



Chittenden County Infrastructure Management System Software Specifications

CCMPO Staff with input from an ad-hoc group of local and regional managers, the Vermont Agency of Transportation (VTrans), Chittenden County Regional Planning Commission Staff, and the CCMPO Technical Advisory Committee (TAC) developed the following specifications. The specifications include both general requirements and specific tasks. The CCMPO employs seven professional staff that will be available as a resource and to work with the Contractor where appropriate. CCMPO staff has expertise in transportation demand modeling, traffic engineering, GIS, project development, and offer extensive local knowledge.

GENERAL REQUIREMENTS

1. Document Copies and Mailings

The Contractor is responsible for providing enough copies of meeting materials, reports and other products as required. There are eighteen municipalities in Chittenden County, so that is approximately the number of copies that will be necessary for any final documents. Key deliverables will be provided to the CCMPO office in three formats: 1) a hard copy format that can be reproduced, 2) an electronic format compatible with Microsoft Office software, and 3) Adobe Acrobat PDF format for use on the CCMPO website.

2. Organization of Public Workshops and other Public Meetings

The scope of work includes three day-long training workshops. CCMPO staff will reserve the necessary spaces to hold the meetings. The Contractor will develop and distribute all notices and will make available relevant summary reports, user guides etc. at least 1 week prior to the meetings. Attendance at these workshops will not exceed 30 participants.

SOFTWARE REQUIREMENTS

This software will provide municipal and regional agencies with information to assist in maintaining and accounting for public assets.

A survey of municipal public works officials performed in 2002 highlighted several important asset types to be included in the asset management software system. The software system should operate with “modules” that will group together several related assets for simplified management. The structure of these modules and the assets managed within them is outlined below.

Transportation Infrastructure Module

1. Highways
2. Bridges
3. Culverts

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Stormwater Assets Module

4. Stormwater facilities (catchbasins, outfalls, lines) and NPDES permitting

Water Assets Module

5. Water and sewer systems (lines, valves)

Municipal Assets Module

6. Recreational facilities (parks)
7. Municipal buildings
8. Municipal Equipment over \$5000

Transportation Assets Module

9. Street signs
10. Street lights
11. Traffic signals
12. Sidewalks and bikepaths
13. Street trees
14. Guardrails
15. Pavement markings
16. Parking meters
17. User defined asset types (polygon, line, or point)

Each asset type will be reviewed to determine appropriate inventory and assessment methodologies. A data dictionary will be developed in consultation with municipal public works officials, including information on the attribute data requirements for the various asset types. When available, existing standards (state and/or national) should be used to define data models and coding standards. An example of this is the Vermont Geographic Information System (VGIS) Bridge and Culvert Data Standards (available for download from <http://www.vcgi.org>).

Specifications for specific software data and analysis capabilities are listed below:

1) The software will provide management tools for Highway Infrastructure. This will include at a minimum:

a) Highway inventory database tools, including the following items: surface type, functional class, VTrans town highway class, length, section beginning and end points, traffic volumes, truck volumes (Equivalent Single Axle Loads), percent trucks, crash data, ownership, pavement distresses (see Table A-1 on page 12), unpaved road distresses (to be determined by contractor), and map coordinate information. The software should be able to group facilities into various networks for analysis according to management needs. For example – all the town maintained highways, or all the highways with functional class of major collector and above. The majority of the required inventory information is already contained in Vermont's master road centerline data layer (TransRoad_RDS) and associated layers (eg: AADT9698, AADT2000). These layers are maintained by VTrans and VCGI, and can be downloaded from the VGIS Data Warehouse (<http://www.vcgi.org/dataware>). The inventory database tools should be able to import any required data from these data layers.

b) Pavement condition assessment tools. This component of the software will have the capability to analyze data collected manually or with automated equipment. Data collected with automated equipment will conform to the specifications listed in Table A-1 of Appendix A to this RFP. Pavement distress data collected manually will use a system similar to the University of New Hampshire's

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Roadway Surface Management Software (RSMS) program (more information available at <http://www.t2.unh.edu/pwms/rsms.html>). The final documentation for the software system will include comprehensive materials on manual data collection suitable for training interns or technicians in the data collection techniques.

The Infrastructure Management software analysis of the distress data will provide well-defined performance measures for pavement condition, such as the MicroPaver pavement condition index, International Roughness Index, and/or other similar methodologies. The software should include appropriate condition assessment tools for unpaved road surfaces. The condition assessment should provide information on individual highway segments and overall network performance measurements.

c) Pavement condition prediction model tools. The system should have the ability to store and analyze multi-year data on project and network condition levels. The system must include the ability to vary acceptable levels of service across the network and specific routes (e.g. set an acceptable surface condition based on ADT or functional classification).

These tools will anticipate future highway network conditions based on current conditions and an anticipated available maintenance budget over a period of time. The software should include default bituminous and composite pavement deterioration models for Vermont/New England conditions, but should also allow users to develop custom prediction models using local data. The models should be based on the expert opinion of the contractor, information available from VTrans, and the project technical panel.

d) Pavement capital budgeting tools. These tools include default and customizable decision trees or other appropriate methods to construct comprehensive maintenance, rehabilitation, and reconstruction strategies based upon history of past performance in Vermont, proven engineering principles, and the expert opinion of the contractor and project technical panel. Each treatment considered should include costs, selection criteria, and expected level of improvement.

This module should include highway capital programming tools to optimize highway investments to make the best use of limited municipal funds. For example, if there are “X” dollars, then the system should identify the best use of these funds for system preservation. Life cycle cost analysis, benefit/cost, and/or user benefit analysis should be incorporated into this system.

e) Compatibility with VTrans systems. The contractor will recommend and implement a system which assures that data stored in the highway infrastructure sub-module is compatible with VTrans’ Linear Referencing (LRS) and Route Log Systems of state owned highways. The pavement management system will be able to import inventory and condition assessment data collected by the VTrans pavement management office and display this information. The contractor will also need to recommend and implement an approach for dealing with locally maintained highways not currently part of VTrans’ LRS.



2) The software will provide management tools for highway structure (bridge and culvert) infrastructure:

a) Bridge and culvert inventory tools. The Vermont Center for Geographic Information (VCGI) has developed a VT GIS bridge and culvert data standard (VGIS Bridge & Culvert Data Standard). The standard is available for download at http://www.vcgi.org/techres/standards/partii_section_h.pdf

The contractor will develop the asset management system to take advantage of these standards by directly accessing structures data stored in Arcview shapefile format or ArcGIS geodatabase format according to the VCGI standard. The software should also include tools to assist in performing updates (additions and/or changes) to data stored in GIS files compliant with the standards. Refer to the Maintenance Procedures section of the VGIS Bridge & Culvert Data Standard.

Data templates are available here: http://www.vcgi.org/techres/tools/vcgi_tools/culvert_kit.htm

b) Bridge and culvert assessment and programming tools. The contractor will recommend and implement a system to analyze culvert and bridge inspection data to identify structures in need of maintenance. Maintenance costs will be estimated and included in the overall capital budgeting needs.

3) The software will provide inventory and assessment tools for sidewalk and shared-use path infrastructure, including but not limited to facility type, location, width, and condition rating.

4) The software will provide appropriate tools for stormwater system inventory and assessment. This will include necessary data to maintain compliance with EPA's NPDES rules as they apply to municipal assets.

5) The software will provide inventory and assessment tools for water and sewer infrastructure, including, but not limited to facility type, pipe material, valve or pump information, length, diameter/size, condition rating, and location.

6) The software will be capable of generating reports to assist municipalities in complying with the GASB 34 accounting standards. Highways, bridges, culverts, and water and sewer systems are expected to use the "modified approach" to GASB implementation which requires the following information:

- a) A current inventory of highway, bridge, culvert, water and sewer assets.
- b) Documentation of the condition of assets using a reproducible procedure.
- c) Demonstration that the assets will be preserved at a condition rating specified by the municipality (e.g. 75% of the highways are in good or better condition).
- d) Estimation of the actual costs necessary to maintain and preserve the assets.

Other assets will likely use a straight-line depreciation method for the sake of simplicity.

7) The software should provide a means for users to modify the database to add any additional assets of interest not listed above specifically. This includes the ability to add a new asset type along with user-defined fields for inventory and condition ratings.

8) The software will be directly compatible with Arcview GIS shapefiles or ArcGIS geodatabases. The software should be able to map all asset inventories and condition ratings. In addition, data should be easily

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exportable into MS Excel or Access formats. The system will function as an extension to ArcView 3.x and ArcView 8.3 or 9.x GIS software. Spatial data layers should be in Vermont's State Plane Coordinate System (meters – NAD83).

9) Digital Photos. The software will include an ability to display digital photos of each infrastructure asset included in the GIS system when they are available.

10) Orthoimagery. The software should have easy-to-use tools to assist in placing orthoimagery files as background images in the Infrastructure Management System user interface.

11) Stand alone operation. If the system requires additional external software to meet all of the functional requirements listed above (e.g. MicroPaver), then the software will be capable of limited operation without the presence of the external software. For example, many towns may not wish to have a license of MicroPaver, and instead will depend on CCMPO to perform the pavement management analysis. The Infrastructure Management System software should allow these towns to collect roadway assessment data for delivery to CCMPO and view condition data calculated by CCMPO using MicroPaver.

12) Off-the-shelf technology. To the extent possible, the software should implement commercial off-the-shelf (COTS) technology to ensure future compatibility and minimize time and cost required for software development. However, CCMPO desires an option to include our own customized components and functionality at our own discretion.

13) Licensing. CCMPO will obtain a regional license for the use of the software. Up to eighteen municipal government agencies within Chittenden County will be granted permission to use the software under this license at any one time, with no restriction on the number of users at each location. In addition, CCMPO and CCRPC use of the software will also be included in the regional license of the infrastructure management software.

Software Deliverables

1. Data dictionary with complete metadata information on the attribute data fields for each asset type.
2. Complete infrastructure management system software installed and fully operational on CCMPO's computer system;
3. Complete description of all hardware, software, and operating system requirements and procedures;
4. Complete system documentation to include operator and system administrator manuals; and
5. Infrastructure management system training documentation for users.

Software license fees will be paid to the selected contractor upon successful completion of system testing.

The contractor will supply 18 copies of the software installation CD-ROM and user manuals to CCMPO once software testing is complete.



TRAINING AND SUPPORT

Training and support are a critical component to the successful implementation of the Infrastructure Management system.

At a minimum, the contractor will provide for appropriate instruction in the use of the infrastructure management system, including field data collection procedures and data maintenance, through at least three day-long workshops in Chittenden County along with comprehensive user guides explaining all software features and data collection methodologies.

In addition CCMPO expects on-going technical support for the software for a period of one year beyond distribution of the completed system. Minor updates and off-site support will be included as part of the software license for a period of one year. Each of the potential users (up to 18) will receive up to 3 hours of on-site support at no cost. Additional requests will be billed on a time and materials basis to municipality/user.



Appendix A

Automated Highway Data Collection Specifications



APPENDIX– Distress descriptions, recording and reporting requirements, and fieldnames [in brackets]

CRACKING

• **Transverse Cracking:**

A transverse crack is a crack longer than 0.6 m, excluding saw cuts, oriented more than 45° from the pavement centerline. Identified transverse cracks shall be categorized as one of the following:

- **Severity level 1:** mean crack width < 6 mm [Tran_Sev_1]
- **Severity level 2:** mean crack width ≥ 6 mm and < 12 mm [Tran_Sev_2]
- **Severity level 3:** mean width ≥ 12 mm, or mean width ≥ 6 mm and parallel narrow cracks immediately adjacent (considered a precursor to spalling), or if more than 25% of the crack is spalled [Tran_Sev_3]
- **Sealed:** any transverse crack that has been sealed so that the severity level cannot be determined [Tran_Seal]

Within a given 0.1 mile section, record and report the number of equivalent full-width transverse cracks of each severity level. (An equivalent full-width crack is the sum of the lengths of the observed cracks of a given severity level, divided by the lane width).

Any portion of the section for which valid transverse cracking data could not be collected shall be reported as percent length [Invid_Tran].

• **Wheelpath Cracking:**

A wheelpath cracking is cracking in the wheelpath, as described in Figure 1, not already identified as a transverse cracking. These may include longitudinal cracks in the wheelpath with few or no intersecting cracks, or a series of interconnected, transverse and longitudinal cracks located in the wheelpaths forming a series of polygons. In the most extreme case, the individual blocks can become loose and develop into potholes. Wheelpath cracking shall be reported separately for the left and right wheelpaths. These shall be categorized as one of the following:

- **Severity Level 1:** Longitudinal cracks in the wheelpath with few or no intersecting cracks, and / or intersecting longitudinal and transverse cracking that form large polygons (block cracking > 0.1 m²), which occur solely in the outside wheel path. If block cracking extends across the mid-area between the wheel paths it should be recorded as miscellaneous non-wheelpath cracking and should not be recorded a second time as wheelpath cracking. [Fat_LWP_Sev_1] & [Fat_RWP_Sev_1]

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- **Severity Level 2:** Longitudinal, diagonal, and short transverse cracks in the wheelpaths whose crack width ranges from hairline to 6 mm. These cracks form a network of polygons, often referred to as alligator or chicken-wire cracks. Some spalling may be observed, however, there shall be no loose pieces of asphalt concrete, nor shall there be any indications of potholes. The average size of the pieces formed by the cracks will be less than 0.1 m². [Fat_LWP_Sev_2] & [Fat_RWP_Sev_2]
- **Severity Level 3:** Longitudinal, diagonal, and short transverse cracks in the wheelpaths whose crack width is generally greater than 6 mm. These cracks form a network of polygons, often referred to as alligator or chicken-wire cracks. These cracks are generally spalled and some potholes may be present. The size of the pieces formed by the cracks will be less than 0.3 m². [Fat_LWP_Sev_3] & [Fat_RWP_Sev_3]
- **Sealed:** Any area of fatigue cracking that has been sealed such that the severity level cannot be determined. [Fat_LWP_Seal] & [Fat_RWP_Seal]

Record and report the percentage of a 0.1 mile section that displays each severity level. Note that the sum of the percentages for each severity level cannot exceed 100%. The units shall be percent.

Any portion of the section for which valid cracking data (wheelpath or miscellaneous non-wheelpath) could not be collected shall be reported as percent length [Invid_Fat].

- **Miscellaneous Non-Wheelpath Cracking:**

Miscellaneous non-wheelpath cracks are those cracks in the areas outside, or between wheelpaths, as described in Figure 1, not already identified as transverse. These may include longitudinal cracks, and also interconnected longitudinal and transverse cracks forming a series of polygons (block cracking). Miscellaneous Non-Wheelpath cracking shall be reported separately for the left edge of lane, the lane center, and the right edge of lane. These shall be categorized as one of the following:

- **Severity level 1:** Longitudinal cracks < 6 mm wide without the presence of interconnected cracking [Misc_LE_Sev_1], [Misc_LC_Sev_1], & [Misc_RE_Sev_1]
- **Severity level 2:** Longitudinal cracks ≥ 6 mm wide, or interconnected longitudinal and transverse cracks < 6mm wide that form polygons [Misc_LE_Sev_2], [Misc_LC_Sev_2], & [Misc_RE_Sev_2]
- **Severity level 3:** Interconnected longitudinal and transverse cracks ≥ 6 mm wide that form polygons [Misc_LE_Sev_3], [Misc_LC_Sev_3], & [Misc_RE_Sev_3]
- **Sealed:** Any block cracking that has been sealed such that the severity level cannot be determined [Misc_LE_Seal], [Misc_LC_Seal], & [Misc_RE_Seal]

Record and report the percentage of each 0.1 mile section that displays each severity level. Note that the sum of the percentages for each severity level cannot exceed 100%. The units shall be percent.

As noted above, any portion of the section for which valid cracking data (wheelpath or miscellaneous non-wheelpath) could not be collected shall be reported as percent length [**Invlid_Fat**].

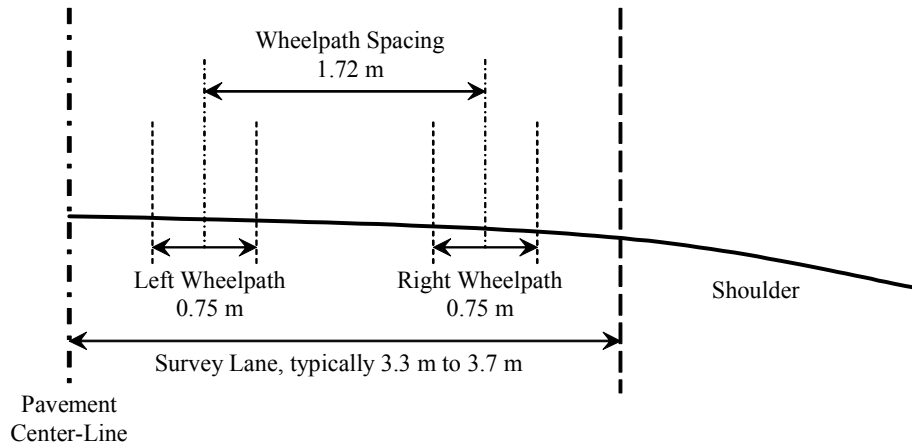


Figure 1 – Wheelpath Spacing and Dimensions

ROUGHNESS

The International Roughness Index (IRI) will be used to describe roughness. Measurements of profile shall be made in accordance with American Society for Testing and Materials (ASTM) Designation E950, Standard Test Method for Measuring the Longitudinal profile on Vehicular Traveled Surfaces with an Inertial Profiler. In instances of conflict, the procedures set forth herein shall take precedence.

Recording and Reporting:

The longitudinal profile points used for calculating the IRI shall have a longitudinal spacing not greater than 150 mm. The appropriate use of anti-aliasing filters and averaging to remove small wavelength content from the profile is left to the consultant and equipment manufacturers.

Two IRI values shall be calculated, recorded, and reported for each 0.1 mile section: one in the left wheelpath [**IRI_L**] and one in the right wheelpath [**IRI_R**]. Additionally, an average of these two IRI values shall be recorded and reported [**Avg_IRI**]. Each IRI shall be reported to the nearest one-hundredth meter per kilometer (0.01 m/km).

Any portion of the section for which valid roughness data could not be collected shall be reported as percent length [**Invlid_Ride**].

RUT DEPTH



A rut is defined as a longitudinal surface depression in the wheelpath of a pavement surface.

Rut depth is the distance from the lowest measured point within a wheelpath to an imaginary line extending from the pavement elevation at the center of the lane to the pavement elevation at outermost (left or right) measurement. See Figure 2.

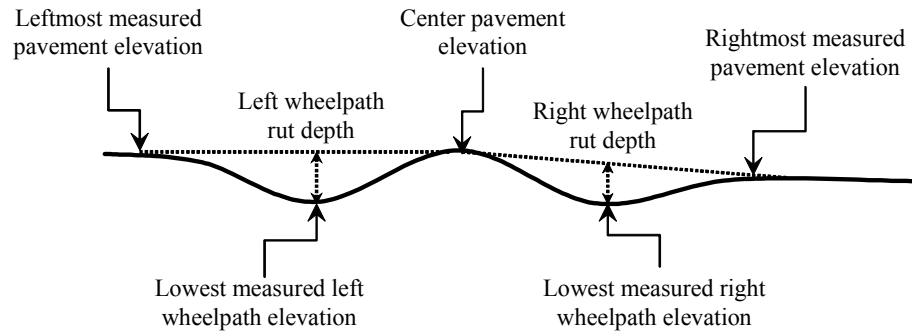


Figure 2 – Rut Depth Measurements

Recording and Reporting:

Rut depths shall be sampled in both wheelpaths of the survey lane. Measurements shall be made longitudinally at maximum intervals of 15 m. The test equipment shall use a minimum of nine sensors to determine the cross sectional profile and rut depths. Any reliable equipment which can measure as specified and which can be adequately calibrated is acceptable.

Average left and right wheelpath depths [**Rut_Avg_L**] & [**Rut_Avg_R**] shall be recorded and reported for each 0.1 mile section. The units shall be millimeters.

Furthermore, the percentage of rut depths falling into each of the four following severity levels shall be recorded and reported for each section. The sum of the four severity levels shall be 100%.

- **Severity Level 1:** Rut depth < 6 mm [**Rut_Sev_1**]
- **Severity Level 2:** Rut depth \geq 6 mm & < 12 mm [**Rut_Sev_2**]
- **Severity Level 3:** Rut depth \geq 12 mm & < 19 mm [**Rut_Sev_3**]
- **Severity Level 4:** Rut depth \geq 19 mm [**Rut_Sev_4**]

Any portion of the section for which valid rut data could not be collected shall be reported as percent length [**Invid_Rut**].

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Table A-1: Automated Data Collection Database Structure

All reported data will be formatted in DBF 111+ format, described as follows:

Fieldname	Type	Width	Decimals	Unit	Description
Roadcode	C	10	-	-	Roadcode used for location referencing
Roadname	C	35	-	-	Name of road
From	N	7	3	miles	Mileage from beginning of road to start of section.
To	N	7	3	miles	Mileage from beginning of road to end of section.
Dir	T	1	-	-	Direction of testing, with or against mile markers
Length	N	5	3	miles	Planned section length(As recognized by VAOT).
Meas_Len	N	5	3	miles	Measured section length(As measured during testing).
Date	D	10	-	mmddyyyy	Date section was tested(to include century).
Invalid	N	3	0	%	Percent length of section with invalid data.
Const	N	3	0	%	Percent length of section in construction area.
Bridge	N	3	0	%	Percent length of section on bridge(s).
Lanede	N	3	0	%	Percent length of section in lane deviation area
RRxing	N	3	0	%	Percent length from start of section to center or railroad Xing.
Node	N	3	0	%	Percent length from start of section to node point.
IRI_R	N	5	2	m/km	Average IRI (m/km) of right wheel path. Valid data only.
IRI_L	N	5	2	m/km	Average IRI (m/km) of left wheel path. Valid data only.
Avg_IRI	N	5	2	m/km	Average IRI (m/km) of both wheel paths. Valid data only.
Invid_Ride	N	3	0	%	Percent length of section with invalid IRI data.
Rut_Avg_R	N	3	0	mm	Average rut depth (mm) for right wheel path.
Rut_Avg_L	N	3	0	mm	Average rut depth (mm) for left wheel path.
Rut_Sev_1	N	3	0	%	Percent length of section with rut depth <6mm.
Rut_Sev_2	N	3	0	%	Percent length of section with rut depth =>6mm to <12mm.
Rut_Sev_3	N	3	0	%	Percent length of section with rut depth =>12mm to <19mm.
Rut_Sev_4	N	3	0	%	Percent length of section with rut depth =>19mm.
Invid_Rut	N	3	0	%	Percent length of section with invalid rut data.
Fat_LWP_Sev_1	N	3	0	%	Percent length of section with severity level 1 fatigue cracks. Left Wheel Path
Fat_LWP_Sev_2	N	3	0	%	Percent length of section with severity level 2 fatigue cracks. Left Wheel Path
Fat_LWP_Sev_3	N	3	0	%	Percent length of section with severity level 3 fatigue cracks. Left Wheel Path
Fat_LWP_Seal	N	3	0	%	Percent length of section with sealed fatigue cracks. Left Wheel Path
Fat_RWP_Sev_1	N	3	0	%	Percent length of section with severity level 1 fatigue cracks. Right Wheel Path
Fat_RWP_Sev_2	N	3	0	%	Percent length of section with severity level 2 fatigue cracks. Right Wheel Path
Fat_RWP_Sev_3	N	3	0	%	Percent length of section with severity level 3 fatigue cracks. Right Wheel Path
Fat_RWP_Seal	N	3	0	%	Percent length of section with sealed fatigue cracks. Right Wheel Path
Misc_LE_Sev_1	N	3	0	%	Percent length of section with severity level 1 Miscellaneous cracks. Left Edge of Lane
Misc_LE_Sev_2	N	3	0	%	Percent length of section with severity level 2 Miscellaneous cracks. Left Edge of Lane
Misc_LE_Sev_3	N	3	0	%	Percent length of section with severity level 3 Miscellaneous cracks. Left Edge of Lane
Misc_LE_Seal	N	3	0	%	Percent length of section with sealed Miscellaneous cracks. Left Edge of Lane
Misc_LC_Sev_1	N	3	0	%	Percent length of section with severity level 1 Miscellaneous cracks. Lane Center
Misc_LC_Sev_2	N	3	0	%	Percent length of section with severity level 2 Miscellaneous cracks. Lane Center
Misc_LC_Sev_3	N	3	0	%	Percent length of section with severity level 3 Miscellaneous cracks. Lane Center
Misc_LC_Seal	N	3	0	%	Percent length of section with sealed Miscellaneous cracks. Lane Center
Misc_RE_Sev_1	N	3	0	%	Percent length of section with severity level 1 Miscellaneous cracks. Right Edge of Lane
Misc_RE_Sev_2	N	3	0	%	Percent length of section with severity level 2 Miscellaneous cracks. Right Edge of Lane
Misc_RE_Sev_3	N	3	0	%	Percent length of section with severity level 3 Miscellaneous cracks. Right Edge of Lane
Misc_RE_Seal	N	3	0	%	Percent length of section with sealed Miscellaneous cracks. Right Edge of Lane
Invid_Fat	N	3	0	%	Percent length of section with invalid fatigue or miscellaneous crack data.
Tran_Sev_1	N	3	0	Count	Number of severity level 1 transverse cracks in section.(# of equivalent full-length trans cracks)
Tran_Sev_2	N	3	0	Count	Number of severity level 2 transverse cracks in section.(# of equivalent full-length trans cracks)
Tran_Sev_3	N	3	0	Count	Number of severity level 3 transverse cracks in section.(# of equivalent full-length trans cracks)
Tran_Seal	N	3	0	Count	Number of sealed transverse cracks in section.(# of equivalent full-length trans cracks)
Invid_Tran	N	3	0	%	Percent length of section with invalid transverse crack data.