Kansas Pavement Condition Data Collection Quality Management Plan

Kansas Department of Transportation

Pavement Management 2018

Version 1.4.2

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Overview/Purpose of Document

Why does this document exist? – it is required (and not a bad idea)

The Kansas Pavement Condition Data Quality Management Plan was completed largely to meet a federal requirement to have such a document. It is also probably a good idea to have this information documented both for succession planning purposes and to broaden the understanding of how the data is collected, processed, and reported. The layout of the document follows three basic parts of the process. The first section is collection of data. The second section is processing. And the third section is reporting. Within each of these sections are explanations about what is done, how it is done, how it is checked, and how those checks are documented.

Following submittal of the original version of this document, FHWA recommended changes that included adding Tables 1 and 2 showing quality control activities before and during collection, adding a description and process to show that KDOT was getting reasonable pavement data (see Data Reporting Process and Table 3), and more detail on checks and fixes to data collection when problems occur (see the Troubleshooting Appendix).

Data Collection Process

What is <u>collected</u>? – location information, forward images, longitudinal profile elevations, and FIS files with proprietarily stored information about intensity and relative elevations for the pavement surface.

Pavement condition data collection is not widely understood, as many people think that the process involves taking a vehicle out on the road and returning with pavement surface attributes like International Roughness Index (IRI), and rutting, and cracking. However, none of those attributes are directly measured. Instead, the systems have fairly limited types of measures they make and record that can be processed to create measures such as IRI, rutting, faulting, cracking, etc. This section describes the data the system actually collects and how it is/can be checked to see that the collection process is being done properly and within reasonable tolerances.

KDOT's Data Collection Vehicle

- 2012 Ford E-350 XLT Van
- Pavemetrics Laser Crack Measurement System
- Dynatest 5051 Mark III/IV Road Surface Profiler
- Mandli DVX and RoW Imaging

KDOT Data Collection Personnel

Bureau of Construction and Materials

Pavement Management Unit

Pavement Evaluation Section

- Pavement Evaluation Specialist
- 3 Trained Operators on Staff
- 1 Seasonal Operator

How does the collection process work? -- users supply referencing data, the systems collect linear and spatial movement, measurements of light reflection intensity and measurements of relative elevations.

Collection of pavement condition data begins with a list of what needs to be collected, an appropriately equipped vehicle, and operator(s). The list is generated by office staff to include all National Highway System Routes, all additional State Highways maintained by KDOT, and HPMS sample locations supplied by KDOT Transportation Planning. The configuration of the data collection system is also checked against established settings and per manufacturer recommendations and calibrations. Table 1 shows Quality control activities conducted before data collection. Table 1 lays out the obvious steps of determining what locations to collect, what to name those locations, verification that equipment is available to collect that data, and checks that equipment is configured and working correctly.

Table 1 - Quality Control Activities Before Data Collection

Item	Quality Expectations	QC Activity	Frequency
All Pavement Data	Completeness	Produce Route List	Once, prior to data collection
		Define equipment configuration	Once, prior to data collection
		Verify equipment configuration	Once, prior to data collection; Also conducted after any equipment changes
		Equipment calibration	Once, prior to data collection; Also conducted after any equipment changes and before each day's collection
		DMI calibration	Once, prior to data collection; Also conducted after any equipment changes

Before data collection each day, operators evaluate the environment, vehicle, and collection components to determine if collection can proceed. Table 2 shows quality control activities conducted during data collection. How to perform most of these checks are in the vendor (Mandli Communications, Inc.) supplied Kansas Pavement Collection System User Manual Dated March 7, 2013. Temperature must be in the vendor specified range, the vehicle must be sound with appropriate tire pressures and all the equipment securely and properly connected both externally and internally. The vehicle must have the equipment to collect and store the relevant data and control the process plus to allow for the operator to input necessary information. The operator needs to supply some basic information about what they plan to collect. Typically, this is done using a preselected route and an indicator if they are collecting in a counting up or counting down direction. The routes are preloaded and named following a standard reference with county, route prefix, number, and suffix and the begin and end county milepost. The operator can override the milepost if they are not starting at the begin or end of the route within the county. Once collection has started, systems within the vehicle are collecting GPS and distance measurement to keep track of location. The forward and downward cameras are being triggered by a wheel encoder based on distance, and the Road Surface Profiler (RSP) is triggered based on time. In Kansas, typical data collection is performed on Monday through Thursday. At the end of a collection week, the data is transferred from the vehicle to the Pavement Management System Unit office for processing. The processing process is described in a later section. Table 2 provides a tabular form of the checks that occur during the collection process.

Table 2 - Quality Control Activities During Data Collection

Deliverable	Quality Expectations	QC Activity	Frequency
All Pavement Data	Safety/Efficiency	Mechanical Inspection	Daily
		Preventive maintenance program	According to Program
	Completeness	Verifier report	After each Route
	Accuracy	Subsystem checks (sensors, computers, software)	Daily
		Real-time quality monitoring (monitor error codes, images, and data streams during collection)	During Active Collection
		Verifier report and KML	Daily
		DMI calibration	Monthly and/or tire change
		Check environmental conditions (dry pavement surface, temperature within equipment operating range)	During Active Collection

How are the data collection processes checked? -- user supplied info is not really checked until the reporting process; GPS data is not checked other than that the system is collecting data and the coordinates provided are within bounding limits; linear referencing is checked by a periodic calibration process, the encoder is checked also through a periodic calibration process, intensity data and the *elevation measurement units are sent back to the manufacturer each year for service, each week height calibrations are performed on the RSP, and the RSP is certified annually by the equipment vendor.*

Operators choose the route information to start the collection process. Methods to verify they selected the right route, are incrementing the linear referencing correctly, and are reasonably close to the correct begin and end points could be done with software, but historically these checks have not been needed or done. The driver is also an important piece of the data collection process. Both operators and drivers are trained to perform the necessary checks before collection, input the data needed to collect, monitor the computers during collection, maintain maps and logs, and drive to get good pavement data.

The GPS data is important but has not been checked historically other than relative to the operator supplied location, the GPS locations are reasonably consistent. The system contains an Inertial Measurement Unit as well as the GPS. During collection, the system monitors the GPS data and the IMU takes over if the GPS is not meeting established accuracy requirements. As well as the system monitoring the GPS data, each day's runs are reported back to the Pavement Evaluation Specialist, Pavement Management Engineer, and vendor staff through an email that includes status information about the runs from a verifier program and kml files that show where the data was collected. If the GPS data is not reasonably correct, the kml files do not show up on maps correctly and so KDOT would know that something was not right with the GPS data. GPS data becomes more important with the process stipulated to remove bridge data from a state's report. KDOT is working on a conflation process that will more consistently place the pavement data from year to year than relying on the linear distance alone.

The linear measurements are a function of a lot of variables and do change with tire wear and pressure and other influences. To keep the linear measurements in check, periodic trips to a known measured site are made and a procedure to calibrate the distance measure is followed. The calibration process results in an adjustment factor being stored in the system and then used for collection until a new calibration is performed. If the operators question the linear measurements while in the field and a long way from the calibration site, they know to look for locations with presumed distances to perform a calibration. Kansas has many county roads on the Public Land Survey System (PLSS) one-mile grid, so finding a location to use to check or calibrate can be done in many places. The calibration process updates both the DMI and the encoder used for linear distance measurement.

Finally, the RSP is "certified" by the vendor as part of annual maintenance on the vehicle. See Figure 1 for sample. They basically follow the process outlined in AASHTO R-56 and provide an annual certification to KDOT. The location they use is one that is also used for the vehicles that collect data in many other states. On a daily basis our operator/driver performs the manufacturer recommended bounce, block, and height tests to check that the height measurements are reasonable and that the accelerometers are reacting to vertical movement. These tests are described in the manufacturer's documentation. We do not record any of the information from the block test, but simply use it as a pass/fail to continue with collection. The bounce test is recorded and are transferred from the drives along with the other data collected each week to the processing computers in the Pavement Management System Unit office. Height tests for the LCMS are stored in the data file (xml) generated in the data processing step, so these values are available for future reference.

Accuracy (%)

Run	Left	Right
1	94.66	93.44
2	94.29	93.88
3	95.54	95.91
4	94.08	94.14
5	**89.35**	90.53
6	**89.44**	91.34
7	**88.96**	90.85
8	**88.24**	90.53
9	**88.99**	91.02
10	**88.54**	91.39

Statistics

Statistic	Repeatability - Left	Repeatability - Right	Accuracy - Left	Accuracy - Right
Comparison Count	45	45	10	10
% Passing	46.67	46.67	40.00	100.00
Mean	93.42	93.53	91.21	92.30
Minimum	87.07	87.69	88.24	90.53
Maximum	99.46	99.34	95.54	95.91
Standard Deviation	4.9	4.6	3.0	1.9
Grade	Passed	Passed	Passed	Passed

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Figure 1 - Annual Profiler Certification Letter Excerpt

How is the checking process documented?

KDOT has quite a bit of documentation of various checks of data quality, but the documents are simply part of the collection process not specifically targeting quality documentation. These documents include, outputs from the verifier that is run at the end of each route that is collected. This verifier checks and cross-checks a lot of the information that was collected and provides a quick color-code of Green/Orange/Red to give the operator feedback at the conclusion of each collection run. At the end of each day, these verifier reports and the aforementioned kml files are emailed back to the Pavement Evaluation Specialist, Pavement Management Engineer, and Mandli Communications customer support staff. Thus, every run and every collection day is a form of checking that the system is collecting data as expected. Figures 2 and 3 respectively show the text from part of a verifier daily summary and the kml file on a Google Map showing the locations collected. The verifier is pretty simple to follow. If the route shows as green, everything is good. If it is orange or red, the operator will investigate the concern and the appropriate response. The example in Figure 2 shows a route that was red due to a "Frame Count Mismatch". The operator likely looked deeper to determine that for a fairly long route, getting 5153 Front images and left images but only 5152 downward (LCMS) images is not really a concern, so they kept the data and went on to collecting other routes. We train our operators to make these kinds of decisions. However, we also provide the troubleshooting appendix of this document to assist the operators and to help with consistency in how issues are resolved. If the operator cannot independently make a determination, they call the Pavement Evaluation Specialist, the Pavement Management Engineer, or vendor customer service at Mandli Communications for support.

```
Verification done by digilog on Tue 05/08/18 05:12 PM
      22 Routes Reported, 21 of which are Good.
      223989 Files, 384757MB
-------------------------------------------
008U0005400S0EB - 1 ERROR (last checked 05/08 11:42)
      15462 Files, 26523MB
      GPS 5153 frames (302KB) performing Standard Checks, Spacing 1.000ft
      RSP (34555KB) performing Standard Checks, vs. Log Distance 0.1%
      RAW 32606 points (2197KB) performing Standard Checks, Positional Acc 3.000m (2.00%), Vertical Acc
3.000m (2.00%), Fix Mode (1.00%)
      Log 05/08/2018: 5154 frames, 0.0000-25.7730mi performing Standard Checks
      GPS Fix Modes: RTCM DGPS=100.0%
      Front(5153), Left(5153), LCMS(5152) (15458 files, 26487MB) performing Standard Checks
 -->Frame Count mismatch

008K0025400S0EB - Verified 05/08 08:57
      10202 Files, 18448MB
      Log 05/08/2018: 3400 frames, 0.0000-16.9979mi performing Standard Checks
      RSP (22793KB) performing Standard Checks, vs. Log Distance 0.1%
      GPS 3400 frames (199KB) performing Standard Checks, Spacing 1.000ft
      RAW 26138 points (1761KB) performing Standard Checks, Positional Acc 3.000m (2.00%), Vertical Acc
3.000m (2.00%), Fix Mode (1.00%)
      GPS Fix Modes: RTCM DGPS=100.0%
      Front(3400), Left(3400), LCMS(3398) (10198 files, 18424MB) performing Standard Checks

008K0025400S0WB - Verified 05/08 01:35
      10157 Files, 18523MB
      Log 05/08/2018: 3385 frames, 17.0500-0.1234mi performing Standard Checks
      GPS 3385 frames (198KB) performing Standard Checks, Spacing 1.000ft
      RAW 25917 points (1746KB) performing Standard Checks, Positional Acc 3.000m (2.00%), Vertical Acc
3.000m (2.00%), Fix Mode (1.00%)
      RSP (22698KB) performing Standard Checks, vs. Log Distance 0.1%
      GPS Fix Modes: RTCM DGPS=100.0%
      Front(3385), Left(3385), LCMS(3383) (10153 files, 18499MB) performing Standard Checks
```

Figure 2 - Sample Verifier Output

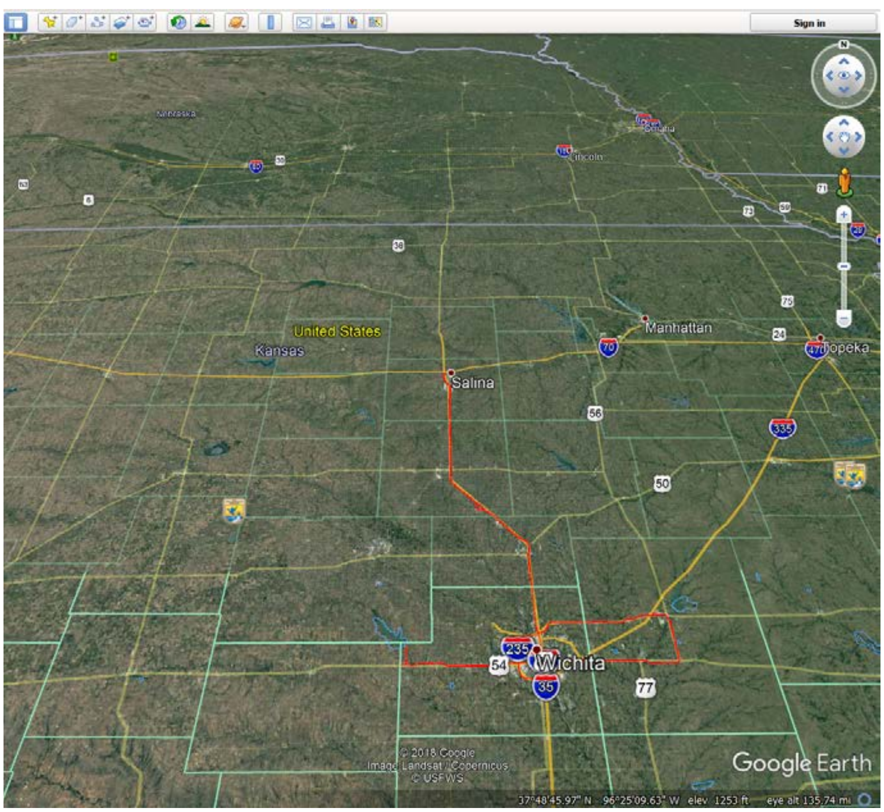

Figure 3 - Sample kml file from collection in red shown in Google Earth

Data Processing Process

How does the processing process work? (within non-disclosure limits) – A lot of this processing step is a black box to users and some of it is proprietary and cannot be disclosed, but basically the data that was collected as described in the previous section is turned into information in this step.

The transformation from data to information requires quite a bit of processing. Some of these processes are established and well documented. Other processes are proprietary and not publicly documented. The processing for KDOT begins with transferring the collected data from the vehicle to office computers. Next, images are viewed for each route and compared to data collection logs for pavement surface type changes, and visual quality of the forward images. At this point, operator logs from collection are also reviewed and any noted concerns are addressed such as collection mileage needs to be reversed, wrong input start/stop, wrong route name, construction, bridge missed, frame mismatch. All of these are possible but very infrequent and can be dealt with before processing. QC Checker software provided by the Mandli Communications is also run on the data at this point. This software provides a report indicating where some typical problems occur such as images with noise, images with excessive cracking in the left wheelpath, images with unusual rutting characteristics, or collection issues such as speed or temperature. Each of these "errors" are indications that something happened that may impact the data quality. The noise issue is usually when road roughness causes the lasers to go out of range, like crossing a railroad track or some manhole covers, or vehicle lean in a tight turn. In most cases, the noise is just accepted, but if it is severe enough recollection is ordered. The excessive cracking in the left-wheelpath is often an indicator of the vehicle being driven too close to the centerline. Again, when the software identifies this issue, the data is reviewed and if necessary recollected. The rutting indication from the QC checker typically occurs when the road has curb and gutter or unusual edge conditions combined with a narrow lane or atypical vehicle position. Again, locations identified as having rutting issues by the checker are reviewed. Use of the QC Checker is documented in the LCMS QC Design 1.0.8 document supplied to KDOT by Mandli Communications in March 2016. When the data all appears to be ready for processing, and the frames where pavement type changes are identified, processing is started. Processing here means to select each of the routes that was run as inputs to a Pavemetrics software that interprets the collected data and generates four output images and a XML data file for each 1/200th of a mile section.

How is the transformation from data to info checked?

There is not a lot of checking of the processing at this level by KDOT. The process itself is proprietary, so most of the checking is simply looking at outputs for reasonableness. KDOT has invested significant effort into looking at these outputs in the form of data and images and worked with the system vendors to better understand the processing and to improve the outputs to better meet KDOT needs. The vendor provides viewing tools that link together all the images and data, so users can view the images associated with the reported data as shown in Figures 4 and 5.

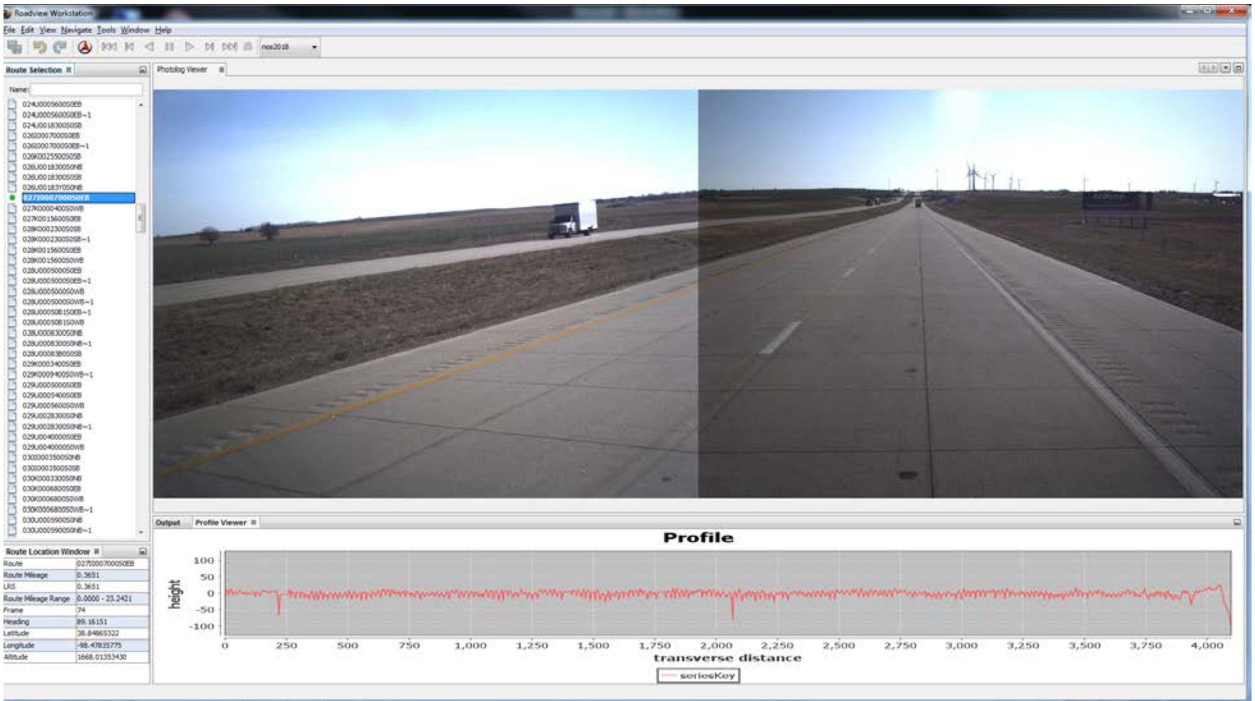

Figure 4 - Forward Image in Workstation

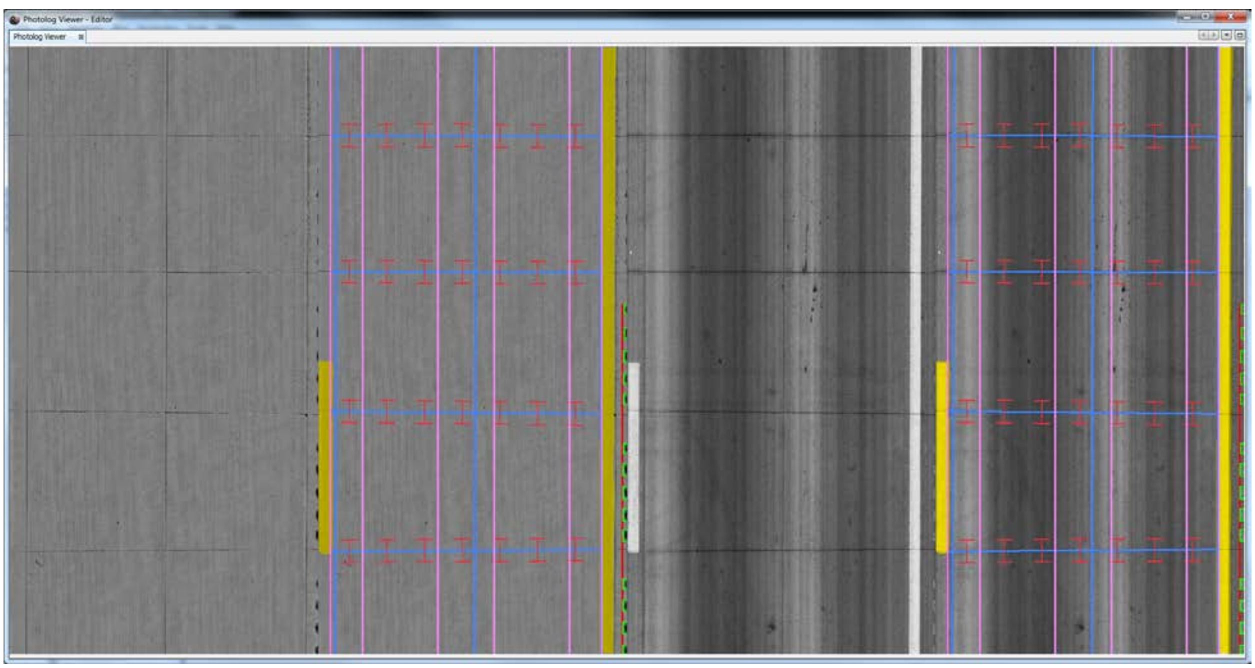

Figure 5- Downward Range and Intensity Images with Overlays

How is the checking process documented?

Again, KDOT spends significant time analyzing and viewing the process outputs but not documenting quality checks. KDOT thinks of the review process more as a cooperative process with the manufacturer and vendor in that any concerns are raised with them, so they can be reviewed and addressed. An example of this is the minimum temperature at which data collection is allowed. The equipment will not operate below freezing, this was done by the manufacturer because they are not comfortable with the quality of data collected in those conditions. KDOT raised some issues about some of the time-series data that seemed to be inconsistent and the vendor and manufacturer reviewed the relevant data and determined that the questionable data was collected at temperatures above freezing but below about 40 degrees Fahrenheit. This led to the manufacturer discouraging data collection below 40 and the vendor introducing software that checked the temperature before collection and issued warnings to the operators if temperatures are out of bounds. This interaction is not really documented, but partly led to the Quality Checker described above and became part of a system check instead of an external quality documentation effort. This is as good of place as any to point out that systems like the one used by KDOT to collect pavement condition data continue to be refined. Thus, as the systems get better at collecting and processing information, the amount of the year-to-year variability in the data due to the change in the processing versus the amount due to change in pavement surface conditions is unknown. This is an area that KDOT and our partner vendors and manufacturers will continue to monitor and evaluate.

Data Reporting Processes

How is the info converted into the required reports? (again within non-disclosure limits) – two different reporting functions are followed to extract pavement condition information and generate the pavement pieces of the Highway Performance Monitoring System (HPMS) report and the reporting that KDOT does for state management and communication of pavement conditions. Currently this document only covers the reporting related to HPMS.

HPMS requirements were released in a December 2016 document entitled "Highway Performance Monitoring System Field Manual". That document describes much more than the pavement attributes that must be reported, but the pieces of relevance for pavement condition reporting are 4-90 through 4-115. KDOT uses reporting software developed by the vendor to take the processed data and generate the elements required and described directly in the HPMS Field Manual or the standards it references. Unfortunately, most of this software was developed before the Field Manual was issued, so there is not an all-encompassing "Easy Button". Currently, KDOT runs reports to generate HPMS data outputs at the finest resolution possible, that is at 1/200th of a mile. This allows pavement type changes, bridge locations, begin/end of routes all to be more precisely reported than just using the tenth of a mile incrementing required for federal reporting. The output reports are imported into a relational database for further processing and checking. Finally, the tenth mile HPMS compliant data is passed to KDOT Transportation Planning for further processing and submittal.

How is the reporting process checked?

The primary checking of the reporting process is a review of time-series data from 5 years of collecting and processing pavement condition data with this equipment and process. The process continues to evolve to better meet federal and state needs. Currently, KDOT is working through a conflation process to better locate the reported data spatially so that it will be consistent over time and so that the federal process to remove bridges from the pavement data will more likely remove bridge data. KDOT is also working with the vendor to improve some of the reporting tools. The vendor's tool currently over-reports cracking percent on concrete pavements because it includes both transverse and longitudinal cracked slabs where the federal rule only counts transverse cracked slabs. KDOT has also talked to the vendor about improving their algorithms for unusual concrete joint configurations like 6x6 slabs. See Figures 4 and 5 for an example. The vendor is also reviewing their interpretation of the asphalt percent cracking based on feedback from KDOT. While this is not specifically process checking, it shows that KDOT pays attention to the data at all levels and constantly strives to improve it to meet our needs.

How is the reporting process documented?

KDOT Pavement Management is not big on documentation for the sake of documentation. However, KDOT has some checks to the overall process performed early in each year's collection process. To satisfy federal requirements for a "Data sampling, review and checking process," KDOT proposes to collect the Kansas Turnpike data very early in the collection cycle and compute median values for IRI and rutting in northbound and eastbound sections. These statistics will be compared to the prior year's data +/- 10% (20% for cracking since the variable was not publicly (and poorly) defined until December of 2016) to establish Quality Acceptance. It should be good enough for PM2 purposes and better than trying to make automated processes match subjective ratings!

The example of this process which will form the basis of future checks was done with the 2018 KTA frame-based data. The logic is that the Turnpike is being managed in a fashion that the pavement conditions measured do not change much from year to year. So, if the measured pavement condition does not change significantly from one year to the next, the data quality will be considered okay (at least it is consistent). An example of this comparison using the 2017 and 2018 data is in Table 3. If this test fails, KDOT will evaluate individual county turnpike data (for instance using northbound I-335 in Osage County and eastbound I-70 in Leavenworth County). This will be a similar check to the whole KTA, but easier to determine why disparities exist. If this check also fails, KDOT will consult with the Kansas FHWA Division Office to determine the cause for these discrepancies and will not use the data for HPMS reporting until the deviations can be documented and explained. Like much of this process, this check will need to be refined over time to address locations where actions are performed, maybe remove bridges and other known anomalies, eventually include conflation prior to the comparisons, etc.

Table 3 - Example KTA Median Values Comparison for Quality Assurance Screening

	KTA Inventory Direction Miles	Median Avg IRI	Median Avg RutVal	Miles of Zero CrkgPct	Median Avg non-zero CrkgPct
2017 values	224.132	42.9	0.097	175.057	7.131
Acceptable Range for 2018		38.6 – 47.2	0.087 - 0.107		5.705 – 8.557
2018 values		42.8	0.106	173.14	7.062
Osage 2017 values	10.524	43.9	0.090	7.704	4.109
Osage Acceptable Range for 2018		39.5 – 48.3	0.081 -0.099		3.287 – 4.931
Osage 2018 values	10.549	51.5	0.102	7.029	3.822
Leavenworth 2017 values	16.481	34.5	0.092	15.046	5.374 SMALL SAMPLE
Leavenworth Acceptable Range for 2018		31.1 – 38.0	0.083 – 0.101		4.299 – 6.449
Leavenworth 2018 values	16.5	35.9	0.101	14.925	7.759

This table shows that using this screen for data quality would have been met had it been in place in 2018. That is, the 2018 average values for the turnpike for IRI, Rut Value, and Cracking Percent were within 10% (20 for cracking) from the 2017 values. While this alone only shows consistency in the collected data from one year to the next, consistency in automated data should really be the goal to get quality over time. The next step towards quality is to determine how much of the variability in the data from one collection cycle to the next comes from changes in the pavement surface (what we really want to know) versus other factors like improvements in the collection system or process, equipment or operator variability, changes in the standards (like a more reasonable standard for cracking), environmental factors, etc. The bottom line is that KDOT will pay attention to the data we are collecting (as we were doing long before we were forced to write a document describing what we do) to meet our needs for quality data and to provide reasonably good data for federal purposes. We will document that we are making the effort to get good data for the federal purposes using the method shown in the table above. Note that the table above also shows that we would have had some additional digging to do if the check would not have passed at the system level as rutting failed for 2018 in the Osage County piece of the turnpike and cracking failed in the Leavenworth piece albeit a very small sample. In both cases, we would have dug deeper and tried to determine how different the 2018 data really is from the 2017 data for those locations and variables. At some point, we would document why they were showing the variability and consulted with the Kansas FHWA Division office.

Future Steps

What will KDOT do to continue to get quality pavement data?

Clearly KDOT recognizes the need for quality data and can take some steps to enhance the effort and to document the effort. Specifically, KDOT will continue to evolve the process to collect the data and process it to meet the needs of FHWA and KDOT. Some of the work needed will be for the vendor to refine the tools they provide for reporting of the data. Other parts of the work will be for KDOT, such as the conflation process to remove much of the spatial error that is currently in the data that should improve the quality of the location of the data relative to the locations of the bridges that get removed. Finally, Appendix A of this document is a troubleshooting guide. At this point, it is largely a framework, but we will attempt to populate it over the next couple of years and see if it becomes a useful tool.

Appendix A – Troubleshooting

This Troubleshooting Guide is intended to both document error resolution procedures and to help users identify data problems with some tools to remediate the problem.

Problem Occurs During:	Problem is with:	Description of Problem:	Action:
Collection System Startup	Collection Vehicle	Damaged	Assess and Report to office
		Flat Tire	Check for cause, fix, recalibrate DMI
		Won't Start	Check for cause, check switch at battery, call office
	Collection System Computer/Components	Won't Start	Check start up procedure document and repeat process. If still fails, contact the office.
		Does Not Connect	Check network settings for "collection", startup procedure document and repeat process. If still fails, contact the office.
		Gives Error Message	If known error and resolution, do it. Else contact manufacturer.
		"Fails" Block/Bounce/Burn	Block: if 1, 2, or 3" heights vary by more than 0.02", reclean lasers, reset to zero to restart block check, and try again. If still fails, call manufacturer. HPMS Height: follow manufacturer's guide for instructions and troubleshooting. Bounce: if file was not produced for bounce test, repeat procedure, if still does not produce file, start over all of the system start up procedures, if that fails call manufacturer. If test completes and IRI values exceed 15, check the surface under the lasers is adequate to perform test. If not, move vehicle, put plate or appropriate surface on the ground under laser and repeat tests. Burn: should cover at least 1 mile of data collection, run verifier to check that all systems are working normally. If GPS accuracy fails, follow manufacturer procedures.
		Does Not Have Route List	Reset the Mac Computer/Mesh. Reload route list from backup file. Contact office.
		Missing or Incorrect Info in Route List	Add or correct route information. Contact office.
Collection System Operation	Collection System Computer/Components	Gives Error Message	If known error and resolution, do it. Else contact manufacturer.
		Fog, Temperature, Moisture, or Other Weather Conditions Out of Range	Do not collect
		Is Not Collecting Profile Data	stop collection, recollect route
		Has Significant Linear Distance Discrepancy With End of Route	check tire pressures and recalibrate DMI
		route verifier indicates problems	judge error severity for acceptance -- usually most "errors" are still acceptable. If RSP is missing or significant frame count mismatch, then recollect.
		repeated verifier problems with frame mismatch	Check DMI and wheel encoder. Recalibrate, replace, check and call office.
		route closed or anomalies	note problem in log stating closure, crap on road, questionable weather, etc.
		[iPad/email stuff?]	
		forward images are not aligned	contact office to reset camera positions.
		forward images are fuzzy	clean windshield and contact office to check focus.
		IRI graph does not match seat of pants	stop collection, check all connections and settings, recollect and continue to monitor.
		RSP missing header	note problem in log for correction before processing
		RSP wrong direction	note problem in log for correction before processing and run RSP Reverser

Problem Occurs During:	Problem is with:	Description of Problem:	Action:
Processing	Software/Data	Drive appears empty when brought to office for processing	These drives are in Apple format, dummy. Use HFS to extract the data to match desktop drive format.
		HFS gives error message during extract	This is normal after about 600 GB of data transfer. Figure out where the software blew up and restart it from that point.
		RV7 won't load route	This could be a lot of things, so a whole document of possible causes and solutions is available in the Cliff Notes for RV7.
		pvt file does not list all frames	This typically occurs when the pvt editor is started before all files have finished being extracted through HFS. Restart pvt editor or manually determine the appropriate frame ranges and enter them.
		processed images have the measles	Check the pick out module setting
		processed images show potholes	Check the processing settings, mostly the checkboxes.
		processed images have continuous "crack" longitudinally through midframe	This is typically caused by an incorrect overlap setting. Typically, these are set by the manufacturer during annual system checks but can be set by KDOT. See manual for overlap setting instructions.
		AASHTO bands dramatically change from frame to frame	Check the lane mark memory setting.
		Error occurs during LCMS processing	Typically, this a problem with a source file or two. The typical remedy is to rerun just that file through processing. If it fails again, replace the file with the backup version and reprocess.
		Quality Checker Summary File Lists Concerns	The manufacturer provides a manual for what these concerns mean and how to address them.
		Error during copy to network drive	There are lots of files and some are pretty large. Space can be an issue.
		Routes don't load into workstation	Check that the loads are not coming from a mapped drive (should be //titan not H:). Try to reload files.
		Routes don't show up in workstation for collection year	Were they loaded to wrong year? Were they loaded from bad drive location? If so, reload them to right place from right location. If not, check for control (rtf) file and rebuild if necessary.
Reporting	Software/Data	TBD	TBD