2019 WORK ZONE SAFETY CONFERENCE
(Presented to NJDOT April 11, 2019)

MAKING WORK ZONES SMARTER- DATA DRIVEN DECISION MAKING

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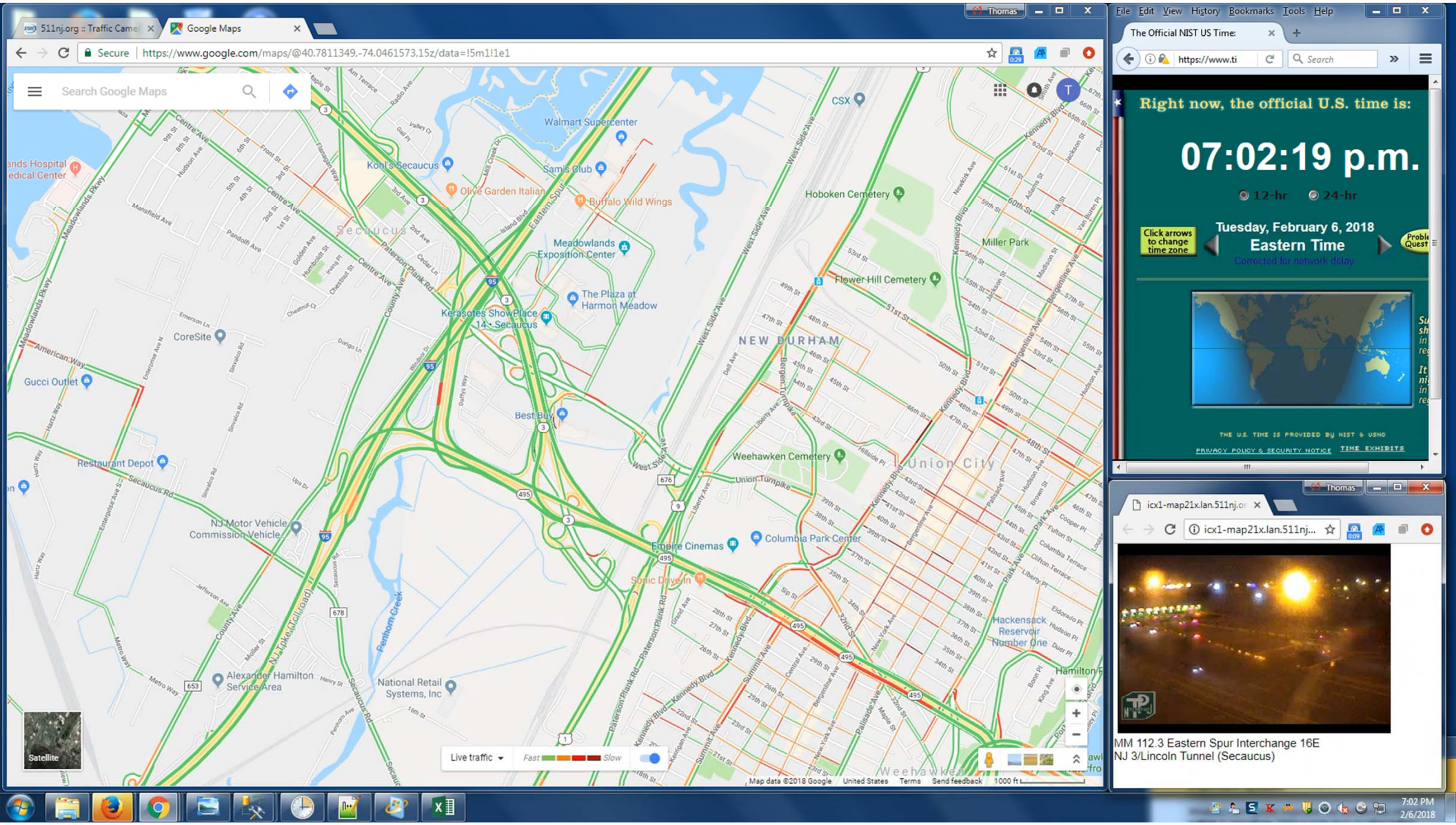
TCNJ THE COLLEGE OF NEW JERSEY


511nj.org :: Traffic Came
Google Maps
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Walmart Supercenter
Kohl's Secaucus
Sam's Club
Olive Garden Italian
Buffalo Wild Wings
Meadowlands Exposition Center
The Plaza at Harmon Meadow
Kerasotes ShowPlace 14 - Secaucus
CoreSite
Gucci Outlet
Best Buy
Restaurant Depot
NJ Motor Vehicle Commission-Vehicle
Alexander Hamilton Service Area
National Retail Systems, Inc
CSX
Hoboken Cemetery
Miller Park
Flower Hill Cemetery
NEW DURHAM
Weehawken Cemetery
Union City
Columbia Park Center
Empire Cinemas
Sonic Drive-In
Hackensack Reservoir Number One
Weehawken
Live traffic
Fast
Slow
Satellite
Map data ©2018 Google
United States
Terms
Send feedback
1000 ft
The Official NIST US Time:
https://www.ti
Right now, the official U.S. time is:
07:02:19 p.m.
12-hr
24-hr
Click arrows to change time zone
Tuesday, February 6, 2018
Eastern Time
Corrected for network delay
THE U.S. TIME IS PROVIDED BY NIST & USNO
PRIVACY POLICY & SECURITY NOTICE
TIME EXHIBITS
icx1-map21x.lan.511nj.or
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MM 112.3 Eastern Spur Interchange 16E
NJ 3/Lincoln Tunnel (Secaucus)
7:02 PM
2/6/2018

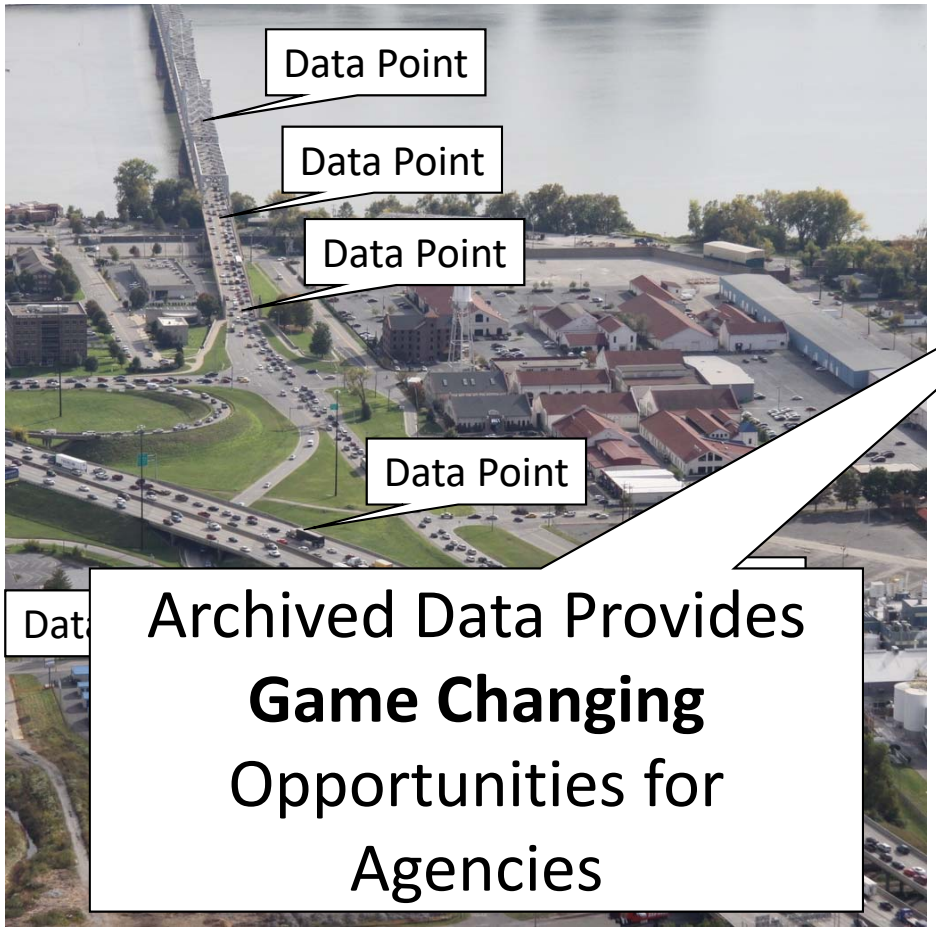
PURPOSE

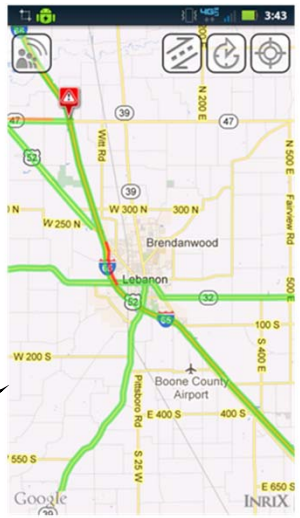
- **Overall Objective:** Data Driven Management
- **Objective:** Review current processes, present common issues, and assess future decisions that agencies will need to make
- Lead to a series of case studies on “Smart Work Zone” Management

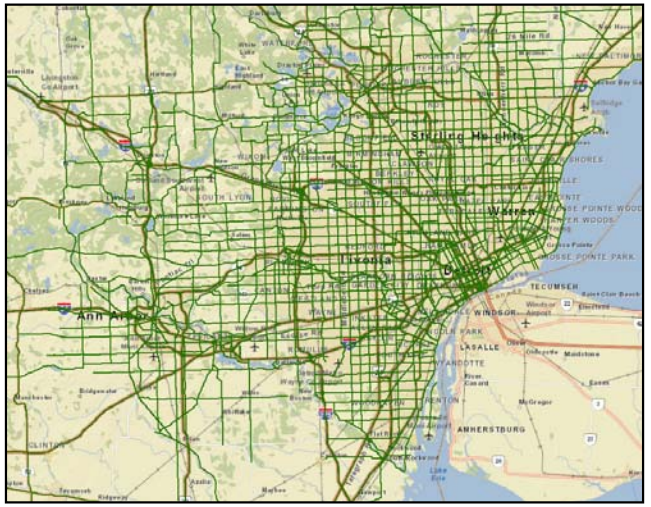
Source: http://workzone.eng.wayne.edu/

> If you can’t **measure** it you can’t **manage** it
>
> Peter Drucker

Probe Data Overview





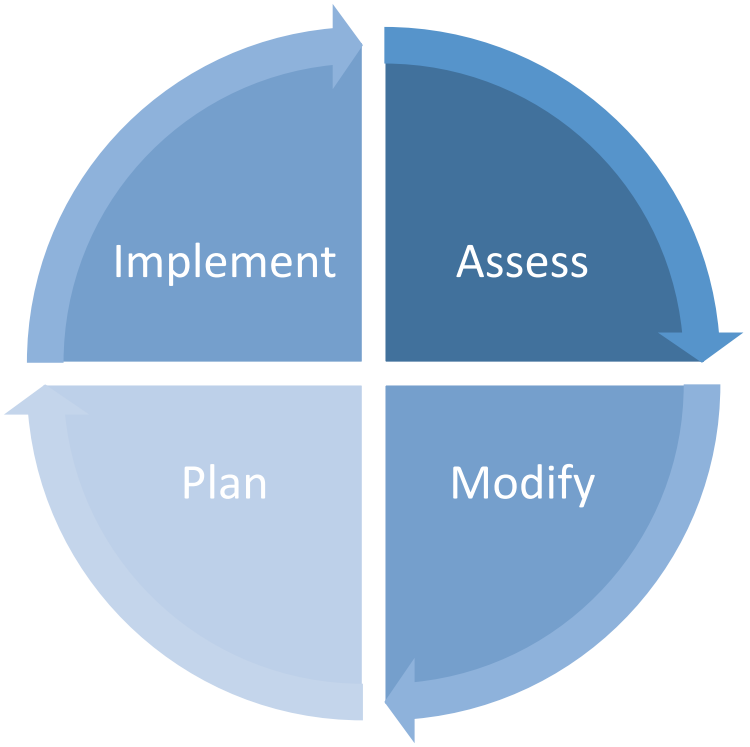


TMC	DIRECTION	ADMIN_LEVEL_1	ADMIN_LEVEL_2	ADMIN_LEVEL_3	DISTANCE	ROAD_NUMBER	ROAD_NAME	LATITUDE	LONGITUDE
101N04099	EASTBOUND	United States	Illinois	Cook	3.27285	I-90	Kennedy EX	37.9615	-121.6961
101N04100	NORTHBOUND	United States	Illinois	Lake	0.88324	I-290	Eisenhower	37.9906	-121.6972

TMC	DATE	EPOCH	COMBINED	PASSENGER	FREIGHT
101N04099	04022012	33	105	99	123
101P04099	04022012	78	98	92	125
101N04100	04022012	5	46	38	51
101N04100	04022012	31	45	39	52

CASE STUDY DESIGN

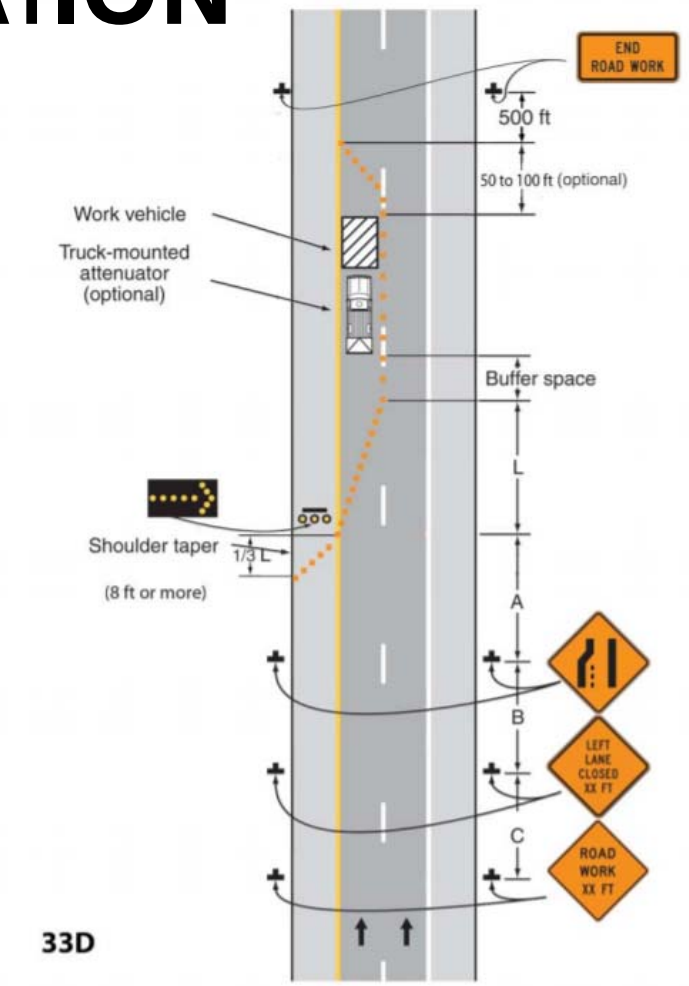
1. Gather Construction Information
2. Determine Analysis Type
3. Select Performance Metrics
4. Download Retrieve Probe Data
5. Define Performance Thresholds
6. Perform Calculations
7. Interpret Results
8. Intervention/Project Analysis
9. Report
10. Document



CONSTRUCTION INFORMATION

Varies from Agency to Agency

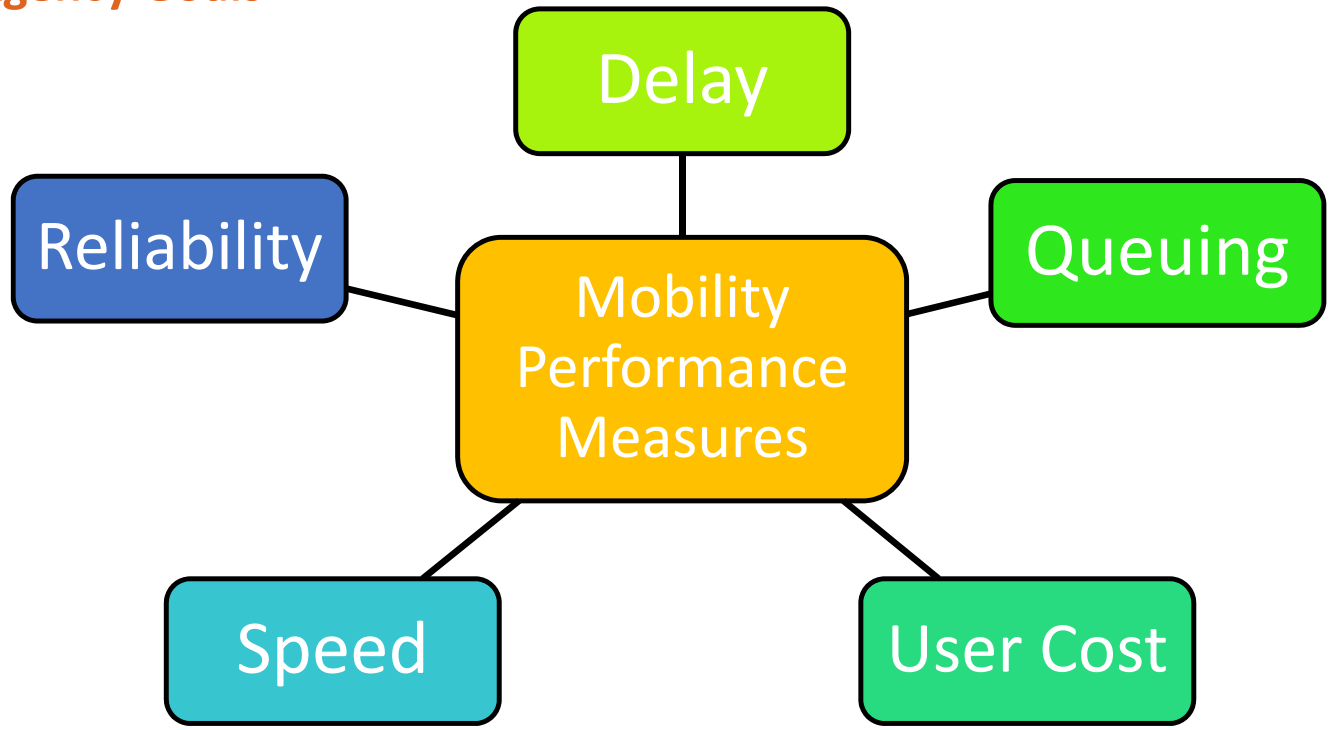
- **Work Zone Exposure Data**
- **Boundaries of Work Zone**
  - **Advanced and Transition Area**
  - **Work Zone Activity**
  - **Post Activity**
- **Dates Ranges**
  - **Construction Dates**
  - **Timeframe for Historical Dates**



Source: MUTCD

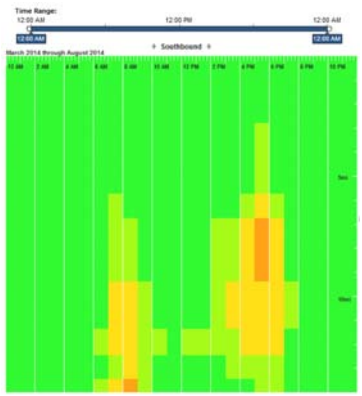
PERFORMANCE MEASURE SELECTION

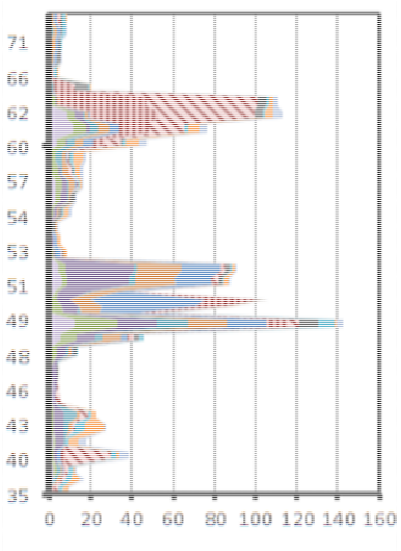
Based on Agency Goals

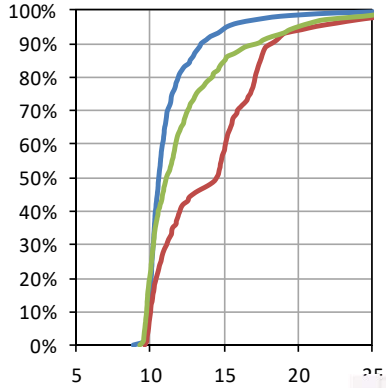


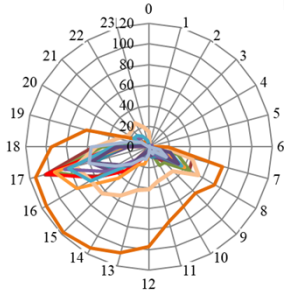
PERFORMANCE MEASURE SELECTION

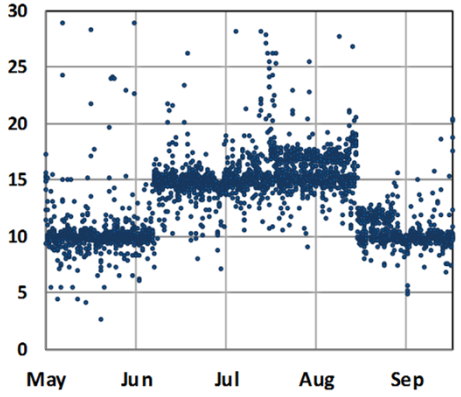
Also Determine Visualizations

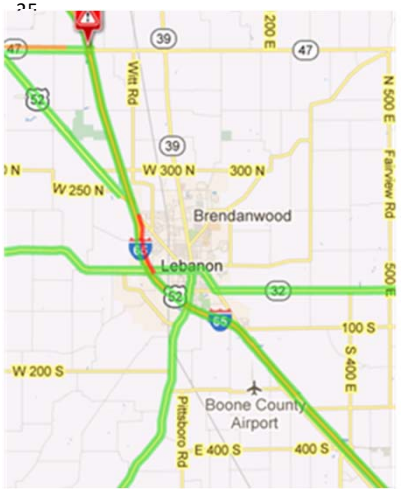








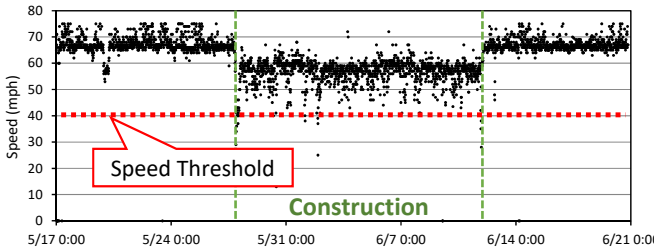


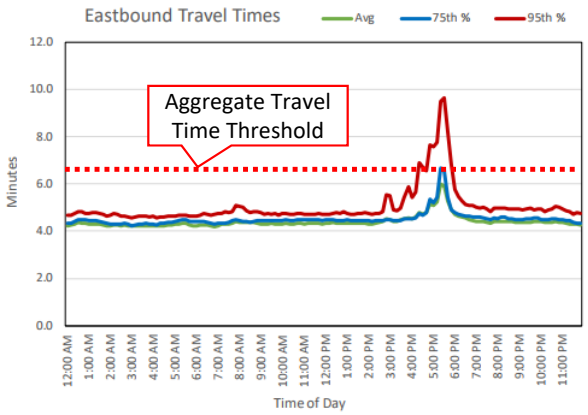


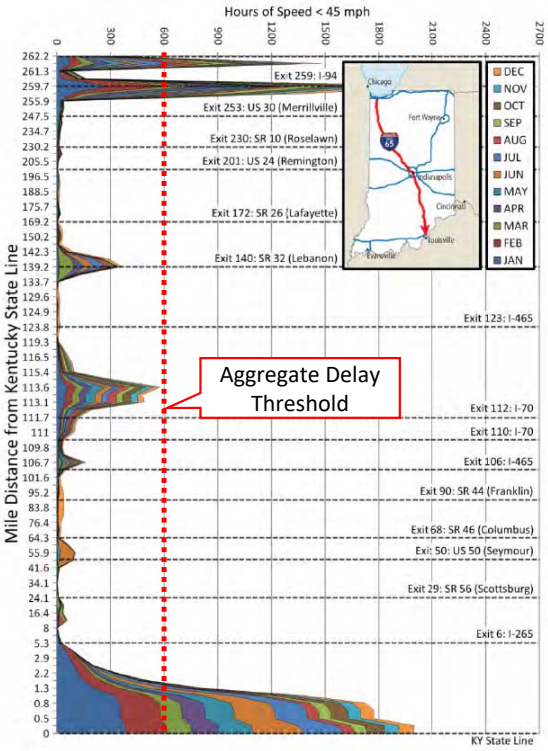
PERFORMANCE THRESHOLDS

Based on Agency Objectives

- Pass/fail State Agency Goal
  - no more than 15 minutes of additional delay
- Regional Level Threshold
  - 20 % increase in delay system wide
  - Categories (minor; moderate; and severe)
- Delay acceptable to drivers
  - WZ vs. Non-Work Zone
- Policy
  - Respond to traveler complaints within 24 hours



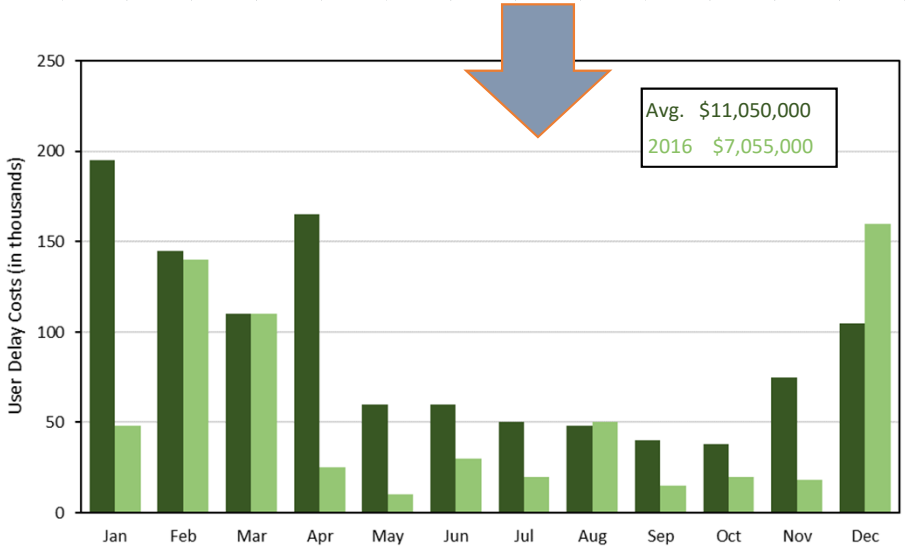




PERFORM CALCULATIONS

Turn Data into Information

	TMC1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	tmc_len
1	108P04216	88.91566	93.6234	92.71223	98.63487	106.0002	123.7682	127.4888	123.4644	68.71791	105.0131	95.36982	101.4443	0.911177
2	108P04220	42.92332	47.3393	13.95449	12.36474	30.02866	28.96882	17.48728	9.538515	23.84629	18.37047	15.89753	17.31064	2.11967
3	108P04214	88.32049	78.13307	53.24034	66.08534	64.75655	66.43969	61.56744	52.62023	54.21479	57.84682	61.39027	65.731	1.063035
4	108P04215	106.7419	104.34	99.34399	103.5714	96.7499	112.6987	102.0342	83.49123	83.39515	112.7948	106.1655	99.05576	1.152928
5	108P04217	80.33835	74.38457	62.55237	54.2623	57.20151	80.33835	115.6842	205.5938	52.45356	58.03052	60.21608	63.15529	0.904372
6	108P04219	35.78957	48.62549	16.46018	15.40311	22.19859	22.95365	14.34603	7.097509	35.18552	28.99408	17.36625	24.31274	1.81213
7	108P04221	39.43922	42.97637	16.80146	11.49574	32.54178	21.93033	9.373448	8.48916	29.00463	24.93691	17.68575	20.33861	2.12229
8	108P04218	128.6274	126.9736	66.335	59.53613	63.39495	77.54397	292.7193	590.5837	72.03136	60.27114	50.1647	69.09131	2.205042
9	108P04222	76.68578	76.93315	23.00573	22.01624	39.33238	39.08501	18.80038	17.56352	41.80612	65.05922	38.09551	32.15855	2.968482
10	108P04213	110.9342	103.0658	58.57559	74.50659	64.404	64.50114	56.24422	44.39311	54.9814	67.60963	77.51794	77.51794	1.165683
11	108P04223	21.83623	22.68541	10.19024	5.337744	13.34436	17.34767	6.914805	7.157429	33.11827	42.33801	13.10174	8.855802	1.455748
12	108P04212	99.37166	86.43023	53.98423	72.93417	56.2952	53.05984	50.564	35.86624	64.52225	74.50563	77.55611	74.13588	1.109265



Work Zone Mobility Audit

What is necessary?

Traffic Flow Data:	• Probe data; National Performance Measurement Research Data Set (NPMRDS), agency provided data sets: HERE, INRIX, TomTom, etc. • Other agency data: continuous count station data, dedicated counts, etc. (NJ Agencies have Access to INRIX)
Work Zone Activity Data:	• Project characteristics • Work zone activity information (location, duration, etc.) • Work zone impacts to base roadway conditions (lanes closed, speed limit reductions, etc.)
Data Storage and Analysis Tools:	• Algorithms / process to develop work zone exposure metrics from traffic flow and work zone activity data. • Database/server capable of storing large quantities of data • Data analysis software or proprietary dashboards

Work Zone Mobility Audit

What is necessary?

Work Zone Traffic Mobility Performance Measures	
Delay Total Delay Delay per Vehicle Delay per VMT	**Queue** Max. Queue Length Max. Queue Duration Total Queue Duration
User Cost Passenger Vehicle Cost Commercial Vehicle Cost	**Reliability** LOTTR Buffer Index Planning Time Index
Speed Average Speed Speed Profiles	**Resiliency** Time to Recover Volume to Capacity

Step 1: *Determine the Performance Measures of interest for use in your agency or district*

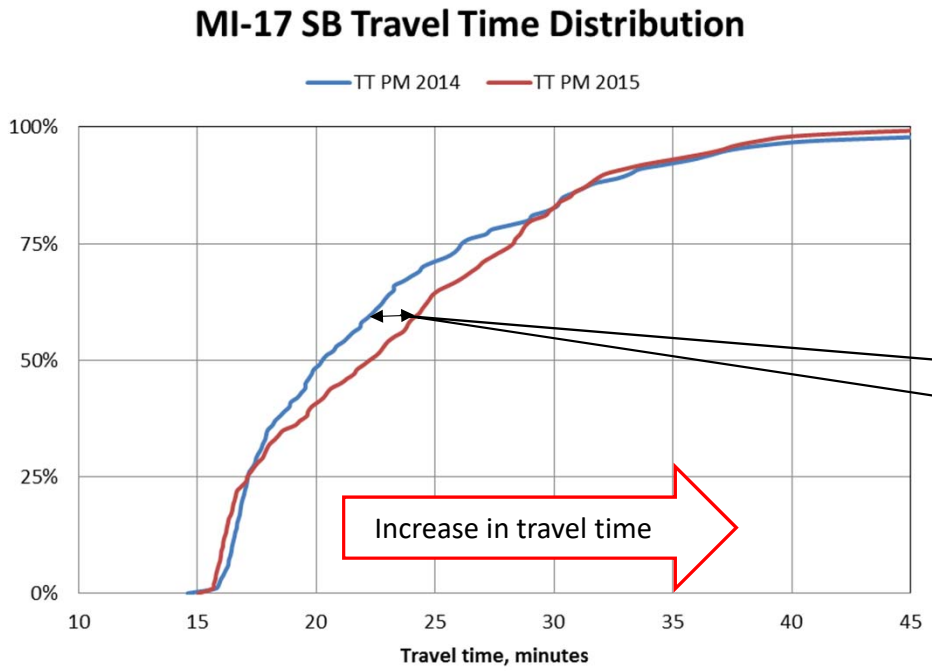
Step 2: *Acquire the probe data from a public or commercial vendor*

Step 3: *Compile the collected data using Excel or other preferred analysis tool*

Step 4: *Create appropriate graphics for quick reference*

Step 5: *Document and Archive Performance Measures for Future Decision Making*

Travel Time Distribution Plots

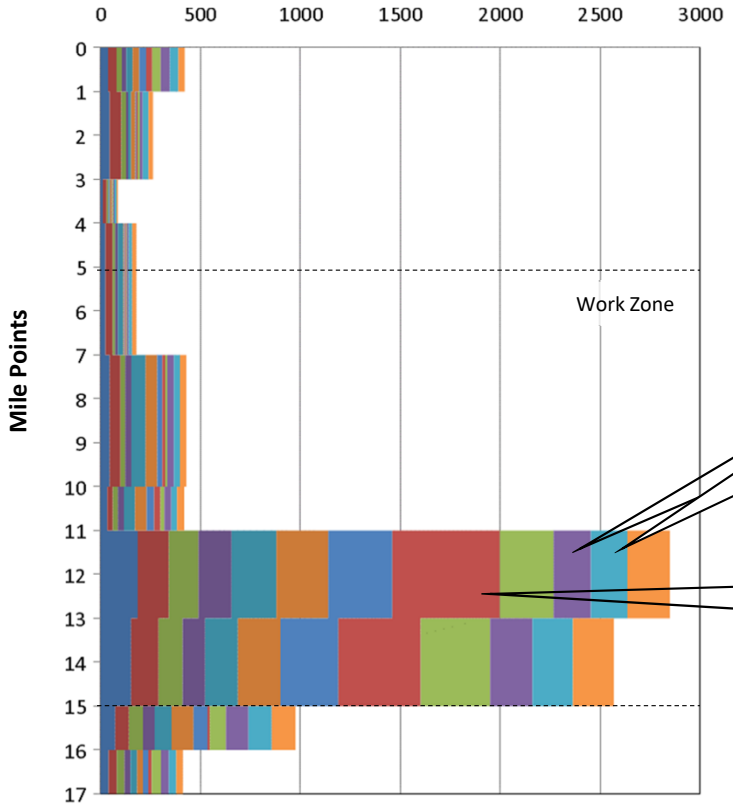


Shows the distribution of travel times in the observation period captured for work year and year prior.

Position of work year line (2015) compared to prior year shows an increase or decrease in travel time.

Congestion “Volcano” Plots

Also available for Queue



Shows congestion levels at various points in the work zone corridor progression based on TMC.

Different colors represent different months of the analysis year.

Wider bands show where and when congestion was more significant for further investigation.

Summary Statistics

Summary Statistics	Year prior	Year of	Net change	% change
Queue Minutes per mile per day	1.2	10.7	+ 9.5	+ 792%
Minutes of queueing per day	10.1	57.7	+ 47.6	+ 471%
Congestion Minutes per mile per day	75.1	103.5	+ 28.4	+ 38%
Delay Minutes per mile per day	43.7	101.8	+ 58.1	+ 133%

- Queues are identified by travel speeds less than 15 mph
- Congestion is identified by travel speeds between 15 and 45 mph
- Delay incorporates all travel speeds that are less than the posted speed limit

RESULTS/INTERVENE/DOCUMENT

Determine if there is an issue

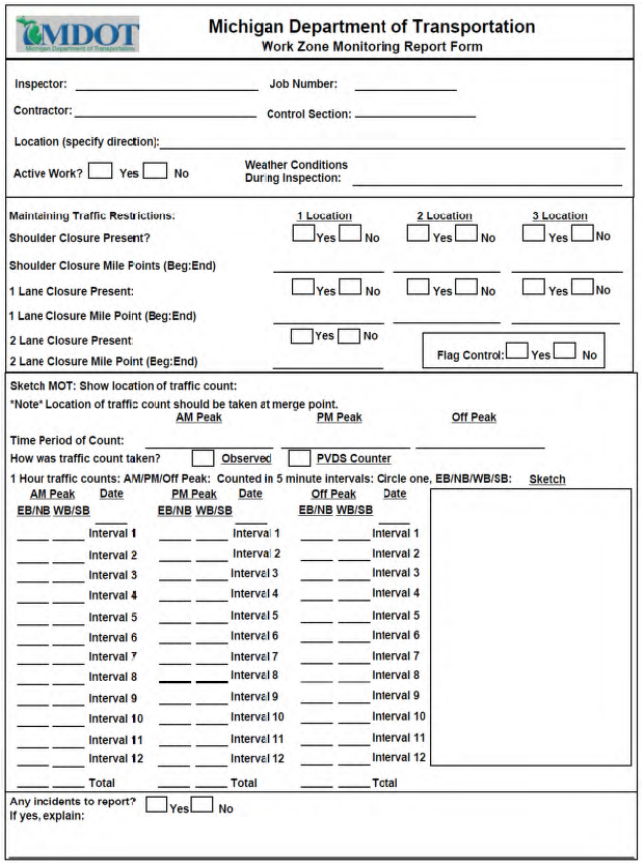
- Are any performance thresholds exceeded?

Intervene, if problems are discovered

- Real Time Probe Data: modify WZ configuration/hours
- Historical: Revisit specifications and revise

Document all changes (successes and failures)

- Document WZ successes and failures
- Create reference of historical WZ to prevent Institutional turnover loss.



MDOT Michigan Department of Transportation
Work Zone Monitoring Report Form

Inspector: _____ Job Number: _____
Contractor: _____ Control Section: _____
Location (specify direction): _____
Active Work? ☐ Yes ☐ No Weather Conditions During Inspection: _____

Maintaining Traffic Restrictions:

	1 Location	2 Location	3 Location
Shoulder Closure Present?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Shoulder Closure Mile Points (Beg:End)			
1 Lane Closure Present:	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
1 Lane Closure Mile Point (Beg:End)			
2 Lane Closure Present	☐ Yes ☐ No		
2 Lane Closure Mile Point (Beg:End)			

Flag Control: ☐ Yes ☐ No

Sketch MOT: Show location of traffic count:
Note Location of traffic count should be taken at merge point.

Time Period of Count: AM Peak _____ PM Peak _____ Off Peak _____
How was traffic count taken? ☐ Observed ☐ PVDS Counter
1 Hour traffic counts: AM/PM/Off Peak: Counted in 5 minute intervals: Circle one, EB/NB/WB/SB: Sketch

AM Peak Date ____ EB/NB WB/SB	PM Peak Date ____ EB/NB WB/SB	Off Peak Date ____ EB/NB WB/SB
____ ____ Interval 1	____ ____ Interval 1	____ ____ Interval 1
____ ____ Interval 2	____ ____ Interval 2	____ ____ Interval 2
____ ____ Interval 3	____ ____ Interval 3	____ ____ Interval 3
____ ____ Interval 4	____ ____ Interval 4	____ ____ Interval 4
____ ____ Interval 5	____ ____ Interval 5	____ ____ Interval 5
____ ____ Interval 6	____ ____ Interval 6	____ ____ Interval 6
____ ____ Interval 7	____ ____ Interval 7	____ ____ Interval 7
____ ____ Interval 8	____ ____ Interval 8	____ ____ Interval 8
____ ____ Interval 9	____ ____ Interval 9	____ ____ Interval 9
____ ____ Interval 10	____ ____ Interval 10	____ ____ Interval 10
____ ____ Interval 11	____ ____ Interval 11	____ ____ Interval 11
____ ____ Interval 12	____ ____ Interval 12	____ ____ Interval 12
____ ____ Total	____ ____ Total	____ ____ Total

Any incidents to report? ☐ Yes ☐ No
If yes, explain:

RESULTS/INTERVENE/DOCUMENT

Document Conditions/Manage Events

MDOT

Michigan Department of Transportation
Work Zone Monitoring Report Form

Inspector: _____ Job Number: _____

Contractor: _____ Control Section: _____

Location (specify direction): _____

Active Work? ☐ Yes ☐ No Weather Conditions During Inspection: _____

Maintaining Traffic Restrictions:	1 Location	2 Location	3 Location
Shoulder Closure Present?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Shoulder Closure Mile Points (Beg:End)	_____	_____	_____
1 Lane Closure Present:	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
1 Lane Closure Mile Point (Beg:End)	_____	_____	_____
2 Lane Closure Present	☐ Yes ☐ No		
2 Lane Closure Mile Point (Beg:End)	_____		

Flag Control: ☐ Yes ☐ No

Sketch MOT: Show location of traffic count:

Note Location of traffic count should be taken at merge point.

Time Period of Count: AM Peak _____ PM Peak _____ Off Peak _____

How was traffic count taken? ☐ Observed ☐ PVDS Counter

1 Hour traffic counts: AM/PM/Off Peak: Counted in 5 minute intervals: Circle one, EB/NB/WB/SB:

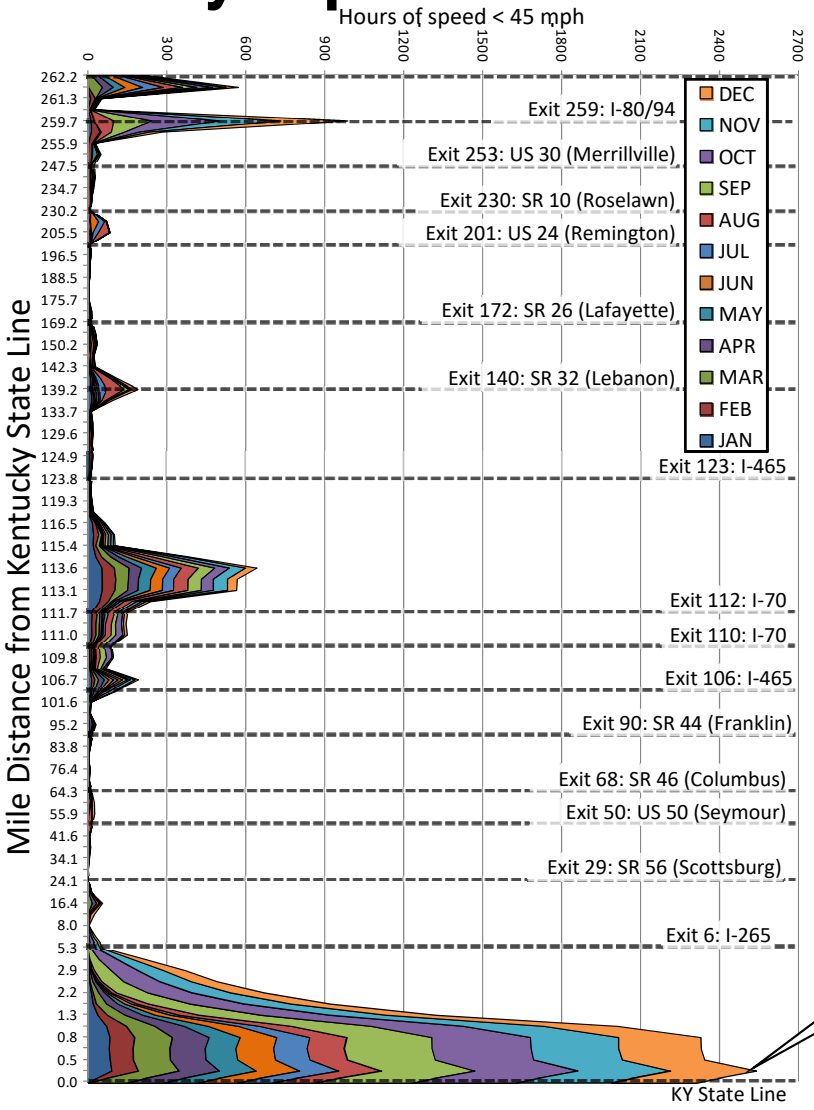
AM Peak Date ____ EB/NB WB/SB	PM Peak Date ____ EB/NB WB/SB	Off Peak Date ____ EB/NB WB/SB
____ ____ Interval 1	____ ____ Interval 1	____ ____ Interval 1
____ ____ Interval 2	____ ____ Interval 2	____ ____ Interval 2
____ ____ Interval 3	____ ____ Interval 3	____ ____ Interval 3
____ ____ Interval 4	____ ____ Interval 4	____ ____ Interval 4
____ ____ Interval 5	____ ____ Interval 5	____ ____ Interval 5
____ ____ Interval 6	____ ____ Interval 6	____ ____ Interval 6
____ ____ Interval 7	____ ____ Interval 7	____ ____ Interval 7
____ ____ Interval 8	____ ____ Interval 8	____ ____ Interval 8
____ ____ Interval 9	____ ____ Interval 9	____ ____ Interval 9
____ ____ Interval 10	____ ____ Interval 10	____ ____ Interval 10
____ ____ Interval 11	____ ____ Interval 11	____ ____ Interval 11
____ ____ Interval 12	____ ____ Interval 12	____ ____ Interval 12
____ ____ Total	____ ____ Total	____ ____ Total

Sketch

Any incidents to report? ☐ Yes ☐ No

If yes, explain:

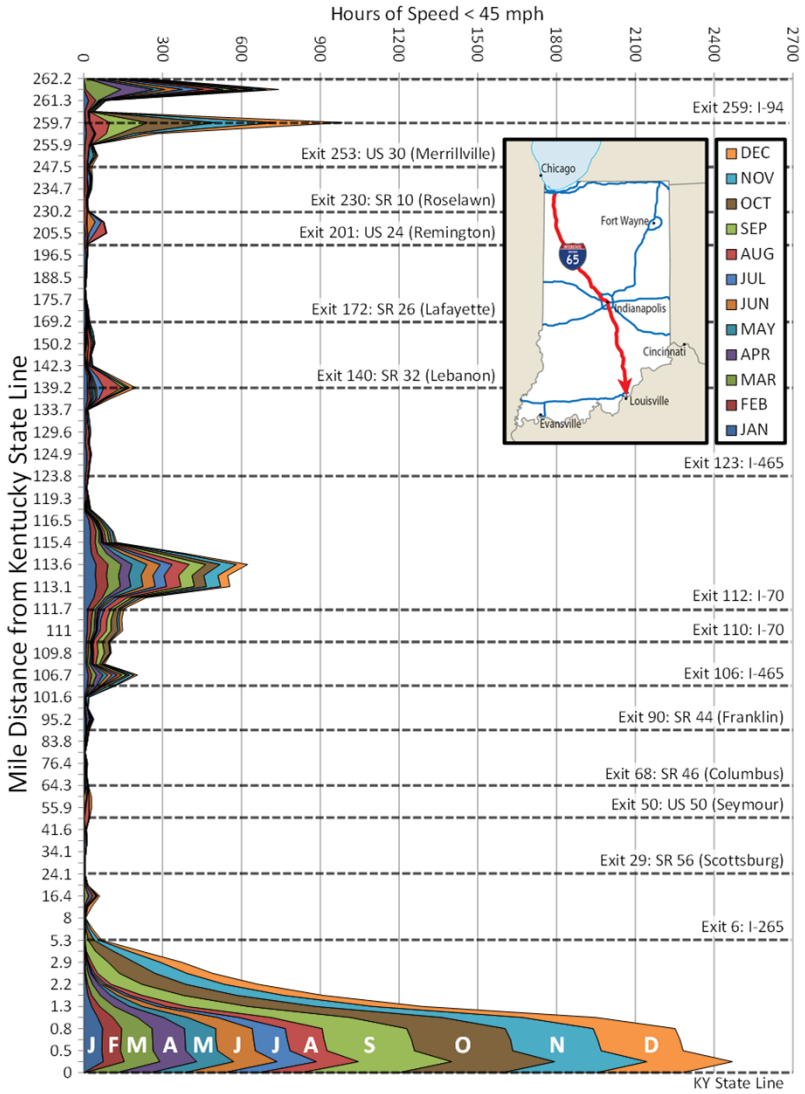
Mobility Report Performance Measures



Almost 2600 hours in a year

Mobility Report Performance Measures

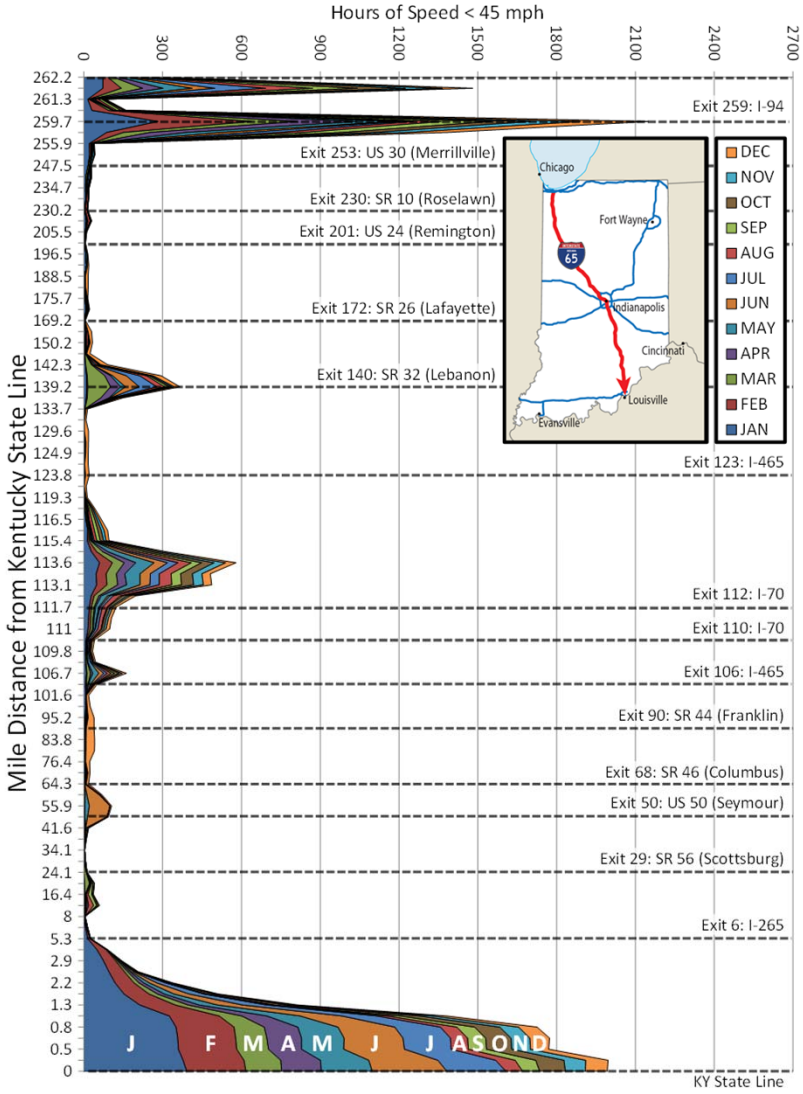
2011 Congestion Hours



PURDUE UNIVERSITY

Mobility Report Performance Measures

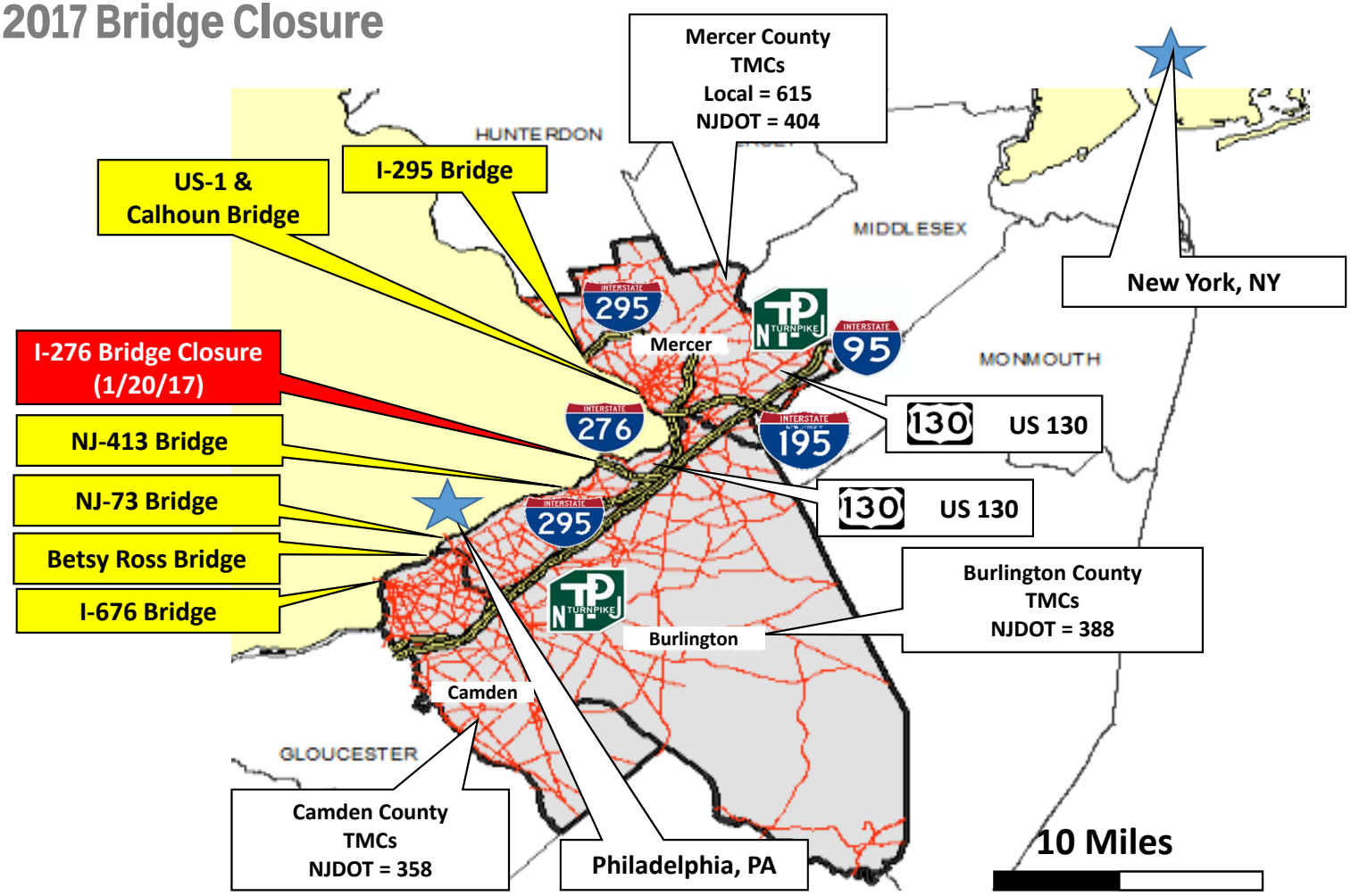
2012 Congestion Hours



PURDUE UNIVERSITY

Regional Mobility Performance Measures

2017 Bridge Closure



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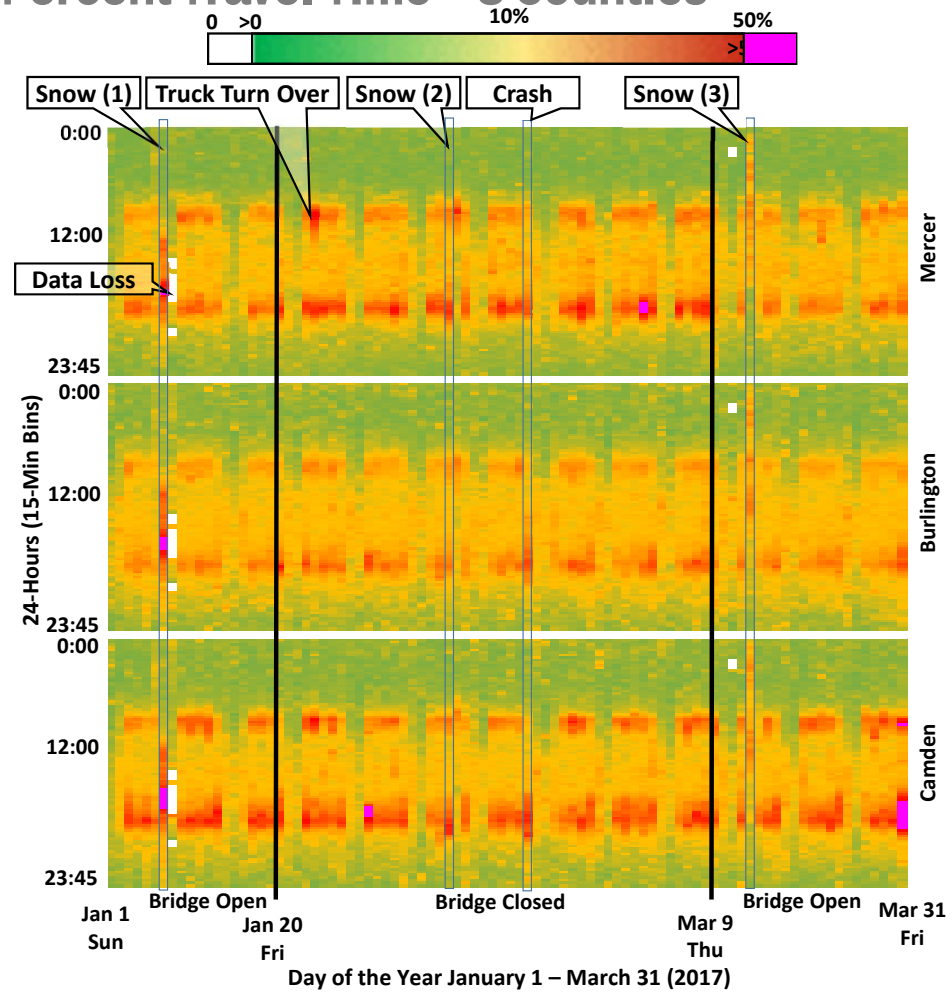
Regional Mobility Performance Measures

2017 Mean Increase in Percent Travel Time – 3 Counties



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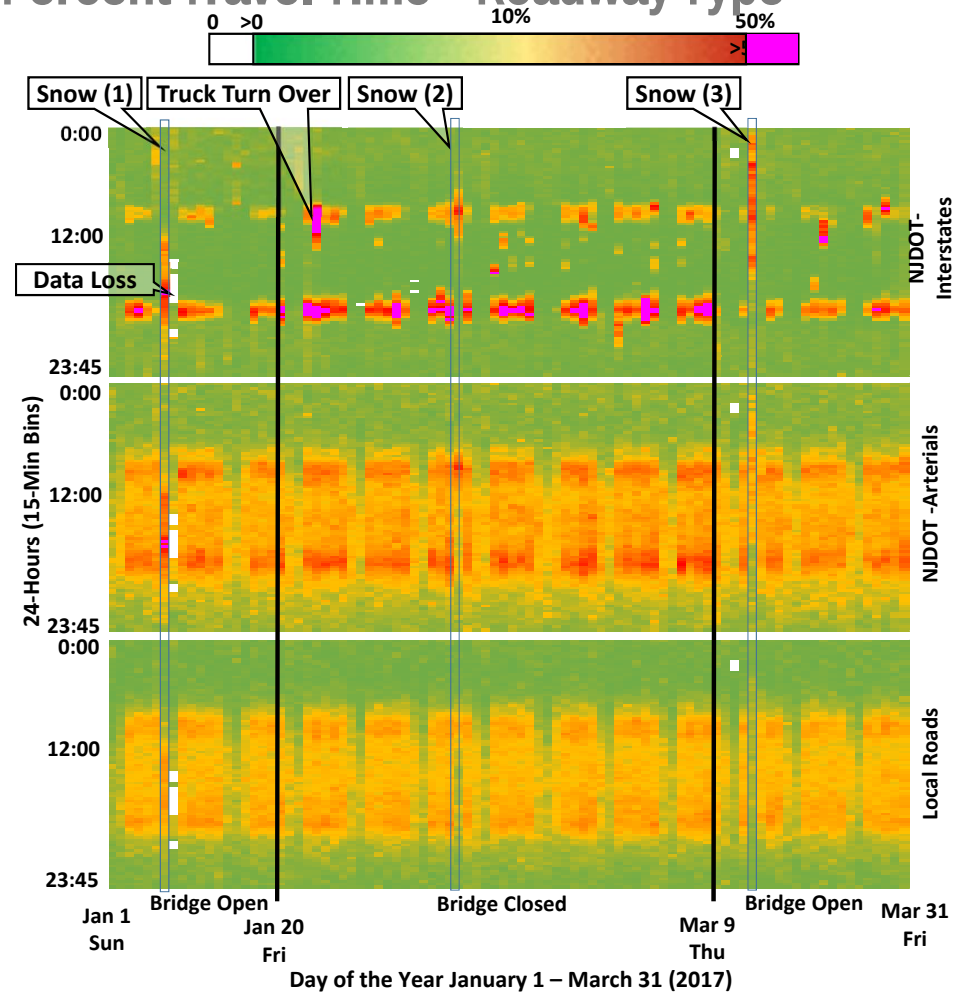
Regional Mobility Performance Measures

2017 Mean Increase in Percent Travel Time – Roadway Type



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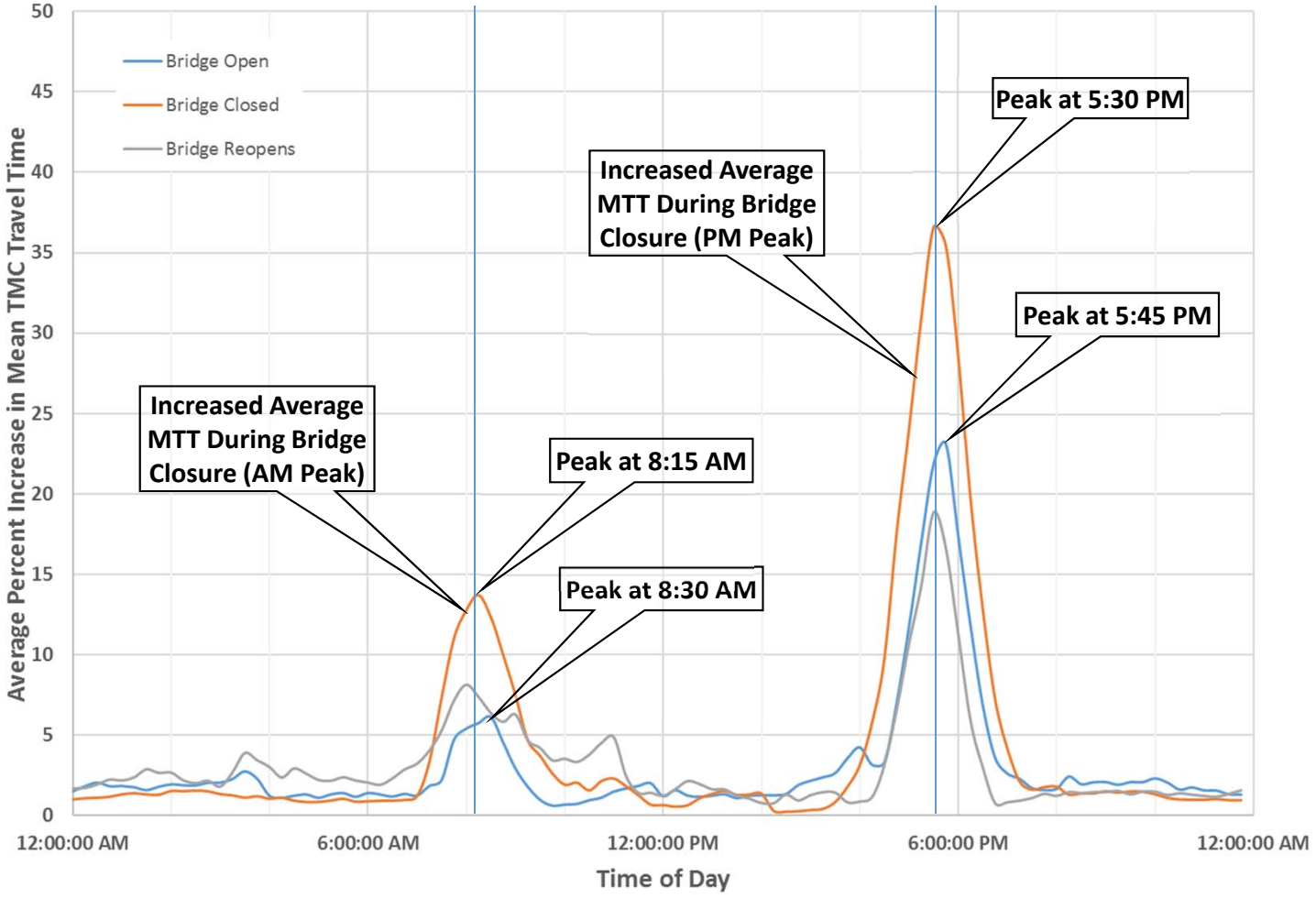
Regional Mobility Performance Measures

2017 Mean Increase in Percent Travel Time – Roadway Type



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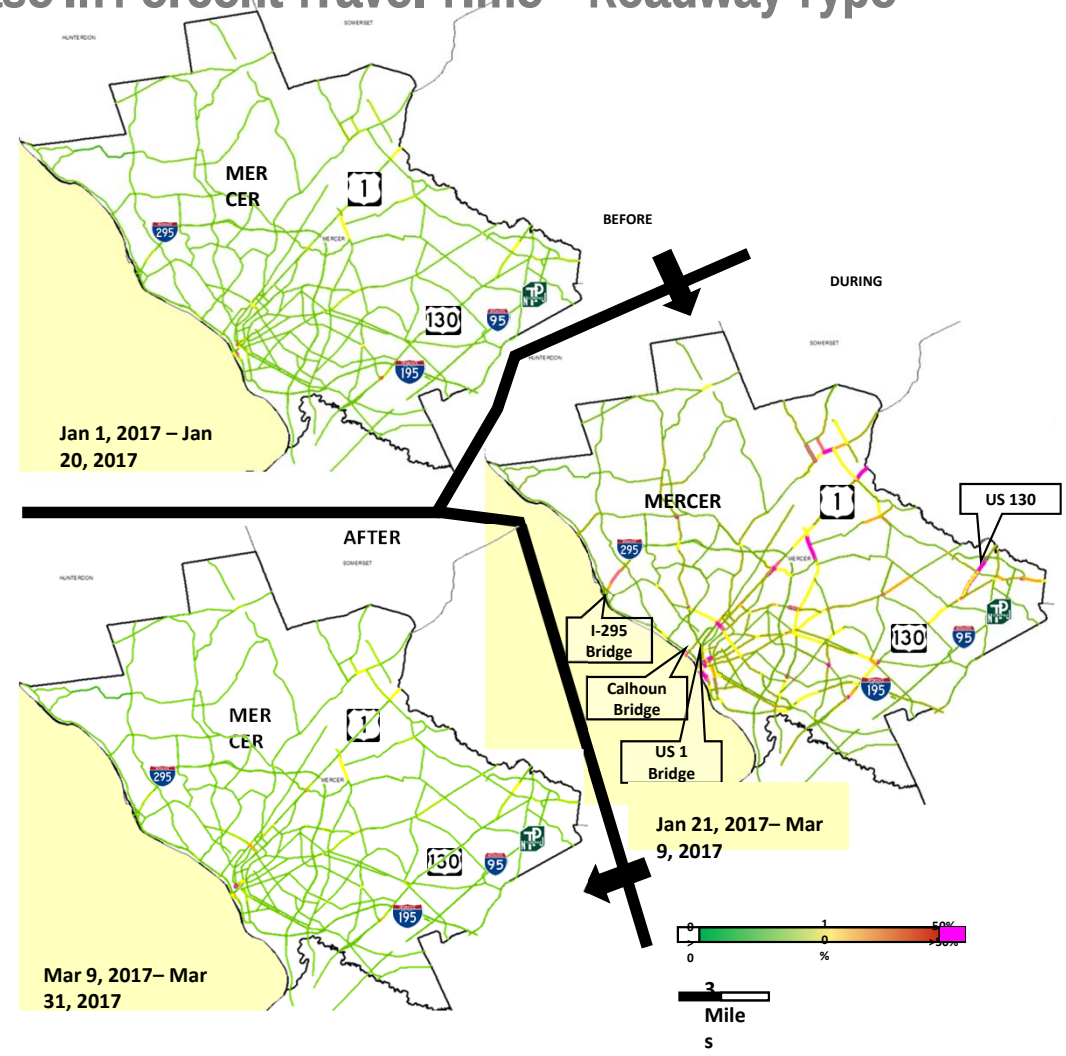
Regional Mobility Performance Measures

2017 Mean Increase in Percent Travel Time – Roadway Type



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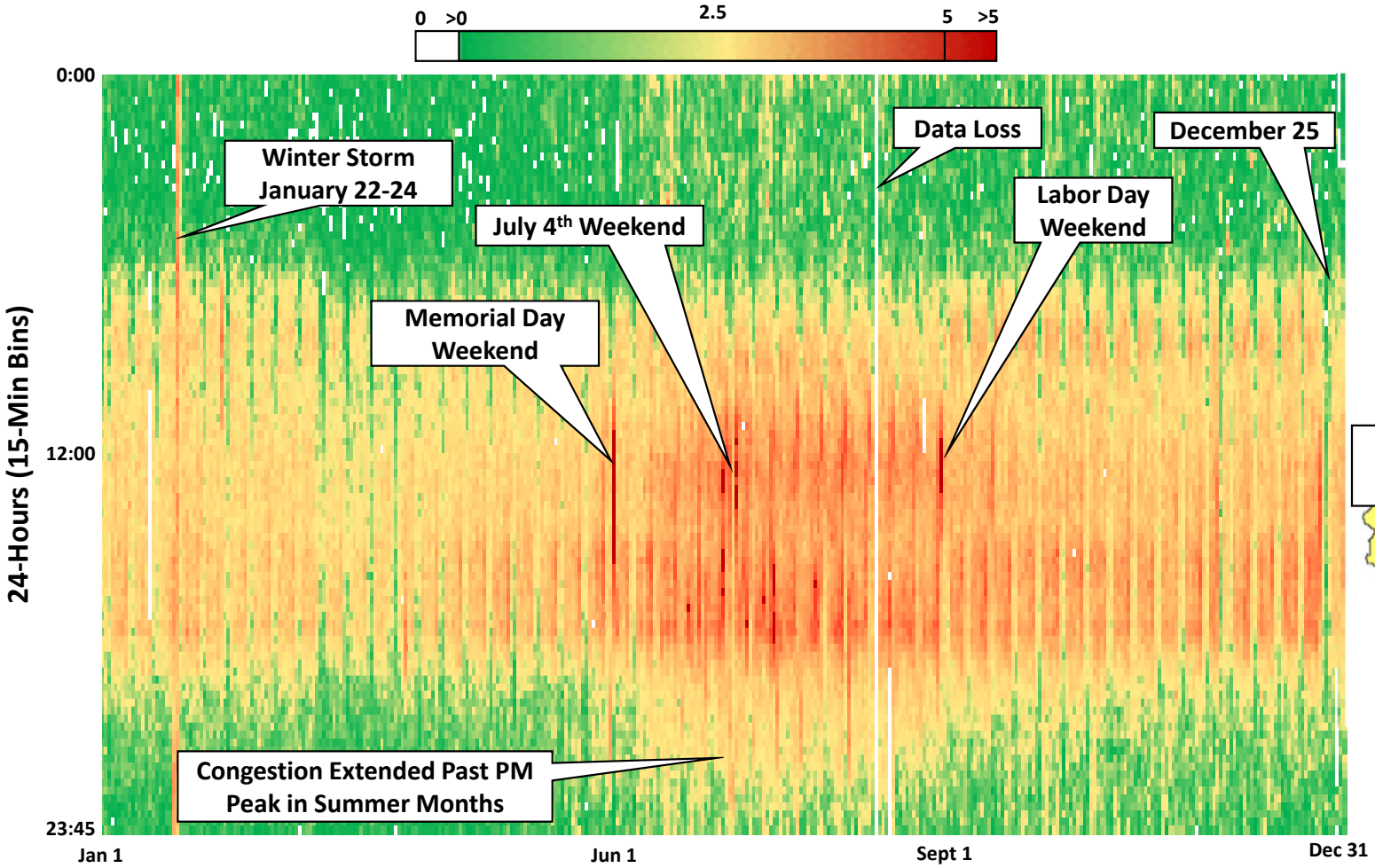
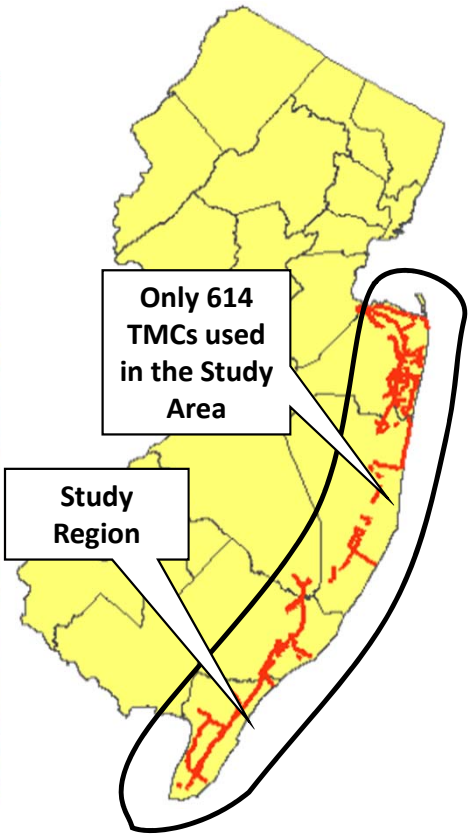
Regional Mobility Performance Measures

2017 Mean Increase in Percent Travel Time – Roadway Type

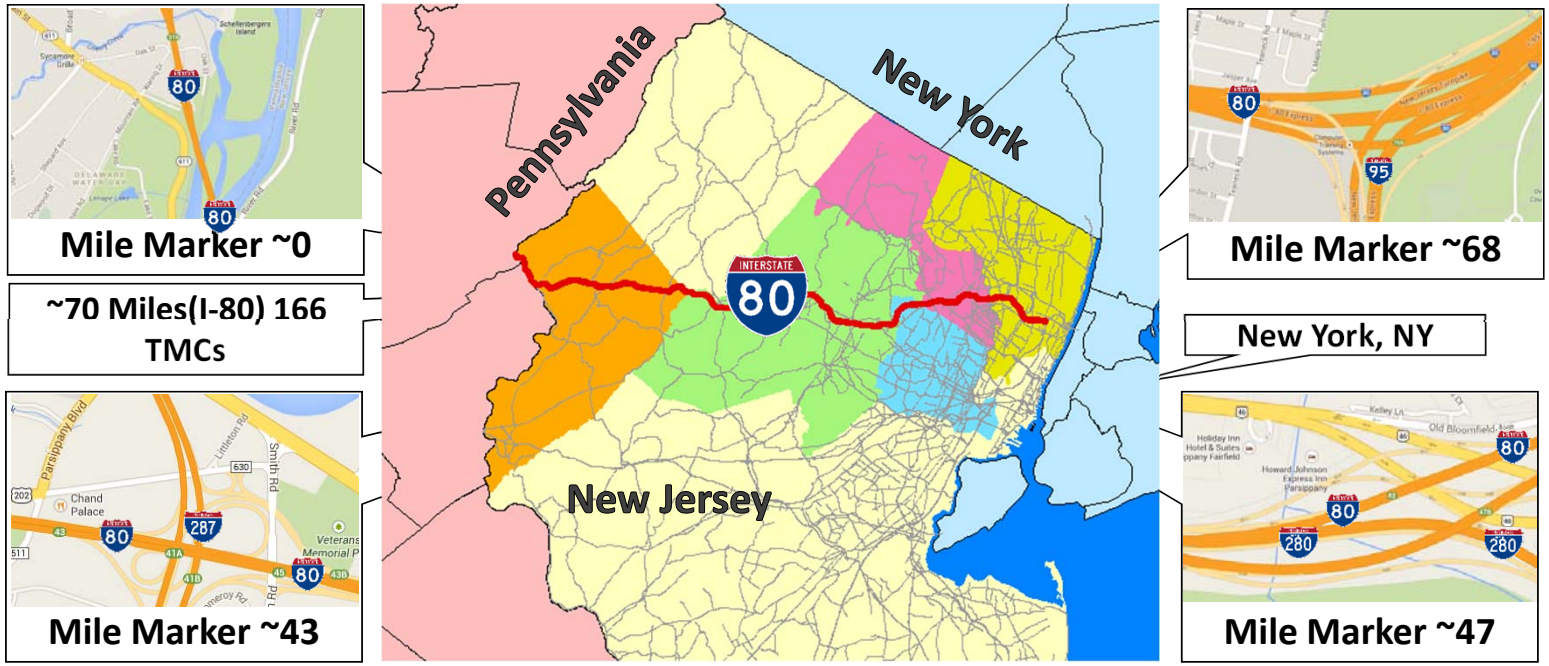




TCNJ THE COLLEGE OF NEW JERSEY

Baseline Corridor Assessment (Needs to be done Statewide)

2013 I-80



- ~68 Miles of Interstate Highway Crossing NJ
- 166 Traffic Message Channels (TMCs)
- ~90 million 1-minute anonymous probe vehicle speed records analyzed

Baseline Corridor Assessment (Needs to be done Statewide)

2013 I-80

INDIANA MOBILITY REPORTS

2012 Indiana Mobility Report: Full Version

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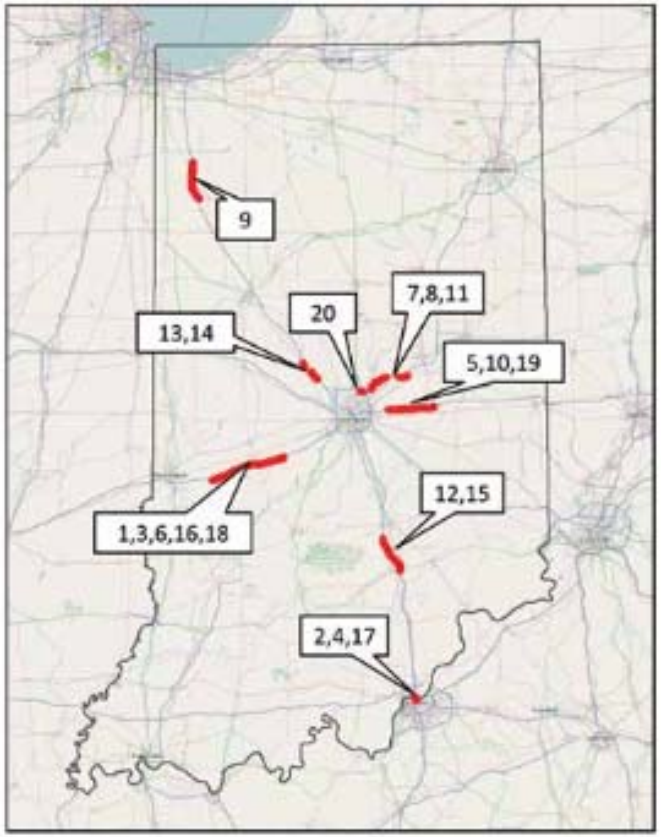
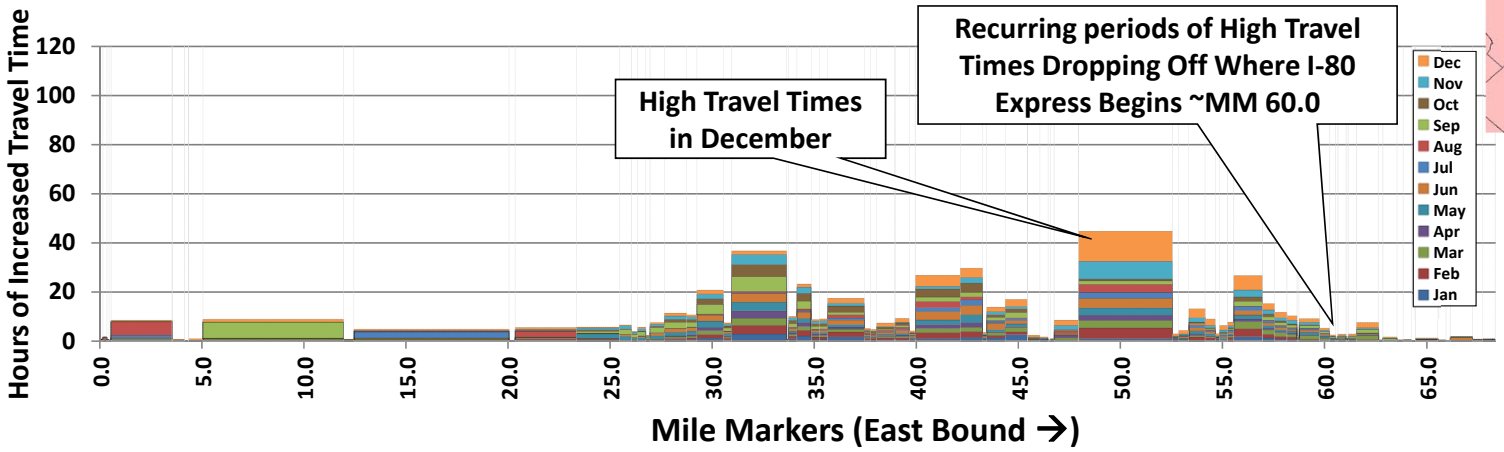


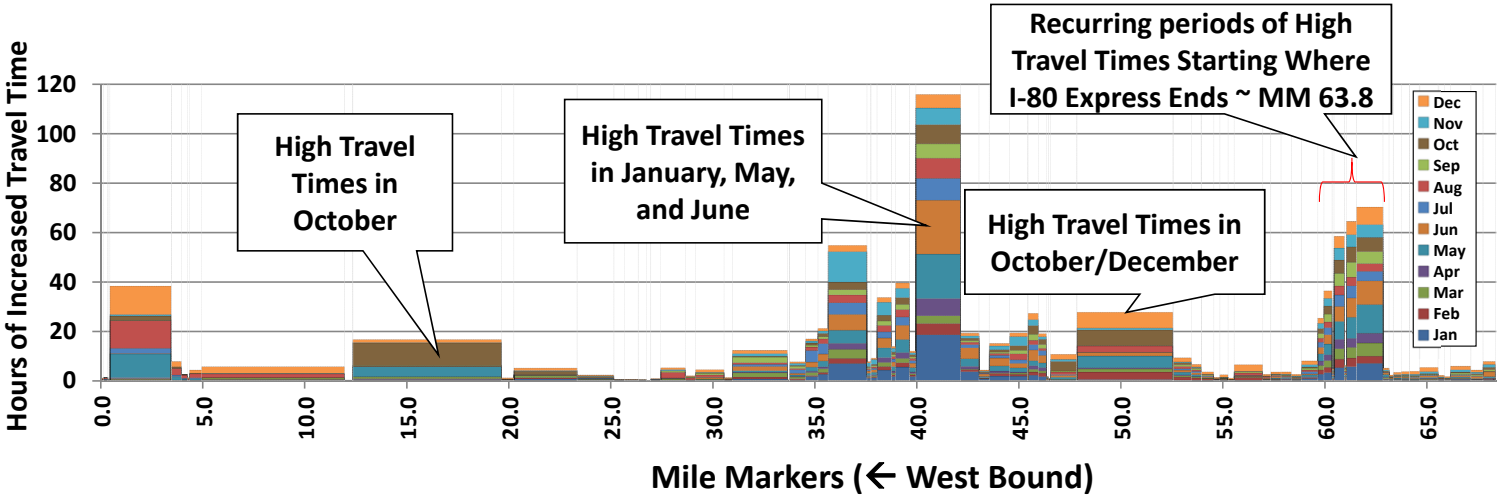
RANK	INTERSTATE	LENGTH (miles)	SEGMENTS (mile markers)	2012 TTD (hours)	2012 CH (hours)
1	I-70 E	13.93	22.5 to 36.4	**174.1**	257.3
2	I-65 S	0.37	1.3 to 0.9	**82.5**	1326.5
3	I-70 W	13.93	36.5 to 22.6	**82.0**	173.0
4	I-65 S	0.44	1.7 to 1.3	**77.2**	780.3
5	I-70 W	7.11	103.0 to 95.9	**75.5**	81.8
6	I-70 W	9.01	49.5 to 40.6	**75.2**	167.5
7	I-69 N	3.70	214.7 to 218.3	**72.7**	168.0
8	I-69 N	1.59	202.9 to 204.5	**63.3**	555.0
9	I-65 N	14.25	215.1 to 229.3	**61.3**	32.8
10	I-70 E	7.09	95.5 to 102.5	**60.6**	94.0
11	I-69 S	5.02	210.4 to 205.6	**60.1**	157.8
12	I-65 N	5.35	49.9 to 55.3	**59.4**	69.0
13	I-65 S	1.48	142.1 to 140.6	**55.3**	296.0
14	I-65 N	3.67	133.5 to 137.2	**53.5**	176.5
15	I-65 S	6.97	63.9 to 56.9	**52.8**	73.0
16	I-70 E	3.46	36.9 to 40.3	**50.8**	143.0
17	I-65 S	0.42	2.2 to 1.7	**50.4**	474.0
18	I-70 E	8.96	40.8 to 49.7	**47.6**	164.5
19	I-70 W	8.85	112.5 to 103.6	**45.3**	24.5
20	I-465 IL	1.03	33.0 to 34.1	**44.8**	442.5

Figure 18.
Top 20 travel time deficit (TTD) segments throughout the Indiana interstate system.

Baseline Corridor Assessment

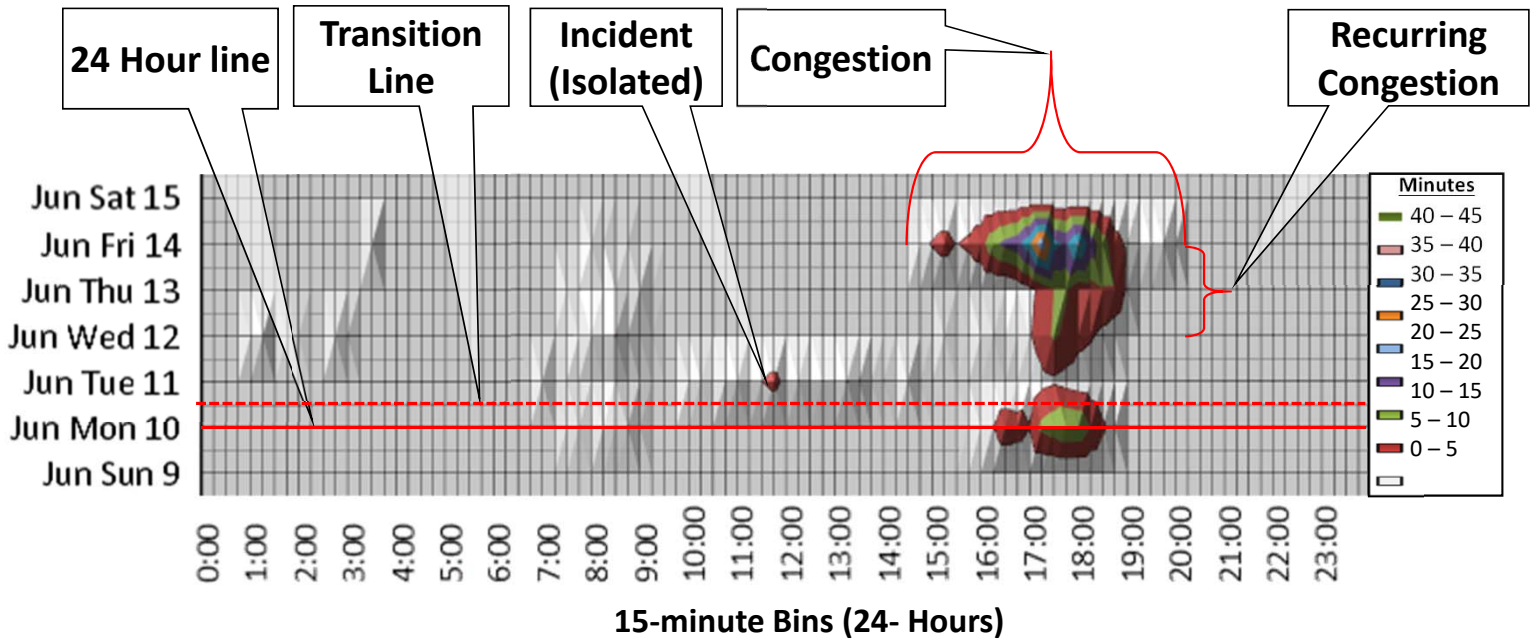
2013 I-80





Baseline Corridor Assessment

2013 I-80



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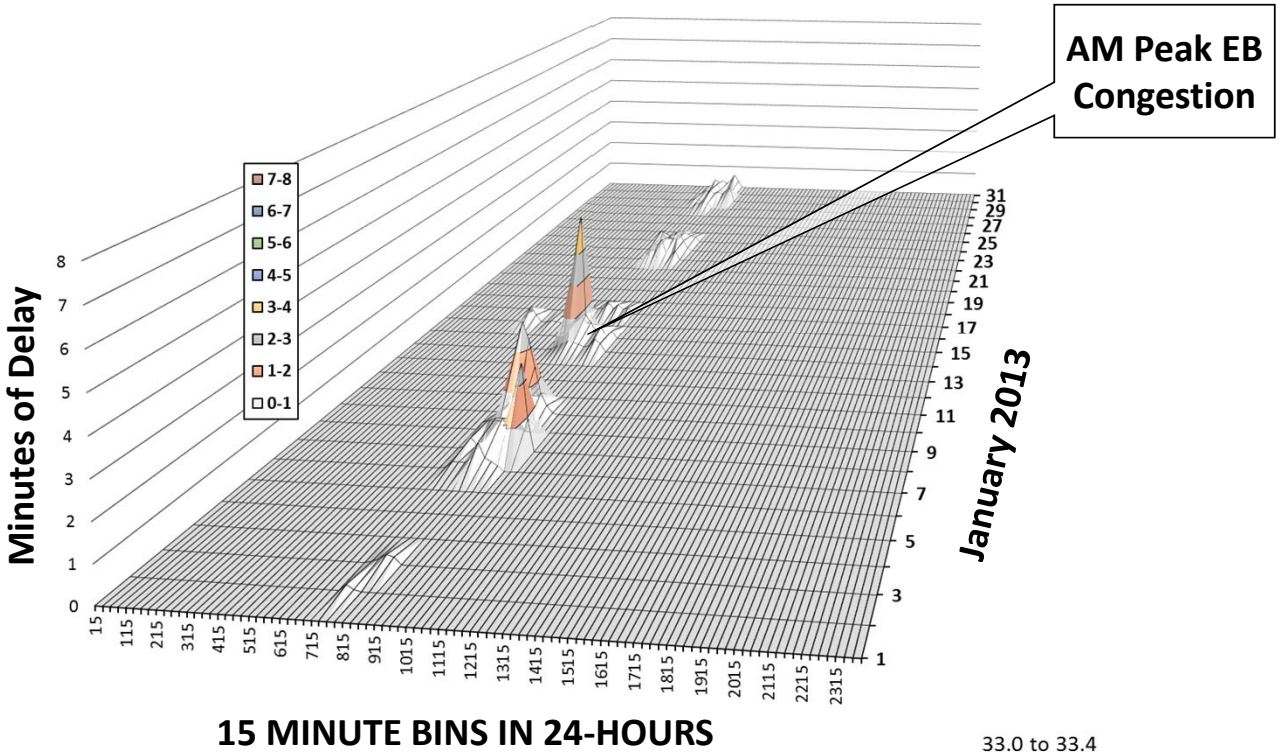
Baseline Corridor Assessment (Different Perspective)

2013 I-80



33.0 to 33.4

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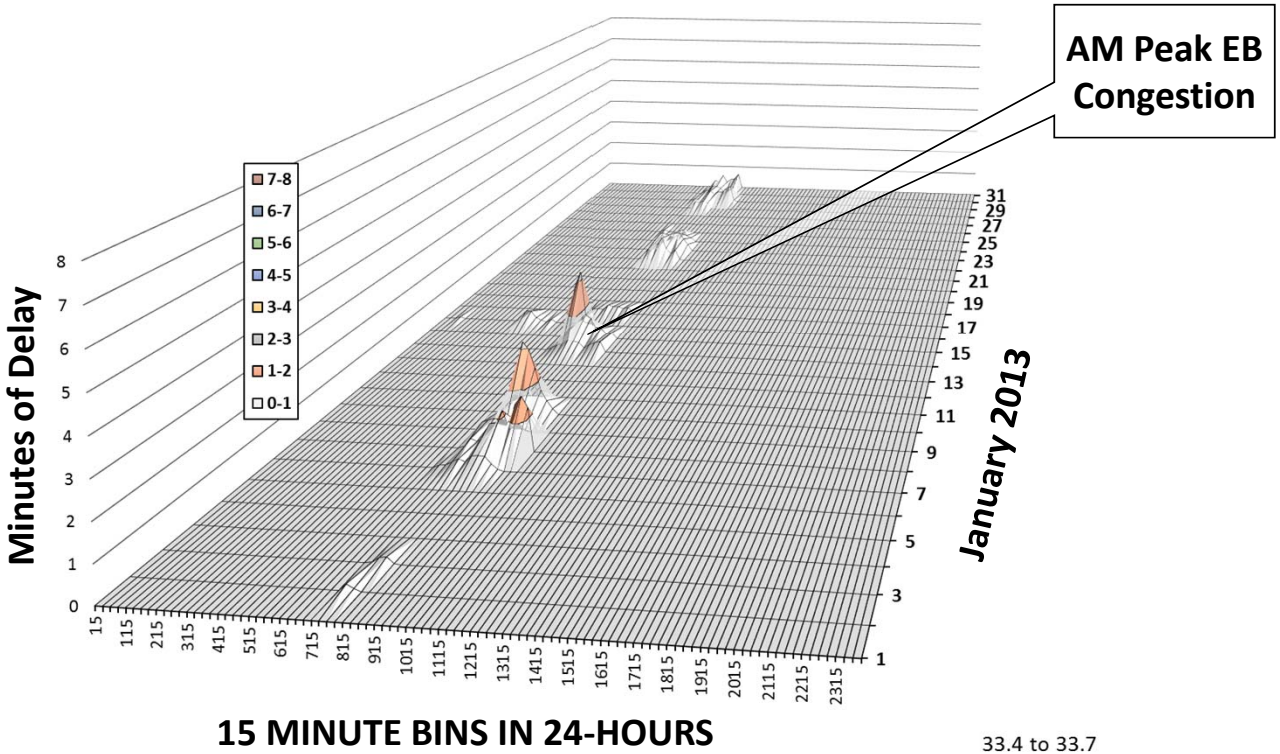
Baseline Corridor Assessment (Different Perspective)

2013 I-80



33.4 to 33.7

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Baseline Corridor Assessment (Different Perspective)

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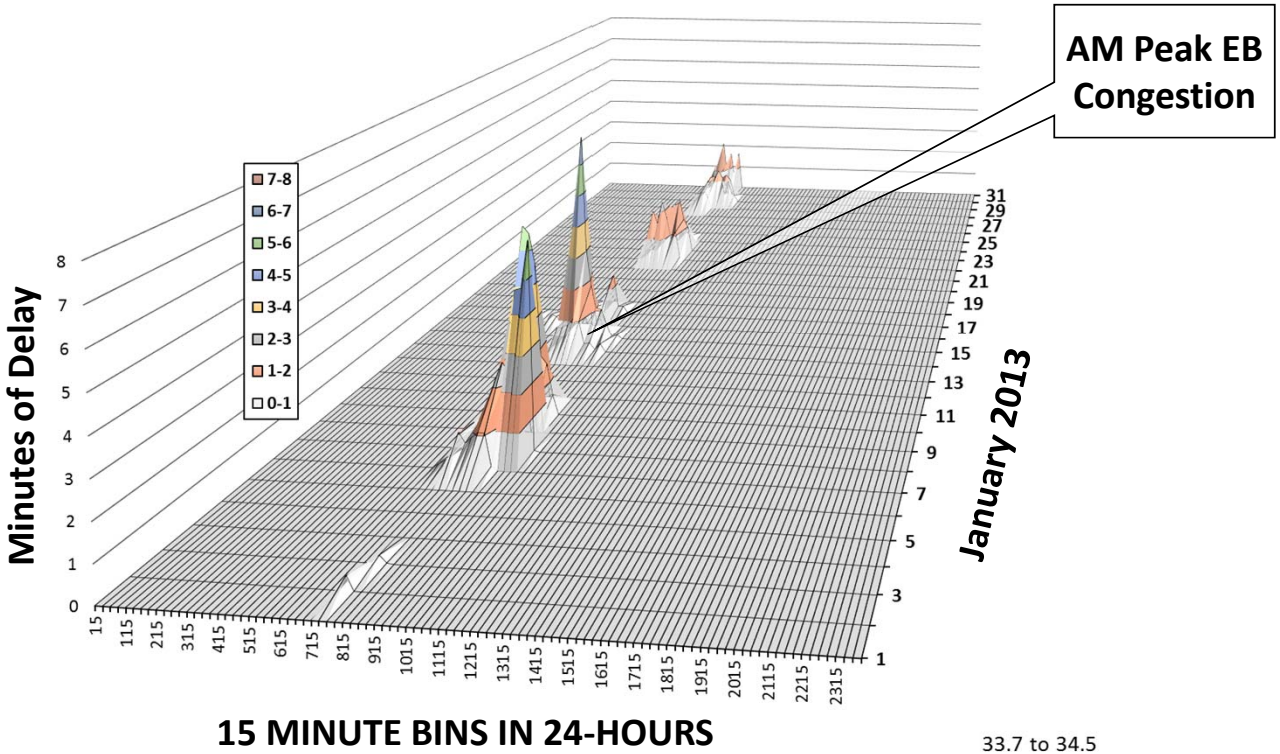

33.7 to 34.5

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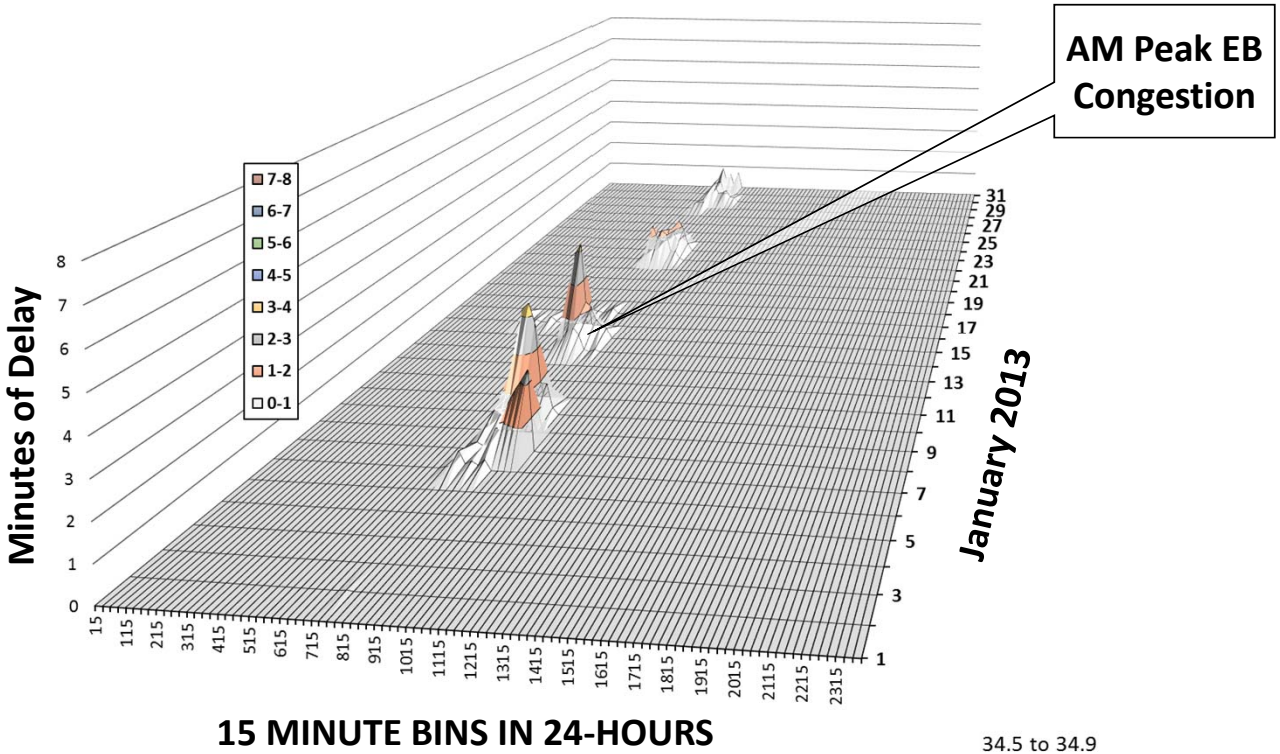
Baseline Corridor Assessment (Different Perspective)

2013 I-80



34.5 to 34.9

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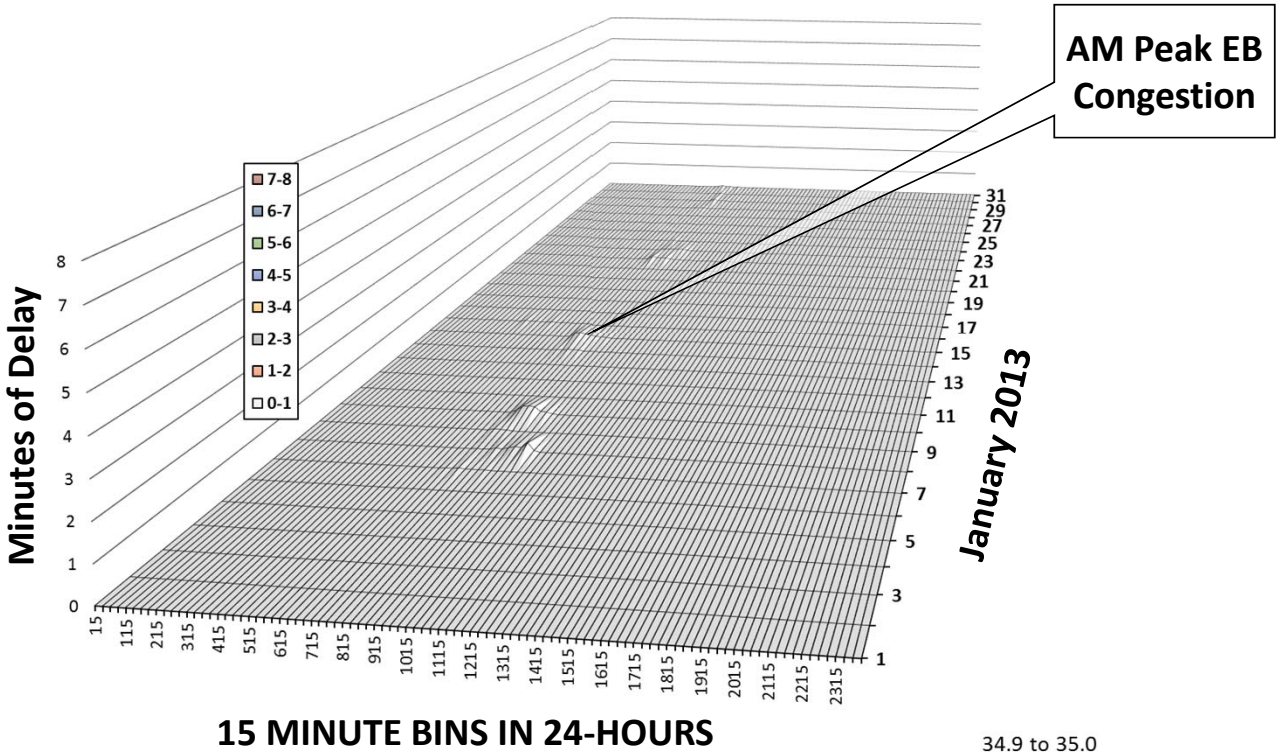
Baseline Corridor Assessment (Different Perspective)

2013 I-80



34.9 to 35.0

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Baseline Corridor Assessment (Different Perspective)

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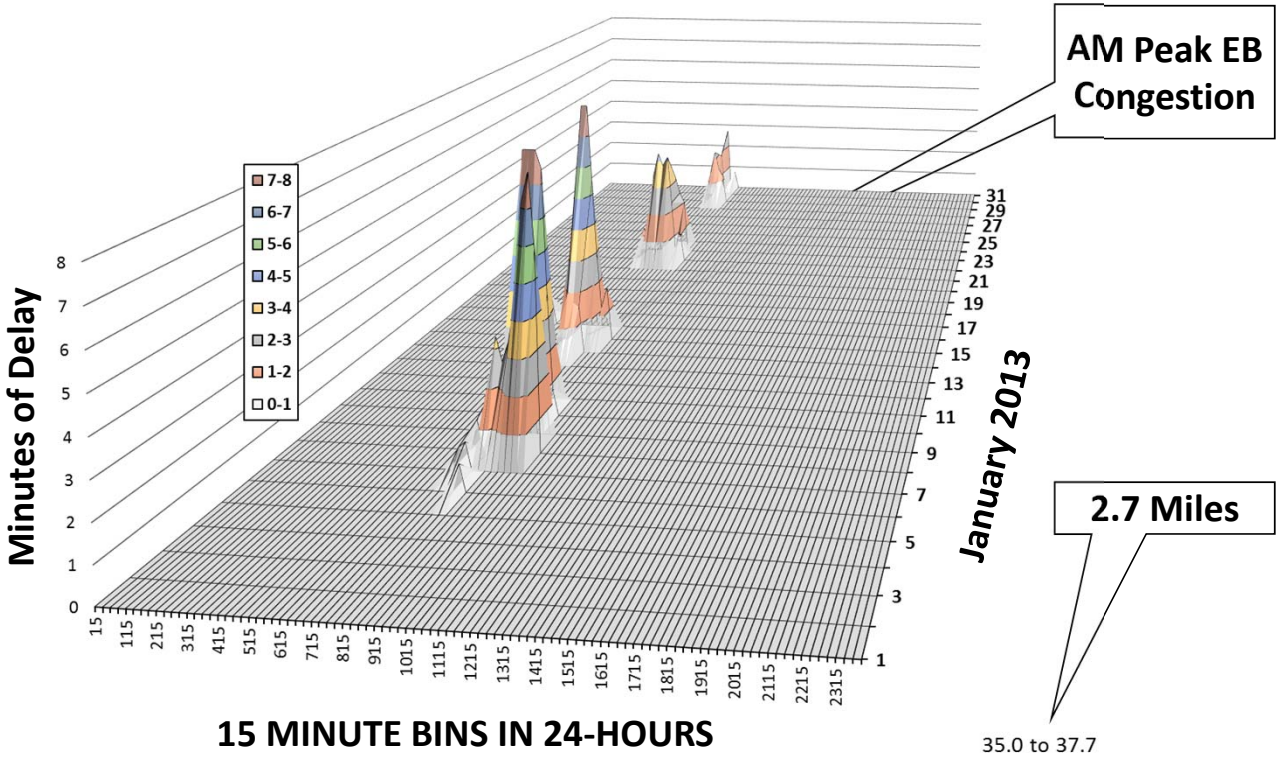

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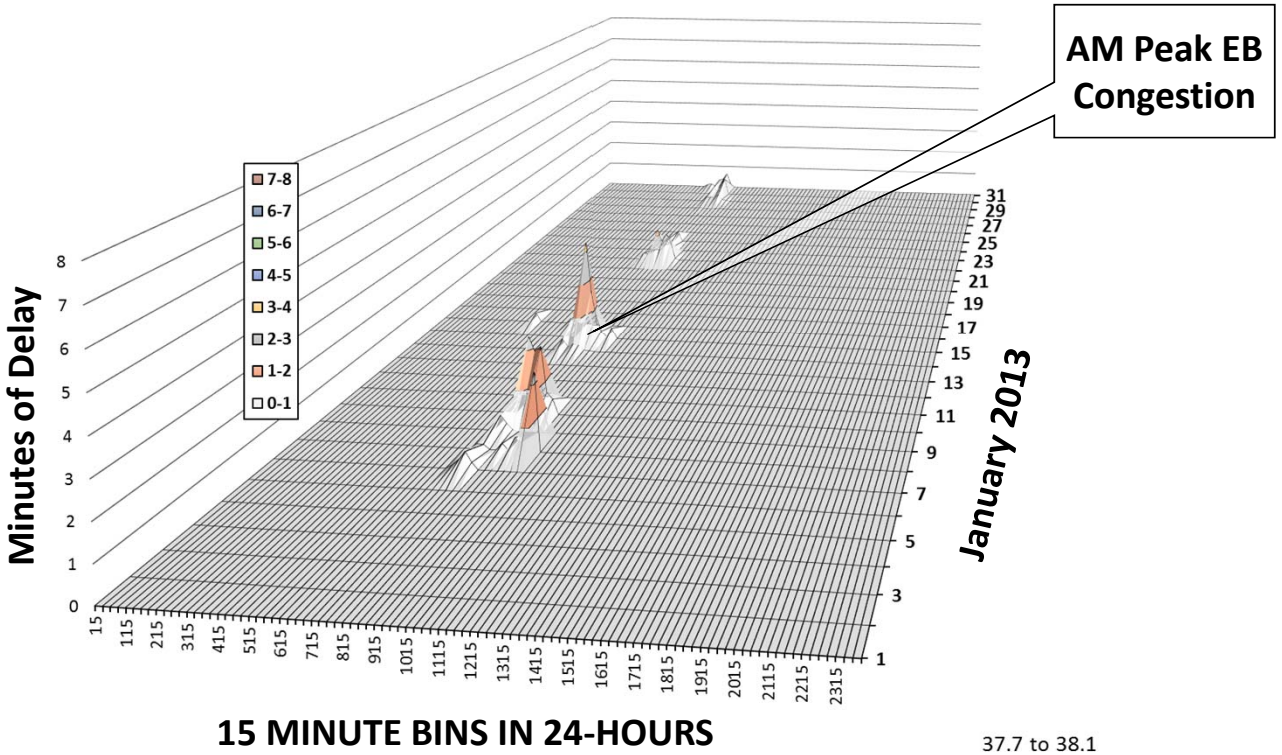
Baseline Corridor Assessment (Different Perspective)

2013 I-80



37.7 to 38.1

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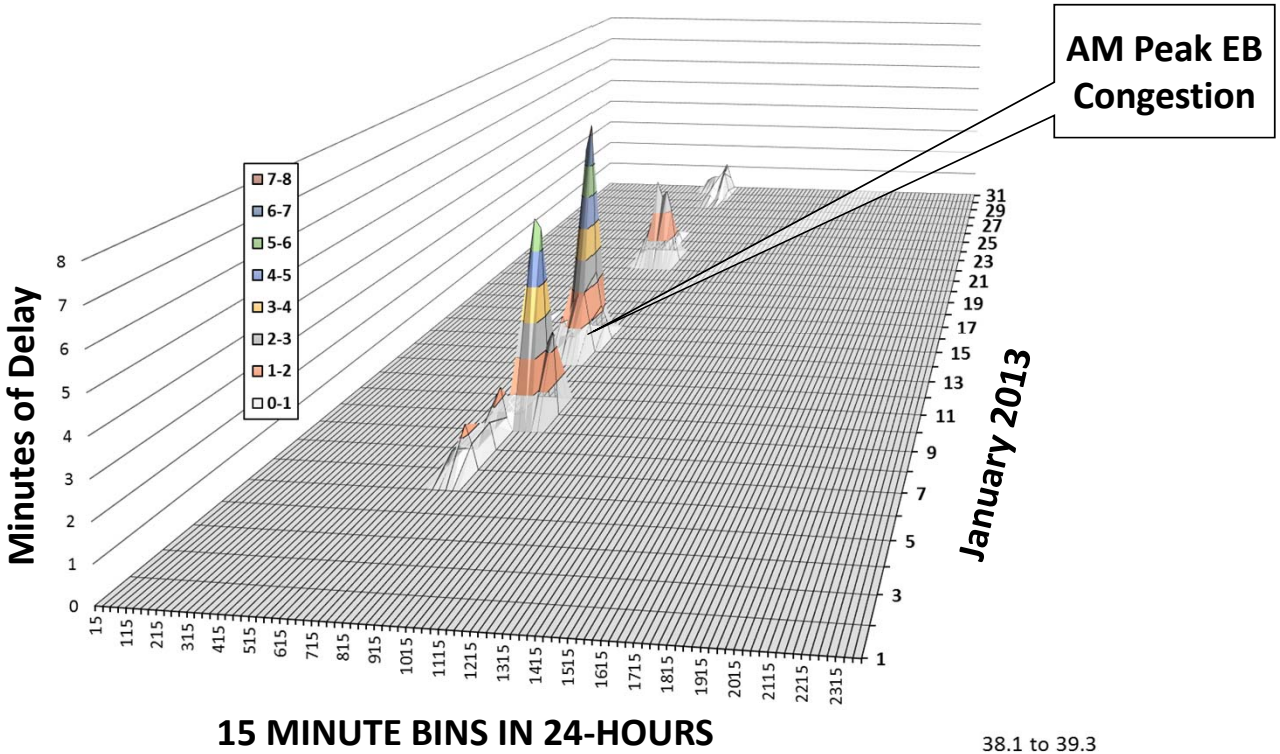
Baseline Corridor Assessment (Different Perspective)

2013 I-80



38.1 to 39.3

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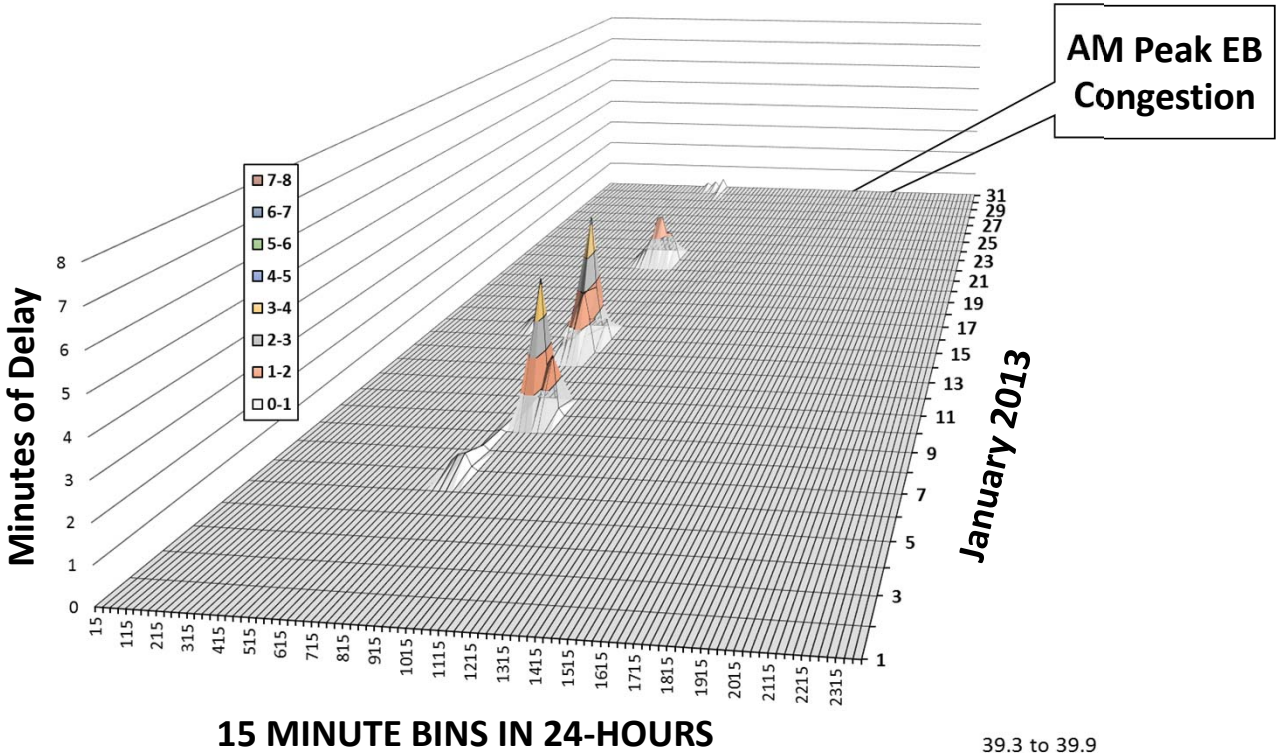
Baseline Corridor Assessment (Different Perspective)

2013 I-80



39.3 to 39.9

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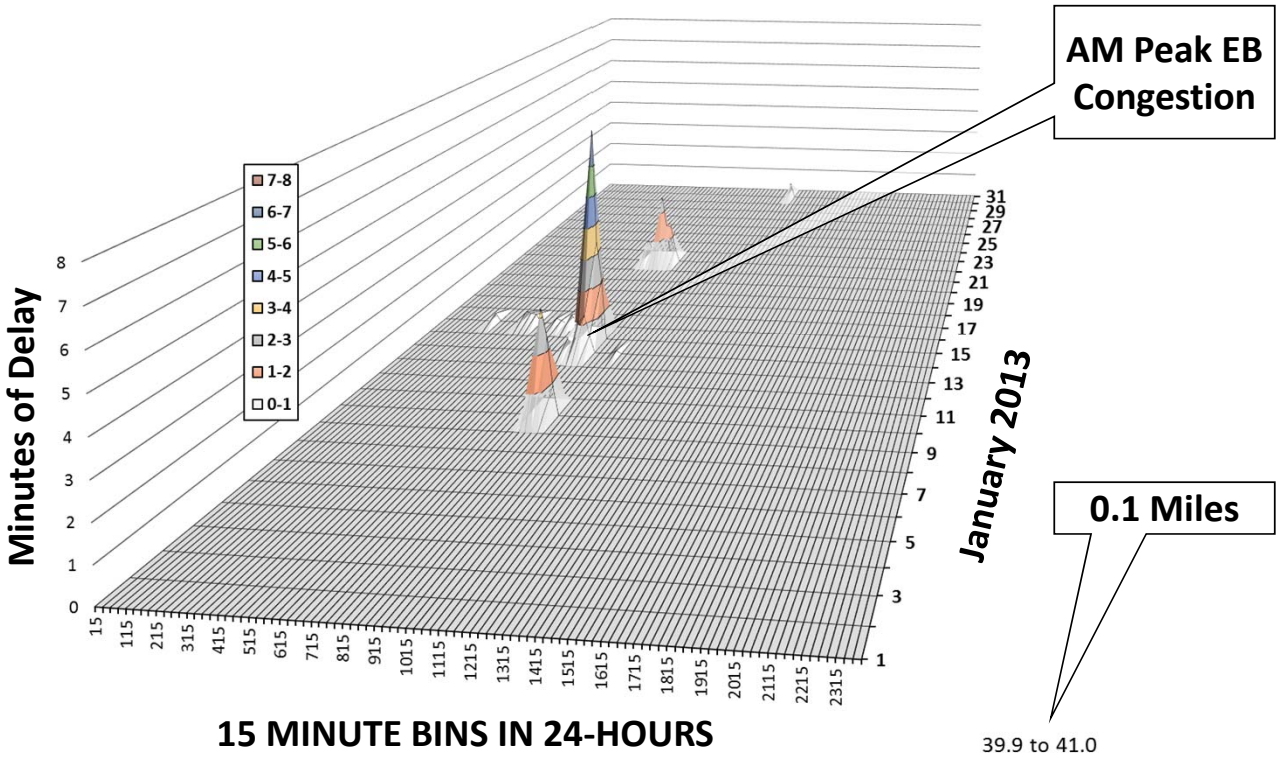
Baseline Corridor Assessment (Different Perspective)

2013 I-80



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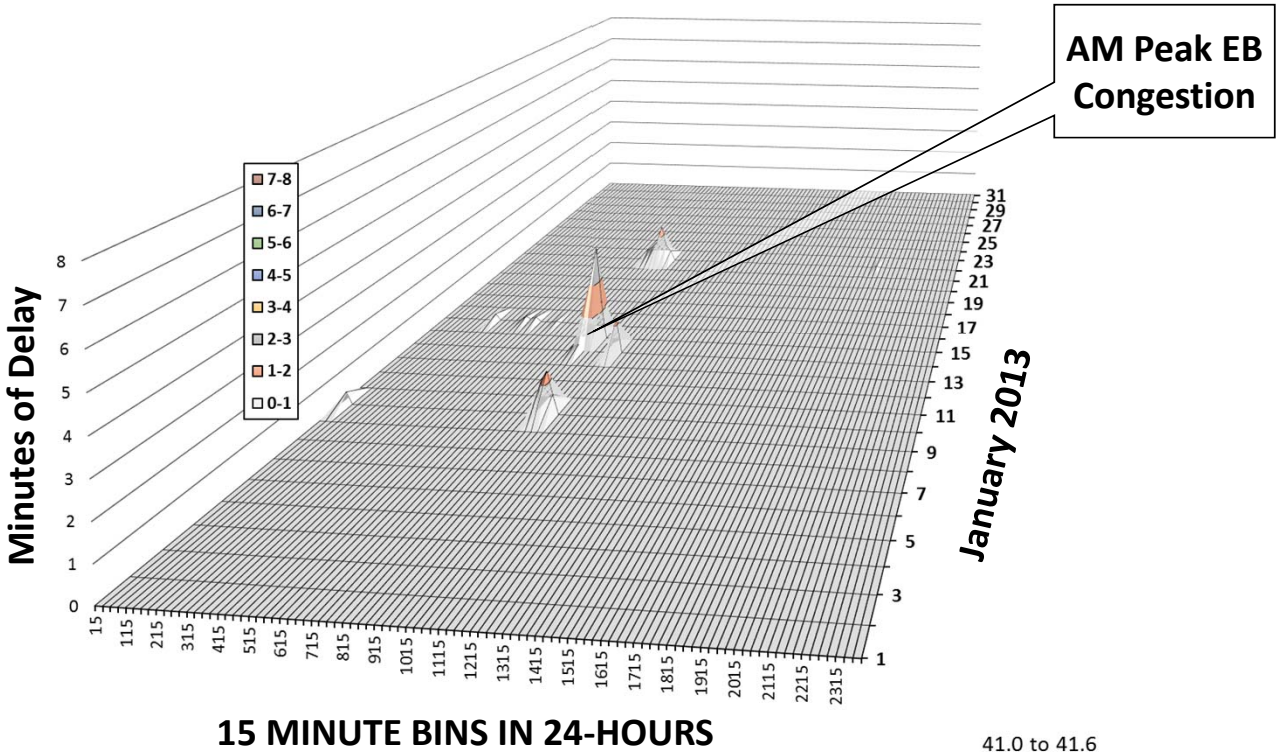
Baseline Corridor Assessment (Different Perspective)

2013 I-80



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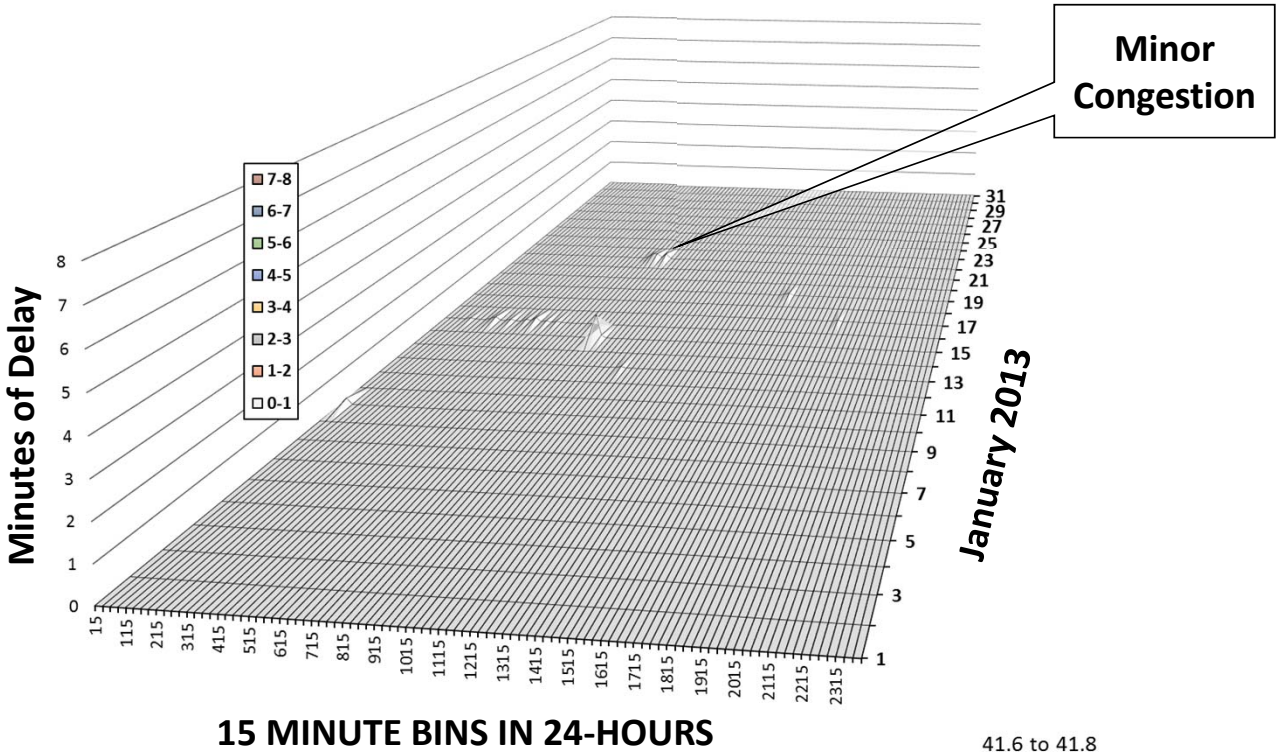
Baseline Corridor Assessment (Different Perspective)

2013 I-80



41.6 to 41.8

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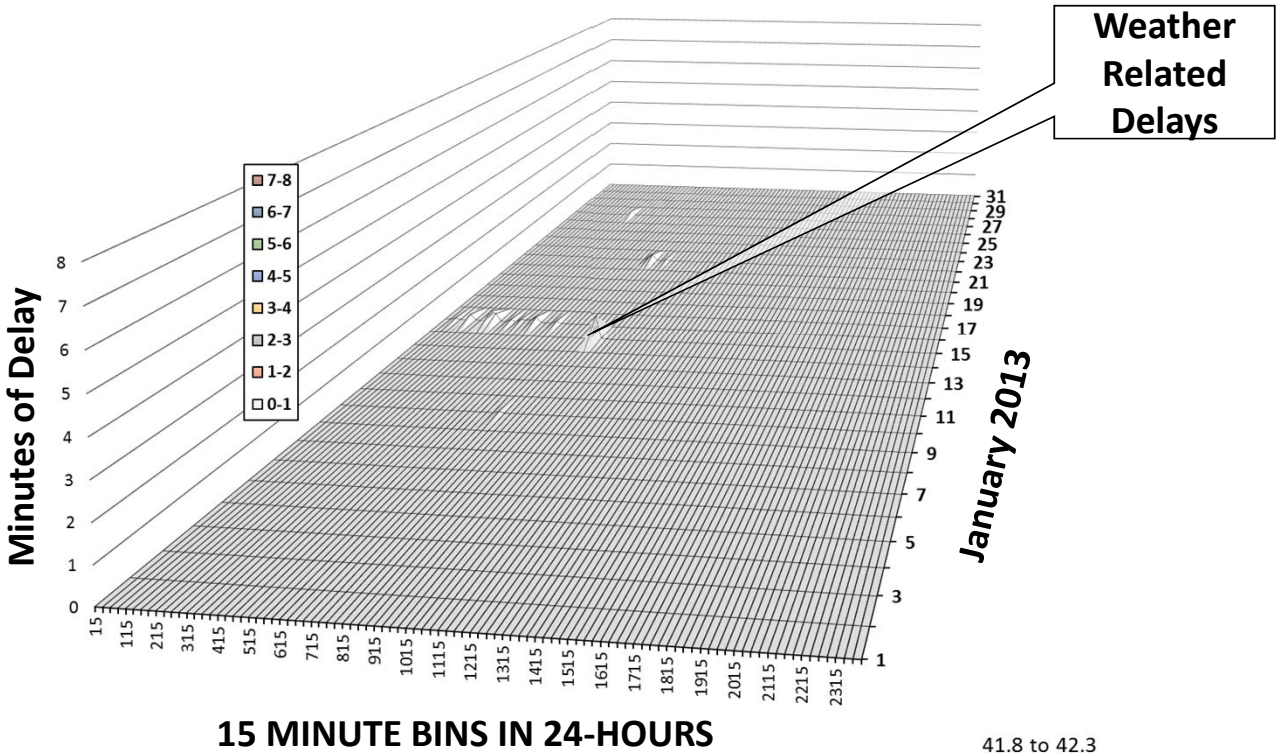
Baseline Corridor Assessment (Different Perspective)

2013 I-80



41.8 to 42.3

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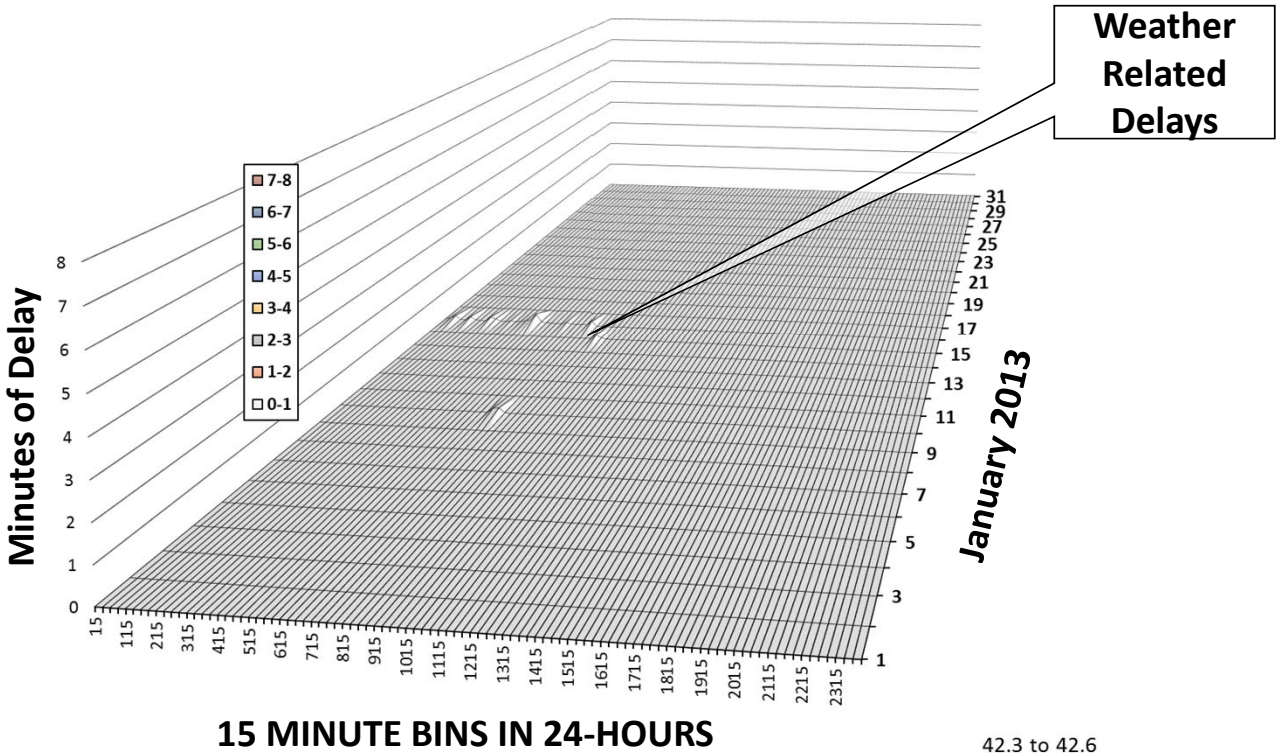
THE COLLEGE OF NEW JERSEY

Baseline Corridor Assessment (Different Perspective)

2013 I-80



42.3 to 42.6

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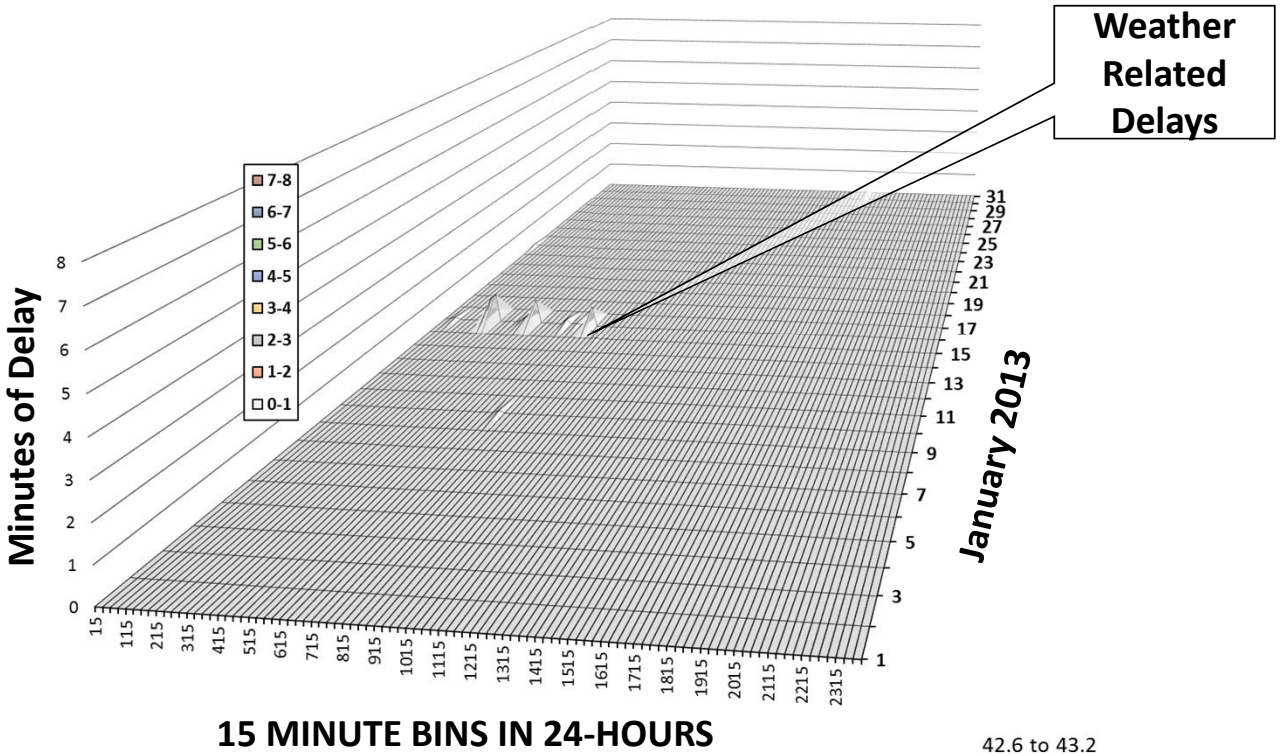
Baseline Corridor Assessment (Different Perspective)

2013 I-80



42.6 to 43.2

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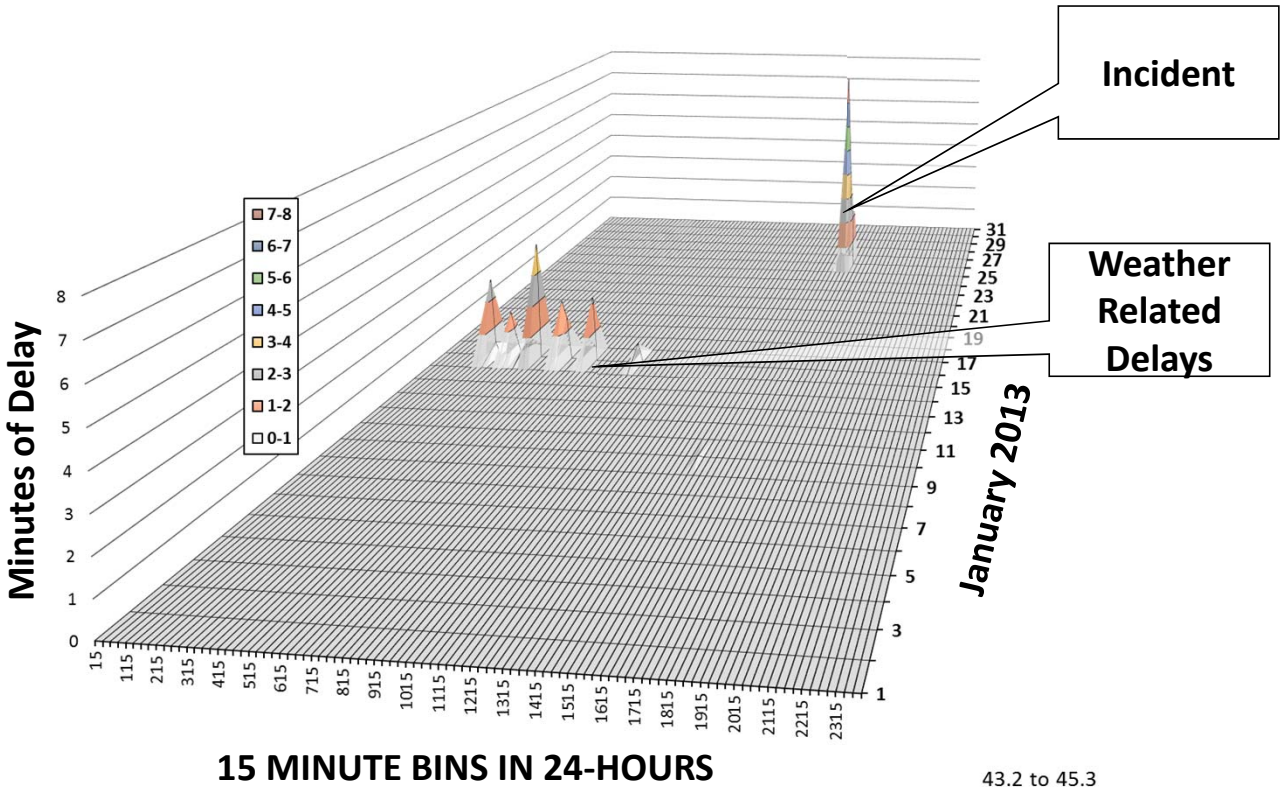
Baseline Corridor Assessment (Different Perspective)

2013 I-80



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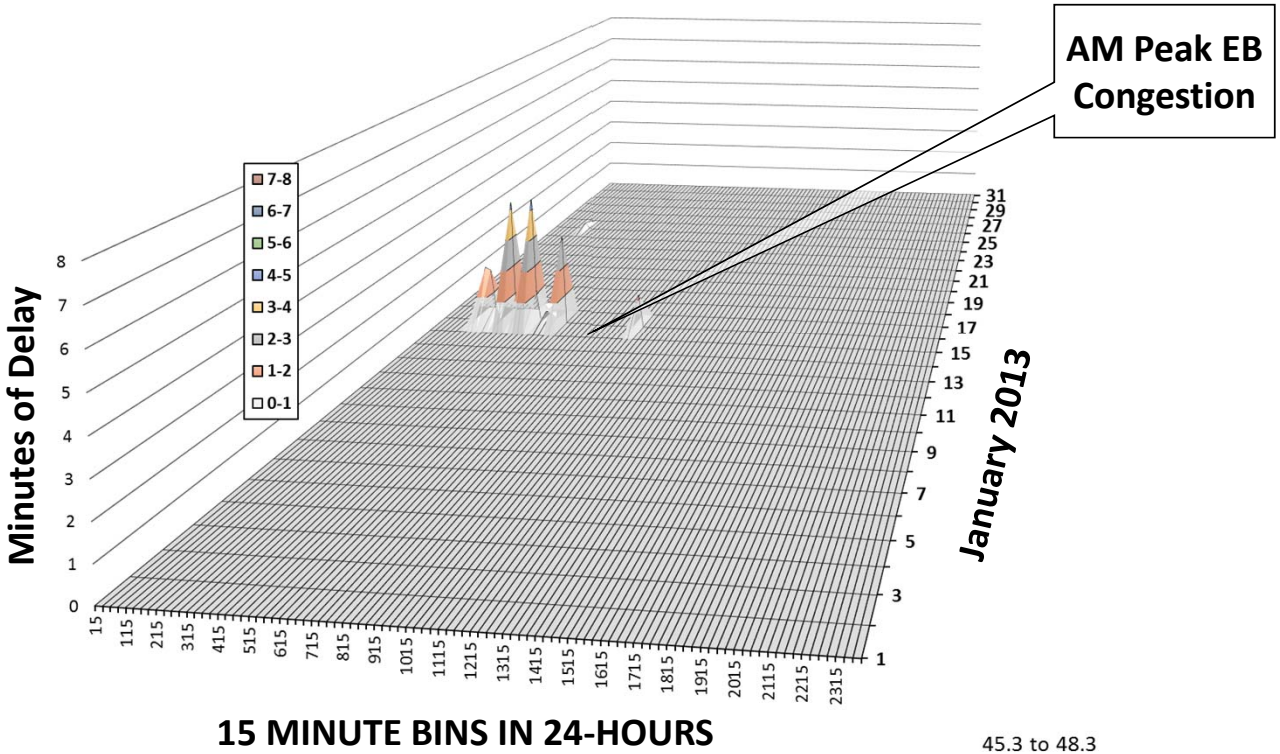
Baseline Corridor Assessment (Different Perspective)

2013 I-80



45.3 to 48.3

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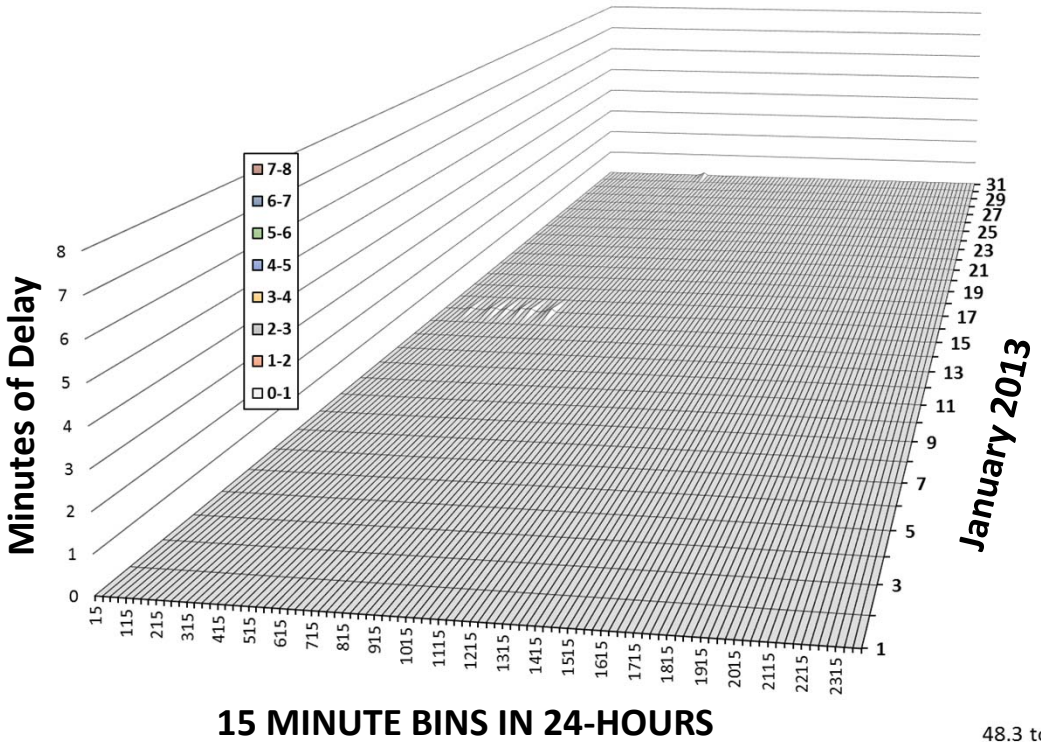
Baseline Corridor Assessment (Different Perspective)

2013 I-80



48.3 to 48.6

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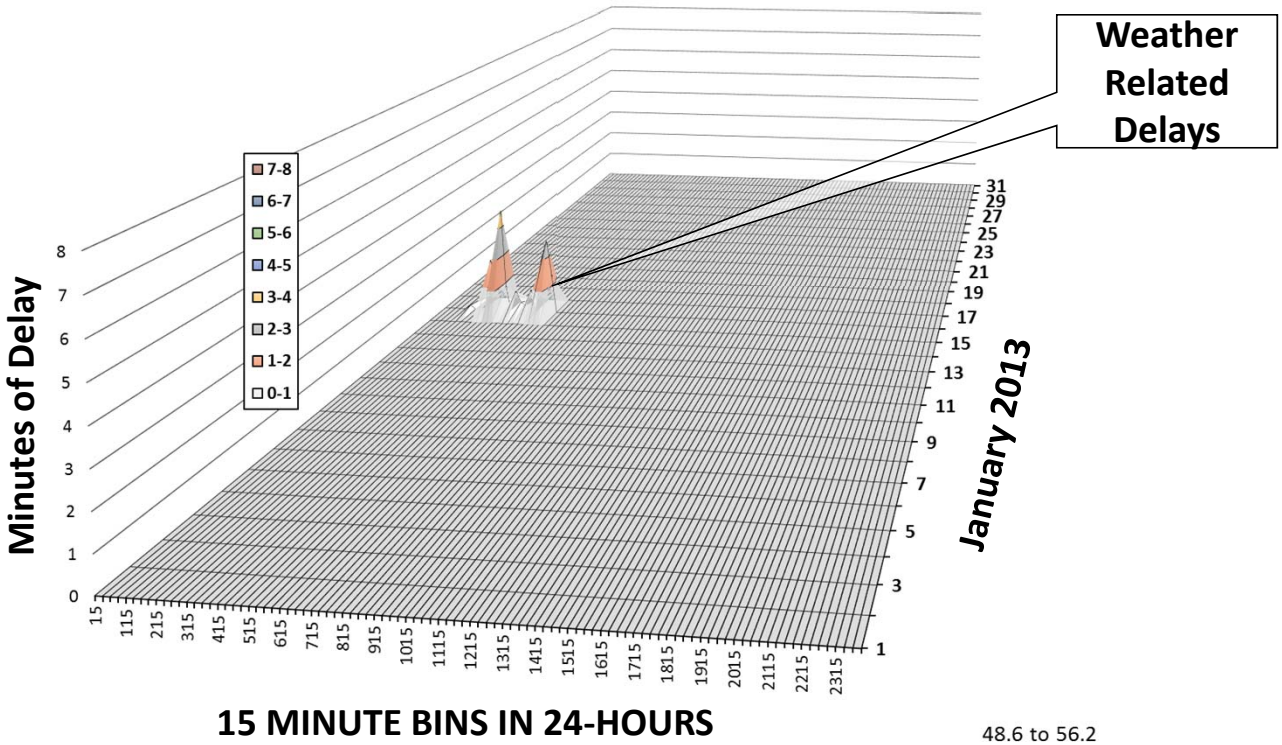
Baseline Corridor Assessment (Different Perspective)

2013 I-80



48.6 to 56.2

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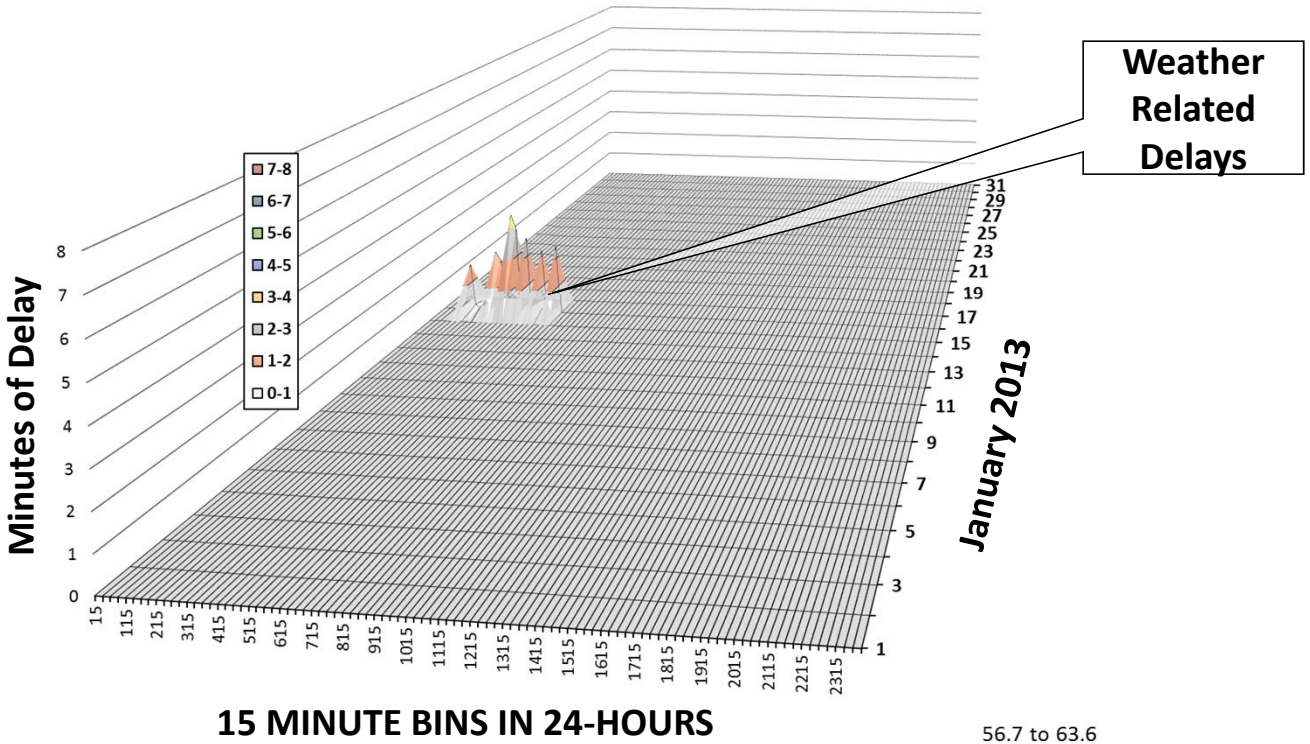
Baseline Corridor Assessment (Different Perspective)

2013 I-80



56.7 to 63.6

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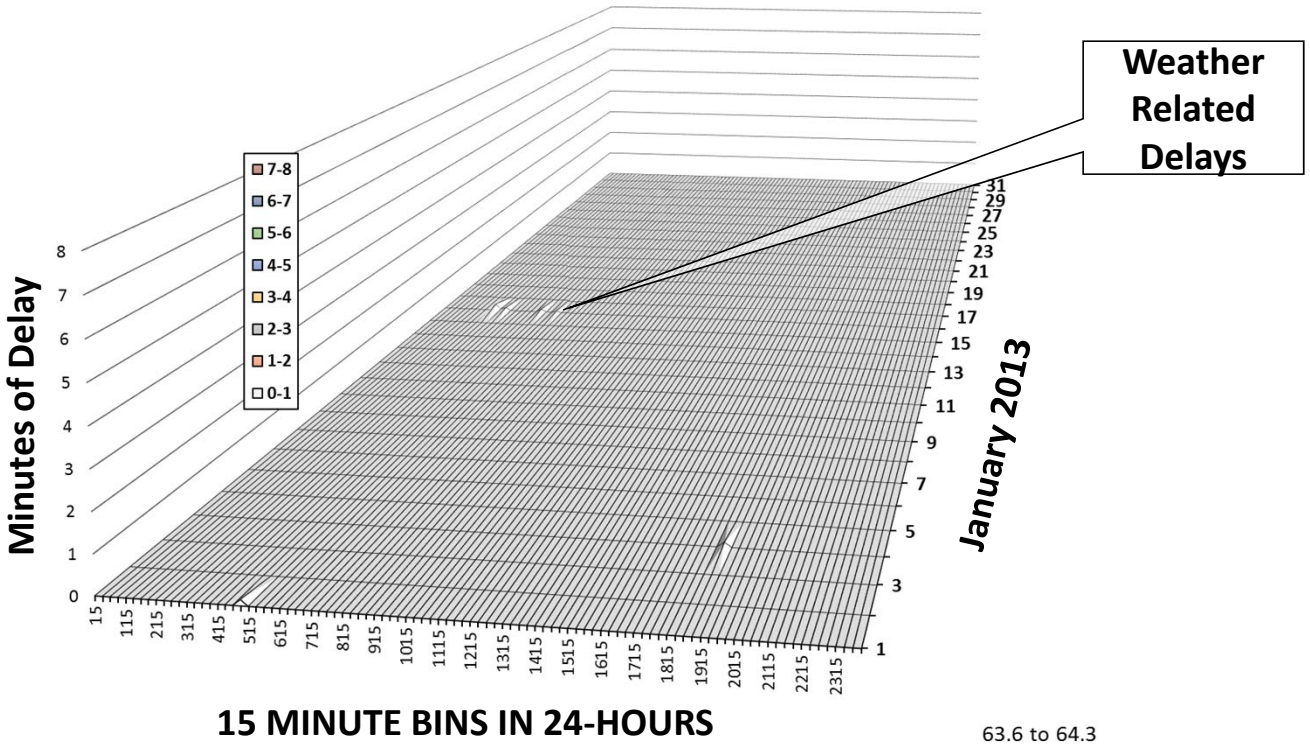
Baseline Corridor Assessment (Different Perspective)

2013 I-80



63.6 to 64.3

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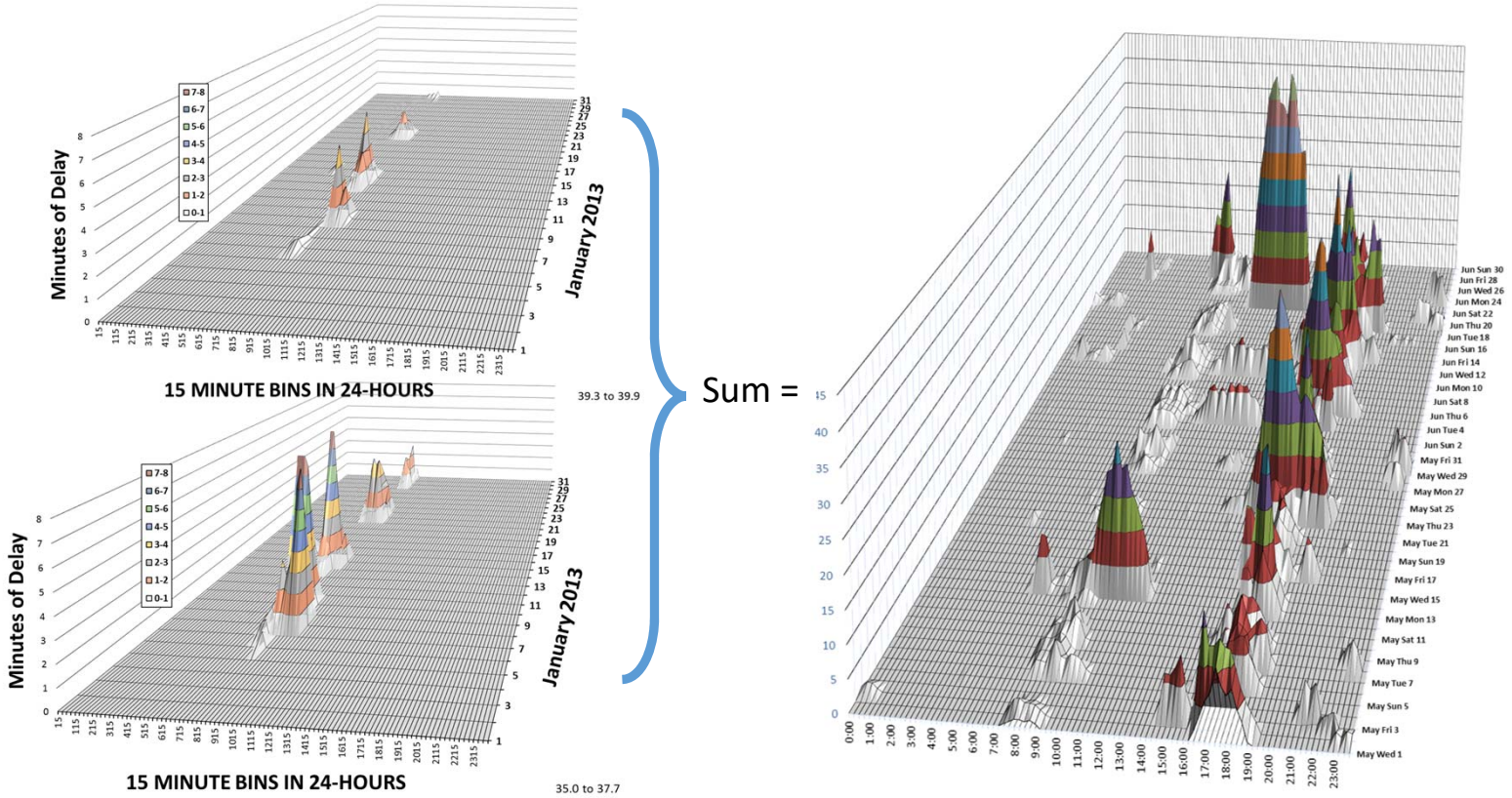
Baseline Corridor Assessment (Different Perspective)

2013 I-80



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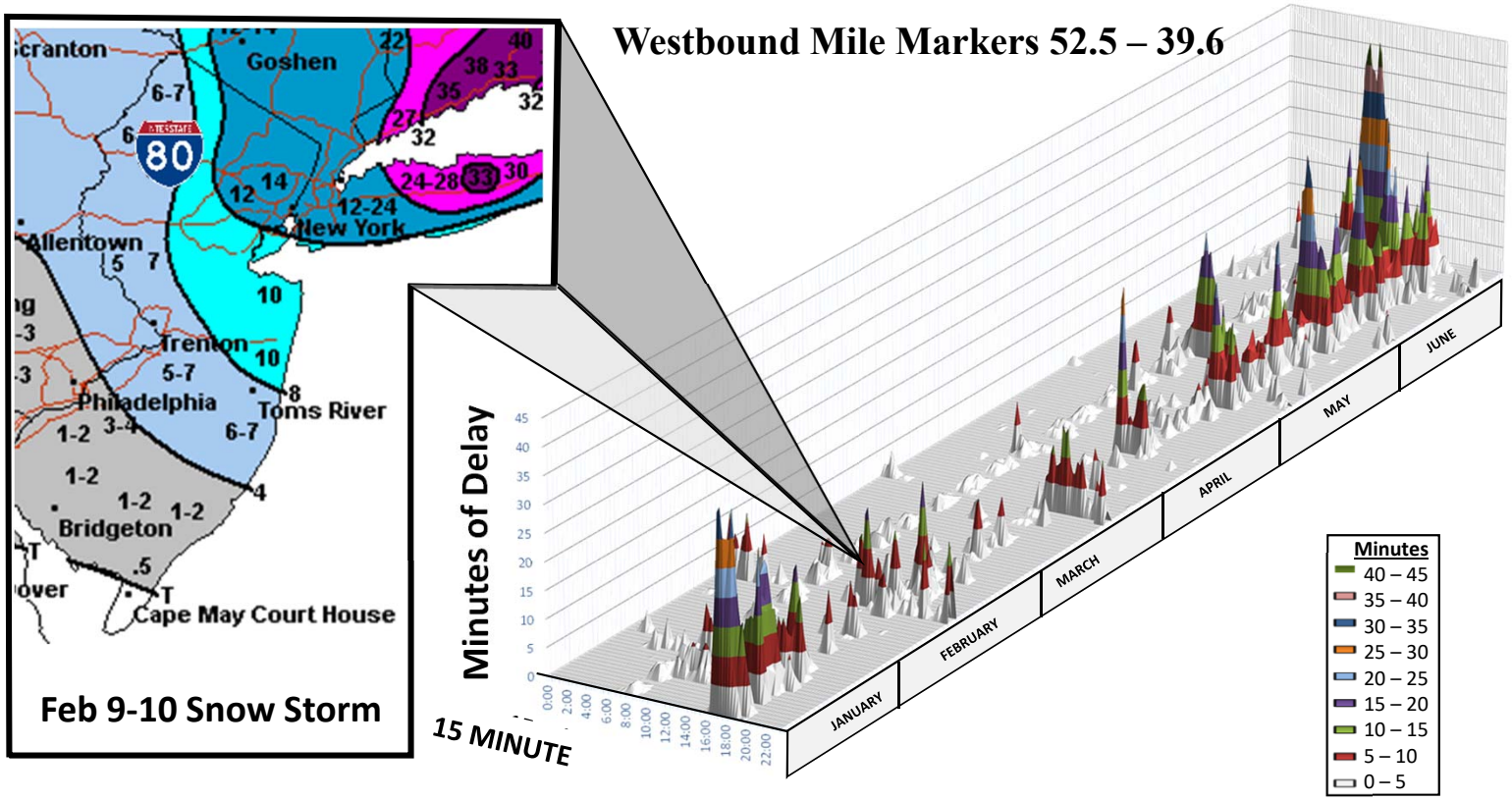
Baseline Corridor Assessment (Different Perspective)

2013 I-80: 6 months



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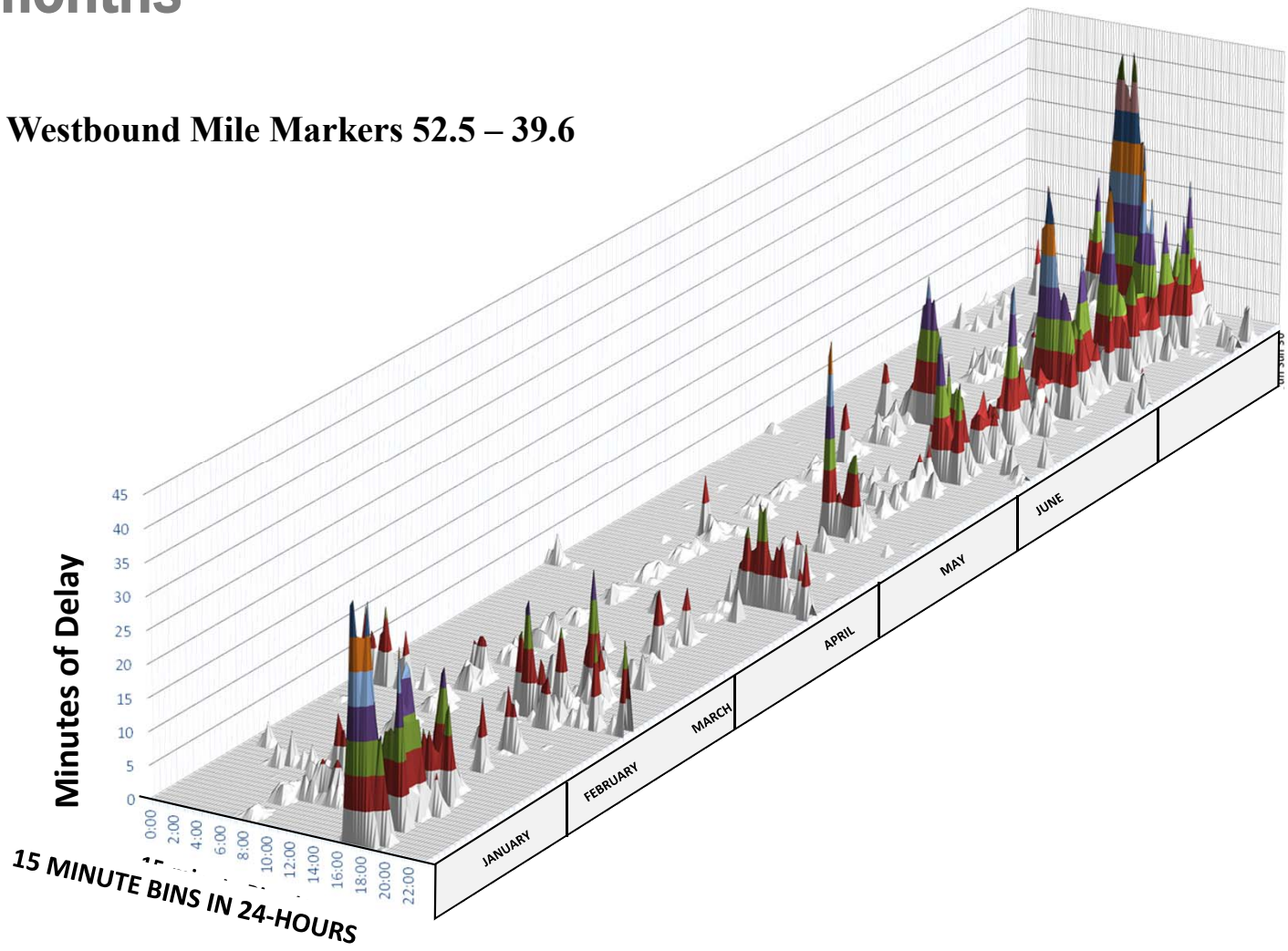
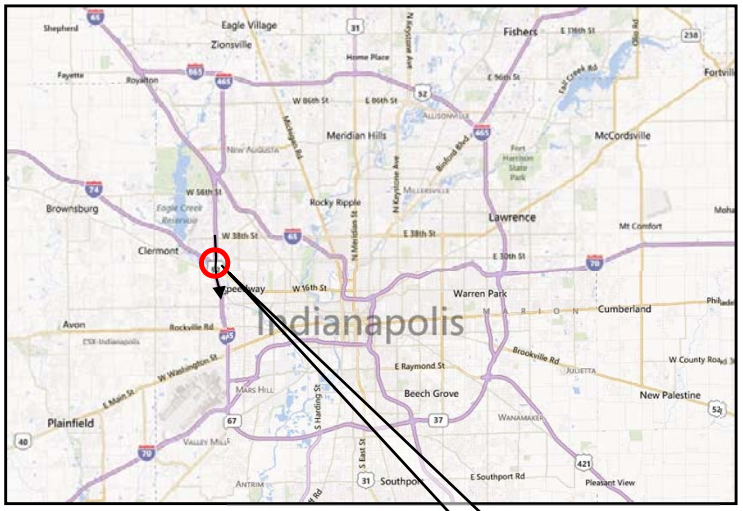
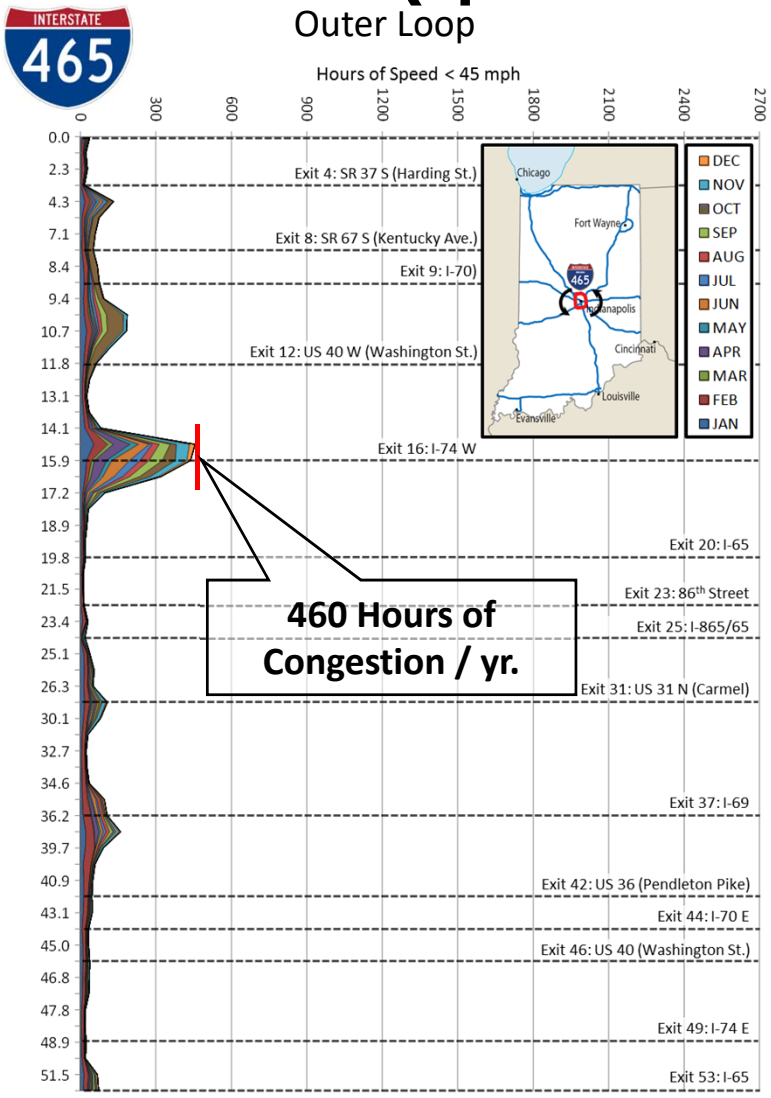
Baseline Corridor Assessment (Different Perspective)

2013 I-80: 6 months

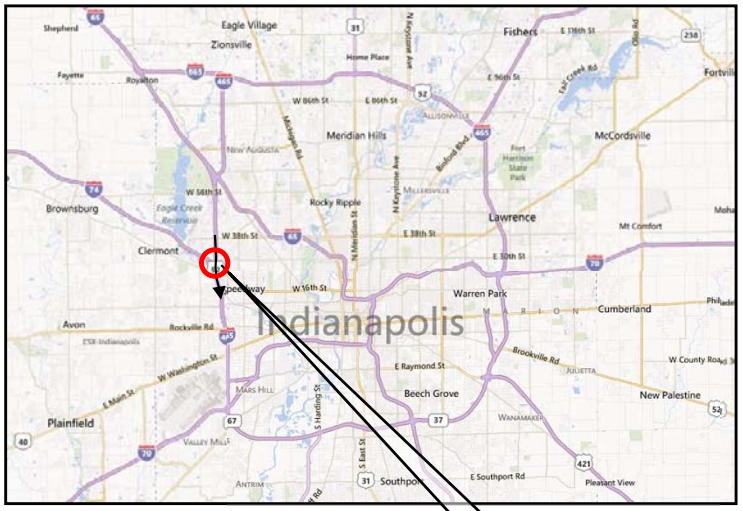


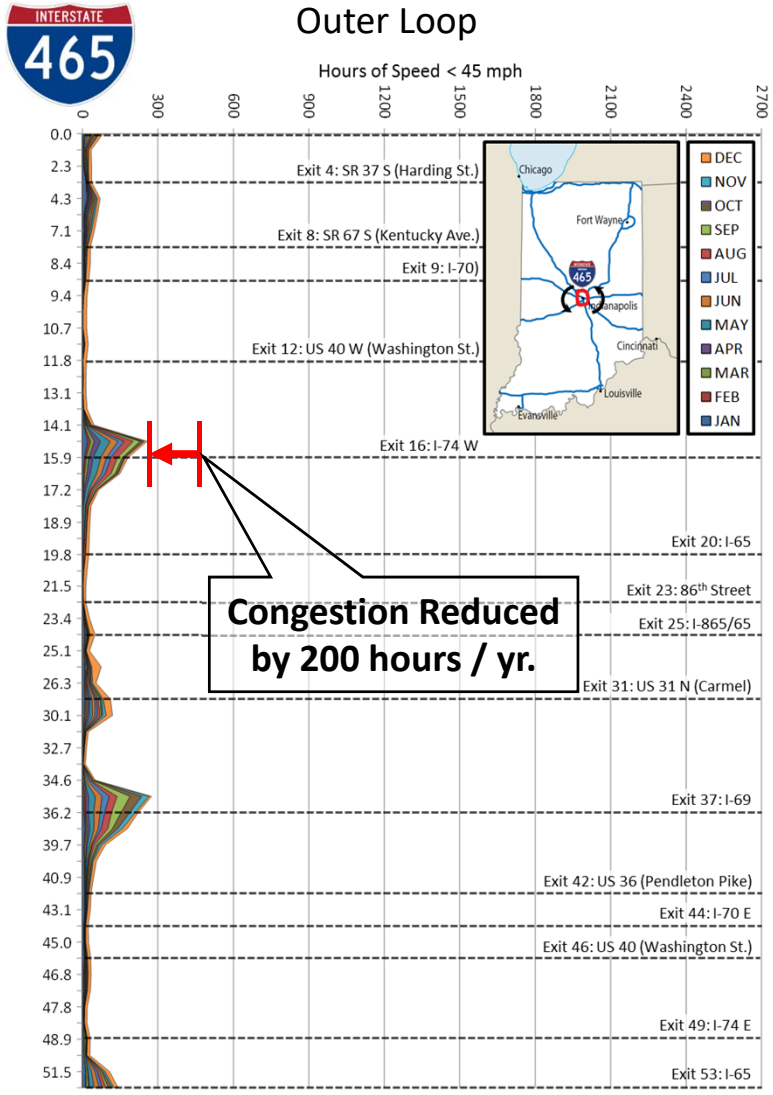
Mobility Report Performance Measures (Specific Construction)





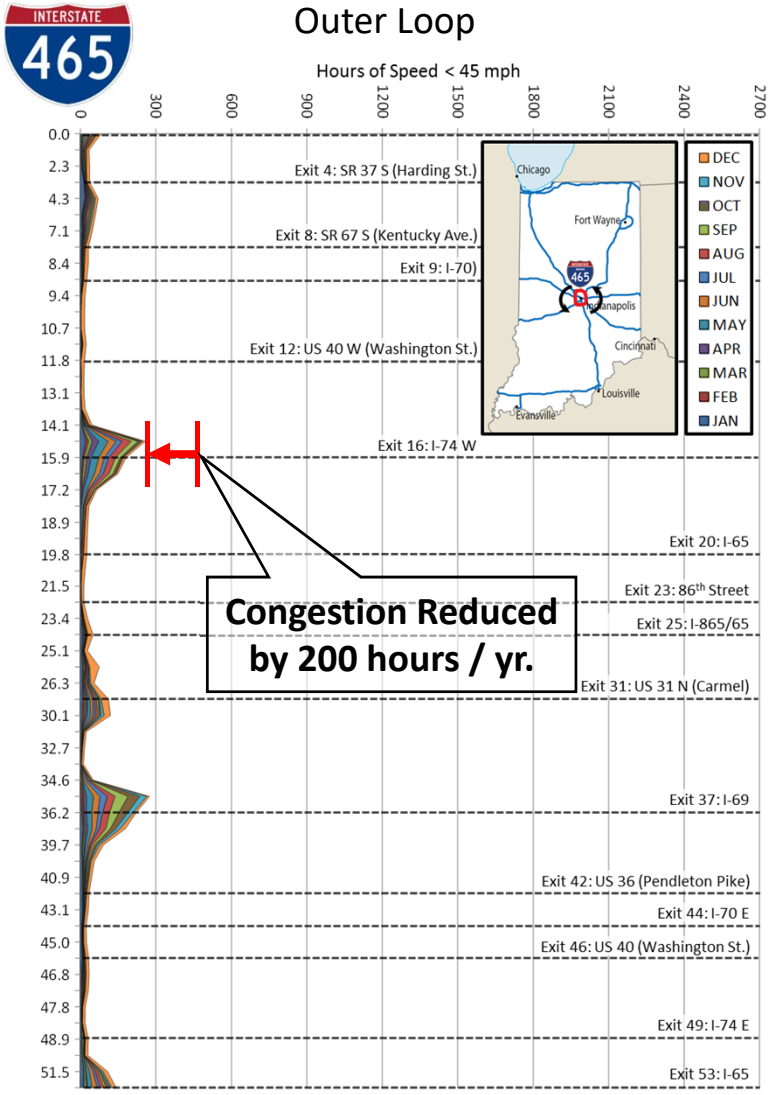
Mobility Report Performance Measures





PURDUE
UNIVERSITY

Mobility Report Performance Measures



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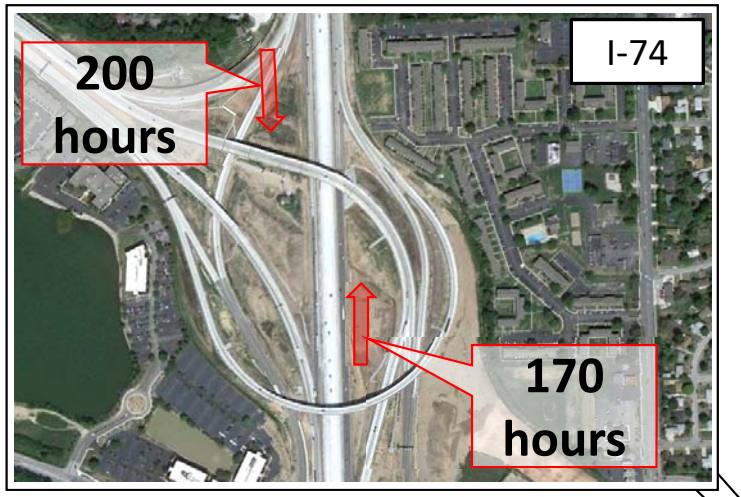
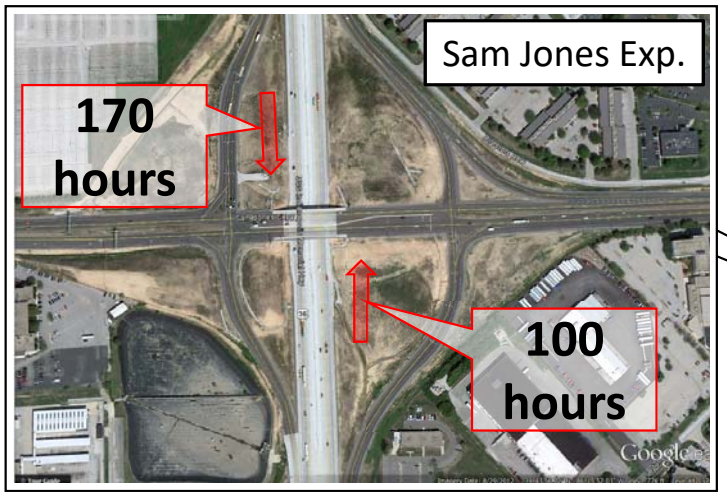
I-465 Projects in 2011

PURDUE UNIVERSITY

I-465 Projects in 2012 (reduced congestion)

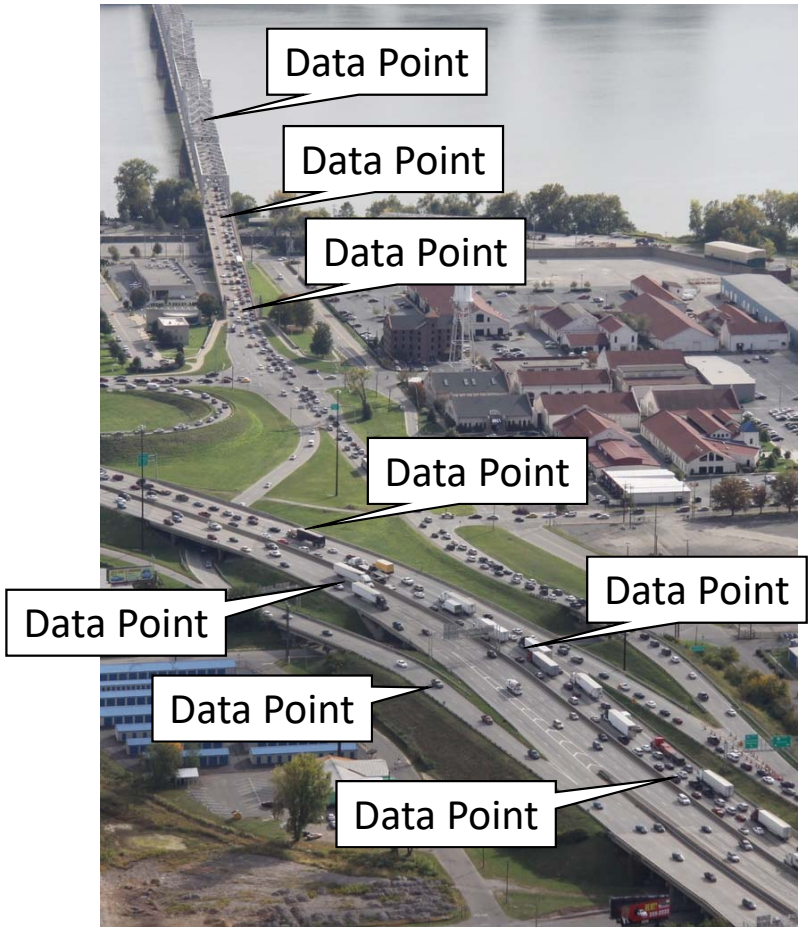




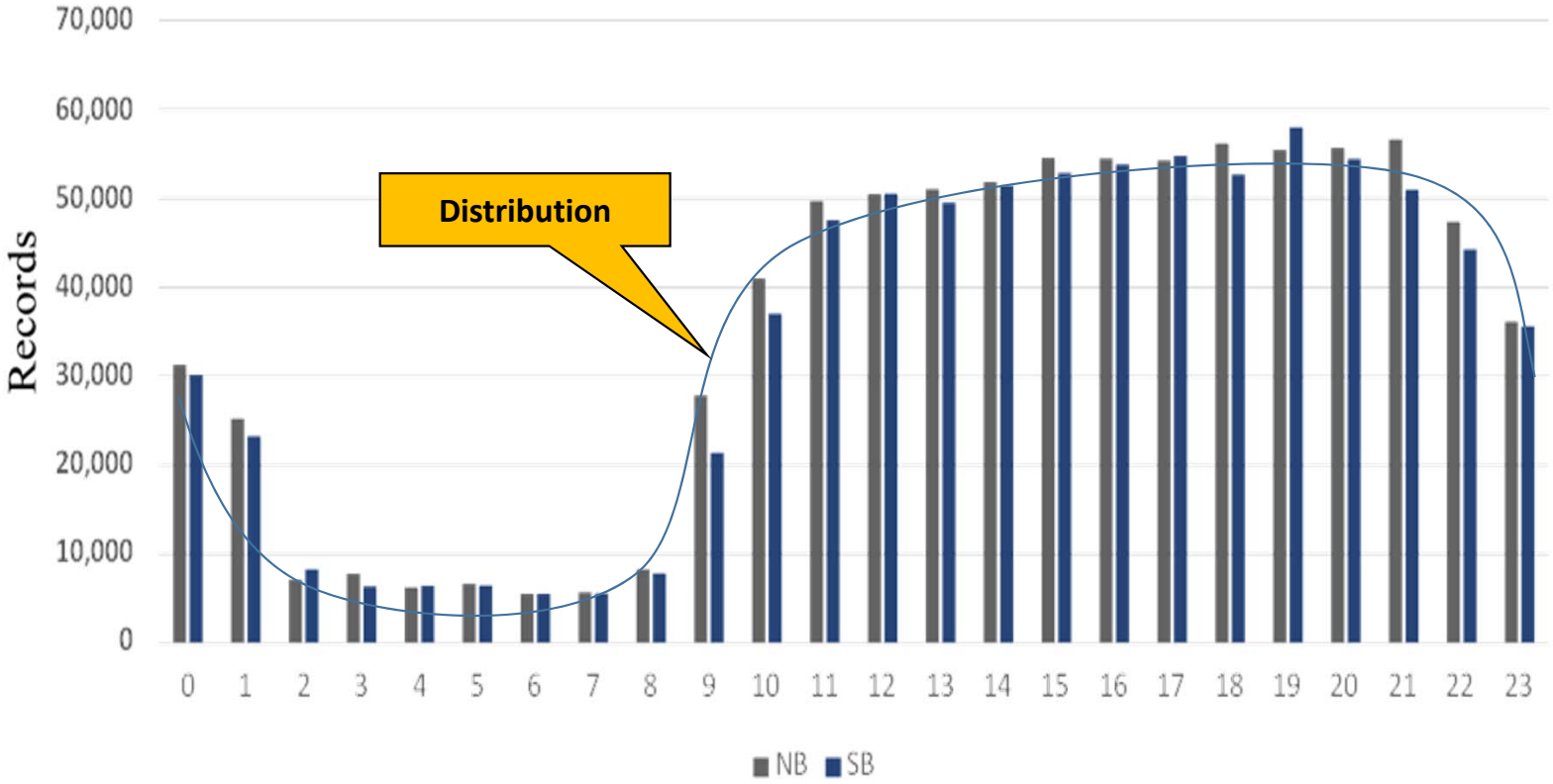
PURDUE UNIVERSITY

Probe Data Case Studies

1. Typical Work Zone Analysis
2. Assessment of New Work Zone Strategies
3. Improvement of Detour Routes
4. Work Zone Mobility Audits

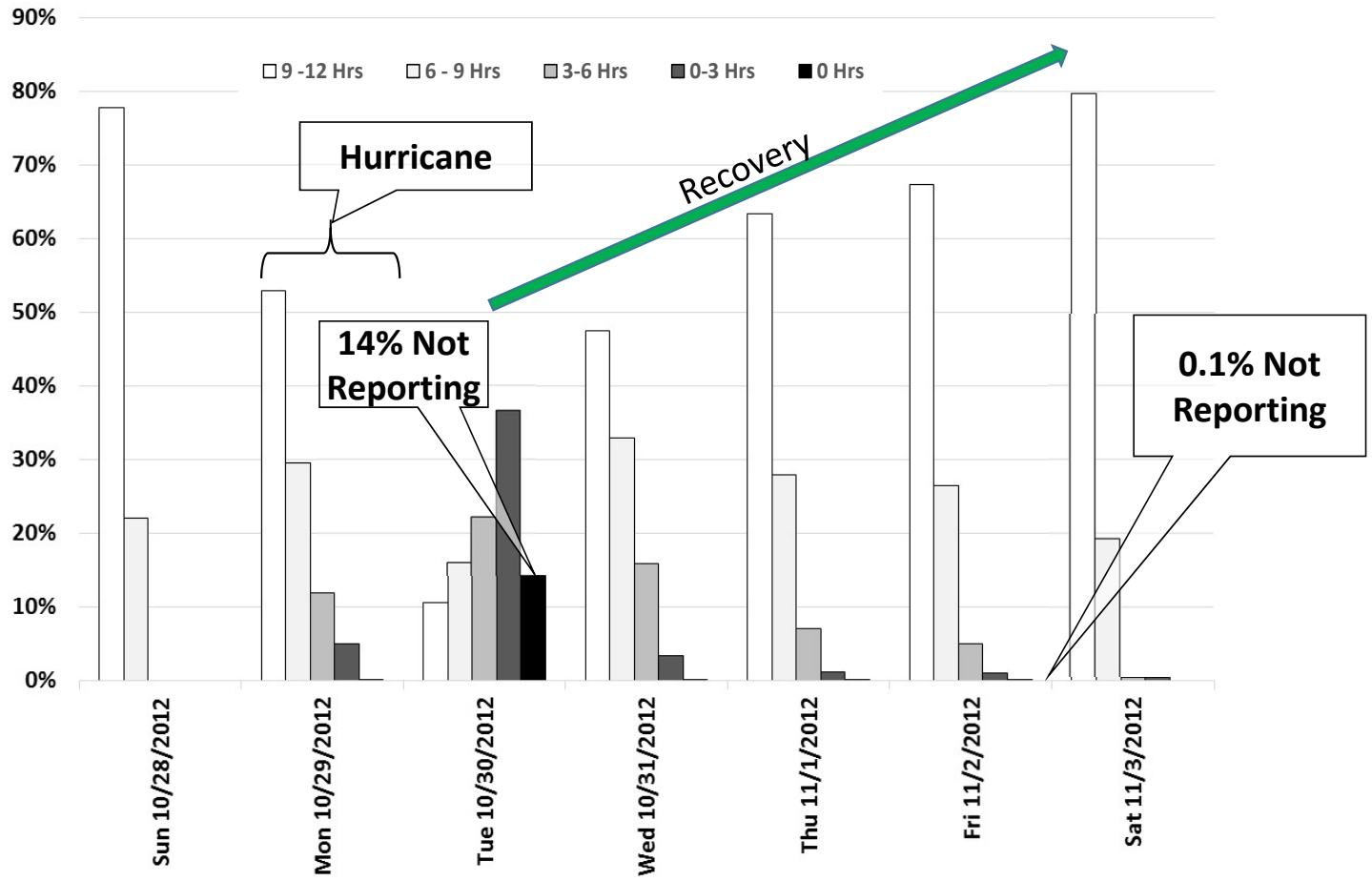


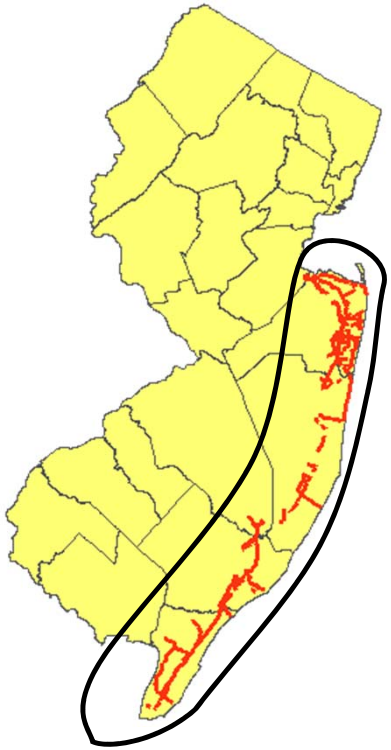
CONSIDER RECORDS FROM PROBE DATA: RECORDS PER HOUR



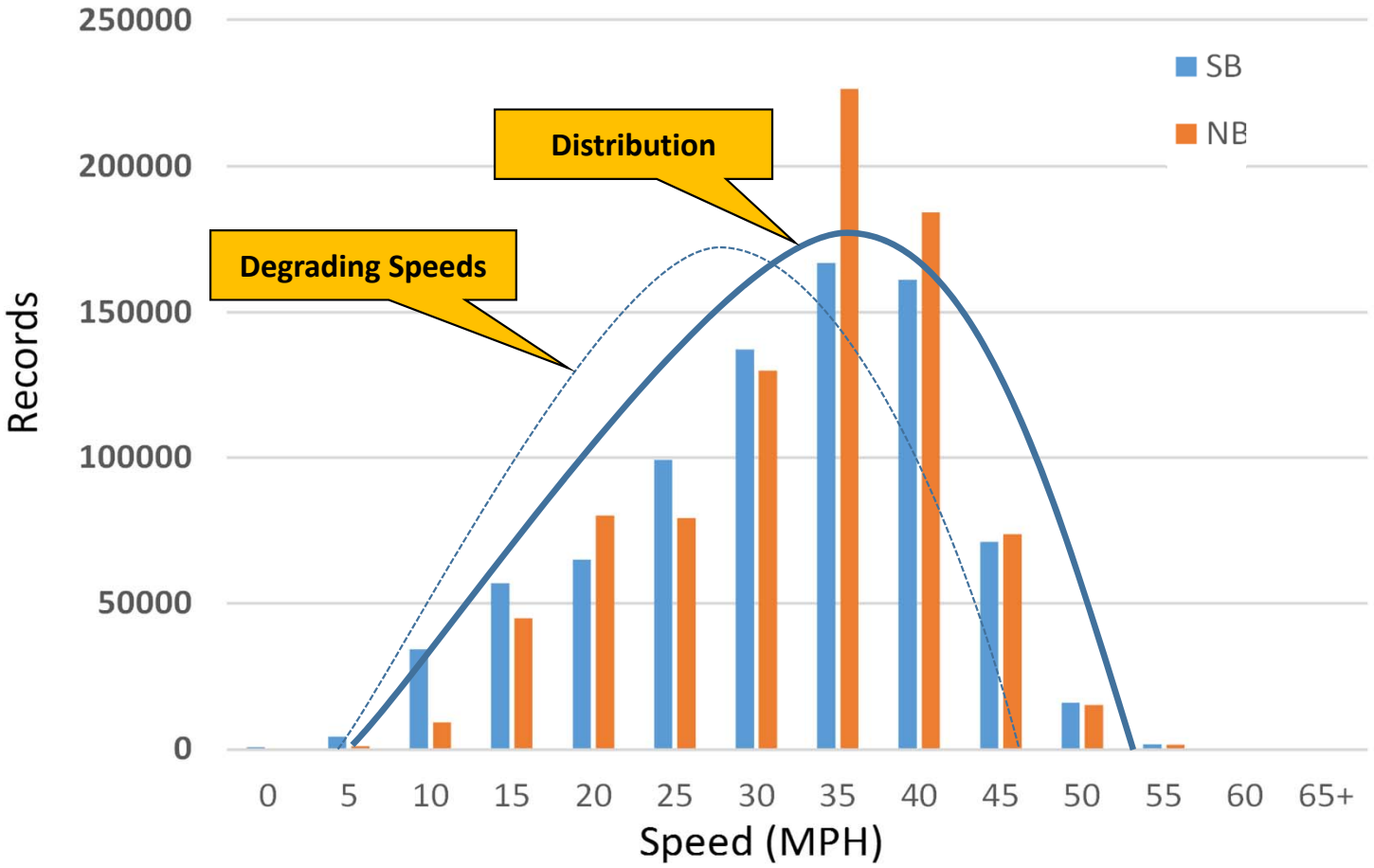
NB/SB
4-Months Corridor
Records per Hour

STATISTICS OF ANONYMOUS PROBE DATA: REPORTING DATA





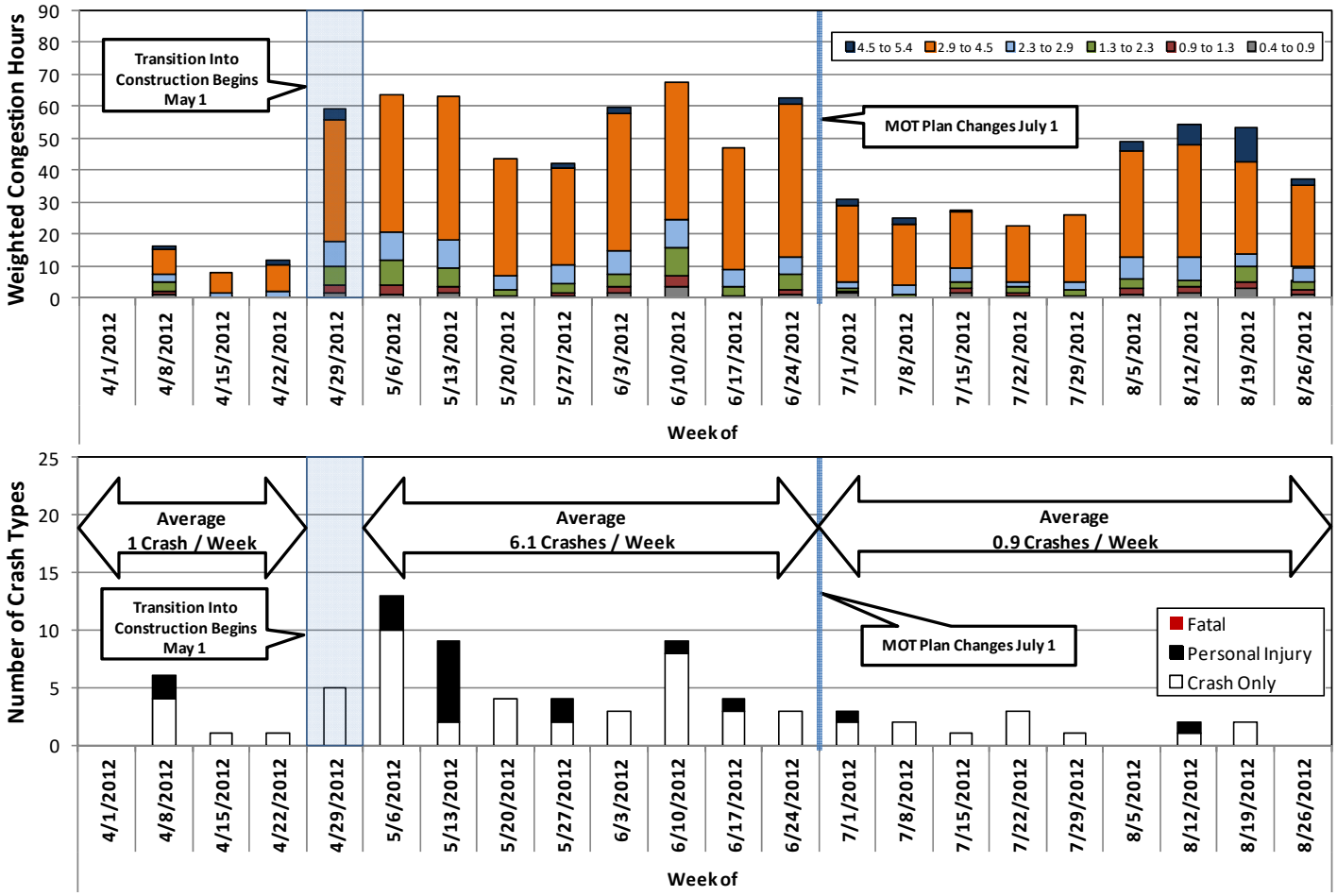
STATISTICS OF ANONYMOUS PROBE DATA: SPEED BINS CAPTURED



NB/SB
4-Months Corridor Travel Speeds

Establishing Speed a Benchmark

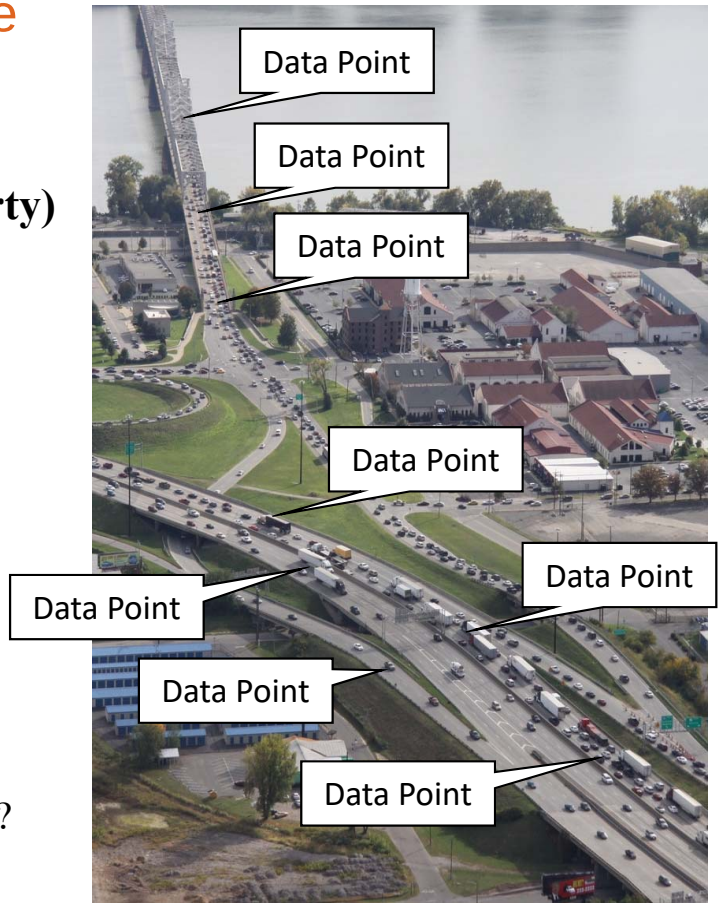
Probe /Crash Data (5 miles I-69 Indian)



THOUGHTS FOR DISCUSSION

Numerous decisions will need to be made at the agency level

- **Work Zone Exposure Data Collection Strategy**
- **Mobility Data Collection (NPMRDS, Detector-Based, Third Party)**
- **Performance Measure Strategies**
  - Whether to do it or not?
  - What types of Work Zones to monitor/measure?
  - What Performance Measure(s) will you use?
  - What Thresholds will you set?
  - What level of detail will you monitored/measured?
  - What frequency will you monitor/measure?
  - How will a poor performing work zone be managed?
- **Higher Level Strategies**
  - How will you archive the information?
  - How will you use it in planning future work zones?
  - Will you develop agency-wide performance measures/standards?
  - Will you incentivize/disincentivize contractors based on mobility data?
  - How do you quantify the benefit of performance measurement?



Conclusions & Next Steps

- **Overall**
  - Probe Data has numerous potential work zone applications
  - It can be a tool to improve performance
- **Discussion is still needed on numerous items including:**
  - Activity Data
  - Performance Thresholds
  - Real-Time vs. Archived Data Benefits
  - Mapping these tools into regular operations
- **Research Needed**
  - Investigate Different Work Zone Types: Lane Closures, Patching, Shoulder Closures, Ramp Closures, etc.
  - Investigate and Develop some threshold recommendations
  - Develop base line report (https://docs.lib.purdue.edu/imr/4/)
  - Create a series of Case Studies using both NPMRDS Data and Third-Party Data