULVERTS, EROSION PIPE, STORM AND SANITARY SEWERS	Install the size and type of pipe culvert, erosion pipe, storm sewer, sanitary sewer, end section, and concrete headwall specified in the contract documents								
	22	RETAINING WALLS	Construct a standard gravity, cast-in-place reinforced concrete (CIP), or gabion retaining wall as specified in the contract. The contractor is responsible for excavating the								

DIVISION	No	Inspection Items	Description of inspected construction work	NUMBER OF INSPECTORS				INSPECTOR EXPERIENCE			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
			retaining walls and crib walls, as shown on the plans.								
INCIDENTAL CONSTRUCTION	23	TRAFFIC CONTROL	Monitor and manage work zone impacts on traffic during construction.								
	24	CONSTRUCTION STAKING	Carrying out staking processes during the project for different construction operations.								
	25	INCIDENTAL CONCRETE STRUCTURES	Construct catch basins, inlets, outlets, manholes, junction boxes, paved ditches, sidewalks, steps, median barriers, curb and gutter, and entrances								
	26	EROSION CONTROL	Prevent erosion on the project and project related borrow areas by installation, and maintenance of temporary erosion control measures.								
	27	RIPRAP	Construct the designated type of riprap as shown in the contract documents.								
	28	GUARDRAIL	Install guardrail conforming to plans, standards, specifications, and contract requirements.								
	29	FENCING	Install fencing work conforming to plans, standards, specifications, and contract requirements.								
	30	PAVEMENT MARKING	Marking the pavement with markers conform to the contract requirements.								
	31	UNDERDRAIN	Construct, install, and place underdrain conforms to plans,								

DIVISION	No	Inspection Items	Description of inspected construction work	NUMBER OF INSPECTORS				INSPECTOR EXPERIENCE			
				New Road Construction or Expansion	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*	*New Road Construction or Expansion*	*Roadway Rehabilitation & Resurfacing*	*Bridge - New or Replacement*	*Bridge Rehabilitation*
			standards, specifications, and contract.								
	32	TRAFFIC SIGNS	Install and construct sign panels and support systems that are manufactured and assembled in accordance with the plans, standards, specifications, and shop drawings.								
	33	ELECTRIC LIGHTING SYSTEMS AND TRAFFIC SIGNALS	Install electric lighting systems and traffic signal items as shown in the contract documents.								
ROADSIDE IMPROVEMENT	34	ROADSIDE TOPSOIL, MULCHING AND SEEDING	Provide and place topsoil at the locations shown in the contract. Provide and uniformly place mulching materials as shown in the contract. Prepare the seedbed, provide the seed, and plant at the rate and in the locations designated in the contract documents.								
	35	TREES AND SHRUBS PLANTING	Provide and plant (or transplant) the designated plants as shown in the contract documents.								

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KANSAS TRANSPORTATION RESEARCH AND NEW-DEVELOPMENT PROGRAM





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