ILLINOIS

National Performance Management Measures
Data Quality Management Program

Reporting Pavement Metrics for the NHS
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CONTENTS

PURPOSE

Provide a Data Quality Management Program per 23 CFR §490.319 that addresses the quality of all data collected, regardless of the method of acquisition, and how to report the pavement condition metrics, as described in 23 CFR §490.311, and data elements as described in 23 CFR §490.309.

DOT's are required to report the four pavement conditions metrics as discussed in 23 CFR §490.311: (1) International Roughness Index (IRI), (2) rutting, (3) faulting, and (4) cracking percent. The four pavement condition metrics will measure (1) percentage of pavements of the Interstate System in Good Condition, (2) percentage of pavements of the Interstate System in Poor condition, (3) percentage of pavements of the non-Interstate National Highway System (NHS) in Good condition, and (4) percentage of pavements of Non-Interstate NHS in Poor condition.

Required to report the collection of the three inventory data elements in accordance with 23 CFR §490.309 and abiding by the HPMS Field Manual: (1) Through lanes, (2) Surface Type, and (3) Structure Type.

DATA COLLECTION

Equipment and methodology utilized

Condition

A Laser Crack Measurement System (LCMS) is used to collect and report: (1) IRI, (2) rutting, (3) cracking, and (4) faulting for all pavements identified for collection.

Equipment

The equipment and systems shall be in accordance to AASHTO M328-14, with the addition of offering 4,000 points of roughness measurements across a 4m width.

Collection Method

Data shall be collected per Driving File (GIS layer package) provided by Illinois Department of Transportation (IDOT) approximately one month prior to collection. The Driving File will be based on IDOT's Linear Reference System (LRS) and includes the interstate system, interstate tollways and all non- interstate NHS pavements. To ensure data consistency year-after-year the following driving instructions shall be followed.
- Collection shall be in the direction of inventory for undivided roadways.
- Both directions shall be collected for divided roadways.
    - With two lanes in each direction the DCV shall drive in the right most lane.
    - With three lanes in each direction the DCV shall drive in the center lane.
    - With four or more lanes in each direction the DCV shall drive in the second-from-right lane.
    - The DCV shall drive the local lanes when there is an express lane option.
- Collection takes place in the through traffic lane, except for six or more lanes the collection lane will be shifted one lane to the left.
- In locations where lanes are added for intersections or for merging traffic, the collection vehicle shall stay in the continuous through lane.
- When parking is allowed in one lane of a multiple lane roadway, the DCV shall stay in the through traffic lane making an effort to keep the centerline in the downward image.
- The DCV shall travel in the wheel paths at a steady speed with passing kept to a minimum.
- Sufficient spacing between the DCV and other vehicles shall be maintained to allow clear pavement views in all images.

- In areas with heavy congestion, data collection shall be performed during non-rush hour periods.
- Impassable highway sections due to construction or other impediment in which collection cannot be safely performed shall not be collected. The reason for no collection is to be noted and reported to IDOT.

All Data Collection Vehicle (DCV) drivers and operators shall receive annual training prior to collection. Training will cover the proper collection criteria, equipment operation, testing, troubleshooting and error resolution.

IRI
The collection of data shall be in accordance with the following standards:
- AASHTO R57-14 Standard Practice for Operating Inertial Profiling Systems
- AASHTO R56-14 Certification of Inertial Profiling Systems

Rutting
The collection of data shall be in accordance with the following standards:
- An Automated Transverse Profile Data method in accordance with the HPMS Field Manual December 2016 edition
- AASHTO PP70-14 Standard Practice for Collecting the Transverse Pavement Profile

Faulting
The collection of data shall be in accordance with the following standards: AASHTO R36-13 Standard Practice for Evaluation Faulting of Concrete Pavement

Cracking
IDOT performs a visual survey on the LCMS pavement images which includes checking for identification of false positive cracking and marked cracking meets severity criteria defined by IDOT. The identified wheel paths are also reviewed to ensure compliance with the HPMS Field Manual December 2016 edition. The collection, quantification, and reporting of cracking data shall be in accordance with the following standards:
- AASHTO PP68-14 Standard Practice for Collecting Images of Pavement Surfaces for Distress Detection
- AASHTO R55-10 Standard Practice for Quantification of Cracking in Asphalt Pavement Surfaces
- HPMS Field Manual December 2016 edition
  - **Asphalt**: automated collection in wheel paths only *(for asphalt: AASHTO PP67-16 Standard Practice for Quantifying Cracks in Asphalt Pavement Surfaces from Collected Pavement Images Utilizing Automated Methods)*
  - **CRCP**: longitudinal cracking and punch-out's
  - **Jointed concret**e: cracked slabs

Pavement

Initial collection to obtain surface type and through lane data shall be obtained from construction as-built plans and field reviews at the end of the construction contract using HPMS manual parameters.

The data collection for through lane data and surface type data shall be in accordance with:
- HPMS Field Manual December 2016 edition
- Full extent of mainline highway of NHS and NHS connectors
- In at least one direction of travel on the Interstate and Toll Interstate Systems
- In at least one direction of travel for the non-Interstate NHS
- On an annual frequency for Interstate route

- On at least a biennial frequency for non-Interstate NHS routes

Structure

Structure type (identified as either a structure, culvert or causeway) data will come from the construction plans when the structure is brand new. This data will be coded into IDOT's database Illinois Structure Inventory System (ISIS). The structure type data collection shall be in compliance with the HPMS Field Manual December 2016 edition.

CERTIFICATION PROCESS

For calibration, and calculations for pavement condition data

Manual Collection

IDOT does not use manual data collection methods for reporting data to meet the Performance Measure requirements.

Configuration and Calibration

Annually, prior to the start of collection, IDOT will be in attendance and will participate in the certification of the equipment used by IDOT's Condition Rating Survey vendor to collect IRI, rutting, cracking percent and faulting data.

IDOT will be in attendance as the vendor performs accuracy and repeatability testing on each vehicle. IDOT and vendor will select appropriate certification sites (asphalt & concrete) to be used for the annual collection cycle. This accuracy and repeatability testing will include LCMS configuration, cross slope calibration, bounce testing, static validation, height check, positional orientation system (POS) configuration, image collection rate, image alignment acceptance, and sample route collection. 5 test runs are recorded for the DMI. The DMI test runs are verified against a pre- measured course. Up to 10 repeat runs are recorded for pavement condition testing. Collected data for IRI, rutting, crack detection and cross slope are compared against each run and the previous test set performed on the course. The initial IRI baseline data will be collected using a profiler and follow the AASHTO R56-14 requirements. The pass/fail criteria shall be in compliance with AASHTO R56-14 Standard Practice for Certification of Inertial Profiling Systems.

The Vendor shall provide a certification letter and testing results prior to starting annual collection that all equipment to be used has been configured, calibrated and is in proper working condition meeting the current standards/operating parameters of the testing equipment. In addition, documentation of the vendor's quality management plan as well as equipment testing parameters and methods shall be provided prior to the start of collection each year. IDOT shall review test results and the vendor's work plan prior to the start of collection. IDOT will work with the vendor to resolve any out of range test results. The vendor shall perform maintenance as recommended by the equipment manufacturer.

Upon completion of the testing and review of the vendor documents, IDOT will certify equipment and the work plan prior to collection beginning.

Calculations and Acceptance Measures

IRI
Calculation shall be in accordance with AASHTO R43-13 Standard Practice for Quantifying Roughness of Pavements and ASTM E1926 Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements. The average IRI values from the current test shall be

within 10% of the value collected in the initial test run of the site. Ten test runs shall have a relative standard deviation of less than 5%. Data shall be reported to the nearest inch.

Rutting
Computation shall be in accordance with AASHTO PP69-14 Standard Practice for Determining Pavement Deformation Parameters and Cross Slope from Collected Transverse Profiles. Average rutting values from the current test shall be plus or minus 0.08 of an inch of the initial control section collection. Ten runs shall have a standard deviation of less than 0.04 inch. Data shall be reported to the nearest 0.01 inch.

Faulting
Reported to the nearest 0.01 inch collected by a 3-D image system scanning laser which is in accordance with AASHTO R36-13 Standard Practice for Evaluating Faulting of Concrete Pavements.

Cracking
The average total distress values shall have less than 15% relative standard deviation from the current test runs. Ten test runs shall have a standard deviation of less than 15% from the baseline value.

DATA QUALITY CONTROL MEASURES

Conducted before data collection begins and periodically during the collection program

Condition

The vendor shall test and certify the LCMS is working properly, and per the contract shall follow the quality assurance guidelines of the AASHTO R43-13 Standard Practice for Quantifying Roughness of Pavements. The LCMS shall be certified prior to entering the State and prior to the start of collecting data. The repeatability and verification test sections shall be collected by each vehicle to be used during collection. Through the initial collection IDOT working with the vendor will establish a repeatability baseline for IRI, rutting, distance and image field of view. The initial results are provided to IDOT before regular collection can begin, and shall include the following steps monthly:

- Repeatability sections are collected and reported to IDOT by each vehicle throughout the collection process
- The equipment and data shall meet the repeatability criteria outlined below.
    - At least 3 runs and no more than 10 runs
    - IRI shall be +/- 10% of the initial baseline collection
    - Rutting shall be +/- 0.08 inch of the initial baseline collection
    - Distance measurement shall meet 0.001 accuracy per mile

The vendor shall preform Weekly in-field equipment testing and verification at site identified at kick off meeting.

- LRS and DMI
    - 5 repeat runs are recorded and compared against a steel tape measurement.
- LCMS Static Validation
    - 18 vertical height measurements
    - 30 horizontal measurements
- Pavement data repeatability for IRI and rutting
    - 5 repeat runs are recorded, and data elements are compared against each run and the previous test at the site.

Weekly/Monthly verification acceptance metrics

DCV Test	Acceptance
LRS	0.15% of a mile 0.1% difference between runs - Unit pulse count difference week to week <0.15%

LCMS Static Validation	▪ Height measurements average error <0.05 inches ▪ Horizontal Measurements average error < 0.15 inches
IRI	▪ Relative standard deviation less than 5%
Rutting	▪ Standard deviation < 1mm

The vendor shall also perform their own QC/QA on the images and data quality prior to the delivery to IDOT. This includes but not limited to verifying construction joints, cracking and concrete pavement.

Once the data is delivered to IDOT, IDOT staff will review all routes for the following:
- Image quality
- LRS accuracy (Route ID verified per the HPMS Field Manual December 2016 edition)
- Correct route collected and reported
- Begin point/End point is correct and per the HPMS Field Manual December 2016 edition
- Length is correct
- Value Date recorded with month and year of data collection

Pavement

Surface type and through lanes shall be reviewed annually on the Interstate, and biennially for Non-Interstate NHS during the pavement condition surveys. Reviews compare information already in IDOT's database Illinois Roadway Inventory System (IRIS) to data acquired during the field review or condition survey. Surface type and through lane will be accepted at a 90% or greater accuracy, if it's less than 90% accurate it will be requested to be reviewed again by the Districts. Corrections will be made to IRIS.

Structure

The structure type data will be verified during the routine inspection by certified bridge inspectors. Once the inspection is completed, the Program Manager of the structure will review the inspection before the data is entered into ISIS. IDOT will conduct reviews on randomly selected bridges as well as all Interstate structures in the inventory system on an annual basis.

ERROR RESOLUTION PROCEDURES

Resolutions to issues discovered in reported data

Condition

If vehicles are found to be out of calibration or inconsistencies are found in the data; the variance shall be verified, and if needed, the vehicle shall be brought back to the correct calibration. Sample data previously collected by vehicle will be reviewed to determine if recollection is necessary. IDOT will work with the vendor to resolve any issues with the data. If the problem is not able to be corrected, data recollection may be required, and IDOT will review and resolve data error resolution and deliverables. IDOT reviews image quality and data integrity prior to authorizing and processing invoices for payment. In the Appendices a chart depicts the error resolution and deliverables.

Pavement

Reviews are performed in conjunction with the pavement condition survey for surface type and through lane data. If there is a discrepancy, the report will be sent to the appropriate IDOT District for further review and correction.

Structure

If there is a structure type discrepancy between the inspection and the data in ISIS, the data will be updated in ISIS appropriately based on the inspection performed by the certified bridge inspectors.
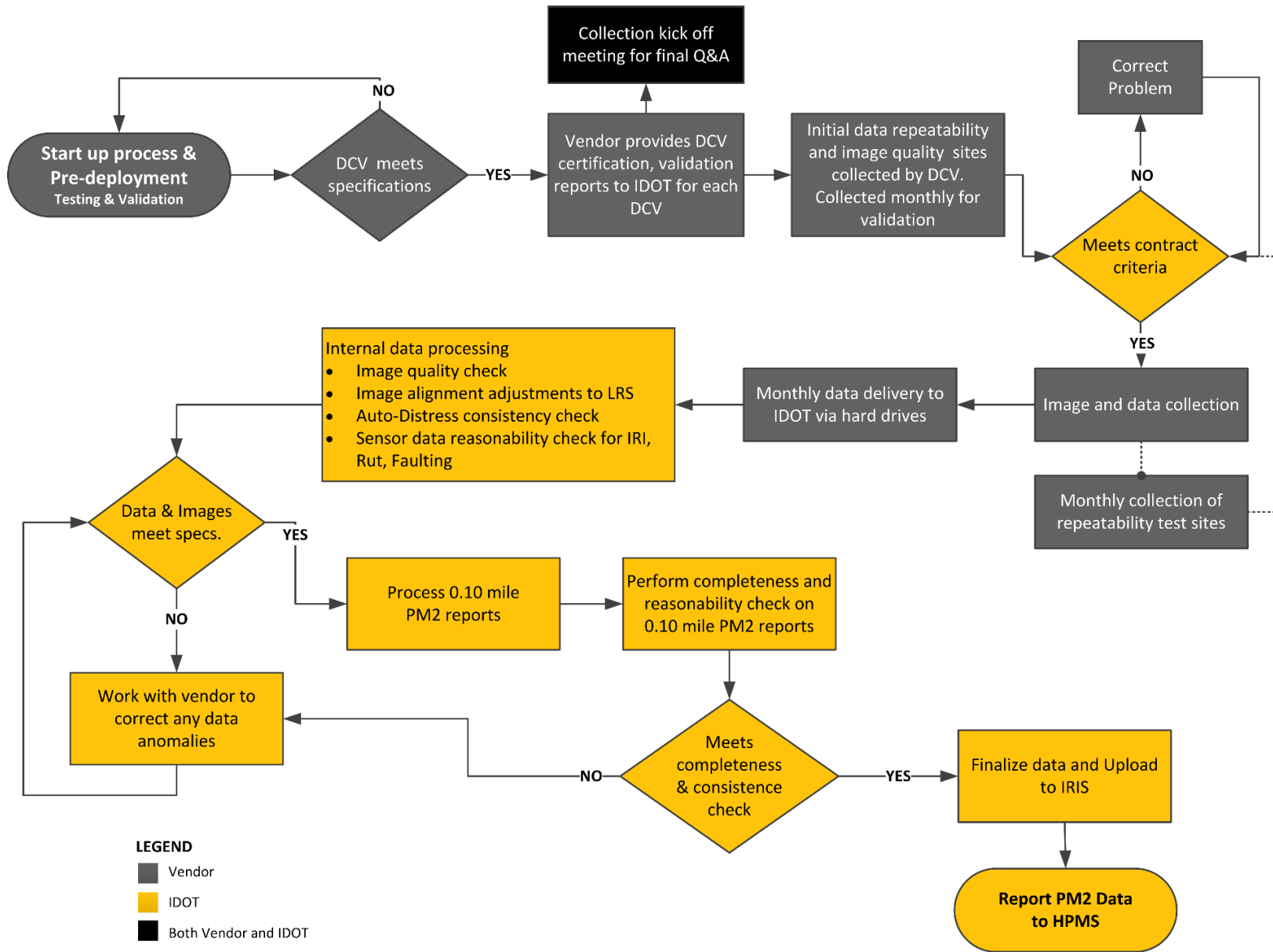
APPENDICES

Acronyms

- **AASHTO**: American Association of State Highway and Transportation Officials
- **ASTM**: American Society for Testing and Materials
- **CRCP**: Continuously Reinforced Concrete Pavements
- **CRS**: Condition Rating Survey
- **DCV**: Data Collection Vehicle
- **DOT**: Department of Transportation
- **GIS**: Geographic Information System
- **HPMS**: Highway Performance Monitoring System
- **IDOT**: Illinois Department of Transportation
- **IRI**: International Roughness Index
- **IRIS**: Illinois Roadway Inventory System
- **ISIS**: Illinois Structure Inventory System
- **LCMS**: Laser Crack Measurement System
- **LRS**: Linear Reference System
- **NHS**: National Highway System
- **POS:** Positional Orientation System
- **QC/QA**: Quality Control / Quality Assurance

Error Resolution and Deliverables

Pre-Deployment, Daily Startup and Monthly Testing - performed by vendor			
PRODUCT	**QA/QC BY IDOT**	**ACCEPTANCE CRITERIA**	**ERROR RESOLUTION**
IRI, Rut, Faulting, DMI, Image Quality, LCMS Crack Identification	▪ Certification letter provided by vendor at start and monthly	▪ 100% is reviewed and Baseline set ▪ Monthly collection compared to baseline	▪ Collection cannot proceed without
Post Collection			
PRODUCT	**QA/QC BY IDOT**	**ACCEPTANCE CRITERIA**	**ERROR RESOLUTION**
IRI	▪ Compared to historical data ▪ Random sample review with each monthly delivery	▪ Test section +/- 10% of initial collection ▪ Pass reasonability check of random sample	▪ Reprocess data ▪ Recollection may be required at discretion of IDOT
Rut	▪ Compared to historical data ▪ Random sample review with each monthly delivery	▪ Test section +/- 0.08 inch of initial collection ▪ Pass reasonability check of random sample	▪ Reprocess data ▪ Recollection may be required at discretion of IDOT
Faulting	▪ Compared to historical data ▪ Random sample review with each monthly delivery	▪ Pass reasonability check of random sample	▪ Reprocess data ▪ Recollection may be required at discretion of IDOT
Cracking CRCP	▪ Random sample review with each monthly delivery	▪ Pass reasonability check of random sample	▪ Reprocess data ▪ Recollection may be required at discretion of IDOT
Cracking JRCP	▪ Random sample review with each monthly delivery	▪ Pass reasonability check of random sample	▪ Reprocess data ▪ Recollection may be required at discretion of IDOT
Cracking Asphalt	▪ Random sample review with each monthly delivery	▪ Pass reasonability check of random sample	▪ Reprocess data ▪ Recollection may be required at discretion of IDOT
Linear Reference System	▪ 100% reviewed ▪ Compared to GIS ▪ Begin/End Station compared to IRIS	▪ 100%	▪ Contact vendor for LRS reprocessing & alignment ▪ Recollection may be required at discretion of IDOT
Images	▪ Quality checked for clarity & ratability	▪ 100%	▪ Contact vendor for image enhancement solution ▪ Recollection may be required at discretion of IDOT

Illinois DOT PM2 Data Quality Process Workflow

Collection kick off meeting for final Q&A

Start up process & Pre-deployment Testing & Validation

DCV meets specifications — **NO**

YES → Vendor provides DCV certification, validation reports to IDOT for each DCV

Initial data repeatability and image quality sites collected by DCV. Collected monthly for validation

Correct Problem

Meets contract criteria — **NO**

YES

Internal data processing
- Image quality check
- Image alignment adjustments to LRS
- Auto-Distress consistency check
- Sensor data reasonability check for IRI, Rut, Faulting

Monthly data delivery to IDOT via hard drives

Image and data collection

Monthly collection of repeatability test sites

Data & Images meet specs. — **YES**

NO

Work with vendor to correct any data anomalies

Process 0.10 mile PM2 reports

Perform completeness and reasonability check on 0.10 mile PM2 reports

Meets completeness & consistence check — **NO** / **YES**

Finalize data and Upload to IRIS

Report PM2 Data to HPMS

LEGEND
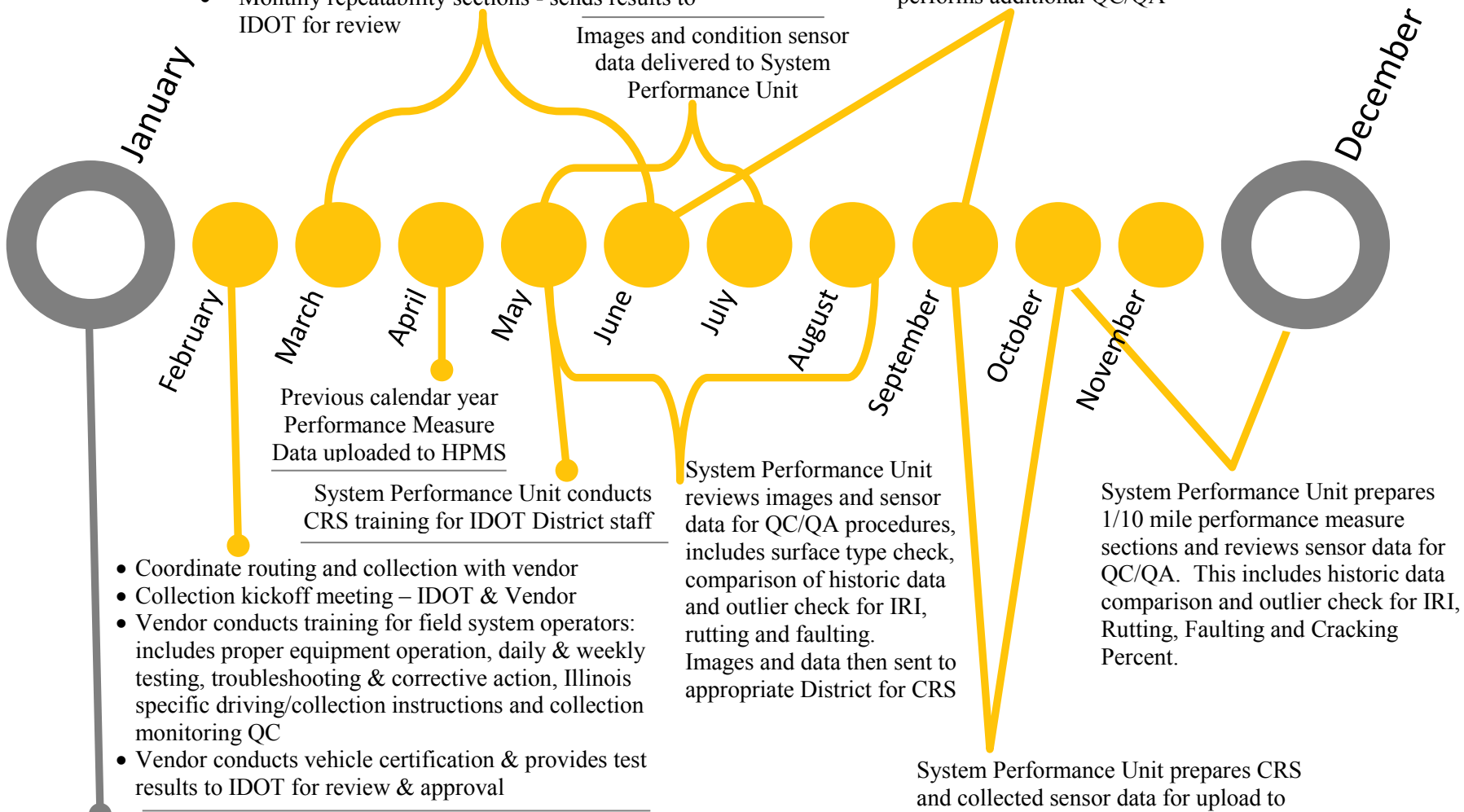- Vendor
- IDOT
- Both Vendor and IDOT

CRS and Pavement Performance Measure Process Time Line

Vendor collects driving file condition data and images
Vendor conducts
- Daily startup test
- Weekly test sections
- Monthly repeatability sections - sends results to IDOT for review

Images and condition sensor data delivered to System Performance Unit

District staff conducts CRS and performs additional QC/QA

Previous calendar year Performance Measure Data uploaded to HPMS

System Performance Unit conducts CRS training for IDOT District staff

- Coordinate routing and collection with vendor
- Collection kickoff meeting – IDOT & Vendor
- Vendor conducts training for field system operators: includes proper equipment operation, daily & weekly testing, troubleshooting & corrective action, Illinois specific driving/collection instructions and collection monitoring QC
- Vendor conducts vehicle certification & provides test results to IDOT for review & approval

System Performance Unit reviews images and sensor data for QC/QA procedures, includes surface type check, comparison of historic data and outlier check for IRI, rutting and faulting.
Images and data then sent to appropriate District for CRS

System Performance Unit prepares CRS and collected sensor data for upload to IRIS. Performs additional QC

System Performance Unit prepares 1/10 mile performance measure sections and reviews sensor data for QC/QA. This includes historic data comparison and outlier check for IRI, Rutting, Faulting and Cracking Percent.

IDOT, System Performance Unit prepares driving file (collection route list) and GIS route file, sends both to vendor

January February March April May June July August September October November December

IDOT Staff Responsibilities for Pavement Performance Measures

STAFF	RESPONSIBILITIES

System Performance Manager
1. Oversees staff responsible for workflow & QC/QA
2. Conducts CRS training,
3. Main point of contact with collection vendor and district staff

System Performance Analyst, System Performance Specialist, & System Classification Manager
1. Performs QC/QA for collection data
2. Prepares pavement condition data files for upload to IRIS and HPMS

Highway Data Manager
1. Uploads data to HPMS system