HIGHWAY PERFORMANCE MONITORING SYSTEM

Data Quality Management Plan for Pavement Condition Data Collection

FDOT Office

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OBJECTIVE

The objective of this Data Quality Management Plan (DQMP) is to address the quality of all data collected to report the pavement condition metrics as described in Title 23 CFR 490-319(c). The DQMP includes details on methods and processes to control and assure quality such as calibration and certification of data collection equipment, data quality control measures, and procedures to resolve issues and accept the final data. An annual report will be prepared to document the quality management program, recommended improvements, and improved technology and reporting methods.

DATA QUALITY MANAGEMENT APPROACH

The Florida Department of Transportation (FDOT) will collect pavement condition data to meet the Highway Performance Monitoring System (HPMS) requirements and pavement performance measures established by MAP-21 and the FAST ACT through Title 23 CFR part 490. Consequently, the subject DQMP has been developed to ensure that all the data quality requirements are satisfied and to guarantee data integrity. The plan identifies key steps and processes to be completed and monitored before, during, and after data collection. Table 1 provides a brief description of each section included in this DQMP.

Table 1. Description of report sections.

REPORT SECTION	DESCRIPTION
Deliverables, Protocols, and Quality Standards	Deliverables subject to quality review, protocols used to collect the pavement data, and the quality standards used to determine a successful deliverable.
Quality Control	Quality control activities that monitor, provide feedback, and verify that the data collection deliverables meet the defined quality standards.
Acceptance	Acceptance testing that will be used to determine if quality criteria are met and the corrective actions that will be taken for any deliverables not meeting the prescribed criteria.
Quality Team Roles and Responsibilities	Related roles and responsibilities of the data collection and reporting team members.
Quality Reporting Plan	Documentation of all quality management activities including quality standards, quality control, acceptance, corrective actions, and the format of the final report.
Acceptance of the Quality Management Plan	Signature page for acceptance of the DQMP.

DELIVERABLES, PROTOCOLS, & QUALITY STANDARDS

Pavement condition to be collected and related roadway identification data are shown in Table 2. Key deliverables as well as associated data collection protocols, and standards are shown in Table 3. Table 3 also includes quality acceptance targets, requirements, and other statistics for both pre- and post-data collection.

Table 2. Pavement condition data items.

DELIVERABLE		
Roadway Identification Data	**Asphalt Pavement**	**Jointed Concrete Pavements***

• Surface type
• Direction
• Roadway ID
• Number of lanes
• Lane tested
• GPS coordinates
• Mileposts
• Roadway events
  – Construction limits
  – Bridge limits
  – Lane deviations
	• IRI
	• Rut depth
	• Cracking percent
		• IRI
		• Fault depth
		• Cracking percent

*All rigid pavements on the state and national highway systems are jointed concrete.

Table 3. Data Collection Protocols and Quality Standards

Deliverable	Protocols	Resolution	Repeatability Or Reproducibility	Accuracy (compared to reference value)	Reference Source
Pre-Data Collection					
IRI	AASHTO M328-14 AASHTO R57-14 AASHTO R43-13 AASHTO R56-14	1 in/mi	Cross correlation score ≥ 0.92	Cross correlation score ≥ 0.90 or within 5% IRI	SurPro
DMI	AASHTO R56-14	0.001 mile	NA	±0.15% of certification site	Surveyed length
Rut Depth	AASHTO R87-18 section 6.7, AASHTO R88-18 HPMS Field Manual (2016)	0.01 in	± 0.06 in	± 0.06 in	Florida Laser Meter
Faulting	AASHTO R36-17 method B HPMS Field Manual (2016)	0.01 in	± 0.08 in	± 0.08 in	Florida Laser Meter
Cracking Percent (Asphalt)	AASHTO R85-18, AASHTO R86-18, HPMS Field Manual (2016)	1%	± 20%	± 20%	Manual image review
Cracking Percent (Jointed Concrete)	AASHTO R86-18, HPMS Field Manual (2016)	1%	± 20%	± 20%	Manual image review
GPS	NA	NA	±10 ft. of calibrated position	±10 ft. of calibrated position	Surveyed marker
Post-Data Collection					
IRI	AASHTO M328-14 AASHTO R57-14 AASHTO R43-13	1 in/mi	Interstate: ±7 in/mi Non-Interstate: ±15% difference*	NA	Department certified profiler
Cracking Percent (Asphalt)	AASHTO R85-18, AASHTO R86-18, HPMS Field Manual (2016)	1%	± 20%	± 20%	Manual image review
Cracking Percent (Jointed Concrete)	AASHTO R86-18, HPMS Field Manual (2016)	1%	± 20%	± 20%	Manual image review

* Values will be monitored, and thresholds will be re-assessed with more data collected at the end of the survey year.

QUALITY CONTROL

Inertial Profiler Certification

FDOT owns and operates a Profiler Certification track located at the Williston Municipal Airport, shown in Figure 1. The certification track is 3,700 feet long and includes open and dense-graded asphalt surfaces. The purpose of this facility is to ensure accurate, reliable, and certifiable longitudinal profile measurements. Figure 2 shows the reference profiling device used as part of the certification program. All Data Survey Vehicles (DSV) and inertial profilers used for data collection and verification must be certified before production data collection starts, according to AASHTO R56-14 and meet the following requirements:

- Repeatability score of 0.92 or greater
- Accuracy score of 0.90 or greater
- DMI accuracy of 0.15% or better

Figure 1. FDOT Profiler Certification Track at Williston Municipal Airport.

Figure 2. SurPro Collecting Reference Longitudinal Profile for AASHTO R56 Certification.

Field Verification Sites (Pre-Data Collection)

In addition to the Profiler Certification track, three flexible and one rigid pavement field sites will be used to verify the ability of the test equipment to measure rut depth, faulting, and percent cracking. The sites are shown in Table 4 and are 0.3-mile in length for the flexible and rigid sections.

Table 4. Field Verification Sites.

Pavement Type	County	Roadway ID	US/SR Route	Lane	Beginning Milepost	Ending Milepost
Flexible	Alachua	26050000	24	R2	15.500	15.800
	Alachua	26080000	20	L2	8.058	7.758
	Alachua	26510000	CR225	L2	3.140	2.840
Rigid	St. Johns	78060000	16	L1	19.755	19.455

A statistical evaluation will be performed to verify the DSV measured rut depth, percent cracking, and fault depth. Ten 0.03-mile subsections measured by the DSV are compared to the reference values for those sub-sections using a Two One-sided Test of Equivalence for Paired-Samples (TOST-P).

Rut Depth: Reference rut depth will be determined through transverse profile measurements in each wheel path using a high-precision laser meter built by the department known as the Florida Laser Meter (FLM) as shown in Figure 3. The FLM is equipped with a laser and measures the elevation change across the length of the device. The FLM is used to measure the left and right wheel path profile and to determine the rutting measurement. Rut depths are calculated as described in AASHTO R87-18 and the HPMS Field Manual.

Percent Cracking: Reference percent cracking of asphalt and rigid pavement (wheel path fatigue cracking) will be performed by an experienced rater that has successfully completed the Department's annual distress verification/certification training. This training is similar to the Long-Term Pavement Performance Program (LTPP) distress accreditation workshops where distress types are reviewed in a classroom setting followed by a field assessment of distresses.

Fault Depths: Reference fault depths will be made with the FLM on the rigid pavement verification section. For faulting verification, the FLM is positioned perpendicular to the joint. Fault depths are calculated as described in AASHTO R36-17 and the HPMS Field Manual.

Figure 3. Florida Laser Meter (FLM) used for rut and fault depth verification.

In addition to the distress verification sites, a roadway with surveyed permanent markers will be used to verify the accuracy of the Global Positioning Satellite (GPS) system measurements of the test vehicle.

The DSV will perform three repeat runs at each field verification site. The resulting data must meet the accuracy and repeatability requirements shown in Table 3 prior to collecting network data. If these requirements are not met, corrective actions must be taken, documented, and approved before any further verification testing. Based on surface type to be tested (either flexible or rigid pavements), field verification on that pavement type must have been performed within the past 30 days.

Data Verification (During and Post-Data Collection)

Verification and calibration tests must be performed before data collection and at specified intervals throughout the testing period. All verification and calibration test results during the data collection process must be documented and provided to the Quality Management Team for review. AASHTO R57-14 provides guidance on the frequency of tests required from a standard inertial profiler. If AASHTO R57-14 is not applicable to the test vehicle used during data collection, the manufacturer's recommended tests and frequencies should be used. Below are the verification and calibration tests outlined in AASHTO R57-14.

- Daily tire pressure check
- Daily accelerometer calibration and bounce test
- Distance check and calibration every 30 days
- Rut verification every 30 days
- Block test every 30 days
- Verification site tests every 30 days

For data verification purposes (post-data collection), at least 10% of all surveyed miles within each District will be sampled for verification of IRI and faulting. A minimum of 5% of all surveyed miles in each District will be sampled for cracking verification purposes. A Department profiler will be used to collect IRI and faulting verification data. Images from the test vehicle will be reviewed manually and compared with the percent crack data reported. IRI, faulting, and percent cracking must meet the requirements in Table 3. In general, verification samples will be randomly selected. However, expected trends based on historical data, construction limits, and other factors may be considered when selecting verification samples.

Data Reporting Format

Pavement condition data should be collected and summarized in the following manner.

- Summarized in nominally uniform 0.1-mile intervals; shorter sections are permitted only at the beginning/ending of a route, at bridges, or other locations where a section of 0.1 mile is not achievable; the maximum length of a section shall not exceed 0.11 miles
- Aligned with other pavement condition measures
- Collected in the furthest outside continuous travel lane
- Collected only in the direction of ascending milepost.

At a minimum, the following data should be collected and reported.

- County ID
- Milepost and GPS coordinates
- Data collected
    - Pavement condition (IRI, rut depth, percent cracking, faulting)
    - Pavement surface type (flexible or rigid)

All data should be collected and reported according to the 2016 Highway Performance Monitoring System Field Manual. If the pavement condition cannot be measured due to construction or any other long-term obstructions, report the reason of no measurement and corresponding roadway mileposts. Delays due to traffic accidents, heavy traffic, weather, or other minor delays should be rescheduled within the initial collection period.

ACCEPTANCE

The focus of the data acceptance process is to validate the key deliverables meet the specified data quality criteria. Table 5 describes the acceptance criteria and actions if the criteria is not met.

Table 5. Data acceptance requirements

Deliverable	Acceptance (% in Limits)	Acceptance Testing	Action if Criteria Not Met
Pre-Data Collection and During Data Collection			
IRI, Rut Depth, Fault Depth, Percent Cracking and Distance Verification	100	• Certification and verification site tests • Routine Equipment checks	Data will be rejected and must be recollected
Post-Data Collection			
IRI	80	• Sample verification testing	Data will be rejected and must be recollected
Cracking Percent	80	• Sample verification testing	Data will be rejected and must be reprocessed or recollected
Data Format	100	• Entire dataset checked for correct format	Data will be rejected and must be reprocessed or recollected
Segment Data	100	• Mileage review • GIS comparison	Data will be rejected and must be recollected

QUALITY TEAM ROLES & RESPONSIBILITIES

The following table identifies the quality-related responsibilities of the data collection team.

Table 6. Quality management roles and responsibilities

Role	Assigned	Quality Management Responsibilities
Pavement Evaluation Engineer	Charles Holzschuher	• Provides overall management, oversight, and direction • Approves quality standards and corrective actions • Approves resolutions of quality issues • Recommends improvement to quality processes
Pavement Condition Survey Administrator	William (Thad) Bryant	• Communicates with data collection team • Ensures certification of Department equipment and qualifications of manual distress rater • Reviews and approves submitted data for completeness, correct format, and quality
Pavement Condition Testing Operator	FDOT Operator	• Communicates with Consultant data collection team • Certifies Department equipment and performs periodic calibration • Collects Department verification data • Maintains Department data quality records • Reviews submitted data for completeness, correct format, and quality
On-Site Consultant Pavement Condition Engineer	Mateo Carvajal	• Maintains test vehicle data quality records • Ensures data collection vehicle Certification • Performs daily, weekly, and final data and image acceptance checks • Communicates and resolves issues with FDOT staff
Test Vehicle Operator and Data Collector	FDOT Operator	• Performs equipment certifications, verifications, periodic equipment checks, and calibrations • Collects pavement condition data as directed • Performs daily review of data logs for quality and completeness • Assures completion of periodic verification testing • Documents all field quality activities and reporting of any problems

QUALITY REPORTING PLAN

Data quality personnel will monitor the data quality according to the methods presented in this plan. Data quality exceptions will be reported as soon as possible, but no later than weekly. Quality is monitored through acceptance testing and issues regarding quality will be reported to the data collection team as soon as they are discovered.

In addition to delivery of the final database and all deliverables, the data collection team will provide documentation of all calibration and verification records, a list of data collection vehicles and personnel used on the project, and any issues or problems encountered and corrective actions taken. The Department will develop a comprehensive log of all issues, resolutions, and findings to document all data quality actions. Recommended improvements will be made to address any issues, shortcomings, or improved technology and reporting methods. An annual report will be prepared that includes all the above aspects.

ACCEPTANCE OF QUALITY MANAGEMENT PLAN

_____ Date:_____

Pavement Evaluation Engineer

_____ Date:_____

Pavement Condition Administrator

APPENDIX: DATA COLLECTION STANDARDS

AASHTO Standard M328-14, Standard Specification for Transportation Materials and Methods of Sampling and Testing, Inertial Profiler, 2014, 34th/2014 Edition.

AASHTO Standard R85-18, Standard Specification for Transportation Materials and Methods of Sampling and Testing, Standard Practice for Quantifying Cracks in Asphalt Pavement Surfaces from Collected Images Utilizing Automated Methods, 2018.

AASHTO Standard R86-18, Standard Specification for Transportation Materials and Methods of Sampling and Testing, Standard Practice for Collecting Images of Pavement Surfaces for Distress Detection, 2018.

AASHTO Standard R87-18, Standard Specification for Transportation Materials and Methods of Sampling and Testing, Standard Practice for Determining Pavement Deformation Parameters and Cross Slope from Collected Transverse Profiles, 2018.

AASHTO Standard R88-18, Standard Specification for Transportation Materials and Methods of Sampling and Testing, Standard Practice for Collecting the Transverse Pavement Profile, 2018.

AASHTO Standard R36-17, Standard Specification for Transportation Materials and Methods of Sampling and Testing, Standard Practice for Evaluating Faulting of Concrete Pavements, 2017.

AASHTO Standard R43-13, Standard Specification for Transportation Materials and Methods of Sampling and Testing, Standard Practice for Quantifying Roughness of Pavement, 2014, 34th/2014 Edition.

AASHTO Standard R56-14, Standard Specification for Transportation Materials and Methods of Sampling and Testing, Standard Practice for Certification of Inertial Profiling Systems, 2014, 34th/2014 Edition.

AASHTO Standard R57-14, Standard Specification for Transportation Materials and Methods of Sampling and Testing, Standard Practice for Operating Inertial Profiling Systems, 2014, 34th/2014 Edition.

U.S. Department of Transportation, Federal Highway Administration, Highway Performance Monitoring System Field Manual, December 2016.