

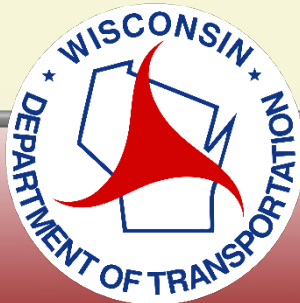
Wisconsin Safety Certification Mapping

Crash Map Automation

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Mid-Continent Transportation Research Symposium

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Wisconsin Traffic Operations and Safety Laboratory

Department of Civil and Environmental Engineering
University of Wisconsin-Madison



Introduction

Safety Certification Mapping

- Develop an application with which users can quickly and easily identify, analyze, and map the most dangerous* segments of highway
 - Where can resources be dedicated most efficiently to reduce safety concerns related to roadway geometry rehabilitation?
 - “Sites of Promise”
- Ready access to data brought together from multiple sources.
 - State Trunk Network (STN), Linear Referencing System (LRS)
 - MetaManager – WisDOT data product

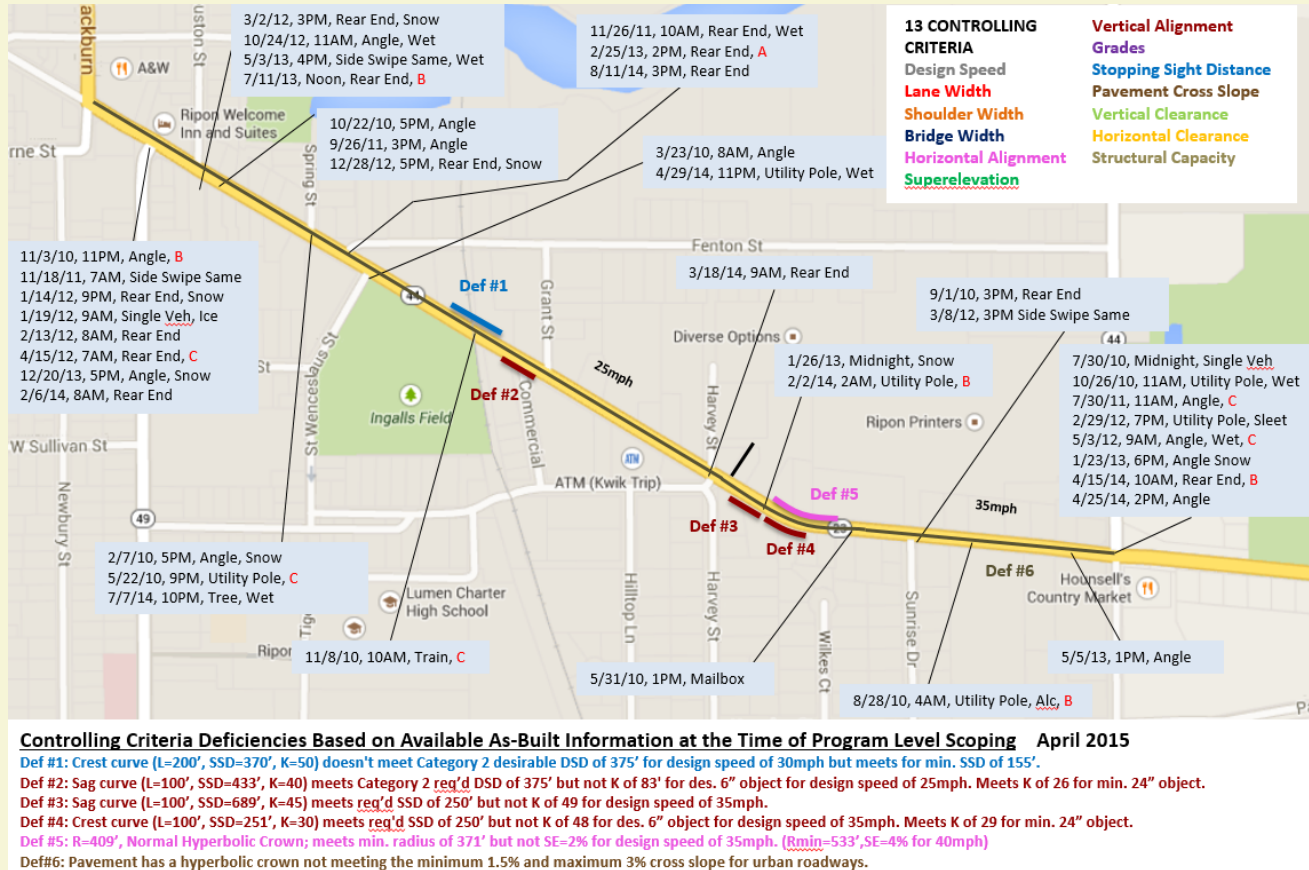
Safety Problem Flags (Crashes/100 million VMT)

- Crash Rate: All crashes
- KAB Crash Rate: Fatalities, Incapacitating Injury, Non-incapacitating Injury
- WisTransPortal Crash Database
- Self Service and easy. Limited or no special training
- Central and accessible storage location



Status Quo Ante

- Manually Created Maps
- Involved lookups to a variety of data sources – Inaccessible in some cases
 - As-built drawings, Asset Management, Crash Data



- Time consuming to make, Not readily reproducible, Stored in “silos”



Data Sources



WisDOT STN

Wisconsin Department of Transportation State Trunk Network

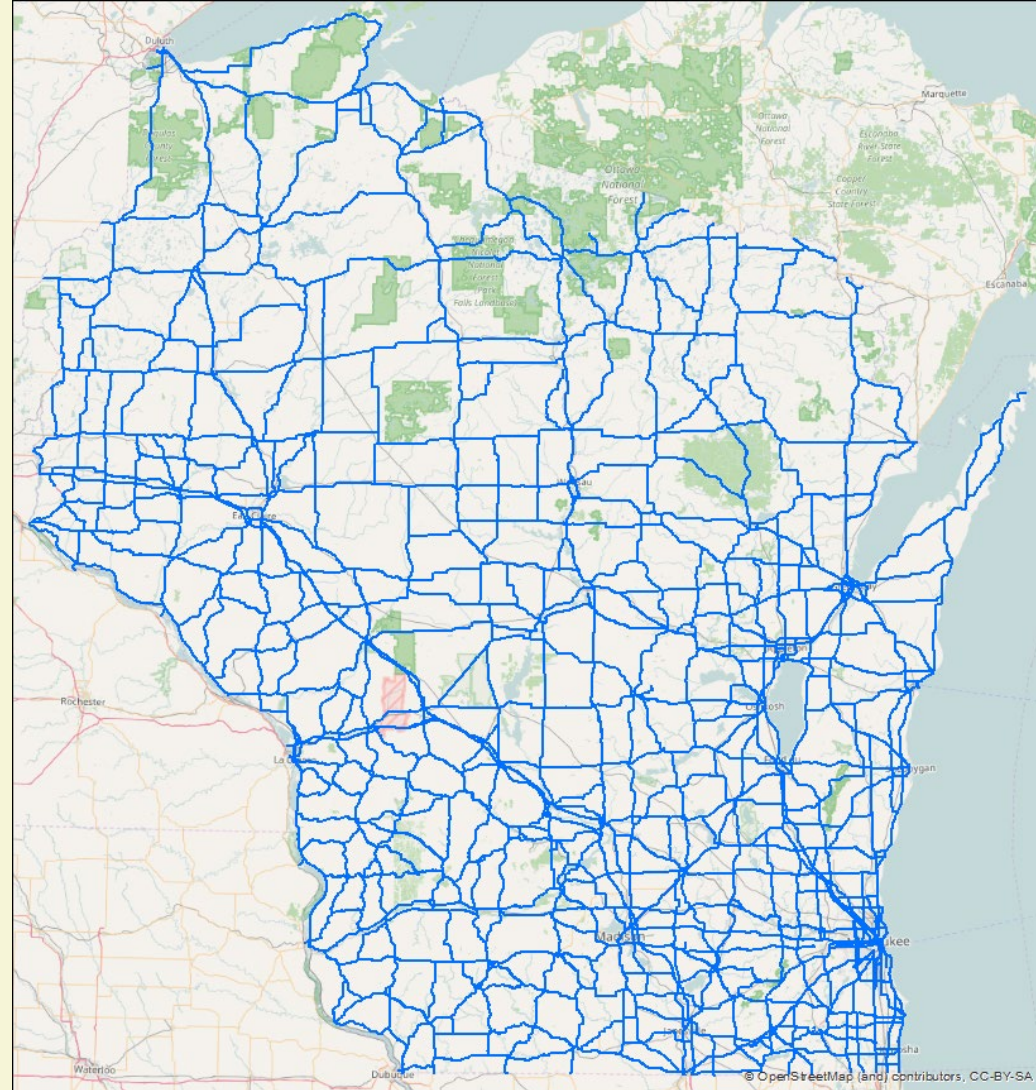
- Interstates
- US Highways
- State Highways

Pioneer of Linear Referencing

Position in terms of:

- Reference Points, Landmarks
- Link and Offset
- Route and Cumulative Mileage

Base linear referencing system for roadway features and operations



WisDOT STN

- Routes
 - Directional routes by highway and direction, concurrent routes addressed
- Links
 - Tabular representation of segments representing a complete route, directional but not meaningful spatial features
- Chains
 - Spatial representation (geometry) of the roadway centerlines
 - No inherent direction. Travel-Digitization direction mismatches
- Cumulative Mileages
 - Mileage at the start of each link relative to the parent route
- Link History – handles realignment and name changes

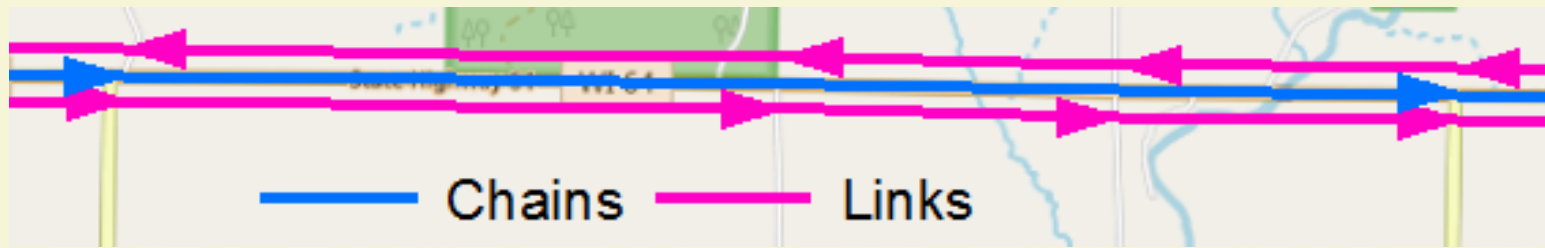
Hard to use for mapping out of the box



WisDOT STN

Lookup tables – Route -> Link, Link -> Chain

- Route to Links - one to many, ordered relationship
- Link to chain lookup is more involved, relationship attributes
 - A given link can be entirely within a single chain or can encompass all of several chains and overlap adjacent
 - Participation of a chain in a link is represented as from and to percentages. Ex. 0.2 - 0.6 or 0.2 – 1, 0.0 -1.0, ..., 0.0 – 0.4
 - Travel/digitization direction inversion represented as from percentage greater than to direction
 - Database solution wherein a link's geometry is generated as a merge of portions of participating chains with travel direction matching digitization direction (PostgreSQL/PostGIS)



WisDOT STN – API

<https://transportal.cee.wisc.edu/gis/webmaps/api/>

Collection of web services with usage and URL parameters described

STN API

STN Year

<https://transportal.cee.wisc.edu/api/stn/years>

Get the number of STN year versions in the database

JSON structure

years: number array

<https://transportal.cee.wisc.edu/api/stn/routes>

Get the STN routes near a specified coordinate

URL parameters

- lon: number
- lat: number
- year: number
- distance: number Search Distance, *Optional* Defaults to 500 feet

JSON structure

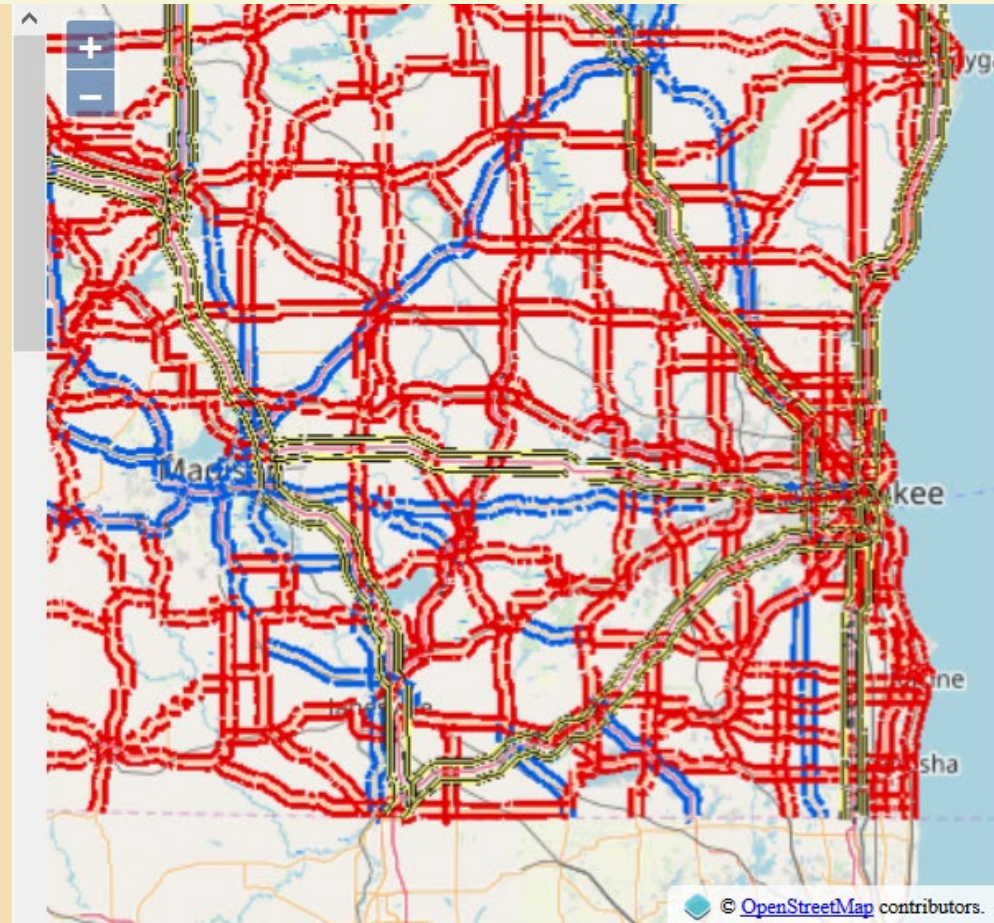
> routes: object
error: text, not present if successful

Example

<https://transportal.cee.wisc.edu/api/stn/routes?lon=-89.516883&lat=43.134362&year=2017>

<https://transportal.cee.wisc.edu/api/stn/snapped>

Get a point snapped to the STN route



WisDOT STN – API

URL endpoints to query STN features, get snapped points, and derive segments based on user specified coordinates or route and mileage.

Snapped point from route, user coordinates and search radius

`/snapped?year=2017
&route=111
&lon=-92.288
&lat=45.198
&distance=500`

```
▼ features:  
  ▼ 0:  
    ▼ properties:  
      dtOpnTrfc: "1993/01/01"  
      lcmDthStl: null  
      lncOffsetMi: 1.62971230205552  
      editIndc: 0  
      lcmDttxnCurr: "1993/01/01"  
      dtLinkCurr: "1993/01/01"  
      lcmStus: "C"  
      dtTrxHstl: null  
      refSiteToId: 2140  
      lncOffsetPcnt: 0.810802140326129  
      refSiteFromId: 2185  
      cumtMilg: 57.1897123020555  
      rdwyLinkId: 7787  
    ▼ routeIds:  
      0: 111  
      year: "2014"  
      lcmFromToDis: 2.01  
      lcmCkotTxnId: 0  
    ▼ geometry:  
      ▼ coordinates:  
        0: -92.2844030288284  
        1: 45.2182346287215  
      type: "Point"  
    type: "Feature"  
  type: "FeatureCollection"
```

Segment from route and start - end miles
`/segment?year=2017&route=111
&startMile=57.1&endMile=57.6`

```
▼ features:  
  ▼ 0:  
    ▼ properties:  
      offsetPcntStart: 0.536044956058009  
      year: 2014  
      offsetMiStart: 1.0774503616766  
      cumtMilgStart: 56.6374503616766  
      rdwyRteId: 111  
      offsetPcntEnd: 0.992609050709553  
      offsetMiEnd: 1.9951441919262  
      rdwyLinkId: [...] (truncated)  
      rdwyLinkIdStart: 7787  
      rdwyLinkIdEnd: 7787  
      cumtMilgEnd: 57.5551441919262  
    ▼ geometry:  
      ▼ coordinates:  
        [...] (truncated)  
      type: "LineString"  
    type: "Feature"  
  type: "FeatureCollection"
```



MetaManager

- WisDOT data product
- Updated 3 times a year
- ~20,000 segments with a typical length of $\frac{3}{4}$ mile, covers 15K miles
- Over 200 attributes per segment, several categories
- Spatially enabled dataset derived from the STN
- Distributed as a zip file with one ESRI shapefile and one Excel document for each of 5 WisDOT regions - loaded into a relational database
- Selected Tables
 - Base – Segment start/end reference points, highway, direction
 - Roadway – AADT, Roadway Attributes, Curve, No-passing zones
 - Pavement – Current and projected pavement conditions
 - Safety – Crash Counts, Accident Flags (last 5 years*)
 - Mobility – Level of service, deficiencies, suggested Improvements
 - Bridge – Attributes, current and projected conditions,



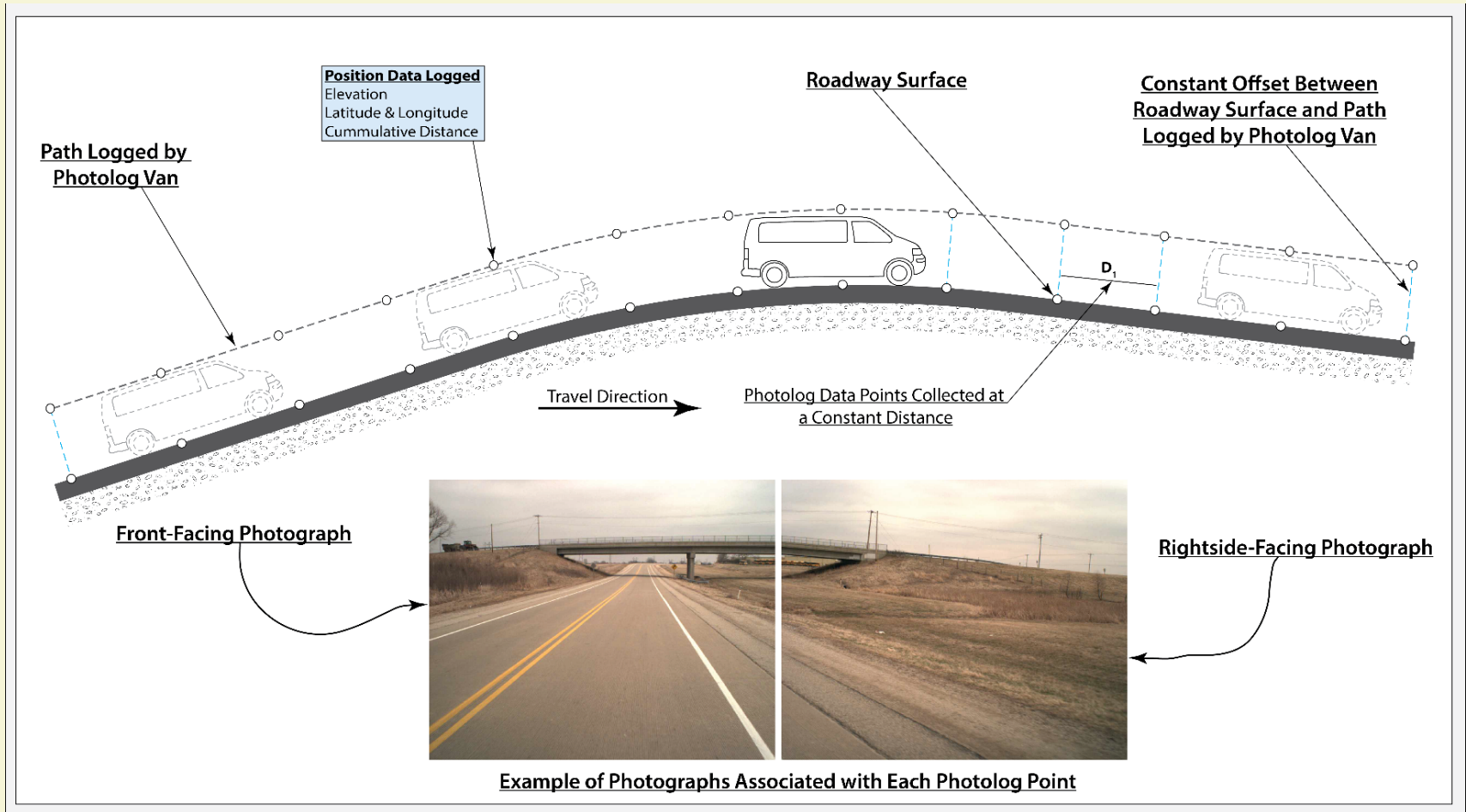
MetaManager

- Unit of analysis is the PDP segment
- Reverse lookup to the STN needed to be created
- Route attribute can be derived from MetaManager attributes
- Lookup table generated by parsing start and end Reference Point (RP) definition given for each segment
 - Reference Point and offset to make start and end cumulative mileages for each PDP segment
- Route and cumulative mileage is the common linear reference for all data in the application



Photolog

- Precise XYZ location at 1/100th mile intervals
- Used for curve identification and visibility analysis

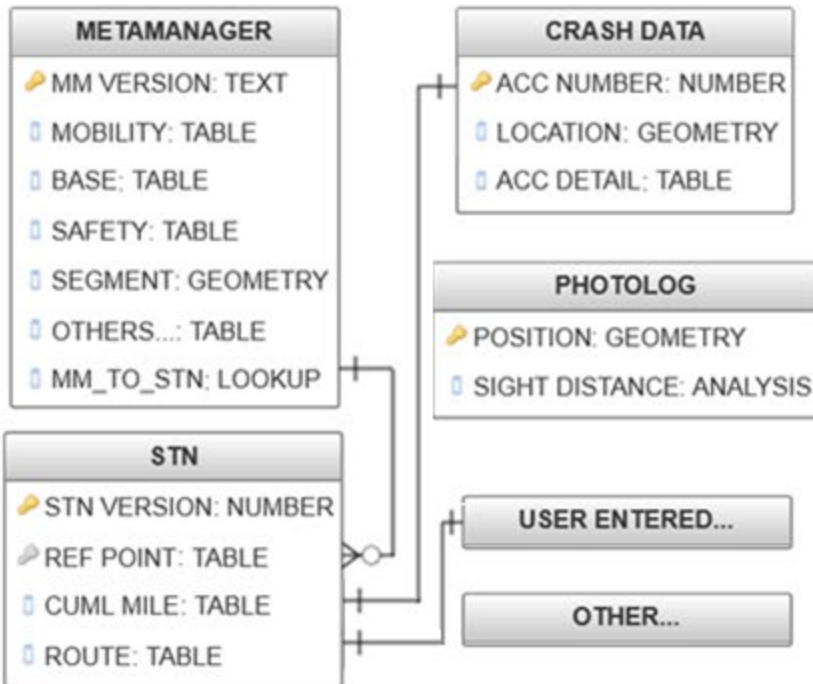


Under the Hood

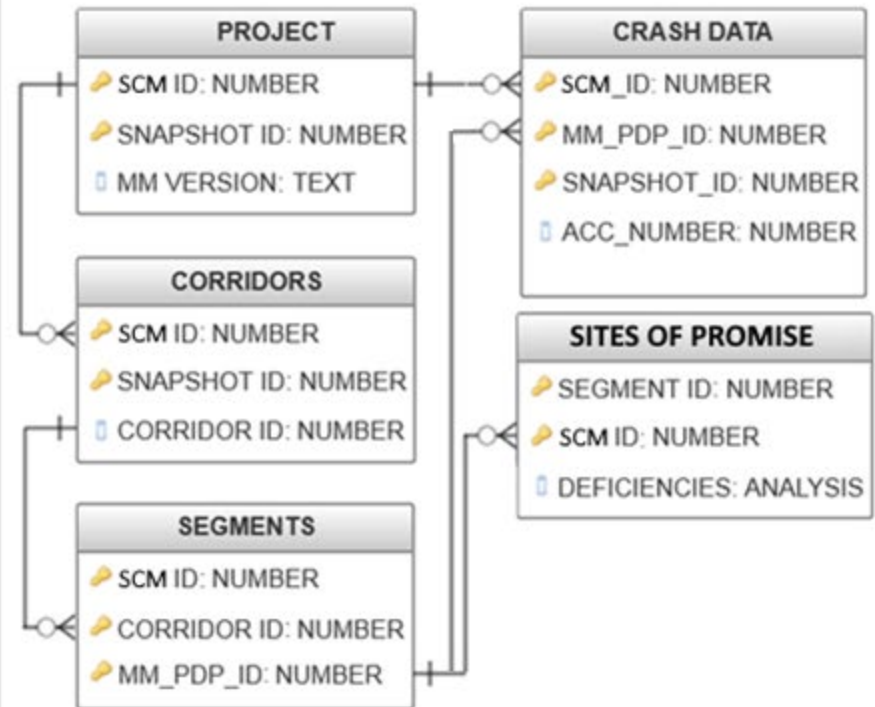


Project Diagram

DATA SOURCES



SAFETY CERTIFICATION MAP



Architecture

Database



ORACLE®

SPATIAL



Server



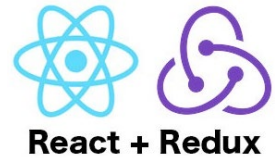
Main Application



STN API



Client/Browser



SCM Project Creation



Project Definition

- Reference to project database to automatically populate SCM project attributes
 - Project title, construction IDs, primary route
- User defined crash date (year) range

Create New SCM

Design ID <input type="text" value="1100-03-31"/>	STN Version <input type="text" value="2016"/>	Meta Manager Version <input type="text" value="2018-06"/>	Meta Manager Crash Year <input type="text" value="2013-2017"/>
Construction ID(s) <input type="text"/> <input type="text" value="1100-03-61"/> <input type="text" value="1100-03-71"/>	<input type="button" value="Add Another Construction ID"/>		
Project Title <input type="text" value="MILWAUKEE - FOND DU LAC"/>	Project Description <input type="text" value="MENOMONEE RIVER BRIDGE"/>		
SCM Comment <input type="text"/>			
SCM Crash Data Start Year <input type="text" value="2016"/>	SCM Crash Data End Year <input type="text" value="2019"/>		



Project Extent

- Definition of a project by the selection of start and end segments for one or more corridors – Highway route and direction and county
- Point-Click interface with interactive popups

The screenshot shows a web application interface for defining project extent. On the left, there is a control panel with the following fields:

- Add Corridor
- Zoom to Extent
- Start County: SAUK
- End County: DANE
- Highway: US 12 EB
- Ref. Point #1: 012E294M000
- Ref. Point #2: 012E352K000
- Buttons: Preview, Add, Cancel
- Corridors list: 013N005 - 013N014

The map shows a blue route starting near Waubesa and ending near Fitchburg. A popup window titled "1 of 2 - End Segment" is overlaid on the map, displaying the following data:

Pdpld	1755	Select
Hwy	US 12 EB	
DivUnd	D	
From	012E351D000	
To	012E352K000	

Project create or modification triggers queries against available data (Crashes)



Project Editing

Home > Applications > Safety Certification Mapping

Welcome, gavorhes | [Manage Account](#) | [Logout](#) | [Help](#)

SCM: 10081, Snapshot: 0, Corridor: 1, PDP: 2148

Cumt Milg: 17.88 - 18.88, RP: 013N024 000 - 013N028 000

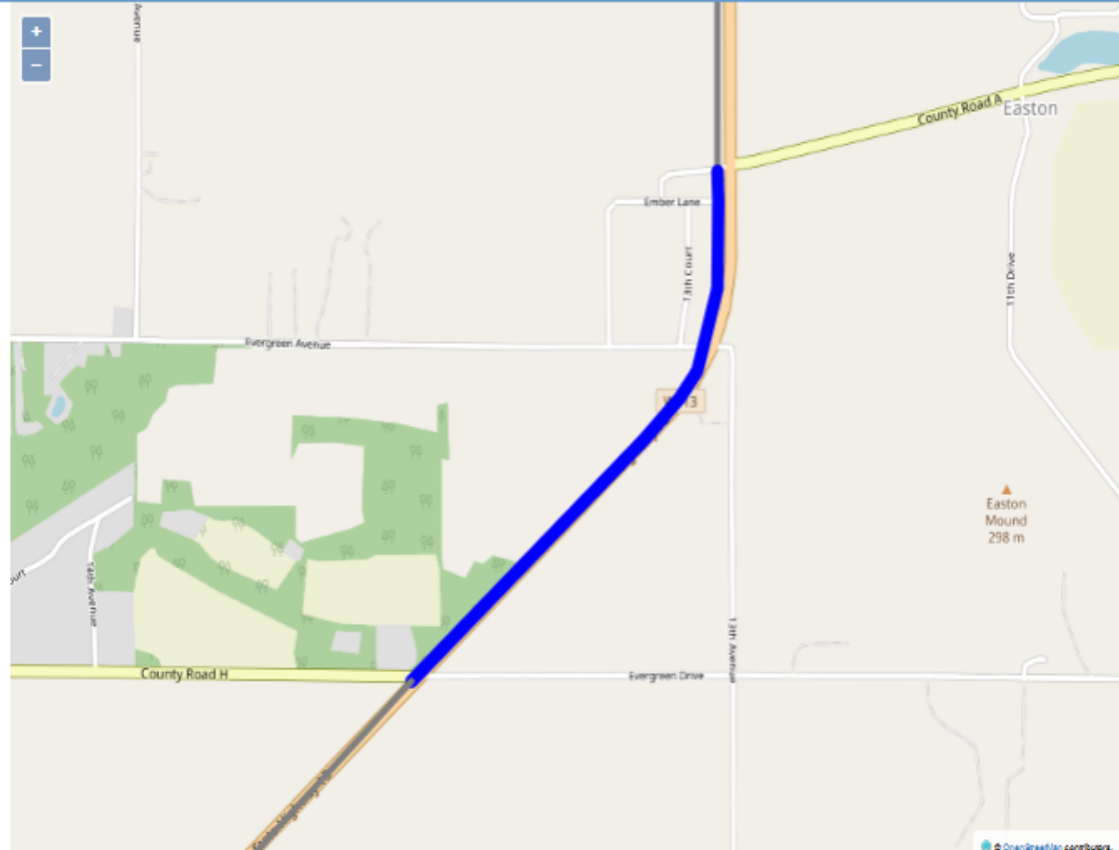
Description: CTH H

Metamanager - Crash Rate: 1.24, KAB Rate: 1.34, Int Crash Rate: NA, Int KAB Rate: NA

Summarize the contributing factors for ALL crashes in the flagged segment or intersection.

Which geometric features contribute to the type and severity of the crashes?

Possible Countermeasures for Safety Mitigation Process



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Crashes



“Sites of Promise”

- Web Interface for definition of extent of segments
- Can be the full PDP segment but are typically shorter
- Utilizes the STN API previously described

Home > Applications > Safety Certification Mapping Welcome, gavorhes | Manage Account | Logout | Help

Sight distance

Which geometric features contribute to the type and severity of the crashes?
Horizontal curve

Possible Countermeasures for Safety Mitigation Process
Change in roadway geometry

Define SCM Segment(s)

Curve

SCM Segment 2

Set By Map | Set By From-To Mile

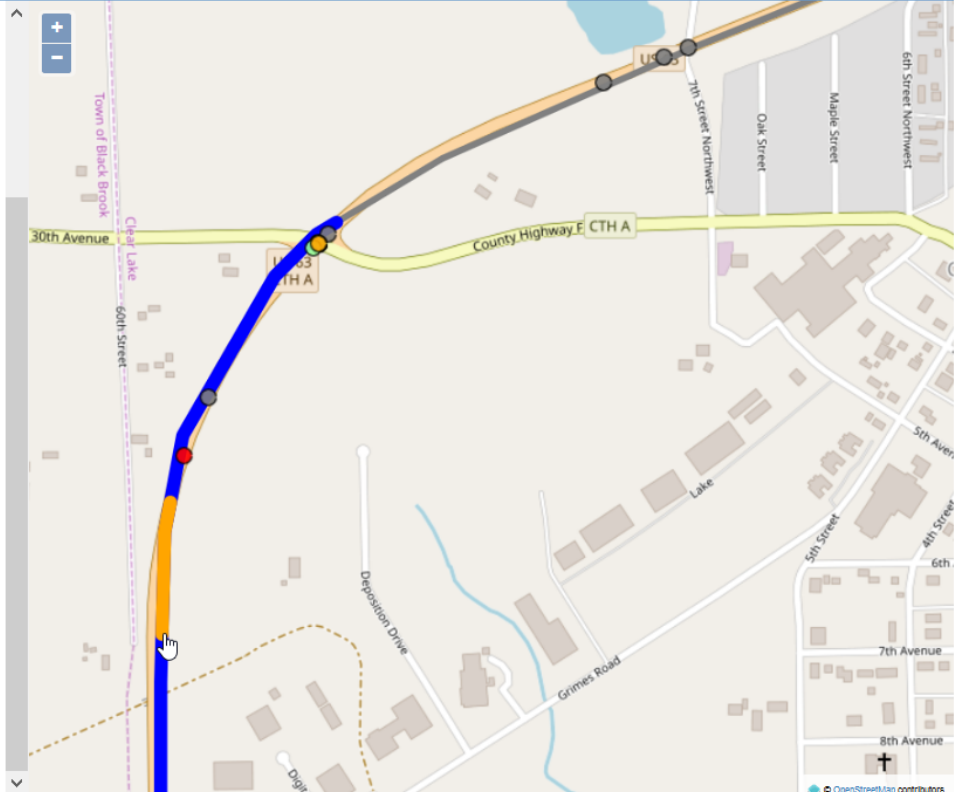
Start Mile

End Mile

SCM Segment Label

SCM Segment Description

Update | Cancel | Delete



Crashes

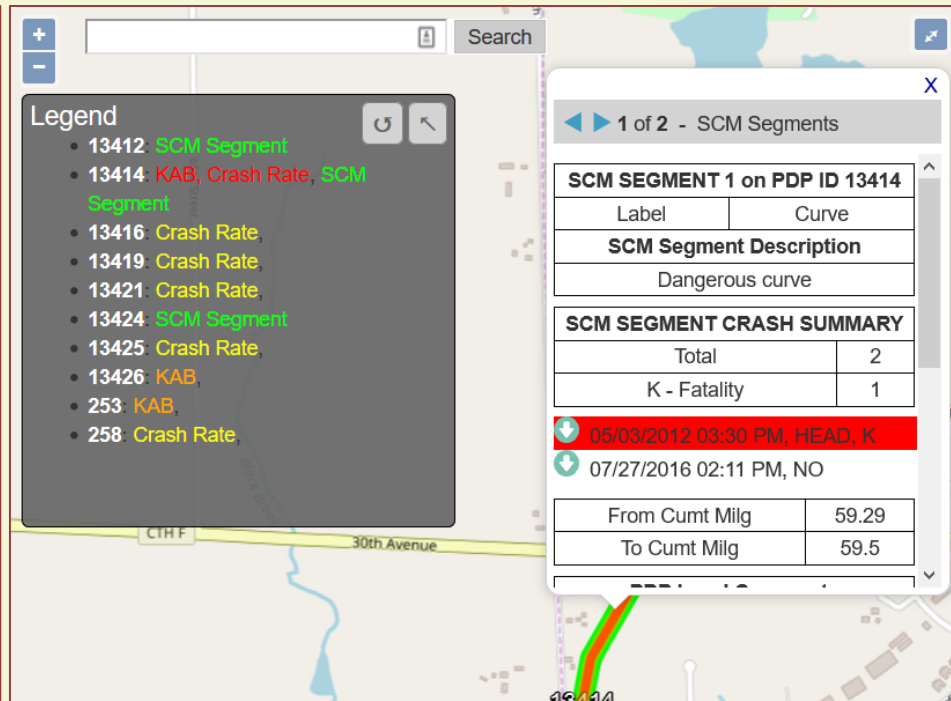
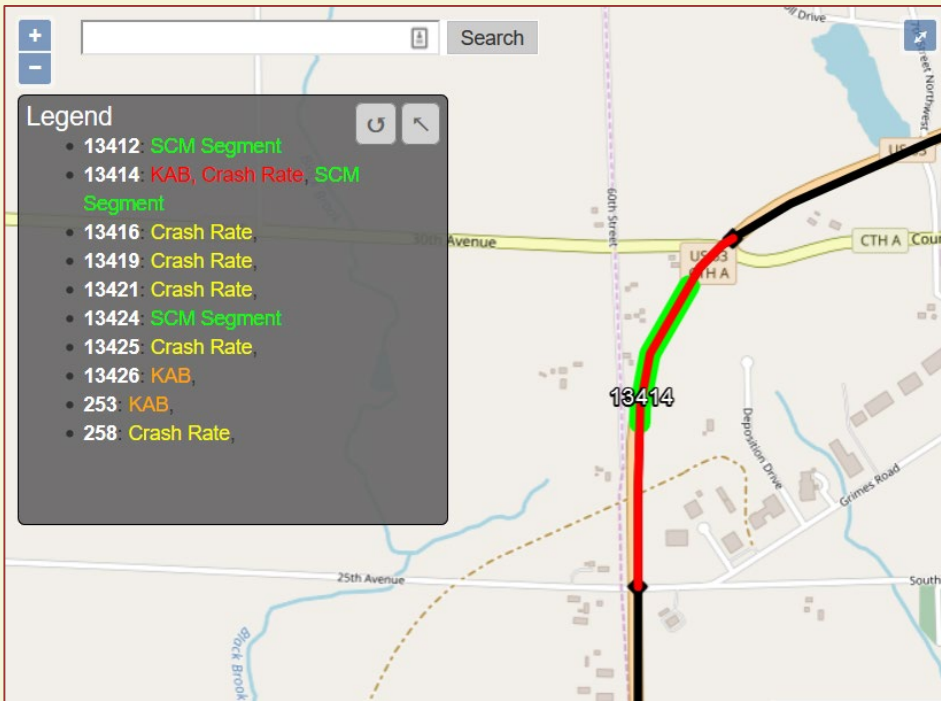
K - Fatality **A - Suspected Major Injury** **B - Suspected Minor Injury** **C - Possible Injury** **O - No Apparent Injury**



Map View

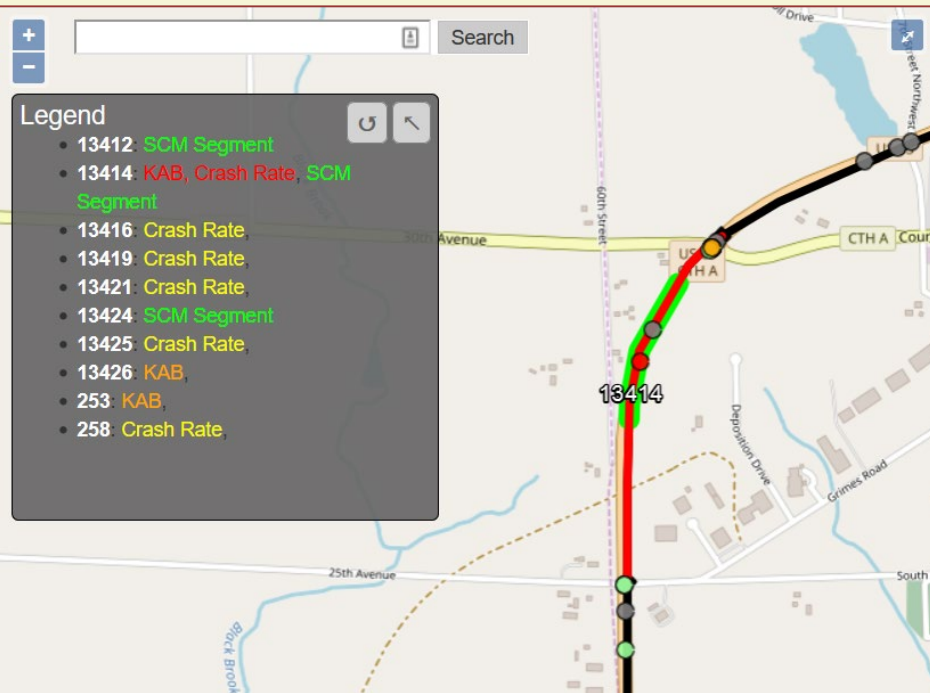
Visualization of MetaManager flagged segments and user defined segments

Popup windows with crash summary by user defined segments

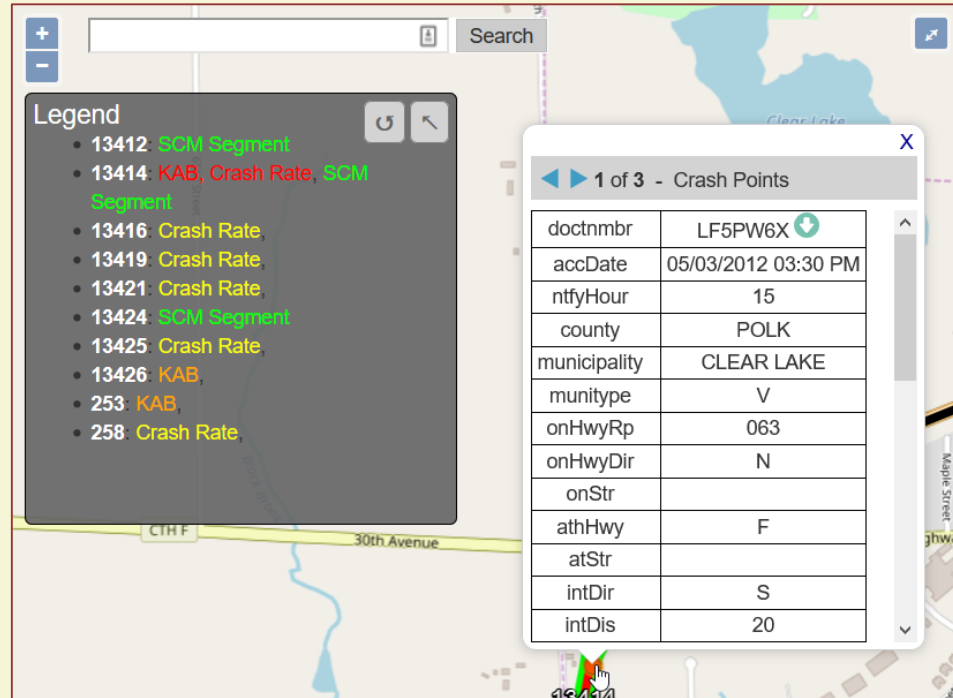


Map View

SCM project extent with crash points symbolized by severity (K, A, B, C, other)



Crash information popup window with crash report download link



SCM Report Generation



Worksheet Download

Downloaded Excel file from SCM Application

Safety Certification Worksheet

Analyst: Zhang, Zhen
 Agency: _____
 Date of Analysis: 2019-08-15
 Meta Manager Release Date: 2016-09
 Meta Manager Crash Years: 2010-2014

Design ID: 1550-04-02
 Highway: US 63 NB
 Project Title: CLEAR LAKE - CUMBERLAND
 Project Description: CTH J TO USH 8
 SCM ID: 2

System Screening - Sites of Promise					Crash Vetting Sites of Promise			Contributing Geometric Analysis			
See FDM 11-38-10.2 for guidance					See FDM 11-38-10.3 for guidance			See FDM 11-38-10.4 for guidance			
PDP ID	From RP	RP Description	To RP	Length (PDP_Mile)	Crash Rate Flag (RATEFLAG) (Insert value if ≥ 1.0)	KAB Crash Rate Flag (MMGR_KAB_CRSH_RT) (Insert value if ≥ 1.0)	Intersection Crash Rate Flag (MM Database Name) (Insert value if ≥ 1.0)	Intersection KAB Crash Rate Flag (MM Database Name) (Insert value if ≥ 1.0)	Summarize the contributing factors for ALL crashes in the flagged segment or intersection.	Which geometric features contribute to the type and severity of the crashes?	Possible Countermeasures for Safety Mitigation Process
13412	063N069 104		063N071 000	0.37					SCM Seg 1: Shoulder Width - Offset to curb face-from Auxiliary Lane		
13413	063N071 000	CTH A	063N072K000	1.48							
13414	063N072K000	25TH AVE	063N072K055	0.55	3.0122	1.3152			Sight distance	Horizontal curve	Change in roadway geometry
13415	063N072K055		063N074 000	0.63							
13416	063N074 000	CTH J	063N075 000	1.1	1.1975						
13417	063N075 000	46TH ST	063N077 000	1.38							
13418	063N077 000	60TH AVE	063N078 000	1.07							
13419	063N078 000	60TH AVE	063N079 000	1.2	1.414						
13420	063N079 000	CTH J	063N080 000	0.89							
13421	063N080 000	CTH P	063N081 000	0.88	1.0132						
13422	063N081 000	15TH ST	063N082 000	0.84							
13423	063N082 000	CTH D	063N083 000	0.38							
13424	063N083 000	CTH D	063N085 000	1.53					SCM Seg 1: Design Speed - Design Speed, Maximum Grade - Maximum Grade-level, Shoulder Width - Offset to curb face-from Travel Lane-median-side, Shoulder Width - Shoulder Width-adjacent to Climbing Lane/Passing Lane		

- PDP Segment Information
 - From and to cumulative mileages
 - MetaManager Flags
 - User entered data



PDF Output

Safety Certification Mapping (SCM) Tool

Design ID
1550-04-02

Construction ID(s)
1550-04-72

Project Title
CLEAR LAKE - CUMBERLAND

Project Description
CTH J TO USH 8

SCM Comment
Comments

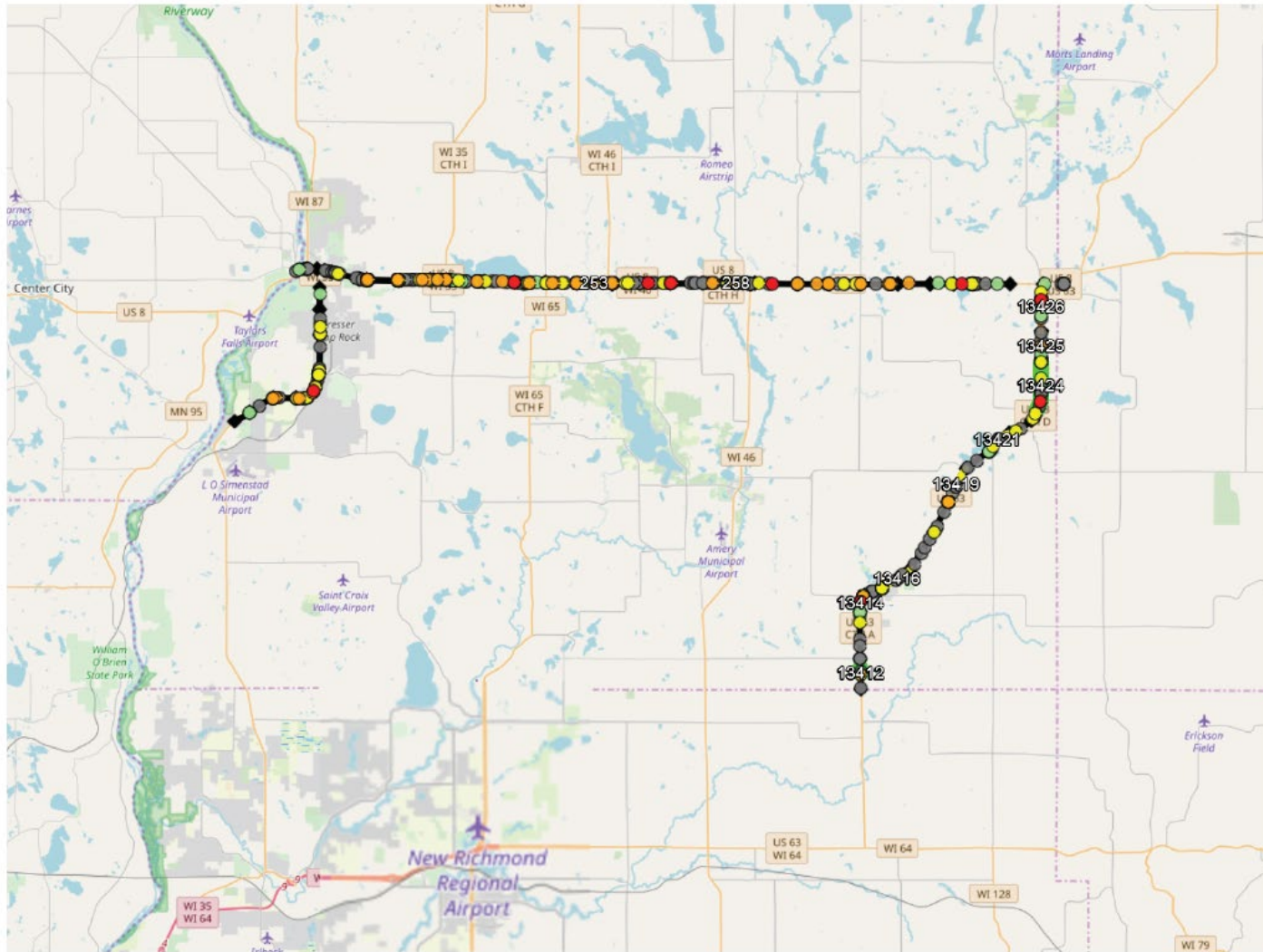
Meta Manager Version: 2016-09
Meta Manager Crash Years: 2010-2014
SCM Crash Years: 2012-2017

Sites of Promise

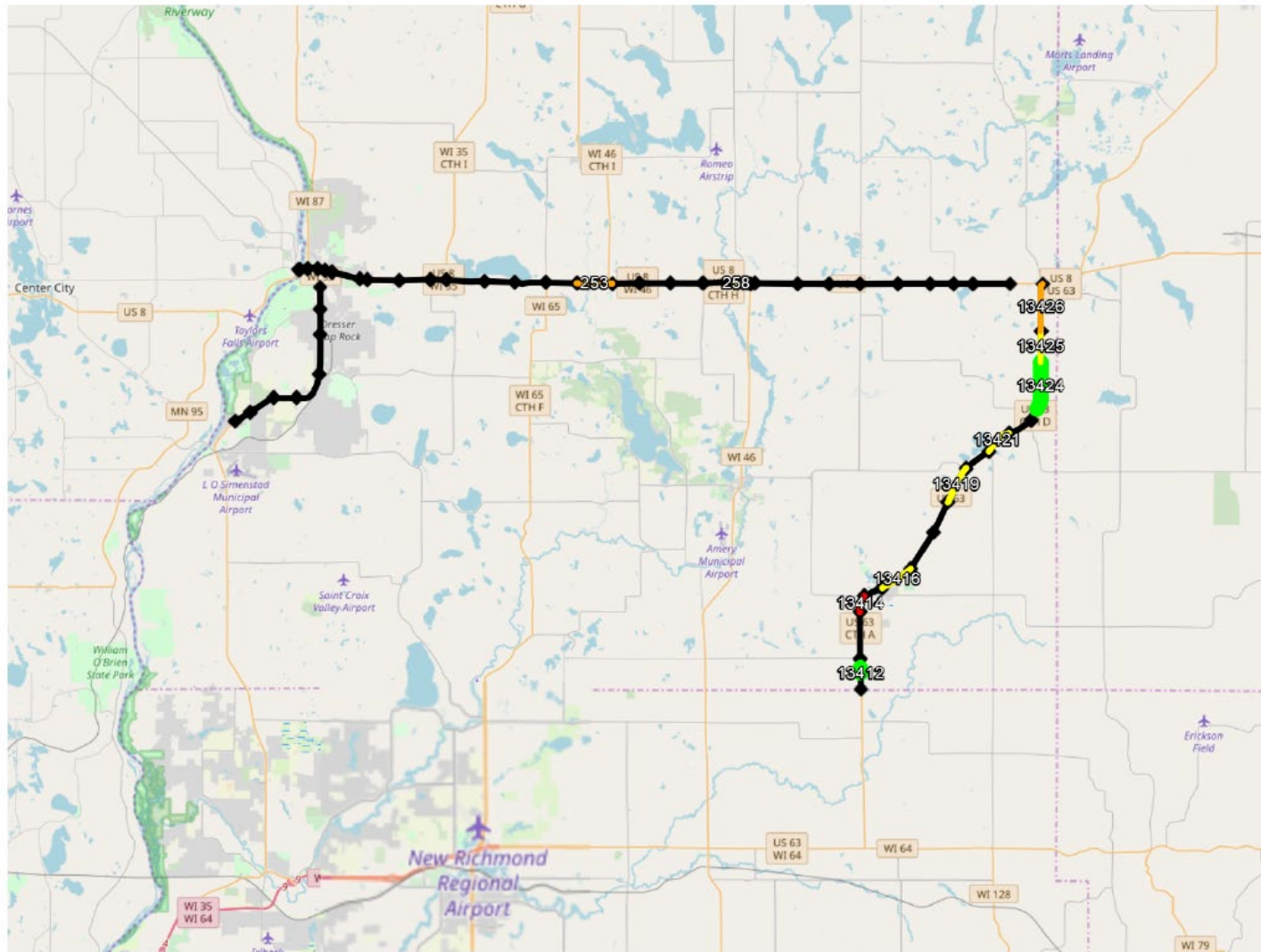
Corridor #	Highway	Start County	End County	Start RP	End RP
1	US 63 NB	POLK	POLK	063N069 104	063N088M000
13412:	SCM Segment				
13414:	KAB, Crash Rate				
13416:	Crash Rate				
13419:	Crash Rate				
13421:	Crash Rate				
13424:	SCM Segment				
13425:	Crash Rate				
13426:	KAB				



PDF Output



PDF Output



PDF Output

SCM ID -2

Version - Current

2019-08-15 15:23:38.371

Corridor # 1: US 63 NB - 063N069 104 - 063N088M000

Meta Manager Version: 2016-09 Crash Years: 2010-2014					SCM Crash Years: 2012-2017					
PDP ID	Crash	KAB	Int Crash	Int KAB	K	A	B	C	O	TOTAL
13412						1			2	3
13413							1	1	5	7
13414	3.0122	1.3152			1	1		3	13	18
13415									3	3
13416	1.1975						1	2	10	13
13417									4	4
13418							1		3	4
13419	1.414					1	4		8	13
13420								1	2	3
13421	1.0132						1	1	7	9
13422							1		1	2
13423							2		2	4
13424					1		2		5	8
13425	1.0133					1	1	2	9	13
13426		1.0808			1		2	3	8	14
TOTAL					3	4	16	13	82	

Manner of Collision

PDP ID	NO COLLISION	REAR END	SS OPP	SS SAME	OTHER	TOTAL
13412	2			1		3
13413	3	2		2		7
13414	3		1	1	13	18
13415	1			1	1	3



Crash Summary Download

- Automated means to summarize crash information within the SCM Project as a CSV
- Indicates to which PDP a crash corresponds
- Crashes specially identified where an intersection with an SCM segment occurs

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	CORRIDORID	CUMULMI	PDPID	SEGLIST	DOCTNMBR	ACCDDATE	NTFYHOUR	REGION	COUNTY	MUNICIPALITY	MUNITYPE	ONHWYRP	ONHWYDIR	ONHWY	ONSTR
2	1	56.63	13412		LF599DQ	3/4/2015	5	NW	POLK	BLACK BROOK	T	63	N	63	
3	1	57.05	13412		LF5CJ2Q	10/19/2014	11	NW	POLK	CLEAR LAKE	T	63	N	63	
4	1	57.17	13412	13412-1	LFCH72S	9/27/2016	0	NW	POLK	BLACK BROOK	T	63	N	63	SB
5	1	57.57	13413		LF5SV23	7/24/2014	15	NW	POLK	CLEAR LAKE	T	63	N	63	
6	1	57.57	13413		LF143RQ	12/17/2016	21	NW	POLK	BLACK BROOK	T	63	N	63	
7	1	57.97	13413		LF5L60Z	1/25/2014	21	NW	POLK	CLEAR LAKE	T	63	N	63	
8	1	58.17	13413		LF5B1MM	9/2/2013	6	NW	POLK	CLEAR LAKE	T	63	N	63	
9	1	58.7	13413		LF5LX9V	9/27/2014	23	NW	POLK	CLEAR LAKE	T	63	N	63	
10	1	58.95	13413		LF7VBL0	11/28/2015	11	NW	POLK	CLEAR LAKE	T	63	N	63	
11	1	59.01	13413		LF7VBJZ	9/7/2014	12	NW	POLK	CLEAR LAKE	T	63	N	63	
12	1	59.05	13414		LF5P50Q	6/9/2015	8	NW	POLK	CLEAR LAKE	V	63	N	63	
13	1	59.05	13414		LF599B2	4/14/2013	14	NW	POLK	CLEAR LAKE	V	63	N	63	
14	1	59.05	13414		C2L0S0ZLWH	8/9/2017	14	NW	POLK	CLEAR LAKE	V	63	N		25TH AVE
15	1	59.38	13414		LF5PW6X	5/3/2012	15	NW	POLK	CLEAR LAKE	V	63	N	63	



Break For Demo



Wisconsin Traffic Operations and Safety Laboratory

Safety Certification Mapping (Testing Site)

[SCM Home](#) | [Search](#) | [Create](#) | [Resources](#)

[Home](#) > [Applications](#) > [Safety Certification Mapping](#)

Welcome, gavorhes | [Manage Account](#) | [Logout](#) | [Help](#)

SCM Safety Certification Mapping

[Search Existing SCMs](#)

[Create New SCM](#)

[Manage Users](#)

The WisTransPortal Safety Certification Mapping (SCM) tool is maintained by the [Wisconsin Traffic Operations and Safety Laboratory](#) in partnership with [Wisconsin Department of Transportation](#). Send questions or comments to crash-data@topslab.wisc.edu. Refer to the [Contact](#) page for support staff contact information.

You are logged in as gavorhes (ADMIN). [Reset](#).

SCM Version: 1.1.0 (SCM) R20190308



Conclusion

- Considerable time savings
 - Safety Certification Map is a required component of new projects
- Central storage and distribution center
- Map and report must be present in Design Study Report
- As an interactive web map, provides more (organized) information than is feasible on a static map

Thank you for coming!

Questions?

