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Survey: Bridging the Data Gap between Quality Assurance and Pavement Management

Thank you for participating in this Federal Highway Administration (FHWA) research effort to advance the digital connection of QA data to pavement management. Your agency's response will inform the development of a data schema and a recommendations guidebook to support State DOTs in advancing their practices.

Here's the updated text:

This survey is designed to be completed collaboratively and submitted by a designated coordinator at your agency. The survey link and the fillable PDF are being distributed to both (1) the agency's representative to the AASHTO Committee on Materials and Pavements (COMP), who is encouraged to coordinate responses with other relevant offices and subject matter experts within the DOT, as applicable, and (2) the three FHWA Federal Lands Highway Divisions.

Agencies may choose to complete either the web-based questionnaire or the fillable PDF, whichever format best suits their preference. Please note that the survey link is unique to your agency and may be shared with multiple individuals within your agency to collaborate on a single consolidated response.

Pavement and Materials Data will be referenced throughout the survey and refers to data that allows the agency to assure the quality of their pavement and material assets.

For the purposes of this survey:

- Materials refers to the agency function responsible for testing, qualifying, and accepting the engineered materials used in pavement construction and maintenance. This includes asphalt binders and mixtures, Portland cement concrete, aggregates and aggregate sources, and geotechnical materials (subgrade soils, embankment fill, base and subbase layers, and aggregate bed materials).
- Quality Assurance (QA) refers to the overall system of activities, procedures, and organizational responsibilities used to ensure the quality and reliability of pavement and materials data and constructed products. This includes contractor quality control (QC), agency acceptance, verification activities, and independent assurance (IA), consistent with FHWA and AASHTO terminology.
- Agency data also includes any consultants that are directly controlled and report to the Agency on their behalf (not consultants etc. that report to contractors, vendors, material suppliers/producers etc.).

The purpose of this survey is to establish a comprehensive understanding of the current state of DOT practices for collecting, managing, exchanging, and using pavement and materials data to support quality assurance activities. The data

collected includes pavement design and pavement management process linkages, enabling a People-Process-Technology-Data framework to assess the extent of data use across design, construction, and asset management.

Estimated time to complete: Approximately 30 minutes. The survey is designed to be completed collaboratively and submitted by a designated agency coordinator. While an individual subject matter expert may be able to complete portions of the survey in approximately 30 minutes, agencies are encouraged to engage personnel from Materials, Construction, Pavement Management, Asset Management, Information Technology, and other relevant offices to develop a coordinated response. The total effort required to prepare a consolidated agency response may therefore vary by agency.

Privacy notice:

Information you provide will be used to characterize the state of practice across U.S. State transportation agencies and to inform the project deliverables.

Responses will be reported in aggregate; no individual agency or respondent will be identified in published findings without written consent. Personally identifiable information will be limited to contact information for follow-up purposes and will be retained only as long as necessary to complete the research.

Disclaimer:

The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear only because they are considered essential to the objective of the research. They are included for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one product or entity.

Questions about this survey

Please contact the research team:

Dr. Hala Nassereddine, Principal Investigator

University of Kentucky, Department of Civil Engineering

hala.nassereddine@uky.edu | (859) 562-2591

1. Agency Profile

1.1 What is the name of your agency?

Single-select dropdown

50 U.S. States, the District of Columbia, Puerto Rico, the three FHWA Federal Lands Highway Divisions (Eastern, Central, Western)

1.2 What is your name and role at the agency?

Full Name: _____

Job Title: _____

Division/Office: _____

If the response included input from other units, please list them here: _____

1.3 What pavement design methodology does your agency primarily use for new, reconstruction, and rehabilitation projects?

Pavement type	AASHTO 1993 Guide	AASHTO Pavement ME (mechanistic-empirical)	State-specific empirical method	State-specific mechanistic-empirical method	Hybrid (varies by project)	Other	Don't know
New construction / reconstruction Asphalt (flexible) pavements							
New construction / reconstruction Concrete (rigid) pavements							
New construction /							

reconstructi on Composite pavements (asphalt over concrete) Rehabilitatio n Asphalt (flexible) pavements							
Rehabilitatio n Concrete (rigid) pavements							
Rehabilitatio n Composite pavements (asphalt over concrete)							

1.4 If your agency uses AASHTO Pavement ME for asphalt or concrete pavement design, is the design method locally calibrated using agency-specific data?

- ☐ Yes; fully calibrated with agency-specific data, and recalibration is performed periodically
- ☐ Yes; initial calibration was performed using agency data, but recalibration is infrequent or not performed
- ☐ Partially; some performance models are locally calibrated, others use national defaults
- ☐ No; Pavement ME is used with national default calibration
- ☐ In progress; calibration effort is underway but not yet complete
- ☐ Don't know

1.5 For agencies using AASHTO Pavement ME with local calibration, which data sources feed the calibration?

- ☐ Long-Term Pavement Performance (LTPP) data
- ☐ Agency-specific performance monitoring data from the Pavement Management System (PMS)
- ☐ Materials testing data from past construction projects
- ☐ Construction records (as-built thickness, density, lift information)
- ☐ Climate data (MERRA or similar)
- ☐ Traffic data (WIM, vehicle classification counts)
- ☐ Other (please specify): _____
- ☐ Don't know

2. Current data management structure

2.1 How is the following pavement and materials data managed within your agency?

Data Type	Stored only within district/local systems and not integrated into central office databases	Stored in both district and central office systems (as duplicate files), but with limited statewide access	Stored in district and central office systems (as duplicate files) that are accessible and used across the state	Stored in central office systems and are accessible and used across the state
Highway Performance Monitoring System (HPMS)/Pavement Condition				
Pavement Design				
Materials Acceptance/Constructio				

n				
Asset Management/Maintenance				

2.2 Does your agency have a formal data governance body (council, board, or equivalent) that has authority over pavement and materials data?

- ☐ Yes; with explicit authority over pavement and materials data
- ☐ Yes; enterprise-wide governance body, but pavement and materials data are not explicitly within its scope
- ☐ Informal coordination only; no formal body
- ☐ No governance structure exists
- ☐ Don't know

3. Data ownership and stewardship

3.1 Which of the following data stewardship roles are assigned at your agency for Highway Performance Monitoring System (HPMS)/Pavement Condition data?

Roles	Formally assigned	Informally assigned	Not assigned	Don't know
Decision-maker (senior leader who articulates decision needs/information requirements)				
Domain Steward (subject-matter authority for pavement, materials, or QA data)				
Business Steward (operational owner who ensures data are produced and consumed in business processes)				
Metadata Steward (defines and maintains data definitions, units, formats, lineage)				
Custodian (technical caretaker for loading, transformation, integration, access control)				
Architect/Integrator (designer of integration patterns and exchange specifications)				

Creator (field, lab, consultant, or contractor staff who originate data records i.e., inspectors, materials testers, contractor/vendor quality control (QC) personnel)				
Trustee (senior accountability holder for data assets at the enterprise level, e.g., Chief Data Officer)				
Approver (formal authority for Information Requirements (IR) publication, schema changes, data product release)				

3.2 How clearly are roles and responsibilities defined across the following stages of the Highway Performance Monitoring System (HPMS)/Pavement Condition data pipeline?

Roles and Responsibilities	Not Defined	Partially Defined	Clearly Defined	Don't know
Defining information requirements				
Capturing and accessing data				
Validating and assuring quality				
Integrating data across systems				
Analyzing and modeling data				
Using data for decision-making				

3.3 How clearly is data ownership defined for Highway Performance Monitoring System (HPMS)/Pavement Condition data?

- ☐ Clearly defined and applied
- ☐ Defined but inconsistent
- ☐ Partially defined
- ☐ Not defined
- ☐ Don't know

3.4[If data ownership is defined] Who is designated as the primary data owner for Highway Performance Monitoring System (HPMS)/Pavement Condition data?

- ☐ Materials Division
- ☐ Construction Division
- ☐ IT/Data Office
- ☐ Pavement Management Division
- ☐ Ownership varies by data class (please specify):
- ☐ Other (please specify):

3.5Which of the following data stewardship roles are assigned at your agency for Pavement Design data?

Roles	Formally assigned	Informally assigned	Not assigned	Don't know
Decision-maker (senior leader who articulates decision needs/information requirements)				
Domain Steward (subject-matter authority for pavement, materials, or QA data)				
Business Steward (operational owner who ensures data are produced and consumed in business processes)				
Metadata Steward (defines and maintains data definitions, units, formats, lineage)				
Custodian (technical caretaker for loading, transformation, integration, access control)				
Architect/Integrator (designer of integration patterns and exchange specifications)				
Creator (field, lab, consultant, or contractor staff who originate data records i.e., inspectors, materials testers, contractor/vendor quality control (QC) personnel)				
Trustee (senior accountability holder for data assets at the enterprise level, e.g., Chief Data Officer)				

Approver (formal authority for Information Requirements (IR) publication, schema changes, data product release)				
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3.6 How clearly are roles and responsibilities defined across the following stages of the Pavement Design data pipeline?

Roles and Responsibilities	Not Defined	Partially Defined	Clearly Defined	Don't know
Defining information requirements				
Capturing and accessing data				
Validating and assuring quality				
Integrating data across systems				
Analyzing and modeling data				
Using data for decision-making				

3.7 How clearly is data ownership defined for Pavement Design data?

- ☐ Clearly defined and applied
- ☐ Defined but inconsistent
- ☐ Partially defined
- ☐ Not defined
- ☐ Don't know

3.8 [If data ownership is defined] Who is designated as the primary data owner for Pavement Design data?

- ☐ Materials Division
- ☐ Construction Division
- ☐ IT/Data Office
- ☐ Pavement Management Division
- ☐ Ownership varies by data class (please specify):
- ☐ Other (please specify):

3.9 Which of the following data stewardship roles are assigned at your agency for Materials Acceptance/Construction data?

Roles	Formally assigned	Informally assigned	Not assigned	Don't know
Decision-maker (senior leader who articulates decision needs/information requirements)				
Domain Steward (subject-matter authority for pavement, materials, or QA data)				
Business Steward (operational owner who ensures data are produced and consumed in business processes)				
Metadata Steward (defines and maintains data definitions, units, formats, lineage)				
Custodian (technical caretaker for loading, transformation, integration, access control)				
Architect/Integrator (designer of integration patterns and exchange specifications)				
Creator (field, lab, consultant, or contractor staff who originate data records i.e., inspectors, materials testers, contractor/vendor quality control (QC) personnel)				
Trustee (senior accountability holder for data assets at the enterprise level, e.g., Chief Data Officer)				
Approver (formal authority for Information Requirements (IR) publication, schema changes, data product release)				

3.10 How clearly are roles and responsibilities defined across the following stages of the Materials Acceptance/Construction data pipeline?

Roles and Responsibilities	Not Defined	Partially Defined	Clearly Defined	Don't know
Defining information requirements				
Capturing and accessing data				
Validating and assuring quality				
Integrating data across systems				

Analyzing and modeling data				
Using data for decision-making				

3.11 How clearly is data ownership defined for Materials

Acceptance/Construction data?

- ☐ Clearly defined and applied
- ☐ Defined but inconsistent
- ☐ Partially defined
- ☐ Not defined
- ☐ Don't know

3.12 [If data ownership is defined] Who is designated as the primary data owner for Materials Acceptance/Construction data?

- ☐ Materials Division
- ☐ Construction Division
- ☐ IT/Data Office
- ☐ Pavement Management Division
- ☐ Ownership varies by data class (please specify):
- ☐ Other (please specify):

3.13 Which of the following data stewardship roles are assigned at your agency for Asset Management/Maintenance data?

Roles	Formally assigned	Informally assigned	Not assigned	Don't know
Decision-maker (senior leader who articulates decision needs/information requirements)				
Domain Steward (subject-matter authority for pavement, materials, or QA data)				
Business Steward (operational owner who ensures data are produced and consumed in business processes)				
Metadata Steward (defines and maintains data definitions, units, formats, lineage)				

Custodian (technical caretaker for loading, transformation, integration, access control)				
Architect/Integrator (designer of integration patterns and exchange specifications)				
Creator (field, lab, consultant, or contractor staff who originate data records i.e., inspectors, materials testers, contractor/vendor quality control (QC) personnel)				
Trustee (senior accountability holder for data assets at the enterprise level, e.g., Chief Data Officer)				
Approver (formal authority for Information Requirements (IR) publication, schema changes, data product release)				

3.14 How clearly are roles and responsibilities defined across the following stages of the Asset Management/Maintenance data pipeline?

Roles and Responsibilities	Not Defined	Partially Defined	Clearly Defined	Don't know
Defining information requirements				
Capturing and accessing data				
Validating and assuring quality				
Integrating data across systems				
Analyzing and modeling data				
Using data for decision-making				

3.15 How clearly is data ownership defined for Asset Management/Maintenance data?

- ☐ Clearly defined and applied
- ☐ Defined but inconsistent
- ☐ Partially defined
- ☐ Not defined
- ☐ Don't know

3.16 [If data ownership is defined] Who is designated as the primary data owner for Asset Management/Maintenance data?

- ☐ Materials Division
- ☐ Construction Division
- ☐ IT/Data Office
- ☐ Pavement Management Division
- ☐ Ownership varies by data class (please specify):
- ☐ Other (please specify):

4. Organizational Coordination

4.1 How frequently do the following functions coordinate on pavement and materials data matters?

Definitions of functions (please read before answering):

For this question, a “function” refers to the work performed, not the name of an organizational unit. Your agency may combine several functions in one office, or split one function across multiple offices. Please answer based on how the work is actually performed at your agency.

- Planning & Pavement Design: network-level program development, project selection and scoping, pavement structural design, and pavement type selection.
- Materials: specification development for engineered materials; mix design review and approval; testing, qualification, and acceptance of asphalt binders and mixtures, Portland cement concrete, aggregates, and geotechnical materials; producer/supplier certification.
- Construction: field inspection, acceptance sampling and testing, verification, contractor oversight, and construction records management during project delivery.
- Construction Records/Digital As-Built: capture, quality assurance, and stewardship of final constructed-condition data (geometry, materials placed, locations and dimensions, e-Ticket records, in-field design changes) and its transfer from project delivery to asset systems. At some agencies this is performed by a dedicated CADD/Survey/Records group; at others it is performed within Construction or Design; at others it is contracted out.

- Maintenance: routine and preventive maintenance, minor rehabilitation, and field condition response on in-service pavements.
- Pavement Management: network-level pavement condition monitoring, performance modeling, treatment programming, and life-cycle analysis for the pavement asset class.
- Asset Management (enterprise): cross-asset performance management, TAMP development, and integration of pavements with other asset classes (bridges, drainage, ITS, etc.).
- IT/Data: enterprise data infrastructure, integration platforms, data architecture, and governance support (sometimes called OIT, Data Services, or the Chief Data Office).

Functions	Never	Rarely	Sometimes	Often	Always
Planning & Pavement Design ↔ Materials					
Planning & Pavement Design ↔ Construction					
Materials ↔ Construction					
Construction ↔ Construction Records/Digital As-Built					
Materials ↔ Construction Records /Digital As-Built					
Construction Records/Digital As-Built ↔ Pavement Management					
Construction Records/Digital As-Built ↔ Maintenance					
Construction Records/Digital As-Built ↔ Asset Management (enterprise)					
Construction ↔ Maintenance					
Materials ↔ Maintenance					
Construction ↔ Pavement Management					
Materials ↔ Pavement Management					
Maintenance ↔ Pavement Management					
Pavement Management ↔ Asset Management (enterprise)					
Materials ↔ IT/Data					
Pavement Management ↔ IT/Data					
Construction Records/Digital As-Built ↔					

IT/Data					
All functions jointly					

4.2 How effective is the coordination between the following functions?

Functions	Very Ineffective	Ineffective	Neither Effective nor Ineffective	Effective	Very Effective
Planning & Pavement Design ↔ Materials					
Planning & Pavement Design ↔ Construction					
Materials ↔ Construction					
Construction ↔ Construction Records/ Digital As-Built					
Materials ↔ Construction Records / Digital As-Built					
Construction Records/Digital As-Built ↔ Pavement Management					
Construction Records/Digital As-Built ↔ Maintenance					
Construction Records/Digital As-Built ↔ Asset Management (enterprise)					
Construction ↔ Maintenance					
Materials ↔ Maintenance					
Construction ↔ Pavement Management					
Materials ↔ Pavement Management					
Maintenance ↔ Pavement Management					
Pavement Management ↔ Asset Management (enterprise)					
Materials ↔ IT/Data					
Pavement Management ↔ IT/Data					

Construction Records/Digital As-Built ↔ IT/Data					
All functions jointly					

5. Workforce capability and training

5.1 How would you characterize the workforce capability at your agency to perform each of the following data-related activities for pavement and materials data?

Activity	Very limited	Limited	Adequate	Strong	Very strong	Don't know	Not Applicable
Defining information requirements							
Capturing and accessing data							
Validating contractor QC data against agency verification testing (per 23 CFR 637 – comparing contractor quality control results to agency verification sampling and testing to determine whether QC data may be used in acceptance)							
Data quality validation (completeness checks, range and reasonableness checks, statistical outlier detection, schema and unit conformance, and other data-management checks applied to records as they move through the							

data lifecycle)							
Integrating with Pavement Management System (PMS)							
Performing analysis for decision-making							
Managing project-to-asset data handoff							

5.2 Does your agency provide formal training or professional development for staff in the following areas?

Training Area	Yes	No	Limited	Don't know
Data governance				
Pavement management tools				
Materials testing systems				
GIS and Linear Referencing System practice				
Statistical methods for acceptance and data validation (e.g., Percent Within Limits, F- and t-tests for QC validation per 23 CFR 637, distribution and normality checks, outlier detection, pay-factor computation, or any other approach)				
Emerging construction technologies				

6. Data producers

6.1 Who produces pavement and materials data at your agency? Select all that apply for each data class.

Data class	Agency staff (in-house)	Agency-controlled consultants	Contractor/producer QC	Independent third party (IA, dispute resolution)	Not produced	Don't know
Mix designs						
Materials acceptance test results (asphalt, concrete, aggregates)						
Materials verification test results						
Construction inspection records						
Density/ smoothness/ friction/ texture measurements						
e-Ticket/ delivery records						
Digital as-built records						
Independent Assurance (IA) test results						

7. Data collection technologies

7.1 Which of the following capture technologies does your agency currently use (in production) for pavement and materials data? Select all that apply.

- ☐ Laboratory Information Management System (LIMS) for materials testing
- ☐ Mobile inspector applications (tablets, phones) with structured data entry
- ☐ In-place density gauges (nuclear)
- ☐ In-place density gauges (non-nuclear/dielectric)
- ☐ Intelligent compaction (IC) rollers with onboard data systems
- ☐ Paver-mounted thermal profiling
- ☐ e-Ticketing for material delivery
- ☐ Material Delivery Management System (MDMS) such as VETA
- ☐ Ground-Penetrating Radar (GPR) for pavement evaluation
- ☐ lidar/point-cloud capture
- ☐ Uncrewed Aircraft Systems (UAS/drones) for pavement or construction inspection
- ☐ Automated pavement condition survey vans (IRI, rutting, faulting, cracking)
- ☐ Falling Weight Deflectometer (FWD)
- ☐ Continues deflection monitoring devices (such as Rolling Weight Deflectometer or traffic speed deflectometer)
- ☐ Pavement friction, profilers
- ☐ Automated machine guidance (AMG) on construction equipment
- ☐ None of the above

7.2(Conditional question) Of the technologies you selected in the previous question, which are typically piloted only versus deployed in production across most projects?

Technology	Pilot only	Some projects	Most projects	All Projects
Laboratory Information Management System (LIMS) for materials testing				
Mobile inspector applications (tablets, phones) with structured data entry				
In-place density gauges (nuclear)				
In-place density gauges (non-nuclear/dielectric)				

Intelligent compaction (IC) rollers with onboard data systems				
Paver-mounted thermal profiling				
e-Ticketing for material delivery				
Material Delivery Management System (MDMS) such as VETA				
Ground-Penetrating Radar (GPR) for pavement evaluation				
lidar/point-cloud capture				
Uncrewed Aircraft Systems (UAS/drones) for pavement or construction inspection				
Automated pavement condition survey vans (IRI, rutting, faulting, cracking)				
Falling Weight Deflectometer (FWD)				
Continues deflection monitoring devices (such as Rolling Weight Deflectometer or traffic speed deflectometer)				
Pavement friction, profilers				
Automated machine guidance (AMG) on construction equipment				
Other (please specify)				
Other (please specify)				

8. Data transmission and reporting

8.1 How are pavement and materials data typically transmitted from the project to the district and/or central office? Select all that apply.

- ☐ Paper records carried or mailed to district/central office
- ☐ Scanned PDFs uploaded to a document management system (e.g., ProjectWise, SharePoint)
- ☐ Email attachments
- ☐ Spreadsheets uploaded to shared drives
- ☐ Direct entry into an enterprise materials/construction management system in the field
- ☐ Automated upload from field/lab instruments to enterprise systems

- ☐ API or system-to-system integration from contractor/lab systems
- ☐ Bar codes/QR code scans
- ☐ Other (please specify): _____
- ☐ Don't know

8.2 At what frequency are pavement and materials data transmitted from the project to the district or central office?

Data class	Real-time/continuous	Daily	Weekly	At project milestones (e.g., lot completion)	At project closeout only	Don't know
Materials acceptance test results						
Construction inspection records						
e-Ticket/delivery records						
Density/smoothness/friction/texture measurements						
Digital as-built records						

9. Systems environment

9.1 What primary system does your agency use as its Pavement Management System (PMS)? *Please consult with your agency's pavement management engineer.*

- ☐ AASHTOWare Pavement Management
- ☐ Deighton dTIMS
- ☐ Agile Assets Pavement Analyst
- ☐ Bentley AssetWise
- ☐ In-house developed system
- ☐ Other commercial system (please specify): _____

- ☐ No formal PMS in production
- ☐ Don't know

9.2 What primary system does your agency use as its Construction Management System (CMS) for data?

- ☐ AASHTOWare Project (formerly SiteManager)
- ☐ Bentley ProjectWise
- ☐ Bentley ProjectWise + custom QA/QC modules
- ☐ Infotech Doc Express/Appia
- ☐ In-house developed CMS
- ☐ Other commercial system (please specify): _____
- ☐ No integrated CMS; records are managed in disparate systems
- ☐ Don't know

10. Data capture during construction and acceptance

10.1 What pavement and material data are captured and received by the agency during pavement acceptance in construction?

	Capture d by the agency	Captured by the agency consultan t and received by the agency	Captured by the agency consultan t but not received by the agency	Captured by the contractor and received by the agency	Captured by the contractor but not received by the agency	Not Captured or received
Agency material and field-testing records (e.g., spot tests, density tests)						
Field Acceptance Testing						
Contractor						

Mix Design Information						
Agency Mix Design Information						
Mix Design Verification						
Material source testing and certifications (e.g., supplier test results, material certifications)						
Operational measurements from Intelligent construction technology data <i>(i.e., for the purpose of this research it means the use of construction technologies that automatically collect, process, or communicate construction-related data to improve quality, productivity, and decision-making. Examples include intelligent compaction, paver-mounted thermal profiling)</i>						
Electronic ticketing (e-Ticket) or material delivery records						

10.2 For Electronic Ticketing (e-Ticket) or material delivery records, which data elements does your agency typically capture and retain?

- ☐ Quantity (weight, volume, or count)
- ☐ Ticket timestamp (date/time of load issuance or delivery)
- ☐ Source plant or quarry (origin of the material)
- ☐ Material identifier (mix ID, source ID, or material specification reference)
- ☐ Material temperature at delivery (for asphalt mixtures, ready-mix concrete)
- ☐ Hauler identifier (trucking company, driver, or truck number)
- ☐ GPS location of load delivery or placement
- ☐ Time of placement (as distinct from time of delivery)
- ☐ Linkage to acceptance test records (ability to identify which acceptance tests correspond to which loads)
- ☐ Linkage to project location (station, milepost, lane, or pavement section being placed)
- ☐ Linkage to crew or equipment (placement crew, paver, roller, or batch plant operator)
- ☐ Other (please specify):

11. Geospatial referencing

11.1 To what extent are the following records georeferenced at the time of data capture?

	All records are geolocated	Most of the records are geolocated	Some of the records are geolocated	Very few of the records are geolocated	None of the records is geolocated
Agency material and test records					
Contractor QC test					

records					
Supplier test records and certifications					
Electronic construction data (e.g. IC, PMPT, GPR)					
Agency e-ticket material records					
Agency Inspection records					

"Geolocated" means associated with a specific physical location on the highway network, by any method, e.g. geographic coordinates (latitude/longitude), Linear Referencing System (LRS) measures, state plane coordinates, or other location reference. The location may be captured at the time of the record's creation (in the field) or assigned later (during ingestion or integration).

- ☐ Yes; all pavement and materials records are geolocated
- ☐ Yes; most pavement and materials records are geolocated
- ☐ Partially; some data types are geolocated, others are not
- ☐ Rarely; geolocation is the exception rather than the rule
- ☐ No; pavement and materials records are not geolocated in enterprise systems
- ☐ Don't know

11.2 Which location reference methods does your agency use to link pavement and materials records to a specific location? Select all that apply.

- ☐ Geographic coordinates (latitude/longitude), referenced to a national geodetic datum
- ☐ Linear Referencing System (LRS); route and measure (e.g., milepost, kilopost, station)
- ☐ State plane coordinates
- ☐ Local or project-specific datum (e.g., project control network, construction grid)
- ☐ Plan-sheet references (e.g., sheet number, plan station)
- ☐ Address or descriptive location (e.g., intersection, landmark)
- ☐ Other (please specify):

12. Data standards and exchange

12.1 Which of the following data exchange standards or specifications does your agency currently use (or pilot) for pavement and materials data? Select all that apply.

Technology	Awareness	Exploring	Pilot	In Use	Not Used
AASHTO standards or specifications					
AASHTOWare-compatible exchange formats					
LandXML					
IFC (Industry Foundation Classes) for infrastructure					
OGC standards (e.g., SensorThings API, GeoPackage)					
Custom agency-specific exchange specifications					
No formal exchange standards in use					

12.2 How is pavement and materials data most commonly transferred from consultants, contractors, and labs to your agency?

- ☐ Automated machine-to-machine feed (API/web service/direct database link)
- ☐ Structured file upload to an agency portal (XML, CSV, JSON, etc.)
- ☐ PDF or scanned document upload to a document management system
- ☐ Email attachments
- ☐ Paper submittal

- ☐ Mixed; different methods for different data classes
- ☐ Don't know

13. Metadata, schema, and structured data

13.1 Does your agency operate a metadata catalog or data dictionary that documents the fields, units, allowed values, and source references for pavement and materials data?

- ☐ Yes; enterprise-wide catalog or dictionary including pavement and materials data
- ☐ Yes; catalog or dictionary at the program-office level
- ☐ Partially; documented for some data classes only
- ☐ No formal catalog or dictionary
- ☐ Don't know

13.2 Approximately what proportion (measured by record count or volume) of your agency's pavement and materials data (Highway Performance Monitoring System (HPMS)/Pavement Condition, Pavement Design, Materials Acceptance/Construction, and Asset Management/Maintenance data) is stored in a fully structured, machine-queryable form (i.e., structured, indexed, and accessible via structured query not as PDFs, scans, or photos)?

Machine-queryable data is structured, indexed, and hosted in a way that allows specific questions to be asked of the data and targeted answers to be retrieved efficiently; for example, a relational database with defined schemas, or data accessible through a queryable API.

- ☐ Less than 10%
- ☐ 10–24%
- ☐ 25–49%
- ☐ 50–74%
- ☐ 75% or more
- ☐ Don't know

13.3 Does your agency maintain a documented data schema (structure, fields, relationships) for pavement and materials data?

- ☐ Yes; a single enterprise-wide schema spans pavement, materials, and construction data
- ☐ Yes; separate schemas for separate data classes (e.g., pavement condition vs. materials testing)
- ☐ Partially; some data classes have documented schemas; others do not
- ☐ No formal schema is documented
- ☐ Don't know

14. Data quality and assurance

14.1 Which of the following quality gates does your agency implement for pavement and materials data captured by agency or received by agency (i.e. from contractor)? (check all that apply)

A "quality gate" is a predefined checkpoint that a data record must pass before advancing to the next lifecycle stage. Quality gates apply to individual data records (e.g., a test result, an inspection record, an e-Ticket) as those records move through capture, ingestion, integration, and publication. Quality gates are distinct from program-level assurance activities such as Independent Assurance under 23 CFR 637, which is addressed in the following question. Please consider both data captured directly by the agency (e.g., agency lab and inspector records) and data received by the agency from contractors, producers, and consultants.

- ☐ Capture-time checks (calibration verification, equipment status, sampling plan compliance)
- ☐ Ingestion-time checks (completeness, range and reasonableness, relational integrity, data comparison, statistical validation checks)
- ☐ Integration-time checks (identifier resolution, location-reference validation, schema conformance)
- ☐ Publication-time review and approval workflow
- ☐ Independent Assurance procedures
- ☐ None of the above
- ☐ I don't know

14.2 Are IA program data captured and integrated into your agency's enterprise materials/construction data systems?

- ☐ Yes; IA results are stored and linked to the corresponding acceptance records
- ☐ Partial; IA results are stored separately and not linked to acceptance records
- ☐ IA results are documented but not in an enterprise system (paper, spreadsheets, personal files)
- ☐ No
- ☐ Don't know

14.3 How would you characterize each of the following data quality dimensions for your agency's pavement and materials data, in general, across Highway Performance Monitoring System (HPMS)/Pavement Condition data, Pavement Design data, Materials Acceptance/Construction data, and Asset Management/Maintenance data?

Quality Dimension	Very poor	Poor	Fair	Good	Excellent	Don't know
Completeness (required fields populated for required records)						
Accuracy (recorded values reflect actual material, location, event)						
Traceability (records linkable to sample, lot/sublot, location, time, personnel, equipment)						
Consistency (equivalent records expressed consistently across systems and over time)						
Timeliness (data available within the time frame the decision requires)						
Accessibility (authorized users can find and retrieve						

without disproportionate effort)						
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15.Lifecycle workflow maturity

15.1 For each lifecycle stage, please indicate the maturity of your agency's documented and standardized workflows for pavement and materials data.

Maturity definitions:

- Level 0 (Siloed) = No documented workflow. Records may exist in practice but are paper-based, in personal files, or in disconnected systems with no agency-wide convention.
- Level 1 (Initial) = Some workflows documented for some projects, but practice varies across districts, project types, or staff.
- Level 2 (Defined) = Agency-wide standard workflow exists.
- Level 3 (Managed) = Workflow has quality gates, audit trails, automation.
- Level 4 (Optimized) = Continuous improvement is operational.

Stage	Level 0 Siloed	Level 1 Initial	Level 2 Defined	Level 3 Managed	Level 4 Optimized	Don't know
Plan/Design (network-level program planning, pavement structural design, mixture design submittal and approval – the engineering artifacts and decisions that define what will be built and what materials will be used, produced before any field sampling)						
Capture (sampling, testing, recording, and field inspection)						
Ingest (transferring						

data from field/lab/contractor to enterprise systems)						
Store (persisting data in governed repositories)						
Compute (transforming data into indicators, compliance determinations, and pay-factor calculations)						
Use (delivering data to decision-makers, dashboards, reports)						
As-Built/Handoff (closeout activities: capture of digital as-built records, project-to-asset (Project Information Model (PIM) to Asset Information Model (AIM)) handoff, transfer of construction-era records to pavement management and asset management systems)						

16.Data handoffs and long-term stewardship

16.1 Which of the following data-handoff points are documented (formal procedure, roles and responsibilities matrices, or written specification) at your agency?

Handoff Point	Yes	No	Partial	Doesn't happen	Don't know
Materials producer/lab à Construction inspectors (e.g., e-ticket data, mix design)					
Contractor Quality Control à Agency					

acceptance/ verification					
Construction office à PMS office (project closeout/as-built data)					
Construction/Materials offices à IT/Data office (transfer of construction records into the enterprise data repository)					
Project Information Model (PIM) à Asset Information Model (AIM) at project closeout					
Independent Assurance (IA) testers à Agency acceptance data system (linkage of IA results to the corresponding acceptance records)					
Inter-agency/Federal reporting (HPMS, NHPP performance measures)					

16.2 How are pavement and materials records typically managed for version control and audit trail?

Data Type	No forma l versio n contr ol	Documen t-based versionin g	Databas e audit logs	Full lineag e trackin g	Mixed; differen t practice s for differen t data types	Don' t kno w
Highway Performance Monitoring System (HPMS)/Pavement Condition						
Pavement Design						
Materials Acceptance/Constructio n						
Asset						

Management/Maintenance						
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16.3 Does your agency have an explicit, documented retention and disposition schedule for pavement and materials data?

- ☐ Yes; documented and applied across the enterprise
- ☐ Yes; documented at the agency or office level but not enterprise-wide
- ☐ Partially; some data classes have schedules; others do not
- ☐ No; retention is ad hoc
- ☐ Don't know

16.4 What is the most common form in which pavement and materials records are stored long-term at your agency?

	Records captured by the agency	Records received from the contractor	Electronic data captured from construction technologies (IC, PMPT, IR)
Paper records (physical files)			
Scanned PDFs in a document management system (e.g., ProjectWise, SharePoint)			
Spreadsheets on an individual computer			
Spreadsheets stored in shared drives			
Structured databases with defined schemas			
Mixed; different forms for different data classes			
Don't know			

17. Persistent identification and traceability

17.1 Are persistent identifiers used for the following entities in your agency's pavement and materials records, such that the identifier is stable across systems and across time?

Identifier	Yes	No	Don't know
Project/contract identifier			
Project type (rehab, preservation, new)			
Prime contractor			
Resident engineer			
Letting date			
completion or final acceptance date			
Pavement section/asset segment identifier			
Materials lot/sublot identifier			
Sample/specimen identifier			
Test method/equipment identifier			
Location reference			

18. Project-to-asset information

18.1 How would you rate the maturity of your agency's PIM-to-AIM (project-to-asset) handover for pavement projects?

- ☐ Level 0 (Siloed): No formal handover; project records are filed but not transferred to asset systems.
- ☐ Level 1 (Initial): Some project records (typically as-built drawings) transfer; QA/QC data do not.
- ☐ Level 2 (Defined): Documented handover specifying which records transfer; transfer is largely manual.
- ☐ Level 3 (Managed): Documented handover with quality gates; transfer is largely automated.
- ☐ Level 4 (Optimized): Full structured handover with metadata, provenance, and continuous improvement.
- ☐ Don't know

19. PMS integration and decision support

19.1 Is project-level data integrated into your agency's Pavement Management System for analytical purposes?

- ☐ Yes; routine, automated linkage of project records to PMS sections
- ☐ Yes; manual linkage performed for specific analyses
- ☐ Pilot or research effort underway, not yet in production
- ☐ No; construction records are not used in PMS analyses
- ☐ Don't know

19.2 Does your agency perform Life Cycle Cost Analysis (LCCA) for pavement decisions?

- ☐ Routinely; LCCA is performed as a standard step for most pavement design and rehabilitation decisions
- ☐ Occasionally; LCCA is performed for major projects or when required by funding source, but not as a standard practice
- ☐ Rarely; LCCA is performed only in exceptional circumstances
- ☐ No; LCCA is not performed
- ☐ Don't know

19.3 [If Routinely; Occasionally; Rarely] Is LCCA integrated with your agency's Pavement Management System?

- ☐ Yes, fully integrated; LCCA runs use PMS condition data, performance models, and cost data directly from the PMS
- ☐ Partially integrated; some inputs (e.g., performance models or unit costs) come from the PMS, but the LCCA itself is performed outside the PMS
- ☐ Not integrated; LCCA is performed in standalone tools (e.g., FHWA RealCost, custom spreadsheets) using inputs assembled manually
- ☐ Don't know

20. Performance feedback and continuous improvement

20.1 Does your agency have a formal feedback loop in which observed pavement performance informs upstream design specifications, mix designs, or acceptance criteria?

- ☐ Yes; formal, recurring review cycle with documented improvement actions
- ☐ Yes; informal but established practice

- ☐ Occasionally; driven by specific projects or events rather than as a recurring practice
- ☐ No; no feedback loop is in place
- ☐ Don't know

21. Information requirement

21.1 Which of the following trigger events currently drive defined information requirements for pavement and materials data at your agency? Select all that apply.

A defined information requirement (IR) is a documented, agency-approved specification of what information the agency needs, in what form, and by when – for example, a data specification document, schema, data dictionary, or documented data call.

- ☐ Programming-cycle (annual/biennial programming, STIP/TIP, target setting)
- ☐ Performance-reporting (HPMS, NHPP/NHFP measures, AASHTO data calls)
- ☐ Design-decision (project scoping, pavement type selection, mix design)
- ☐ Specification-development (revision cycles, new test methods, PRS)
- ☐ Acceptance/payment (lot acceptance, pay-factor, dispute resolution)
- ☐ Real-time construction (IC alerts, thermal profile, density verification, e-ticketing)
- ☐ Independent assurance/validation (IA checks, split samples, lab competency)
- ☐ Project-closeout (final acceptance, PIM-to-AIM handover, warranty)
- ☐ Condition-threshold (PMS thresholds, treatment selection, preservation cycles)
- ☐ Asset-event (distress reports, emergency repair, warranty claims)
- ☐ Forensic/research (premature failure investigation, model recalibration)
- ☐ Governance/compliance (audits, FOIA, retention reviews, cybersecurity)
- ☐ Technology/integration (system migration, new data source onboarding, API changes)
- ☐ None of these are formally defined as IR triggers

22. Provenance and lineage

22.1 How is provenance/lineage (origin, derivation, processing history) documented for derived pavement performance indicators or QA-based metrics produced by your agency?

Provenance is the record of where a data value came from and how it was processed; i.e. the audit trail that lets a derived indicator be traced back to its source records and to the analytical steps that produced it

- ☐ Full provenance tracking; each derived value can be traced to its source records, processing steps, and version of analytical code
- ☐ Documented processing methodology; the methodology is documented but record-level traceability is not maintained
- ☐ Informal; provenance is reconstructable through institutional knowledge but not documented
- ☐ Provenance is not documented
- ☐ Not applicable; we do not produce derived QA-based metrics
- ☐ Don't know

23. Analytics and visualization

23.1 What analytical and visualization tools does your agency use to derive insights from pavement and materials data?

- ☐ Built-in PMS analytics/reporting
- ☐ Power BI
- ☐ Tableau
- ☐ Esri ArcGIS Dashboards/Insights
- ☐ Custom in-house dashboards or web applications
- ☐ Statistical software (R, SAS, Python, SPSS)
- ☐ Excel/spreadsheet-based analysis (predominant tool)
- ☐ None of the above
- ☐ Don't know

24. Current business use cases

24.1 For each of the following use cases, indicate whether your agency uses pavement and materials data today.

Use Case	In use	Pilot only	Aspirational	Not applicable	Don't know
test results inform pay-factor adjustments at acceptance					
construction data inform performance-related specifications (PRS)					
construction data feed PMS performance models as leading indicators					
Intelligent compaction data inform structural design assumptions					
Materials testing data inform mix-design optimization					
construction data link to pavement section condition history					
Construction data support cost estimation, cost analysis, or Life Cycle Cost Analysis (LCCA)					
Construction data support forensic investigation of premature failures					
Construction data support warranty claim adjudication					

25. Forensic traceability

25.1 Does your agency have a documented forensic-analysis capability that allows pavement performance problems to be traced back to their construction-era records?

Forensic traceability means the ability to identify, for a specific pavement section experiencing a problem (premature distress, warranty claim, unexpected failure), the mix design used, the aggregate sources and structural layers, the contractor QC

results, the agency acceptance test results, the placement conditions, the intelligent construction outputs (if any), and the inspectors and equipment involved.

- ☐ Routinely; these records are linked to pavement sections in our systems and can be retrieved without significant effort
- ☐ With effort; records exist but require manual research across multiple systems and offices to assemble
- ☐ Partially; some classes of records (e.g., mix designs) are retrievable; others (e.g., intelligent compaction outputs, aggregate sources) are not
- ☐ Rarely; historical records are difficult to retrieve once a project is closed out
- ☐ Not at all; forensic investigation is not a practice our agency performs
- ☐ Don't know

26. Official records and contractor payment

26.1 At what point in the data lifecycle does pavement and materials data become the official record used for contractor payment?

- ☐ At field/lab data entry (real-time)
- ☐ When verified by the agency inspector or materials engineer on the project
- ☐ When loaded into the agency's materials/construction management system
- ☐ When reviewed and approved by district/central office
- ☐ At lot or project closeout
- ☐ Other (please specify): _____
- ☐ Don't know

27. Barriers to integration

27.1 What is the biggest process-related barrier to pavement and materials data integration for each of the following types of integration?

Quality assurance with lab: _____

Quality assurance with Pavement Management System (PMS) _____

Quality assurance with digital-as-builts (DAB) _____

27.2 Briefly describe the single greatest data-related challenge your agency faces in advancing pavement and materials data integration.

(open text field)_____

27.3 Briefly describe the single greatest people-related barrier to integrating pavement and materials data at your agency?

(open text field)_____

27.4 Briefly describe the single greatest technology-related challenge your agency faces in advancing pavement and materials data integration.

(open text field)_____

28.Future state and agency needs

28.1 Which of the following practices would your agency like to implement but has not yet been able to?

- ☐ Real-time linkage of construction pavement and materials data to PMS sections via Geospatial location
- ☐ Automated PIM-to-AIM handover at project closeout
- ☐ Enterprise data catalog including pavement and materials data
- ☐ ISO 19650-aligned information requirement framework
- ☐ Lineage tracking for derived performance indicators
- ☐ Standardized exchange specifications with contractors and consultants
- ☐ Centralized intelligent construction data repository
- ☐ Performance-based feedback from PMS to design/specification
- ☐ Common Data Environment (CDE) for pavement information
- ☐ Other (please specify): _____
- ☐ We are satisfied with current practices; no significant aspirations beyond present state

28.2 What barriers are preventing implementation of the practices you indicated in the previous questions?

- ☐ Resource/budget constraints
- ☐ Staff capacity or skill gaps
- ☐ Technology limitations or vendor constraints
- ☐ Organizational/governance barriers (silos, role clarity)

- ☐ Absence of industry standards or guidance
- ☐ Procurement/contract structure does not support new practice
- ☐ Other (please specify): _____
- ☐ Not applicable

28.3 What forms of assistance from FHWA, AASHTO, or peer agencies would most accelerate progress at your agency? Select all that apply.

- ☐ Standardized data schemas and exchange specifications
- ☐ Reference architectures or technical guidance documents
- ☐ Funding opportunities (grants, pooled-fund studies)
- ☐ Peer-exchange and case-study sharing
- ☐ Training and professional development programs
- ☐ Evaluation tools (internal note: this is what we are developing)
- ☐ Model contract/specification language
- ☐ Maturity assessment by business unit
- ☐ Maturity assessment agencywide
- ☐ Identification of expertise needed
- ☐ National requirements
- ☐ Other (please specify): _____

29. Lessons learned and follow-up

29.1 Briefly describe the single most successful practice your agency has implemented for pavement and materials data integration that you believe other agencies could learn from.

(open text field) _____

29.2 Please upload to this survey or send to hala.nassereddine@uky.edu any documentation (e.g., workflows, policies, or guidance documents) that you would like to share with the research team.

[upload button]

29.3 Is there anything you would like to add to your response?

(open text field) _____

29.4 Would your agency be willing to participate in a follow-up semi-structured interview (60 minutes) to provide additional depth on advanced practices or implementation challenges?

☐ Yes

☐ No

[If Yes] Please provide your:

Name: _____

Email Address: _____