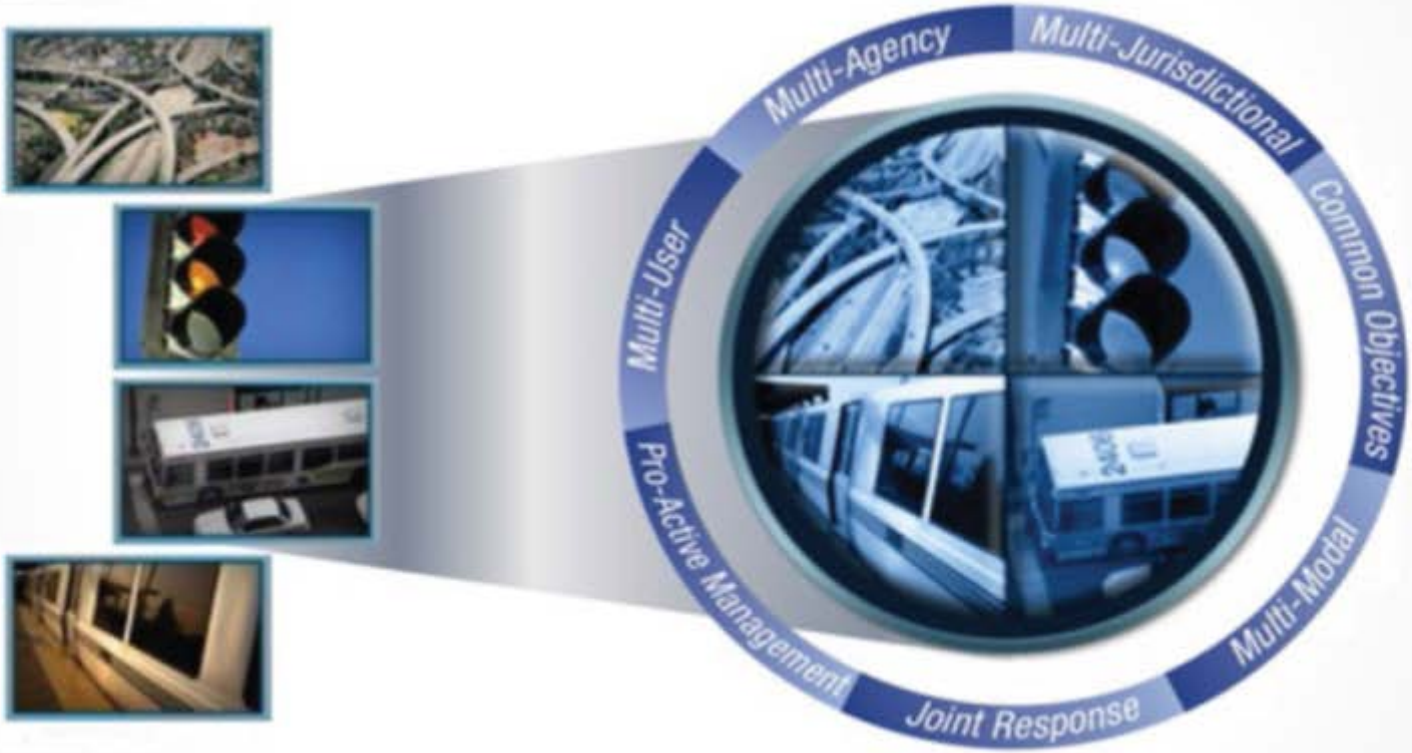
Integrated Corridor Management (ICM) 4 U

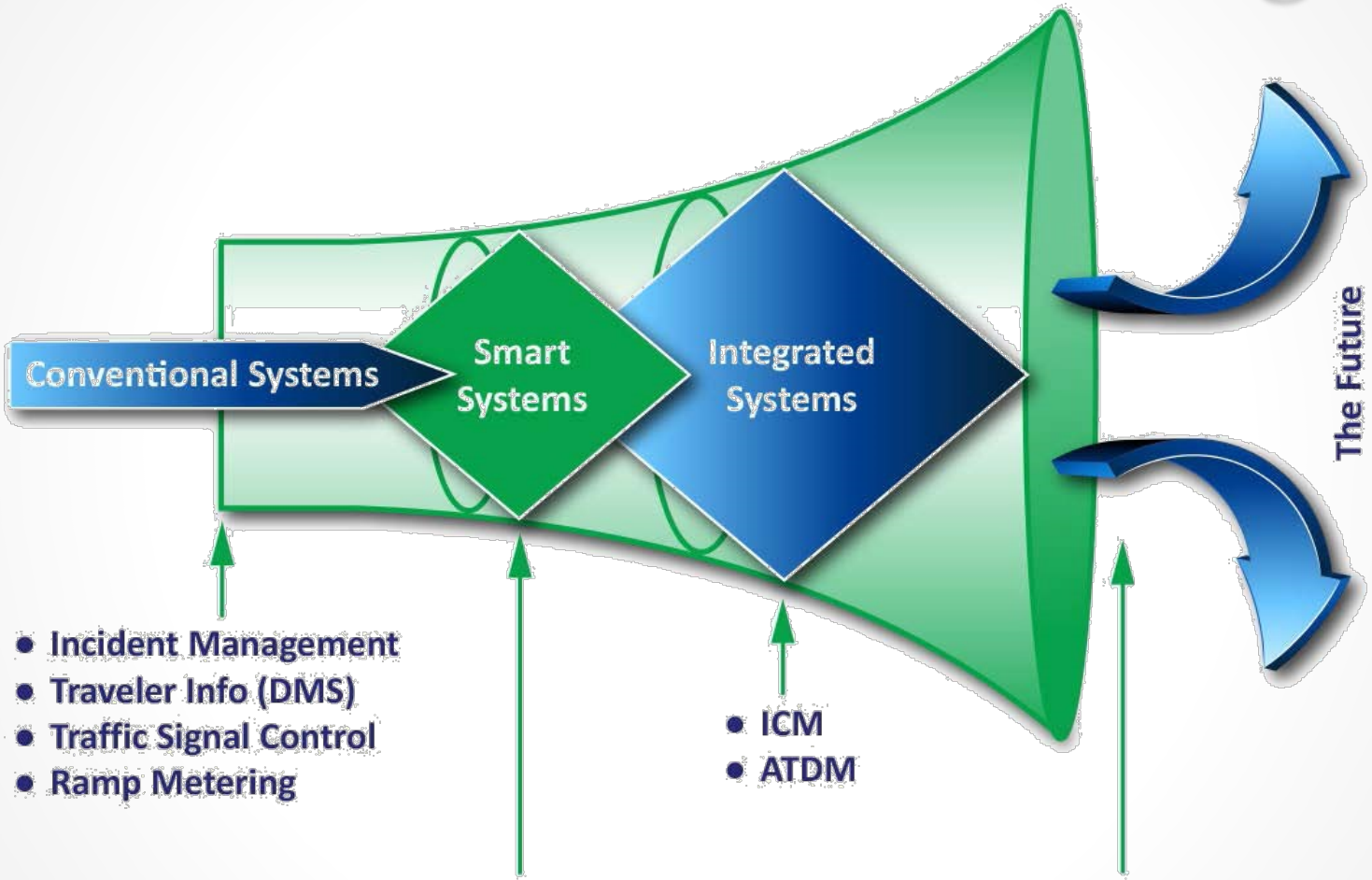


Leveraging Technology & Collaboration to Improve Safety and Mobility

Brad Freeze, Traffic Operations Division Director, TDOT

TN TDOT Department of Transportation

Evolution of a TSM&O Program



- Incident Management
- Traveler Info (DMS)
- Traffic Signal Control
- Ramp Metering

- ICM
- ATDM

- Traveler Info (Social Media)
- Active Traffic Management (ATM)
- Adaptive Signal Control
- Bus Rapid Transit (BRT)
- Adaptive Metering

- Connected Vehicle
- Automated Vehicles
- Cloud Computing

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Integrated Corridor Management (ICM)

The vision of Integrated Corridor Management (ICM) is that transportation networks will realize significant improvements in the efficient movement of people and goods through institutional collaboration and aggressive, proactive integration of existing infrastructure along major corridors.

-FHWA

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Integrated Corridor Management (ICM)

ICM combines two fundamental concepts: active management and integration. Active management involves monitoring and assessing the performance of the system and, at the same time, dynamically implementing actions and providing services in response to fluctuations in demand.

-FHWA

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Why ICM?

- Pro-actively Manage Congestion
- Provide Choices
- Maximize System Capacity
- Improve Coordination/ Interoperability
- Manage and Operate Across Modes and Agencies

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Integration on 3 Levels

Institutional Integration

- **Commitment** - collaboration between various agencies, modes, and jurisdictions that transcends institutional boundaries

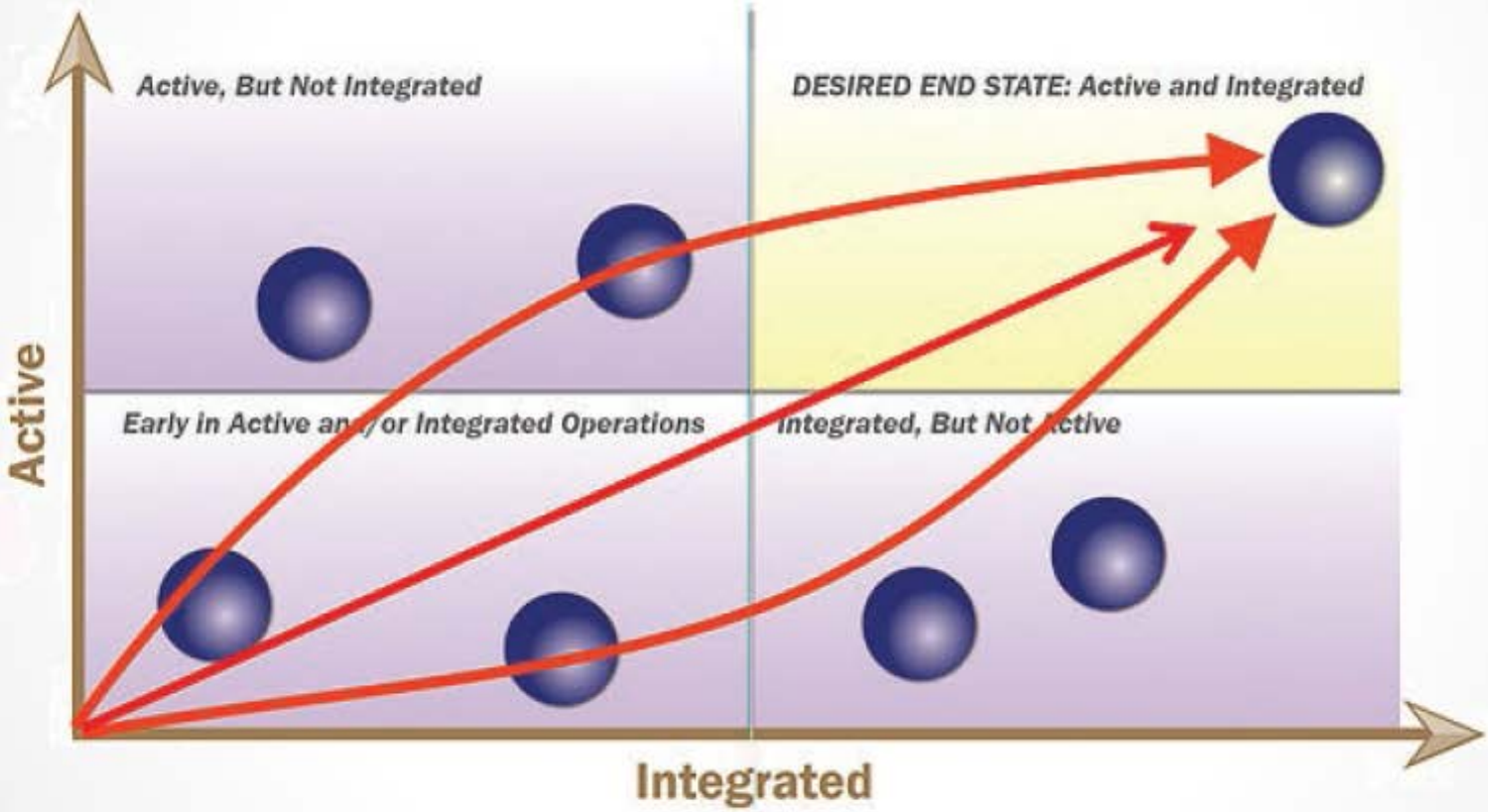
Operational Integration

- **All inclusive customer focus** - Joint operational objectives and strategies to manage and balance the total capacity and demand of the corridor

Technical Integration

- **Sharing and distribution** - of information and system operations control functions to support the analysis and immediate response

ICM, The Ultimate Goal



Source: Federal Highway Administration

FHWA ICM Demonstration Sites

Dallas, TX: US-75

- ICM Corridor covers a 28-mile segment of US-75 and is the primary connector between Dallas and northern suburbs.
- Serves commuter, commercial, and regional trips.
- Weekday mainline traffic volumes reach 250,000 vehicles with 30,000 on frontage roads.
- 167 miles of arterial roadways.
- High Occupancy Vehicle (HOV) lanes, Light Rail Transit (LRT), Bus Service, and Park-and-Ride lots.

For more information about the Dallas, TX, Demonstration Site contact:

Koorosh Olyai
Dallas Area Rapid Transit (DART)
olyai@dart.org

San Diego, CA: I-15

- ICM Corridor covers a 21-mile segment of I-15 and runs from SR-78 in the north to SR-163 interchange in the south.
- Serves commuter, goods, and services movement from northern San Diego to the downtown area.
- Weekday traffic volumes range from 170,000 to 290,000 vehicles on general purpose lanes.
- Managed Lanes and Bus Rapid Transit (BRT) that will operate in the Managed Lanes.
- Dynamic variable pricing in the managed Lanes will help manage traffic flow.

For more information about the San Diego, CA, Demonstration Site contact:

Alex Estrella
San Diego Association of Governments
aes@sandag.org

FHWA ICM Demonstration Sites

Strategies and Partners at the ICM Demonstration Sites

	Example DSS Response Plan Strategies	Partners
Dallas	• Divert onto frontage roads, arterials, and/or light rail, depending on severity of event on freeway • Implement dynamic signal timing to maximize throughput on diversion routes • Provide real-time information on traffic conditions (including speeds), public transit, and parking availability through 511 system • Provide diversion recommendations (including mode shift to light rail) on dynamic message signs, under certain conditions	• Dallas Area Rapid Transit • City of Dallas • Town of Highland Park • North Central Texas Council of Governments • North Texas Tollway Authority • City of Plano • City of Richardson • Texas Department of Transportation • City of University Park
San Diego	• Provide en-route and pre-trip traveler information and enhanced transit network information through a new 511 smartphone app for trip decision-making • Coordinate signal timing with ramp meters to optimize mode shifts between the freeway and arterials • Deploy dynamic wayfinding signs on arterials to re-direct diverted traffic back to freeways	• San Diego Association of Governments (SANDAG) • California Department of Transportation • City of Escondido • Metropolitan Transit System • North County Transit District • City of Poway • City of San Diego

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Other Notable Examples

I-80 Corridor, CA

- 20-mile transportation and freight corridor
  (270,000 cars per day)
- The most congested corridor in the region,
  4-5 hours of delay in each peak period
- Carpool lane is 3+
- Major transit corridor

I-80 ICM Project Elements

- 44 On-ramps
- 67 Variable Advisory Speed Signs
- 11 Gantries with Lane Use Signs
- 6 Information Display Boards
- 34 Arterial Trailblazer Signs
- 4 Arterial Changeable Message Signs
- TSP, CCTV Cameras, Microwave Vehicle Detection, Variable Message Signs
- Local Workstations at 12 Agencies
- 160 Traffic Signals on 3 Signal Systems
- Central Equipment

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I-24 SMART CORRIDOR

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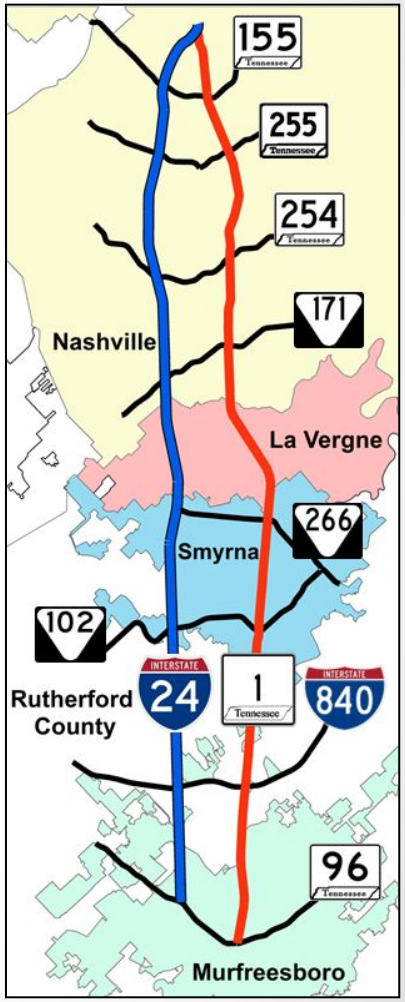
The Need

- Interstate 24 (I-24) is a integral part of the Nashville transportation network and a major route for commuters and freight.
- Traffic volumes along the I-24 corridor have experienced exponential growth rates over the past decade. Since 2005, traffic volumes have increased more than 60% on I-24 near Murfreesboro.
- Currently, peak hour volumes exceed capacity and even a minor incident can have a severe impact on travel time reliability.
- Due to physical, environmental, and financial constraints along the Corridor there are no viable, short term roadway widening projects.



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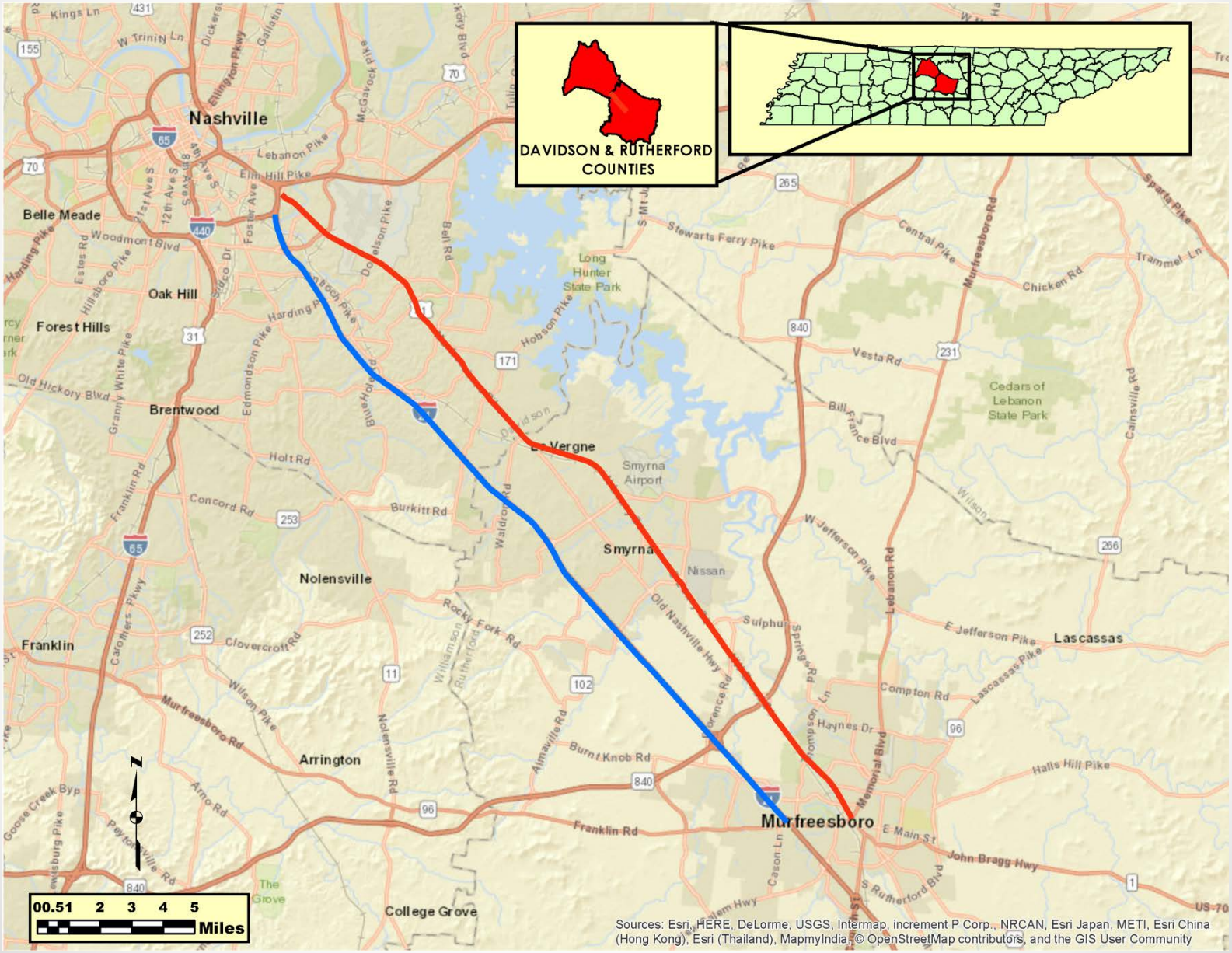
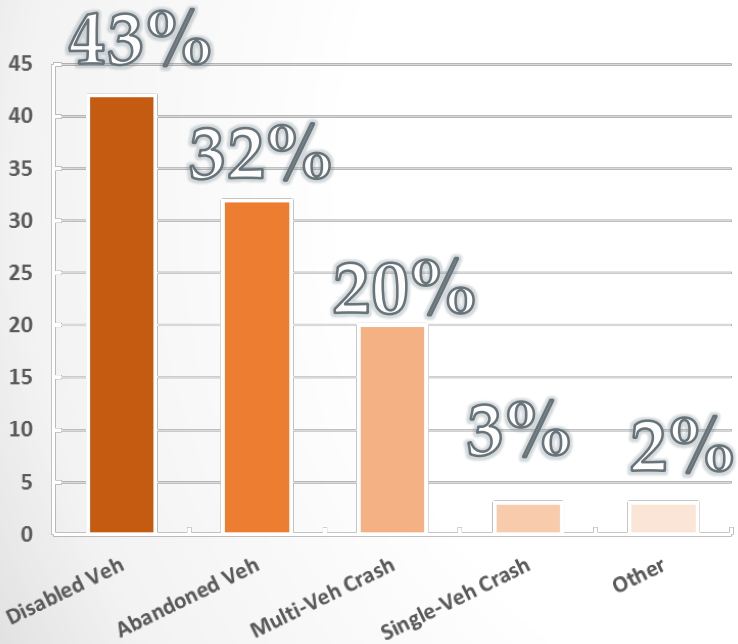
Area Map

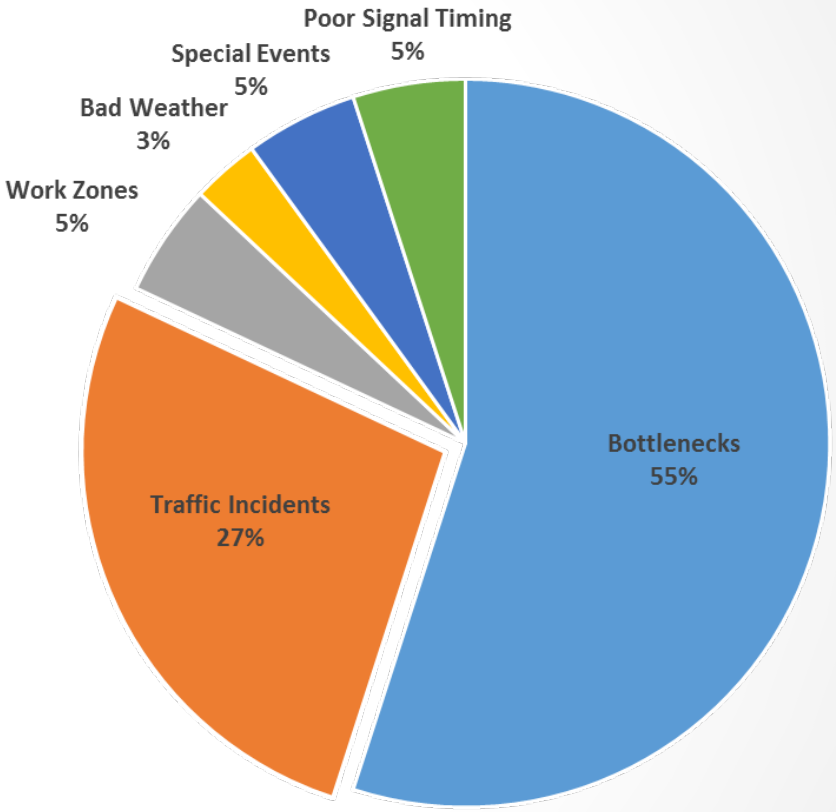

DAVIDSON & RUTHERFORD COUNTIES
Nashville
Belle Meade
Oak Hill
Forest Hills
Brentwood
Nolensville
Franklin
Arrington
College Grove
La Vergne
Smyrna
Murfreesboro
Lascassas
Long Hunter State Park
Smyrna Airport
Cedars of Lebanon State Park
Nissan
00.51 2 3 4 5 Miles
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

I-24 Congestion Contributors

Traffic Incidents 27%



Incidents Breakdown 2015
(Total Crashes:1,661)



Contributors to Congestion

TN TDOT Department of Transportation

Crash History & Analysis

I-24 Section Crash Rate

Section Location	Actual Crash Rate	Severe Crash Rate	Fatal Crash Rate	Incapacitating Injury Crash Rate	Other Injury Crash Rate
Statewide Average Crash Rate (2012-2014)	**1.036**	**0.029**	**0.005**	**0.024**	**0.226**
SR-155 (Briley Pkwy) to Harding Pl (L.M. 18.38 to 20.43)	**2.086**	0.013	0.003	0.010	**0.543**
Harding Pl to Haywood Ln (L.M. 20.43 to 21.74)	**2.099**	**0.033**	0.000	**0.033**	**0.666**
Haywood Ln to Bell Rd (L.M. 21.74 to 24.12)	**1.529**	**0.033**	**0.012**	0.021	**0.447**
Bell Rd to Hickory Hollow Pkwy (L.M. 24.12 to 24.81)	**1.097**	0.017	**0.017**	0.000	**0.296**
Hickory Hollow Pkwy to Old Hickory Blvd (L.M. 24.81 to 27.18)	0.883	0.010	0.003	0.008	0.220
Old Hickory Blvd to Waldron Rd (L.M. 27.18 to 1.23)	0.925	**0.045**	**0.007**	**0.037**	**0.251**
Waldron Rd to Sam Ridley Pkwy (L.M. 1.23 to 3.22)	0.856	**0.038**	**0.006**	**0.032**	**0.238**
Sam Ridley Pkwy to Almaville Rd (L.M. 3.22 to 6.80)	0.808	**0.033**	**0.009**	**0.024**	0.225
Almaville Rd to SR-840 (L.M. 6.80 to 11.47)	0.530	0.026	0.004	0.023	0.137

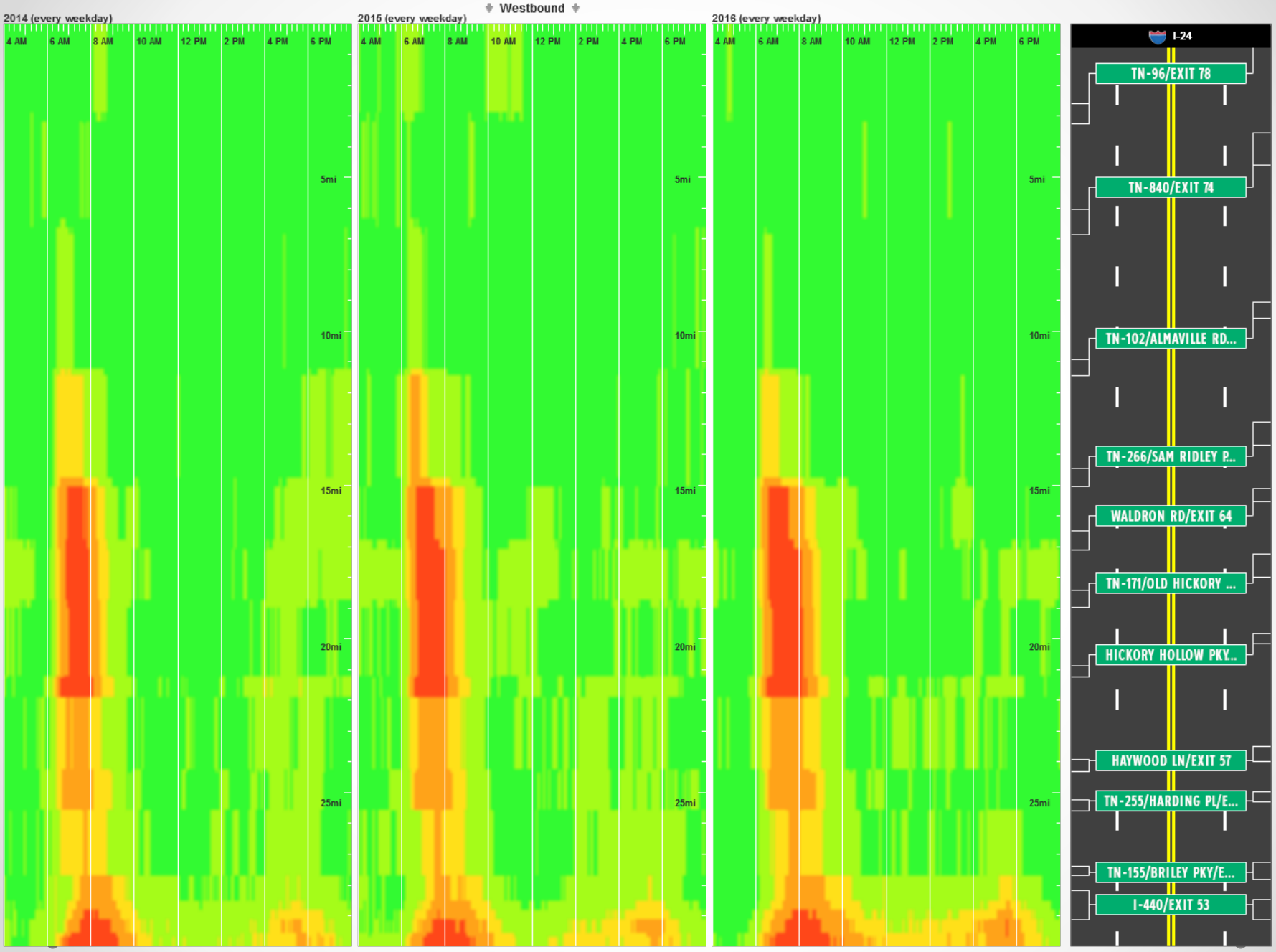
*Note: Numbers shown in **red** are greater than statewide average rates.*

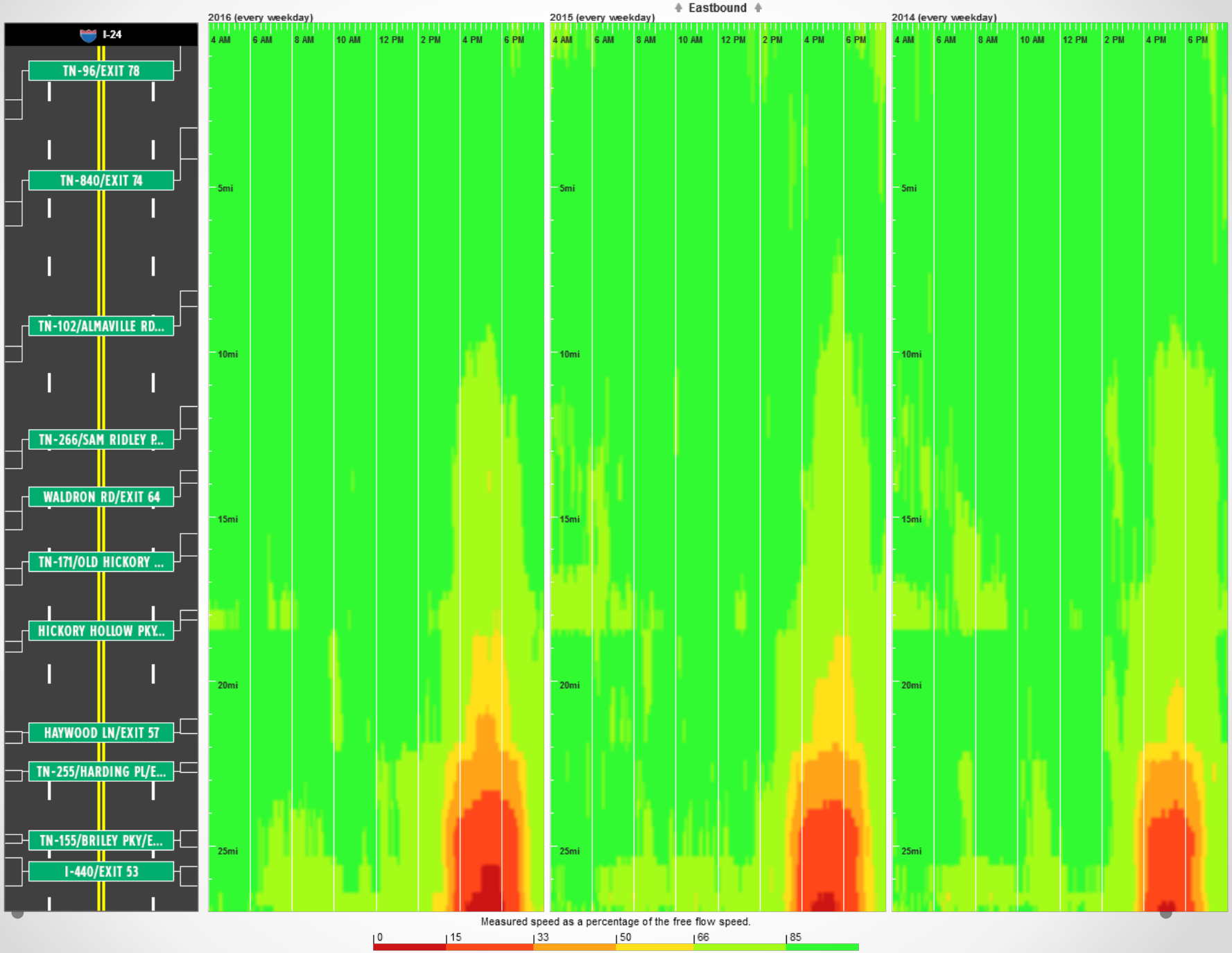
- Crash Rate Data represents information collected between 2013-2015

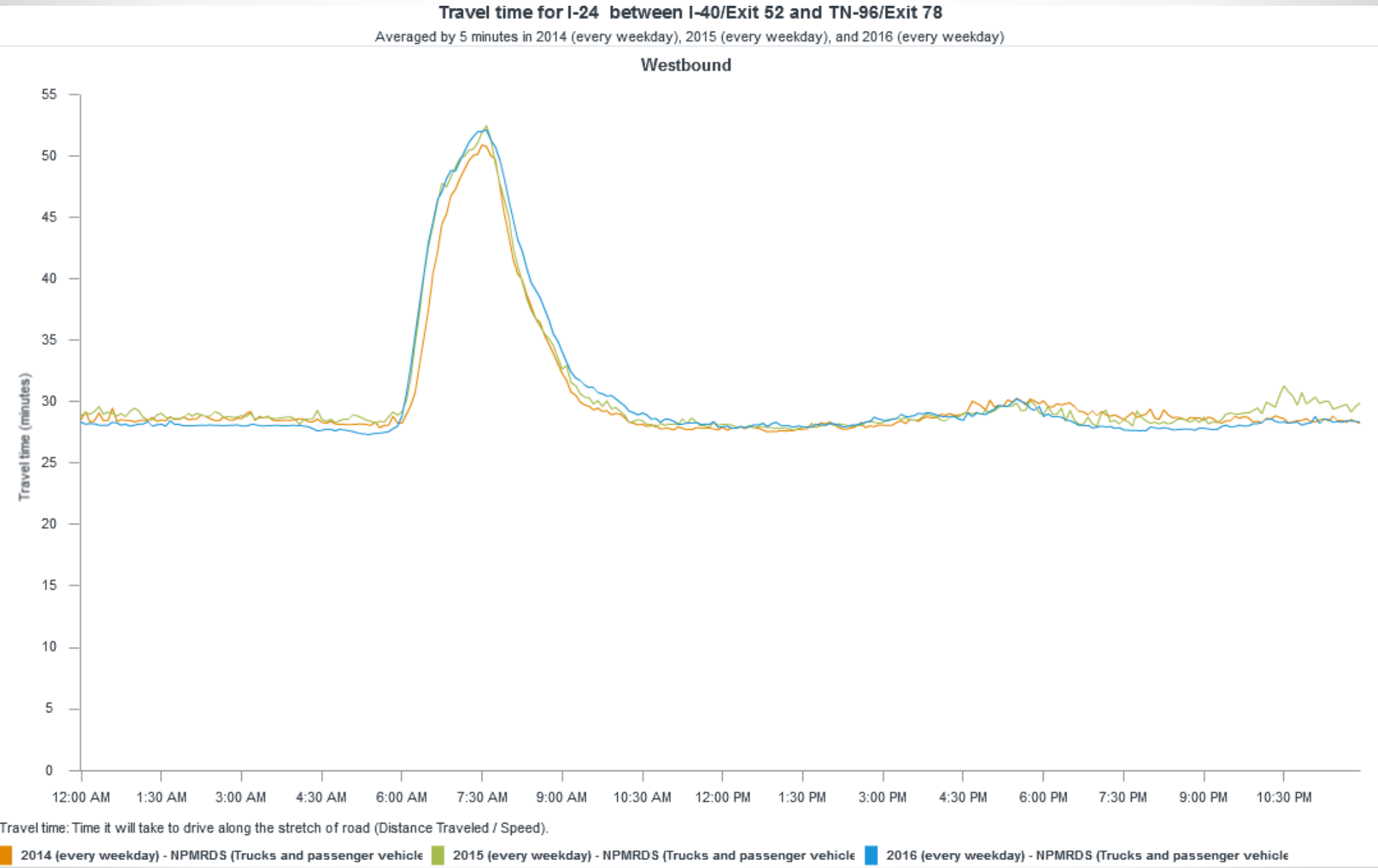
System Performance Review

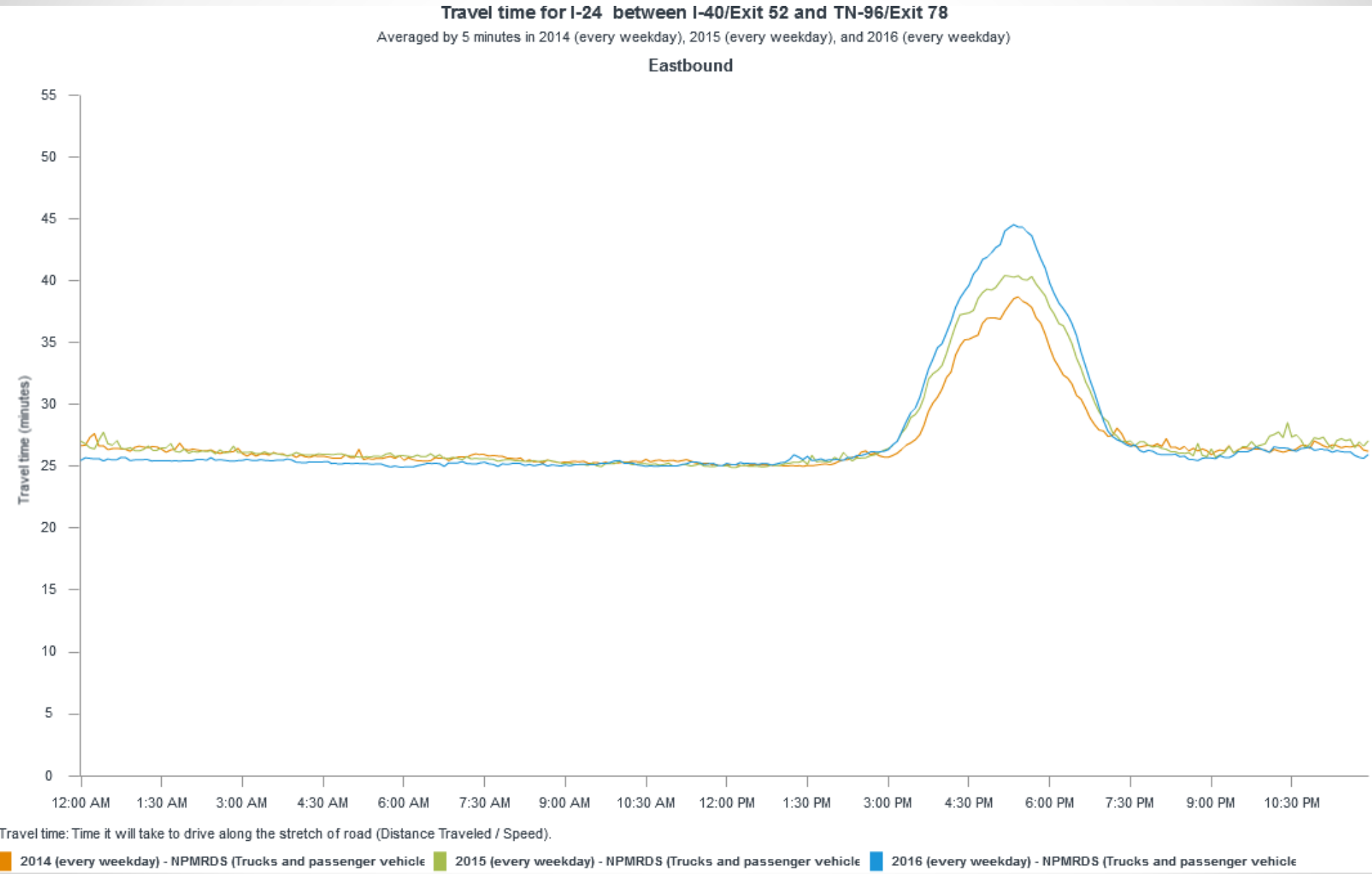
Congestion on I-24 between I-40/Exit 52 and TN-96/Exit 78 using NPMRDS (Trucks and passenger vehicles) data

Averaged by 5 minutes for 2016 (every weekday), for 2015 (every weekday), and for 2014 (every weekday)




Congestion on I-24 between I-40/Exit 52 and TN-96/Exit 78 using NPMRDS (Trucks and passenger vehicles) data
Averaged by 5 minutes for 2016 (every weekday), for 2015 (every weekday), and for 2014 (every weekday)
Eastbound
I-24
TN-96/EXIT 78
TN-840/EXIT 74
TN-102/ALMAVILLE RD...
TN-266/SAM RIDLEY P...
WALDRON RD/EXIT 64
TN-171/OLD HICKORY ...
HICKORY HOLLOW PKY...
HAYWOOD LN/EXIT 57
TN-255/HARDING PL/E...
TN-155/BRILEY PKY/E...
I-440/EXIT 53
2016 (every weekday)
2015 (every weekday)
2014 (every weekday)
4 AM
6 AM
8 AM
10 AM
12 PM
2 PM
4 PM
6 PM
5mi
10mi
15mi
20mi
25mi
Measured speed as a percentage of the free flow speed.
0
15
33
50
66
85


Travel time for I-24 between I-40/Exit 52 and TN-96/Exit 78
Averaged by 5 minutes in 2014 (every weekday), 2015 (every weekday), and 2016 (every weekday)
Westbound
Travel time (minutes)
55
50
45
40
35
30
25
20
15
10
5
0
12:00 AM
1:30 AM
3:00 AM
4:30 AM
6:00 AM
7:30 AM
9:00 AM
10:30 AM
12:00 PM
1:30 PM
3:00 PM
4:30 PM
6:00 PM
7:30 PM
9:00 PM
10:30 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2014 (every weekday) - NPMRDS (Trucks and passenger vehicle
2015 (every weekday) - NPMRDS (Trucks and passenger vehicle
2016 (every weekday) - NPMRDS (Trucks and passenger vehicle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Eastbound
Travel time (minutes)
55
50
45
40
35
30
25
20
15
10
5
0
12:00 AM
1:30 AM
3:00 AM
4:30 AM
6:00 AM
7:30 AM
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10:30 AM
12:00 PM
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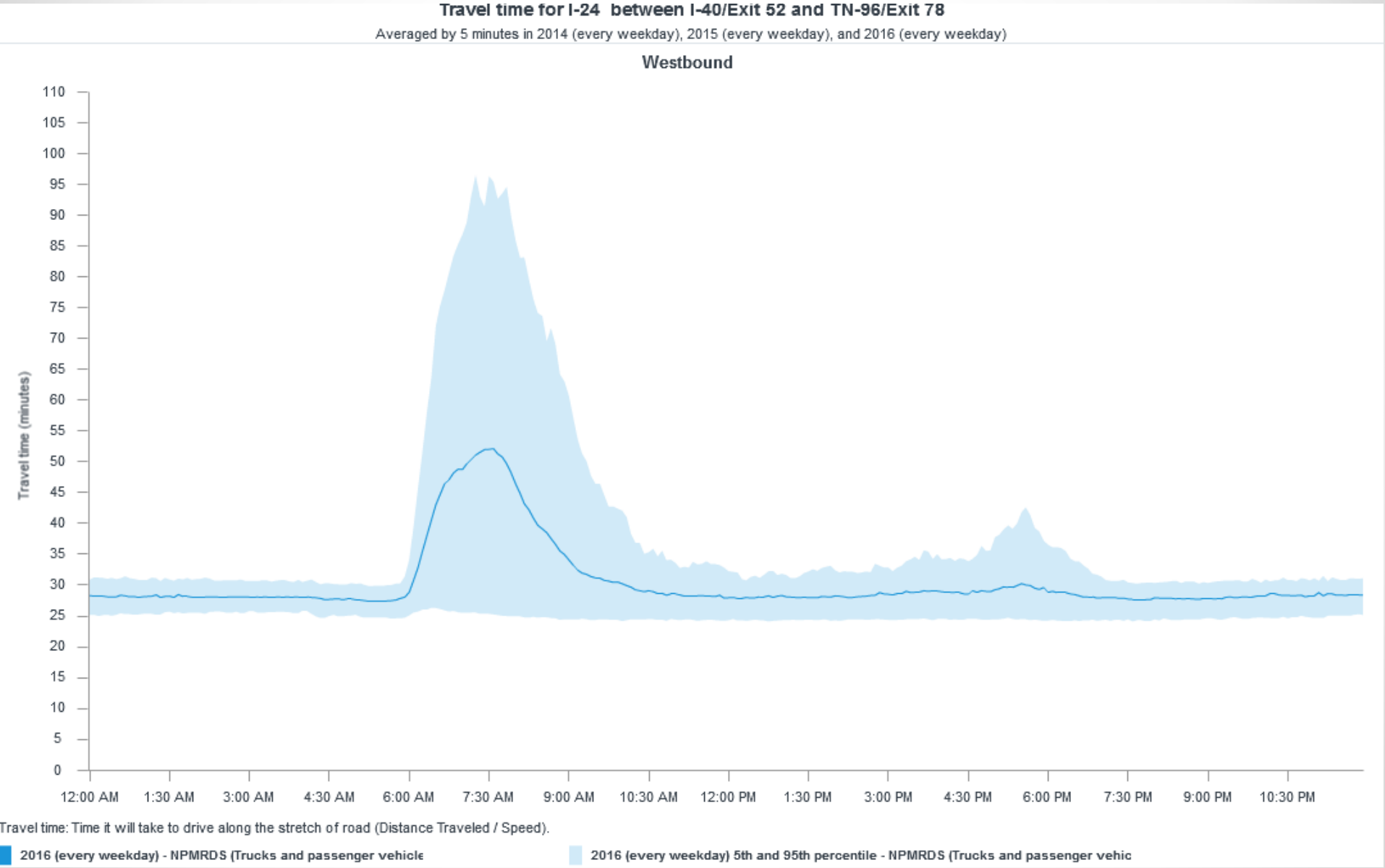
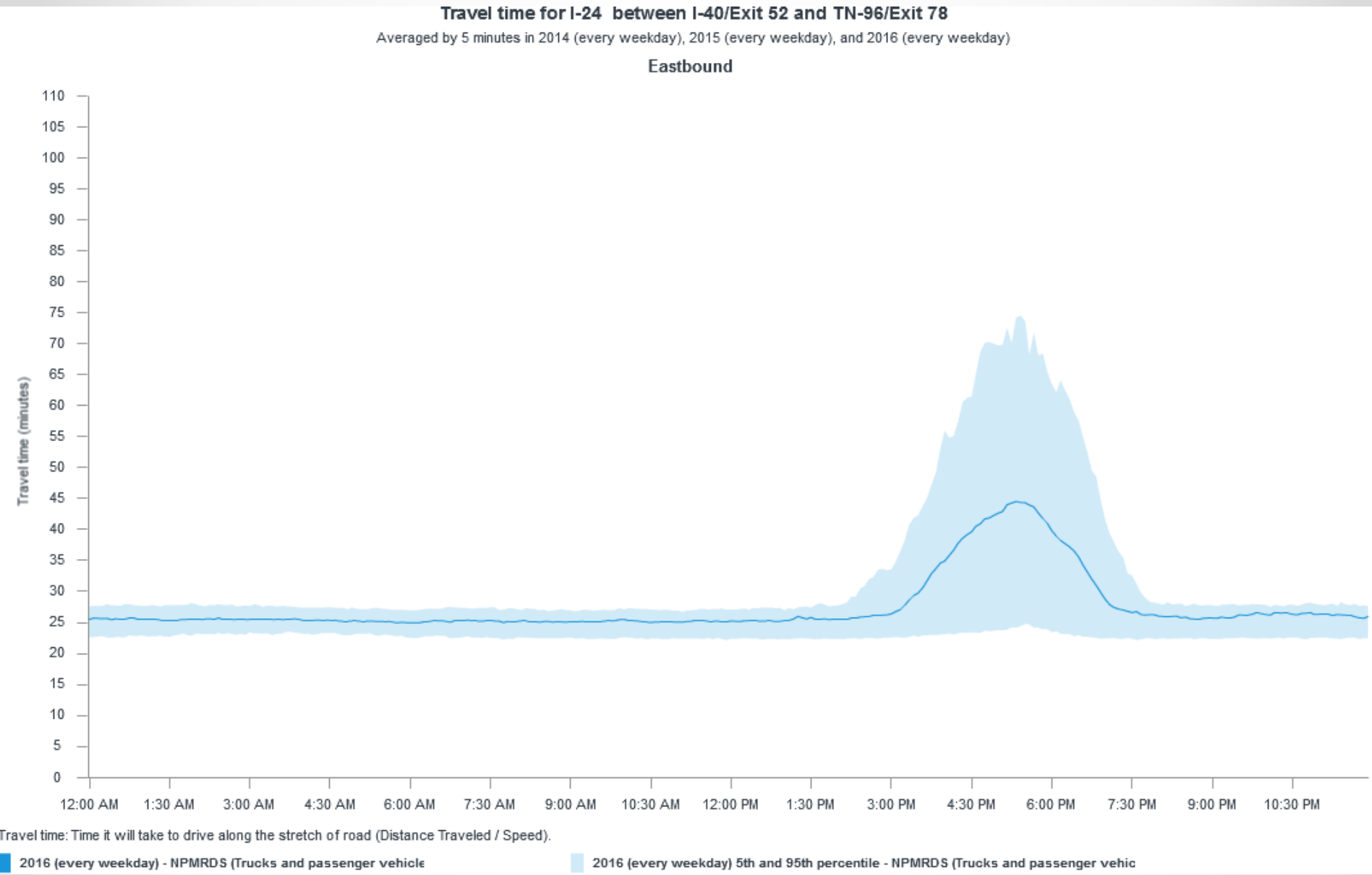
10:30 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2014 (every weekday) - NPMRDS (Trucks and passenger vehicle
2015 (every weekday) - NPMRDS (Trucks and passenger vehicle
2016 (every weekday) - NPMRDS (Trucks and passenger vehicle


Travel time for I-24 between I-40/Exit 52 and TN-96/Exit 78
Averaged by 5 minutes in 2014 (every weekday), 2015 (every weekday), and 2016 (every weekday)
Westbound
Travel time (minutes)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
12:00 AM
1:30 AM
3:00 AM
4:30 AM
6:00 AM
7:30 AM
9:00 AM
10:30 AM
12:00 PM
1:30 PM
3:00 PM
4:30 PM
6:00 PM
7:30 PM
9:00 PM
10:30 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2016 (every weekday) - NPMRDS (Trucks and passenger vehicle
2016 (every weekday) 5th and 95th percentile - NPMRDS (Trucks and passenger vehic


Travel time for I-24 between I-40/Exit 52 and TN-96/Exit 78
Averaged by 5 minutes in 2014 (every weekday), 2015 (every weekday), and 2016 (every weekday)
Eastbound
Travel time (minutes)
110
105
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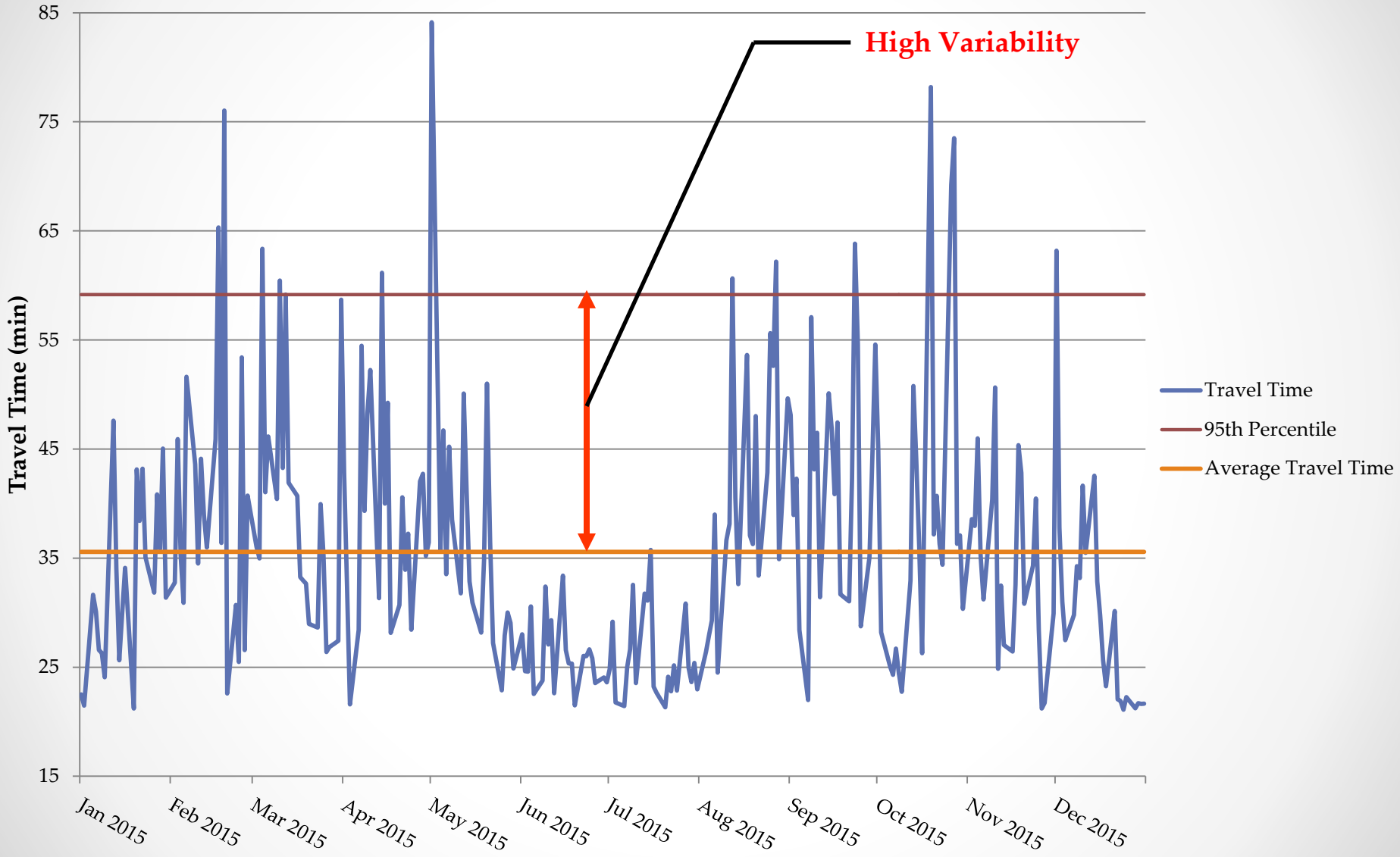
10:30 PM
Travel time: Time it will take to drive along the stretch of road (Distance Traveled / Speed).
2016 (every weekday) - NPMRDS (Trucks and passenger vehicle
2016 (every weekday) 5th and 95th percentile - NPMRDS (Trucks and passenger vehic

AM Peak Period Travel Time

I-24 From I-840 to Briley Pkwy.



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Reliability

From Exit 78 (SR-96) & Exit 53 (I-440 Interchange), 25 miles

Westbound Travel (Weekdays 2014-2016)

Buffer time (minutes)		Planning time (minutes)		Travel time (minutes)	
5:00 AM - 9:00 AM	3:00 PM - 7:00 PM	5:00 AM - 9:00 AM	3:00 PM - 7:00 PM	5:00 AM - 9:00 AM	3:00 PM - 7:00 PM
39.64	3.59	69.32	30.14	36	27.94
43.98	4.48	73.64	31.04	37.3	27.57
43.57	4.63	73.22	31.18	37.59	27.32

Eastbound Travel (Weekdays 2014-2016)

Buffer time (minutes)		Planning time (minutes)		Travel time (minutes)	
5:00 AM - 9:00 AM	3:00 PM - 7:00 PM	5:00 AM - 9:00 AM	3:00 PM - 7:00 PM	5:00 AM - 9:00 AM	3:00 PM - 7:00 PM
2.76	19.18	27.22	45.71	24.93	30.63
2.86	22.16	27.31	48.69	24.97	32.53
1.97	25.85	26.43	52.38	24.46	33.92

User Costs

2014

Delay cost:
- Total: $49,529,063.56
- Per VMT: $0.04

Hours of delay:
- Person-hours: 2,200,712h 50m 29s
- Vehicle-hours: 1,796,500h 16m 43s

Vehicle miles traveled (VMT):
- Total: 1,146,999,316 miles
- Passenger: 1,032,299,384 miles
- Commercial: 114,699,932 miles

2015

Delay cost:
- Total: $62,221,638.77
- Per VMT: $0.05

Hours of delay:
- Person-hours: 2,764,678h 57m
- Vehicle-hours: 2,256,880h 46m 32s

Vehicle miles traveled (VMT):
- Total: 1,150,831,939 miles
- Passenger: 1,035,748,745 miles
- Commercial: 115,083,194 miles

2016

Delay cost:
- Total: $63,826,374.28
- Per VMT: $0.05

Hours of delay:
- Person-hours: 2,835,981h 46m 24s
- Vehicle-hours: 2,315,087h 9m 43s

Vehicle miles traveled (VMT):
- Total: 1,153,704,781 miles
- Passenger: 1,038,334,303 miles
- Commercial: 115,370,478 miles

Previous Studies

I-24 Multimodal Corridor Study

- Identified short- and long-term solutions for improving problem spots along the entire corridor.
- Investigated a range of multimodal solutions to address future travel demands, with emphases on:
  - managing congestion,
  - improving safety,
  - maximizing the potential for freight diversion, and
  - preserving/enhancing the corridor's economic benefits.

I-24 Multimodal Corridor Study

Recommended Capacity Improvement Projects

I-24 Location	Description of Project	Length	Recommended Build year	I-24 Corridor Study Project ID	Year of Expenditure Total Cost
Exit 54 to Exit 57	Widen from 8 to 10 lanes from SR-155 (Briley Pkwy) to Haywood Lane	3.4	2020	306	$ 59,528,734
Exit 57 to Exit 62	Widen from 6 to 8 lanes from Haywood Lane to SR-171/Old Hickory Blvd	5.4	2020	307	$ 94,545,629
Exit 62 to Exit 70	Widen from 6 to 8 lanes from SR-171/Old Hickory Blvd to SR-102/Nissan Drive	6.8	2020	308	$ 119,057,468
Exit 70 to Exit 74	Widen from 6 to 8 lanes from SR-102/Nissan Drive to I-840	4.8	2030	309	$ 119,698,082
Exit 74	Implement new collector-distributor roads at I-840 EB and WB to remove weaving section	N/A	2040	254	$ 39,496,352
				Total:	**$ 432,326,265**

I-24 Multimodal Corridor Study

Proposed ITS Improvements

- Strategies identified during the study and considered for urban areas include:
  - Variable Speed Limit (VSL)
  - Road Weather Information System (RWIS)
  - Ramp Metering
- Recommended to install ramp metering components and system software in urban locations along I-24.
- Recommended to install arterial ITS instrumentation and communications on SR-1 between I-440 interchange and SR-96 (Murfreesboro)
-

Previous Studies

I-24 Congestion Mitigation Report

- Build on operational recommendations from I-24 Multimodal Corridor Study
- Assessed the potential to manage congestion and improve travel reliability by applying the following strategies:
  - Bus on Shoulder (BOS) System
  - Ramp Metering
  - Variable Speed Limits (VSL)
  - Active Arterial Management (AAM)
- The initial analysis of the strategies showed a strong potential for crash reduction and improvement in travel time reliability.
-

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Recent Program Expansions

HELP Program

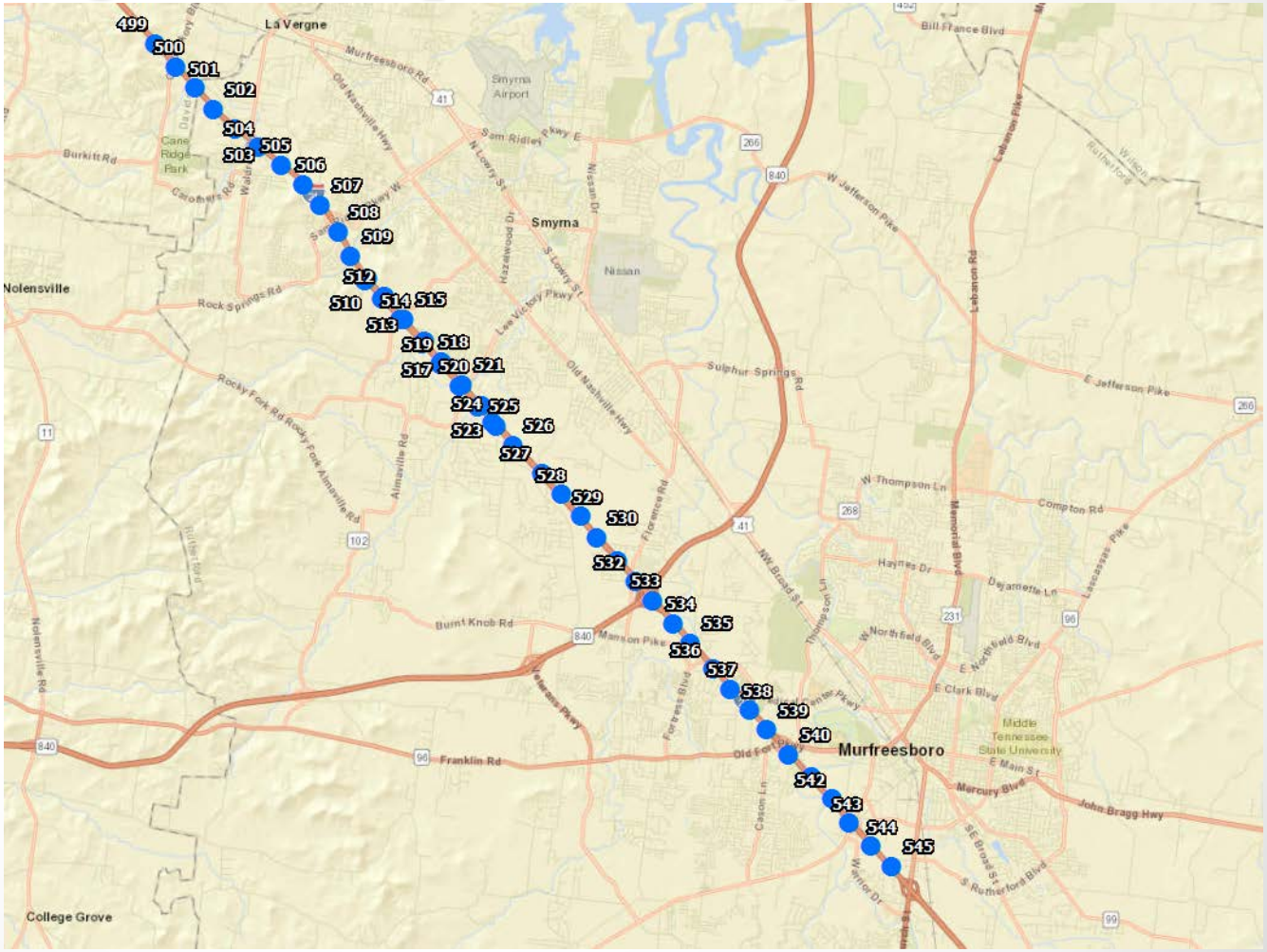
- TDOT was awarded a federal Congestion Mitigation and Air Quality grant that allowed the department to add more HELP Operators and trucks, as well as expand the routes of the HELP program.
- The I-24 route east of Nashville now covers from downtown to SR-96 in Murfreesboro and has two additional operators.

-

Recent Program Expansions

Intelligent Transportation System

- 24 CCTV
- 9 DMS
- 47 RDS



Area Project Stakeholders

- City of Nashville*
- City of LaVergne*
- Town of Smyrna*
- City of Murfreesboro*
- Rutherford County*
- Rutherford County Sherriff's Department*
- THP/ TN Dept. of Safety*
- Federal Highway Administration (FHWA)*
- Metro Transit Authority (MTA)*
- Regional Transportation Authority (RTA)*
- TN. Dept. of Economic Development
- Rover – Murfreesboro Transit Agency*
- Transportation Management Association (TMA)*

*Note: Collaboration underway

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Goals & Objectives

Goals

- Enhance safety along the corridor
- Optimizing existing travel capacity
- Manage demand across all modes
- Enhance the traveling public's experience
- Convey accurate, timely travel information both on and off route

Objectives

- Reduce the number and severity of traffic incidents
- Reduce incident clearance times
- Improved reliability of travel times
- Increase the availability of real-time traffic information
- Increased transit ridership

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The Initiative

- TDOT is forming partnerships with local authorities to implement the I-24 Smart Corridor Initiative, an Intelligent Transportation System (ITS) project that is targeted to improve the safety and reliability of travel.

- The initiative will focus on providing drivers accurate, real-time information and active traffic management in order to create a more efficient system without adding additional capacity.

-

TN TDOT Department of Transportation

Active Freeway Management

Description

A combination of congestion management techniques to dynamically manage traffic based on current and near-term expected conditions. Includes:

- Variable Speed Limits
- Temporary Shoulder Use
- Queue Warning
- Dynamic Merge Control

How will this help?

- Increased reliability
- Decreased crash rates
- Delays onset of congestion
- Provides tools for managing congestion

Implementation Examples

WSDOT's Smarter Highways, MnDOT's Smart Lanes

Target: Freeway

Work Required: ITS

Cost: ★★★★★

TN TDOT Department of Transportation

Ramp Metering

Description
The installation of traffic signals at freeway on-ramps to control vehicle flow onto the freeway

How will this help?
- Increased reliability
- Decreased crash rates
- Increased volume throughput and speed

Implementation Examples
More than 23 metropolitan areas in US utilize ramp meters

Target: Freeway

Work Required: Striping, Signing, Ramp Widening, and ITS

Cost: ★★★☆☆

Bus On Shoulder

Description
Allows only transit vehicles to utilize the designated shoulder in specific conditions and driving regulations

How will this help?
- More reliable transit service
- Possible increase to transit ridership
- Could serve as hard shoulder running in future

Implementation Examples
Currently operating in California, Delaware, Florida, Georgia, Illinois, Maryland, Minnesota, New Jersey, Virginia, and Washington

Target: Transit and Freeway

Work Required: Paving, Striping, and Signing

Cost: ★★★★☆

TN TDOT Department of Transportation

Active Arterial Management

Description
Actively managing and operating traffic signals to improve mobility and safety along a corridor

How will this help?
- Increased reliability
- Decreased crash rates
- Increased volume throughput and speed
- AAM supports freeway operation
  - Diversion strategies
  - Keeping local trips local

Implementation Examples
GDOT's Regional Traffic Operations Program (RTOP)

Target: Arterial and Freeway

Work Required: ITS

Cost: ★★★☆☆

Technical Advisory Committee (TAC)

Purpose: The technical advisory committee is an assembly of stakeholder technical staff whose purpose is to support the development, design, and deployment of the I-24 Smart Corridor Initiative. The requested support will take many forms but will specifically address the following processes:

- Proposed System Concept of Operations
- System Requirements
- High-Level Design Support
- System Verification & Deployment
- System Validation

Technical Advisory Committee (TAC)

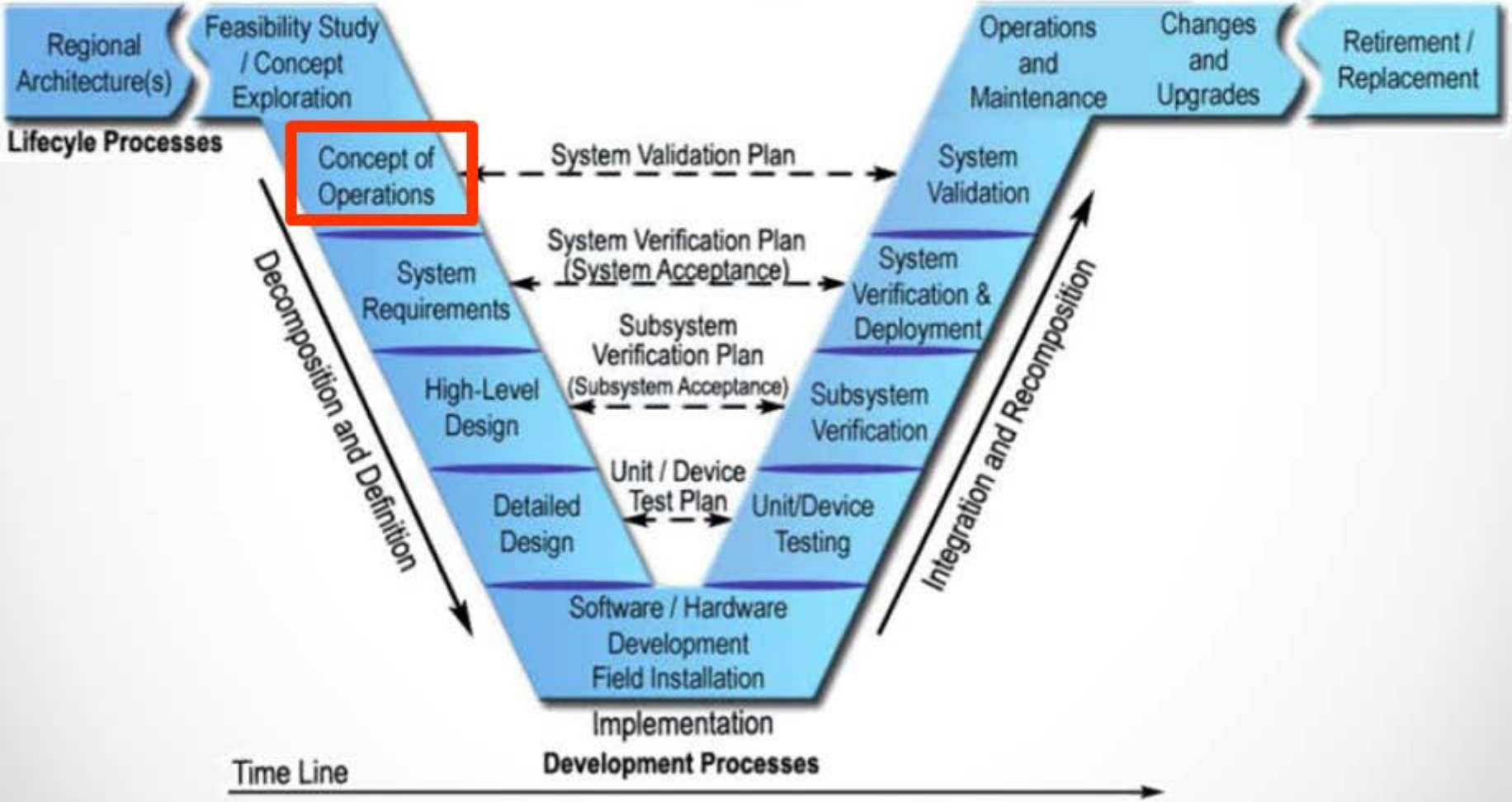
Meetings: We will plan to hold both in person and Teleconference/Internet based meeting monthly, and as needed.

Stakeholders: Additional stakeholders will be added as they are identified during the development process.

Resolution of Support: A resolution of support document is under development and will be distributed to all stakeholders. We will look to have this document signed by the leadership of each stakeholder agency.

Committee Charter: A TAC Charter will be developed and shared with the membership

System Engineering Analysis



Thank you …

TN TDOT Department of Transportation