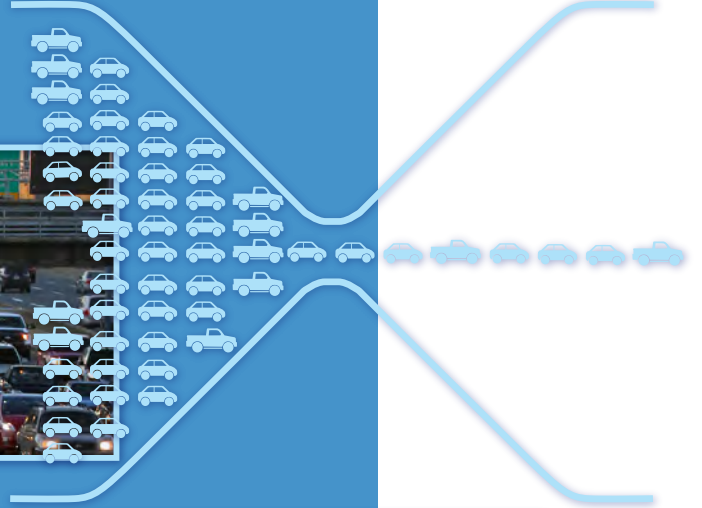


# Low-Cost Improvements to Express-Highway Bottleneck Locations



# Low-Cost Improvements to Express-Highway Bottleneck Locations

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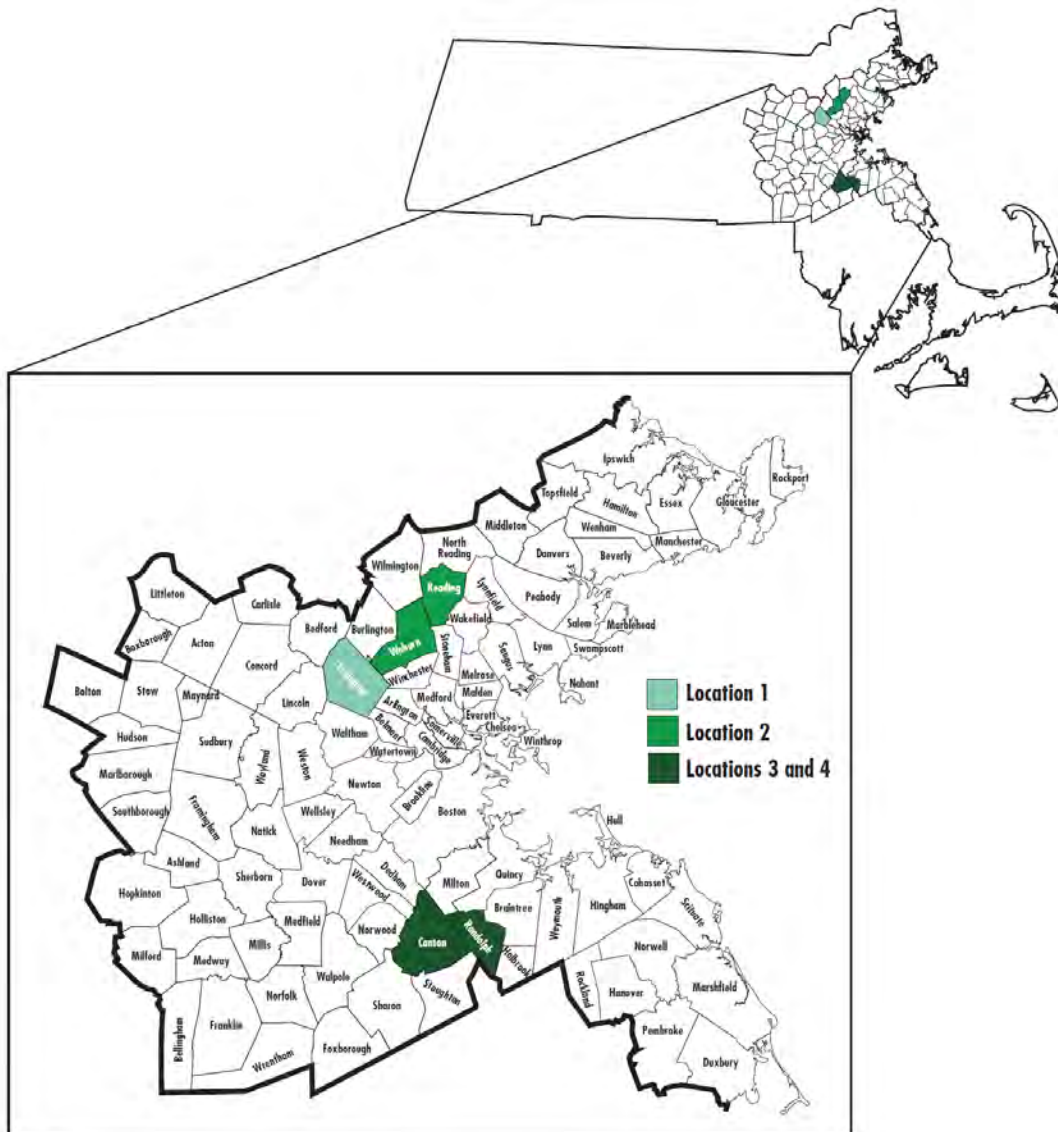
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# Abstract

The purpose of the *Low-Cost Improvements to Express-Highway Bottleneck Locations* study is to identify low-cost improvements that will help reduce congestion at freeway bottleneck locations in the Boston Metropolitan Planning Organization (MPO) region. Bottlenecks in the freeway network can occur where geometric elements such as ramps or lane drops restrict traffic flow, and are a major contributor to recurring congestion. This study was undertaken in cooperation with the Massachusetts Department of Transportation (MassDOT) Highway Division and the Federal Highway Administration (FHWA) Massachusetts Division and is part of federal fiscal year (FFY) 2017.

Candidate locations were selected based on input from the MassDOT Highway Division as well as Congestion Management Process (CMP) data. The screening process yielded four locations that had the potential to respond to low-cost improvement measures. These locations included:

- Interstate-95 northbound between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza) in Lexington
- Interstate-93 southbound between Exit 37C (Commerce Way) and Exit 37B (I-95) in Woburn and Reading
- Route 24 northbound between Exit 20 (Route 139) and Exit 21 (I-93) in Randolph, Canton, and Stoughton
- Route 24 southbound between Exit 21 (I-93) and Exit 20 (Route 139) in Randolph, Canton, and Stoughton

All locations regularly experience poor level of service (LOS) as a result of one or more freeway bottlenecks during peak travel periods.

The MPO staff developed one or more low-cost improvement proposals to address each bottleneck. If implemented, the modifications would result in capacity and safety improvements on these four high-volume facilities. Some recommendations of three previous low-cost bottleneck studies have already been implemented with positive results.

This report summarizes the analyses and recommendations from the study. The report is divided into multiple chapters, with four chapters covering each study location. Each location chapter summarizes existing conditions, proposes various low-cost measures to address the bottlenecks, and evaluates the efficacy of the proposed alternatives using methodology from the Highway Capacity Manual (HCM). The report concludes with a summary of the recommendations, followed by figures that illustrate features of the proposed improvements. The report also includes technical appendices that cite the methods used and the data applied.

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- Appendix A: Review Comments and Selection Process
- Appendix B: ATR and Classification Data
- Appendix C: Crash Tables
- Appendix D: HCS Printouts

# Chapter 1—Introduction

## 1.1 INTRODUCTION

This report summarizes the results of the analyses and improvement alternatives considered in the federal fiscal year (FFY) 2017 Low-Cost Improvements to Express-Highway Bottleneck Locations study. The report opens with background information and describes the purpose of the study, followed by the selection of study locations, an assessment of the safety and operational problems, and a discussion of the potential improvement strategies. The final section presents study recommendations. The report concludes with technical appendices, which cite the study methods and describe how the data were applied, including detailed reports from the freeway merge and diverge analyses. If implemented, the report's recommendations are expected to result in improvements on the freeway facilities; they would improve traffic safety, make traffic operations more efficient, and reduce congestion at the bottlenecks.

## 1.2 BACKGROUND

According to the Federal Highway Administration (FHWA), “Much of recurring congestion is due to physical bottlenecks—potentially correctible points on the highway system where traffic flow is restricted. While many of the nation’s bottlenecks can only be addressed through costly major construction projects, there is a significant opportunity for the application of operational and low-cost infrastructure solutions to bring about relief at these chokepoints.”<sup>1</sup> To be consistent with this guidance, the FHWA Massachusetts Division has recommended, as part of its comments on the Unified Planning Work Program process, that the Boston Region Metropolitan Planning Organization (MPO) identify the worst bottlenecks in the region that can be mitigated with low-cost countermeasures and develop recommendations for such countermeasures at these locations.

In general, recurring bottlenecks, the subject of this study, are influenced by the design or operation present at the point where the bottleneck begins (for example, merges, diverges, lane drops, traffic weaving, and abrupt changes in highway alignment). Previously, MPO staff analyzed several express-highway bottleneck locations in three consecutive studies, Low-Cost Improvements to Bottlenecks Phase I (FFY 2011), Phase II (FFY 2012), and Phase III (FFY 2015),

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<sup>1</sup> Federal Highway Administration, *Recurring Traffic Bottlenecks: A Primer: Focus on Low-Cost Operations Improvements*, US Department of Transportation, Federal Highway Administration, June 2009, p. 1.

which were well received by the Massachusetts Department of Transportation (MassDOT) and the FHWA.<sup>2,3,4</sup> Previous study locations included sections of Interstate 95 in Burlington, Lexington, and Weston; sections of Interstate 93 in Woburn; and sections of Route 3 in Braintree.

Many of the recommendations from those studies have been implemented, and the FHWA has interviewed MPO staff about these successful implementations, including:

- Restriping lanes to serve traffic demand better on I-95 northbound at Interchange 24 in Weston
- Restriping lanes to serve traffic demand better on I-95 southbound at Interchange 24 in Weston
- Providing two-lane exit for traffic exiting I-95 northbound to Route 3 northbound and the Middlesex Turnpike at Interchange 32 in Lexington and Burlington
- Providing two-lane exit for traffic exiting I-95 southbound to Route 3 northbound and the Middlesex Turnpike at Interchange 32 in Burlington

### 1.3 PURPOSE OF STUDY

The purpose of this study is twofold:

- Identify two or more bottleneck segments or points where low-cost mitigation improvements seem applicable
- Recommend low-cost mitigation improvements based on analysis of geometric design, traffic volumes and other data, and projected service performance associated with the improvements at each location

The MPO has been conducting these studies in the Boston region to identify low-cost methods to reduce congestion, increase safety, and improve traffic operations. In the current study, the MPO staff will rely on their technical expertise regarding the nature of bottlenecks and will seek input from MassDOT Highway Division staff, who are familiar with the region's express-highway system operations, to develop and evaluate a comprehensive list of potential improvements at the bottleneck locations.

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<sup>2</sup> Seth Asante, MPO staff, memorandum to the Transportation Planning and Programming Committee of the Boston Region MPO, "Low-Cost Improvements to Bottleneck Locations, Phase I," June 2, 2011.

<sup>3</sup> Chen-Yuan Wang, MPO staff, memorandum to the Transportation Planning and Programming Committee of the Boston Region MPO, "Low-Cost Improvements to Bottleneck Locations, Phase II," March 12, 2012.

<sup>4</sup> Seth Asante, MPO staff, memorandum to the Transportation Planning and Programming Committee of the Boston Region MPO, "Low-Cost Improvements to Express-Highway Bottleneck Locations," December 3, 2015.

## Chapter 2—Selection of Study Locations

The selection of study locations included the inventorying and screening of candidate locations.<sup>5</sup> MPO staff developed an initial list of candidate locations in the MPO region based on the following parameters:

- Consultations with the MassDOT Highway Division
- Review of Congestion Management Process (CMP) monitoring data and recent MPO and other planning studies
- Staff knowledge of bottleneck locations in the Boston MPO region

The inventory process yielded nine bottleneck locations in the Boston Region MPO area for screening, which are presented in Table 1.

**TABLE 1.**  
**Inventory of Express-Highway Bottleneck Locations for Screening**

Location Number	City/Town	MassDOT District	Express-Highway Section	Problem
1	Lexington*	4	I-95 northbound between Exit 29 (Rte. 2) and Exit 30 (Rte. 2A/ Service Plaza)	Merge/diverge
2	Woburn/Reading*	4	I-93 southbound between Commerce Way and I-95	Merge/diverge
3	Randolph/Canton*	6	Rte. 24 northbound between Exit 20 (Rte. 139) and Exit 21 (I-93)	Merge/diverge
4	Randolph/Canton*	6	Rte. 24 southbound between Exit 20 (Rte. 139) and Exit 21 (I-93)	Merge/diverge
5	Medford	4	I-93 southbound between Rte. 16 on-ramp and Exit 31 (Rte. 16 off-ramp)	Weave
6	Wilmington	4	I-93 northbound between Exit 40 (Rte. 62) and Exit 41 (Rte. 125)	Merge/diverge
7	Canton/Randolph	6	I-93 northbound between Exit 1 (I-95) and Exit 4 (Rte. 24)	Merge/diverge/weave
8	Canton/Randolph	6	I-93 southbound between Exit 1 (I-95) and Exit 4 (Rte. 24)	Merge/diverge/weave
9	Reading	4	I-95 northbound between Exit 37 (I-93) and Exit 38 (Rte. 28)	Weave

\* = locations selected for analysis

Source: Central Transportation Planning Staff.

<sup>5</sup> Seth Asante, MPO staff, memorandum to the Boston Region MPO, "Low-Cost Improvements to Express-Highway Bottleneck Locations: Selection of Study Locations," April 2, 2015.

## 2.1 SCREENING CRITERIA

MPO staff used the following three criteria to screen the bottleneck locations:

1. Does the location qualify as a bottleneck? A repetitive, long-traffic queue upstream trailing free-flowing traffic downstream usually characterizes the location as a bottleneck. In other words, the location experiences routine and predictable congestion because traffic volume exceeds the available capacity at that location.
2. Is a physical design constraint or operational conflict inherent in the location the cause of the bottleneck? Examples of these include the following constraints or conflicts:
  - a. Lane drop: one or more travel lanes end, requiring traffic to merge
  - b. Weaving area: drivers must merge across one or more lanes to access an entry or exit ramp
  - c. Merge area: on-ramp traffic merges with mainline traffic to enter the freeway
  - d. Major interchanges: high-volume traffic is directed from one freeway to another
3. Can the bottleneck be fixed with low-cost operational and geometric improvements? These exclude costly long-term solutions such as expansion or widening of the roadway. Examples of low-cost operational and geometric improvements include the following:
  - a. Using a short section of shoulder as an additional travel lane or for lengthening an acceleration or deceleration lane
  - b. Restriping merge and diverge areas to better serve traffic demand
  - c. Providing all-purpose reversible lanes
  - d. Changing or adding signs and striping

Each location must meet these criteria for it to be selected for study. In addition, the number of locations selected for study is also dependent on funding allocated for the study.

## 2.2 STUDY LOCATIONS

Based on the screening criteria and consultations with MassDOT Highway Division officials, MPO staff selected locations 1, 2, 3, and 4 for study. Figure 1 shows the study locations, which are described below. Although locations 5, 6, 7, and 8 met the screening criteria, they were not selected for study in this round of bottleneck study because of funding—these locations would be considered for the next round of bottleneck study. Appendix A contains comments about the study from the MassDOT Highway Division and a memorandum to the MPO that describes the selection process in detail. (All figures are included at the end of the report.)

***Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza) in Lexington***

This bottleneck is located on I-95 northbound between the Route 2 and Route 2A interchanges, and is present during AM and PM peak periods. The I-95 northbound mainline can carry up to 7,600 vehicles per hour, while up to 1,500 vehicles per hour merge from Route 2 westbound and up to 1,300 exit to Route 2A and the service plaza. The merging and diverging activities of these vehicles slow down traffic on the freeway upstream of the Route 2A interchange, making it difficult to enter the freeway from Route 2. The existing conditions analyses, problem identification, and the improvements proposed to this bottleneck location are described in Chapter 4.

***Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way) and Exit 37B (I-95) in Woburn and Reading***

This bottleneck is located on I-93 southbound upstream from the point where traffic begins to diverge onto I-95 southbound. During the AM peak period, traffic going to I-95 southbound backs up on the ramp and spills onto the I-93 mainline, thus impacting flow on the right most low-speed southbound lane. As a result, motorists attempt to get into the breakdown lane as soon as possible to stay clear of the low-speed lane. But usually vehicles are still queuing on the low-speed lane, compounding the problems. The other three southbound lanes are almost in free flow conditions (that is, uncongested conditions with drivers traveling at posted speeds) during this period. In the segment, the four I-93 southbound lanes carry up to 7,500 vehicles per hour, of which approximately 2,000 vehicles exit to I-95 southbound. The existing conditions analyses, problem identification, and the improvements proposed to this bottleneck location are described in Chapter 5.

***Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93) in Randolph, Canton, and Stoughton***

This bottleneck is located on Route 24 northbound at the point where traffic diverges onto I-93 northbound and southbound. Bottleneck conditions emerge primarily during the AM peak period and extend south from I-93 in Randolph as far as Route 27 in Brockton, or approximately seven miles. During this period, Route 24 northbound carries approximately 4,600 vehicles per hour, with volumes of 2,300 vehicles heading northbound on I-93 and approximately 2,300 vehicles heading to I-93 southbound. These volumes are low because of the bottleneck, and they do not reflect actual traffic demand or traffic capacity of Route 24 mainline or connector ramps. The merging activity of these vehicles on I-93 slows down traffic on the Route 24 connector ramps and causes traffic to back up on Route 24. The existing conditions analyses, problem identification,



and the improvements proposed to this bottleneck location are described in Chapter 6.

***Location 4: Route 24 Southbound Segment between Exit 21 (I-93) and Exit 20 (Route 139) in Randolph, Canton, and Stoughton***

This bottleneck is located on Route 24 southbound at the point where traffic from the I-93 connector ramps merges onto Route 24 southbound. Bottleneck conditions emerge primarily during the PM peak period. During this period, Route 24 southbound carries approximately 5,300 vehicles per hour, of which approximately 2,700 vehicles enter from I-93 northbound and another 2,600 from I-93 southbound. The merging activity of these vehicles creates a bottleneck that causes a one-mile-long traffic queue to extend from the Canton Street Bridge under Route 24 onto the I-93 northbound and southbound lanes. The existing conditions analyses, problem identification, and the improvements proposed to this bottleneck location are described in Chapter 7.

### **2.3 RATIONALE FOR NOT SELECTING LOCATION 9 FOR STUDY**

MPO staff did not select Location 9: I-95 Northbound between Exit 37 (I-93) and Exit 38 (Route 28) in Reading for the study. This section of highway frequently is congested because of a lane drop, intensive weaving, and merging and diverging activities, which slow down mainline traffic, especially during the PM peak period. During that time, the I-95 northbound mainline carries approximately 6,000 vehicles per hour, and the Exit 37 off- and on-ramps carry approximately 3,000 and 2,600 vehicles per hour, respectively. Adding an auxiliary lane northbound on I-95 would provide more room for the merging and diverging activities and reduce disturbance to mainline traffic. Staff did not select this location because the weave problem at Exit 37 could not be corrected in a low-cost manner and an auxiliary lane would need to be extended for a long distance (three to four interchanges downstream) to reduce congestion and the queue, which could be expensive.

# Chapter 3—Data Collection

## 3.1 TRAFFIC VOLUME DATA

The MassDOT Highway Division's Traffic Data Collection Program conducted automatic traffic recorder (ATR) counts for the ramps and freeways at the locations selected for study. The ATR counts traffic continuously for at least 48 hours. These counts are used to determine the average weekday daily traffic of a highway. The traffic volume data are included in Appendix B.

## 3.2 CLASSIFICATION DATA

Although the ATR data that MassDOT collected for this study did not include vehicle classification, other count methods can capture this information. MPO staff used the MassDOT traffic count database to access classification data collected during previous traffic counts inside the study areas. The heavy vehicle percentages present in these counts were used to estimate truck traffic for the freeway analyses. All the counts used in this way were taken between 2014 and 2017. They are included in Appendix B.

## 3.3 CRASH DATA

MPO staff used crash data from January 2010 through December 2014 from the MassDOT's Registry of Motor Vehicles database to evaluate safety for motorists. Crash data are included in Appendix C.

## 3.4 SPEED DATA

MPO staff used speed data from spring 2015 and fall 2015 for average weekday from the MPO's CMP. The CMP maintains average speed data on express-highway systems in the MPO region with use of the INRIX historical traffic speed data archive.

## 3.4 FREEWAY COMPONENTS

### 3.4.1 Basic Freeway Segment

Basic freeway segments are outside of the influence area of ramps or weaving areas of the freeway. The flow in such segments occurs more smoothly than segments with merging, diverging, or weaving. The exact point at where basic freeway segments begin or end—the area where the influence of merging, diverging, or weaving has dissipated—depends on local conditions, particularly the level of service (LOS) operating at the time. If traffic flow is light, the influence

may be negligible, whereas under congested conditions, queues may be extensive.

### **3.4.2 Entrance Ramp**

An entrance ramp is a one-way roadway that allows traffic to enter a freeway from other crossing highways. Sufficient acceleration distance is needed to allow a vehicle to enter the freeway mainline safely and comfortably; drivers on the entrance ramp need to be able to see a sufficient distance upstream from the entrance to locate the gaps in the traffic stream within which to merge.

### **3.4.3 Exit Ramp**

An exit ramp is a one-way roadway that allows traffic to exit from the freeway and provide access to other crossing highways. Sufficient deceleration distance is needed to allow a vehicle to leave the freeway mainline safely and comfortably.

### **3.4.4 Weaving Segment**

Weaving segments are formed when a freeway merge is followed by a freeway diverge within one-half mile. This geometry creates an area of intense lane changing as the two streams of traffic travel in conflicting directions. Weaving length, or the distance between merge and diverge points, must be sufficient to allow drivers to make the required lane changes safely and comfortably.

### **3.4.5 Major Merge and Diverge Areas**

A major merge occurs when two multilane freeway segments combine to form a single freeway segment with three or more lanes. Likewise, a major diverge occurs when a freeway segment with three or more lanes splits into two multilane basic freeway segments. While these locations can create turbulence in the traffic flow, they are less restrictive than freeway ramps because speed differences are smaller and lane changes are often unnecessary.

## **3.5 LEVEL-OF-SERVICE CRITERIA FOR ANALYSES**

LOS is a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. Factors influencing LOS are volume, lane width, lateral obstructions, traffic composition, grade, and speed. The Highway Capacity Manual (HCM) methodology demonstrates driving conditions on freeways in terms of LOS ratings from A

through F.<sup>6</sup> The LOS criteria characterize freeway performance measures in terms of density (passenger cars per lane mile, [pc/lane mile]). Table 2 shows the LOS criteria for basic freeway and ramp merge/diverge and weaving segments.

**TABLE 2.**  
**LOS Criteria for Basic Freeway, Ramp Merge/Diverge, and Weaving Segments**

	<b>Basic Freeway Segment</b>	<b>Ramp Merge/Diverge and Weaving Segments</b>
LOS	Density (pc/lane mile)	Density (pc/lane mile)
A	≤ 11	≤ 10
B	> 11–18	> 10–20
C	> 18–26	> 20–28
D	> 26–35	> 28–35
E	> 35–45	> 35
F	> 45, Demand exceeds capacity	Demand exceeds capacity

pc/lane mile = passenger cars per lane mile  
Source: Highway Capacity Manual 2010.

LOS A represents the best operating conditions (unrestricted operations), while LOS F represents the worst operating conditions (queuing on the freeway and/or ramp). LOS A through LOS D represent acceptable operating conditions. LOS E represents operating conditions at capacity. LOS F represents failing conditions (demand exceeds capacity).

MPO staff conducted traffic operations analyses consistent with HCM methodologies. Using the data collected, MPO staff built traffic analysis networks for the AM and PM peak hours with the 2010 Highway Capacity Software (HCS) to assess the capacity and quality of traffic flow at the bottleneck area. Detailed reports generated by the HCS software are included in Appendix D.<sup>7</sup>

<sup>6</sup> Highway Capacity Manual 2010, Transportation Research Board of the National Academies, Washington, DC, December 2010.

<sup>7</sup> Highway Capacity Software 7, Version 7.3, McTrans Center, PO Box 116585, Gainesville, Florida, 2017.

# Chapter 4—Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza) in Lexington

Location 1 is a stretch of Interstate 95/Route 128 northbound in Lexington. Figure 1 shows the location of the bottleneck within the MPO region. The northbound on- and off-ramps connect to and from Route 2 (Concord Turnpike), Route 2A (Merrett Road), and a service plaza. The bottleneck conditions form primarily during the PM peak period, when high volumes of rush hour traffic heads northbound on I-95. This interchange and the roadways are under the jurisdiction of MassDOT Highway Division, and they are located in District 4.

## 4.1 EXISTING FREEWAY CHARACTERISTICS

Operations at this bottleneck are associated with the freeway components described below.

### 4.1.1 Basic Freeway Section

The basic freeway section of I-95 northbound has four 12-foot travel lanes, a 10-foot right shoulder, and a 10- to 11-foot left shoulder. This section carries approximately 7,500 vehicles per hour during both the AM and PM peak periods.<sup>8</sup> The posted speed limit is 65 miles per hour (mph). Freeway exit signs are posted at one-mile and one-half-mile intervals to guide drivers to Routes 2 and 2A. As a result of recent resurfacing, neither side of I-95 northbound at this location is equipped with a rumble strip.

### 4.1.2 Entrance Ramp

The entrance ramp from Route 2 westbound to I-95 northbound is a one-lane, one-way roadway. It carries as many as 1,500 vehicles per hour during the AM peak period and 1,100 vehicles per hour during the PM peak period. The length of the acceleration lane for traffic entering the section from Route 2 westbound is approximately 500 feet long,<sup>9</sup> and the posted speed limit on the entrance ramp is 25 mph. Based on highway design and entrance ramp curve design speeds, the length of the acceleration lane does not meet MassDOT's standards. The

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<sup>8</sup> The AM peak period is 6:00 AM to 10:00 AM, and the PM peak period is 3:00 PM to 7:00 PM. Source: Central Transportation Planning Staff.

<sup>9</sup> Acceleration and deceleration lanes are measured from the point where the lane reaches 12 feet wide to the first controlling curve. Source: *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2004. Chapter 10 Grade Separations and Interchanges.

MassDOT Highway Division's current Project Development and Design Guide specifies a minimum acceleration lane of 1,220 feet for a freeway facility with a design speed of 65 mph, an entrance ramp curve design speed of 25 mph, and a grade of two percent or less.

#### 4.1.3 Exit Ramp

The exit ramp from I-95 northbound to Route 2A is a one-way, one-lane roadway that leads to a connector-distributor road approximately 4,000 feet long. Traffic bound for Route 2A westbound, eastbound, and the Lexington service plaza all use Exit 30. Combined, these three destinations produce flows of 1,300 vehicles per hour on the ramp during peak hours. The length of the deceleration lane is approximately 740 feet long, and the posted speed limit on the exit ramp is 30 mph. Based on highway design and exit ramp curve design speeds, the length of the deceleration lane meets MassDOT's standards. The MassDOT Highway Division's current Project Development and Design Guide specifies a minimum deceleration length of 440 feet for a freeway facility with a design speed of 65 mph, an exit ramp curve design speed of 35 mph, and a grade of two percent or less. The MassDOT design guide recommends using parallel type deceleration lanes instead of the taper type that is used on Exit 30, although in this case the presence of a nearby bridge (over Lincoln Street) might make a parallel design difficult.

### 4.2 PROBLEMS

The existing bottleneck creates intense interruption of traffic flow primarily during PM peak travel periods, experienced by virtually all drivers in the section. It reduces travel speeds on the freeway mainline to 35 mph or less during the PM peak period. In addition, the bottleneck causes many crashes in this area and results in poor operating LOS, especially at the diverge area connecting the exit ramp to Route 2A eastbound.

### 4.3 CAUSES

MPO staff identified two factors that contribute to form the bottleneck:

- A high volume of traffic during peak hours
- A short acceleration lane at the ramp from Route 2

#### 4.3.1 High Volume of Traffic

Figure 2 shows the traffic flows during the AM and PM peak periods. The merging and diverging activities of vehicles using the ramps slow down traffic on the freeway upstream of the Route 2A interchange, creating a bottleneck and making it difficult to enter the freeway from Route 2.

Although ATR data show similar ramp and mainline volumes in the two peaks, vehicle speed data indicate that the worst congestion occurs during the PM peak (see Section 4.4.2). During this period of time, traffic slows considerably and queues extend for miles down I-95. This observation suggests that the actual demand on the facility is greater than the number of vehicles it is able to serve. True demand is nearly 8,800 vehicles per hour, which is the theoretical capacity of a four-lane freeway operating in uncongested conditions.

### 4.3.2 Short Acceleration Lane

A short acceleration lane for the high-volume traffic entering I-95 northbound from Route 2 westbound forces drivers to merge quickly and does not give them the distance needed to reach safe freeway speeds. The intense merging maneuvers slow down traffic, causing a bottleneck upstream from the merge location.

## 4.4 IMPACTS

### 4.4.1 Crashes

A summary of the crashes in this segment is presented in Table 3. There were 108 crashes in this area between 2010 and 2014 (Appendix C). Figure 3 shows the location of these crashes. The majority (98 crashes) occurred in the vicinity of the off-ramp at Exit 30.

**TABLE 3.**  
**Crash Summary (2010–14):**  
**Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and Exit 30**  
**(Route 2A/Service Plaza)**

Crash Variable	Number of Crashes		Total
	At Merge	At Diverge	
<b>Crash severity</b>			
Fatal injury	0	0	0
Nonfatal injury	4	20	24
Property damage only	6	75	81
Not reported/unknown	0	3	3
<b>Manner of collision</b>			
Angle	0	9	9
Rear-end	5	49	54
Rear-to-rear	0	2	2
Sideswipe, same direction	2	7	9
Single-vehicle crash	3	28	31
Not reported/unknown	0	3	3

<b>Road surface conditions</b>			
Dry	8	68	76
Wet	2	6	8
Snow	0	24	24
<b>Ambient light conditions</b>			
Daylight	5	58	63
Dark: lighted roadway	1	11	12
Dark: nonlighted roadway	4	22	26
Dawn	0	3	3
Dusk	0	4	4
<b>Weather conditions</b>			
Clear	7	59	66
Cloudy	1	17	18
Rain	2	11	13
Snow	0	6	6
Not reported/unknown	0	5	5
<b>Travel period</b>			
Peak	5	60	65
Off-peak	5	38	43
<b>Total crashes</b>	10	98	108
Five-year average (rounded)	2	20	22

Below is a summary of the crashes in this segment:

- 22 percent of the crashes resulted in injury
- 50 percent of the crashes were rear-end collisions, the largest share among collision types
- 60 percent of the crashes occurred during peak travel periods
- 42 percent of the crashes occurred outside daylight conditions
- 70 percent of the crashes occurred under dry roadway conditions

#### 4.4.2 Travel Speed

Figure 4 is a congestion scan that shows the average travel speeds on I-95 northbound at the bottleneck location between Route 2 and Route 2A. The bottleneck reduces travel speeds less than 25 mph between 3:00 PM and 5:00 PM. Vehicle speeds this far below free-flow correlate with LOS F conditions on the freeway. Travel speed during the AM peak is less affected and remains more than 50 mph.



### 4.4.3 Level of Service

MPO staff conducted traffic operations analyses consistent with HCM methodologies. Using data from MassDOT, MPO staff built traffic analysis networks for the AM and PM peak hours with the HCS suite to assess the capacity and quality of traffic flow at the bottleneck area.<sup>10</sup> Full HCS reports are included in Appendix D.

Table 4 presents the results of the LOS analyses for existing conditions at Location 1. The primary bottleneck is located at the merge from Route 2 westbound. Some simplifications were necessary to fit the HCS model more closely with observed conditions and are stated in the table notes.

**TABLE 4.**  
**LOS Analysis–Existing Conditions:**  
**Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and**  
**Exit 30 (Route 2A/Service Plaza)**

Location	Peak Period	Density (pc/lane mile)	Speed (mph) <sup>a</sup>	V/C Ratio	LOS <sup>b</sup>
<i>HCM Analysis Type: Basic Freeway Segment</i>					
I-95 northbound between Exit 29 and Exit 30	AM	32.9	59.1	0.84	D
	PM	41.7	53.7	0.96	E
<i>HCM Analysis Type: Merge Area<sup>d</sup></i>					
Ramp from Route 2 westbound	AM	34.5	53.3	0.83	D
	PM	N/A <sup>e</sup>	N/A	1.05	F
<i>HCM Analysis Type: Diverge Area</i>					
Exit 30 to Route 2A and service plaza	AM	33.4	51.3	0.83	D
	PM	38.8	51.1	0.95	E
<i>HCM Analysis Type: Weaving Segment<sup>f</sup></i>					
I-95 northbound between Exit 29 and Exit 30	AM	N/A	N/A	1.10	F
	PM	41.8	42.8	0.89	E

<sup>a</sup> Refers to ramp influence area speed for merge/diverge areas.

<sup>b</sup> LOS A through LOS D represent acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity).

<sup>c</sup> Estimated demand flow rate of 8,800 vph used for all PM existing condition analyses (see Section 4.3.1)

<sup>d</sup> In HCM merge and diverge analyses, acceleration and deceleration lanes are measured from the tip of the painted gore to the end of the taper. This may differ from the AASHTO length.

<sup>e</sup> HCM does not provide density and speed data for scenarios that result in LOS F.

<sup>f</sup> Uses a weaving segment of five lanes so limiting factor is weaving behavior and not mainline capacity. (HCM weaving analysis assumes a lane drop after the merge.)

HCM = Highway Capacity Manual; LOS = level of service; mph = miles per hour; pc/lane mile = passenger cars per lane mile; V/C = volume-to-capacity; vph = vehicles per hour

<sup>10</sup> Highway Capacity Software 7, Version 7.3, McTrans Center, PO Box 116585, Gainesville, Florida, 2017.

Table 4 shows that most facilities operate at LOS D during the AM peak and LOS E during the PM peak. The two exceptions are the PM merge from Route 2 and the AM weaving segment analysis, both of which reach LOS F.

The high combined-ramp volume during the AM peak (2,600 entering and exiting vehicles per hour) also causes the weaving analysis to fail during this period. This means that the formulas in the HCM predict that not all vehicles using the ramps during the AM peak will be able to successfully merge within the available 1,720 feet. However, this does not fit with observed conditions. One possible explanation is that this and other bottlenecks along I-95 reduce speed on the northbound mainline below free-flow speed, giving vehicles more time to execute a lane change. Driver behavior may also be misrepresented in the formulas. At any rate, the fact that weaving fails during the AM peak period when congestion is not a big problem suggests that weaving analysis is not well suited to this bottleneck location.

## 4.5 IMPROVEMENT ALTERNATIVES

MPO staff developed the following improvements to address safety and operational issues at the bottleneck:

- Alternative 1: Lengthen the acceleration lane at the on-ramp from Route 2 westbound (Figure 5).
- Alternative 2: Create an auxiliary lane for merging and diverging traffic (Figure 6).
- Alternative 3: Add new signage at Exit 30 to help clarify the location of the three destinations served by this ramp.

The alternatives were analyzed using projected year 2030 traffic volumes. MPO staff estimated a five percent total background growth from 2017 to 2030.

### 4.5.1 Alternative 1: Lengthen the Acceleration Lane at the On-Ramp from Route 2

The existing acceleration lane is short; it does not meet MassDOT's standards and contributes to poor traffic operations. MPO staff recommends lengthening the acceleration lane from the Route 2 westbound on-ramp.

Figure 5 shows the following improvements recommended in Alternative 1:

- Extend the acceleration lane for the on-ramp from Route 2 westbound. The current ramp features a 500-foot full-width acceleration lane followed by a 540-foot taper. Alternative 1 would extend the full-width lane as far as permitted by the existing right-hand paved shoulder, which would bring the new length to approximately 1,030 feet. While still not quite in line with the

1,220-foot acceleration lane that the MassDOT standards recommend, the additional length would improve system operations and safety while leaving enough of a buffer before the subsequent ramp. The taper would be reduced from 540 feet to 300 feet, leaving 300 feet before the beginning of the taper for Exit 30. Right-hand shoulder width would be reduced to a minimum of two feet to provide space for the acceleration lane.

#### 4.5.2 Alternative 2: Create an Auxiliary Lane for Merging and Diverging Traffic

An auxiliary lane is defined as the portion of the roadway adjoining the traveled freeway for speed change, merging, diverging, weaving, and other purposes supplementary to through-traffic movement. Alternative 2 would create an auxiliary lane between the on-ramp at Exit 29 and the off-ramp at Exit 30. This lane would extend the distance available for merging or diverging traffic maneuvers and would provide sufficient distance to accommodate speed changes and vehicle weaving. The auxiliary lane would also upgrade the acceleration lane to meet MassDOT's standards.

Figure 6 shows the following improvements recommended in Alternative 2:

- Restripe I-95 northbound between Exit 29 and Exit 30 (about one-third of a mile) to accommodate a fifth 12-foot auxiliary lane on the right. This would bring the total lane width to 60 feet along this distance. Use the existing paved area on both the left and right shoulders to provide the required additional width. The highway alignment would need to be shifted to the left by approximately four feet to accomplish this. Alternative 2 would reduce the left shoulder to approximately 6 feet and the right shoulder to a minimum of 2 feet.
- Relocate existing guide signs or install new guide signs and pavement markings to direct drivers to merge onto the mainline or to use Exit 30.
- Modify pavement markings to delineate the auxiliary lane from the mainline travel lanes.

Alternative 2 does present some design difficulties. First, an existing bridge carries I-95 northbound over Lincoln Street in Lexington only 200 feet from the beginning of the gore area at Exit 30. Currently the taper for the Exit 30 ramp extends onto the bridge, and creating an auxiliary lane in this area would require expanding this taper to a full-width lane. The bridge looks to be approximately 64 to 66 feet wide, providing space for five 12-foot lanes and a two- to three-foot offset on each side. These less-than-minimal shoulders would require a Design Exception Report (DER). Second, while the paved shoulder along this stretch of highway is wide enough to accommodate an extra travel lane, it is not wide

enough to fit an additional emergency pullover or stopping area. Any such area would require additional paving and possibly significant grading work because of a moderate slope to the right of the roadway.

#### 4.5.3 Alternative 3: Signage Improvements for Exit 30

Because of the high frequency of crashes observed in the vicinity of Exit 30, some signage modifications are recommended. The following improvements are recommended as part of Alternative 3:

- Add a sign for the service plaza at each location where there is a sign for Exit 30A or 30B, to reinforce that this ramp serves all three movements.
- Use a more prominent arrow sign for the service plaza right at the exit.
- Use “Next right” or “Second right” on all signs, or consider using a lane diagram.
- Move the speed limit sign closer to the beginning of the ramp to remind drivers to slow down.

These signage modifications are safety-oriented and do not result in operational improvements.

While signage is a factor, the underlying design of the Route 2A interchange may also play a role in the frequency of crashes observed here. The ramp at Exit 30 leads to a connector-distributor road that serves a high-speed off-ramp, then a service plaza, and then the remaining three legs of the cloverleaf interchange before rejoining the I-95 mainline. The placement of a service plaza in the midst of a high-speed interchange is an unusual design not seen elsewhere in the northeast and may confuse drivers, especially visiting drivers using the service plaza. This confusion could contribute to the high crash rate. However, re-designing the Route 2A interchange would be a high-cost project and is beyond the scope of this report.

#### 4.6 EFFECTIVENESS AND COST OF THE IMPROVEMENTS

Table 5 presents the 2030 future LOS analyses compiled using the HCS software. Results for the no-build scenario are compared against Alternative 1 and Alternative 2 for all facilities where modifications affect system operations. All scenarios use a uniform five percent growth for 2030 traffic volumes. Alternative 3 does not affect LOS and is not included in Table 5. Approximations made as part of the HCM analysis are given where applicable.

**TABLE 5.**  
**LOS Analysis–Improvement Alternatives:**  
**Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and**  
**Exit 30 (Route 2A/Service Plaza)**

Location	Peak Period	Scenario	Density (pc/lane mile)	Speed (mph)	V/C Ratio	LOS
<i>HCM Analysis Type: Basic Freeway Segment</i>						
I-95 northbound between Exit 29 and Exit 30	AM	No-Build	35.5	57.6	0.88	E
		Alt 2	26.6	61.4	0.71	D
	PM <sup>a</sup>	No-Build	41.7	53.7	0.96	E
		Alt 2	29.6	60.5	0.77	D
<i>HCM Analysis Type: Merge Area<sup>b</sup></i>						
Ramp from Route 2 westbound	AM	No-Build	36.7	52.2	0.87	D
		Alt 1	36.6	52.5	0.87	D
		Alt 2	36.4	53.2	0.87	D
	PM	No-Build	N/A <sup>c</sup>	N/A	1.05	F
		Alt 1	N/A	N/A	1.05	F
		Alt 2	N/A	N/A	1.05	F
<i>HCM Analysis Type: Diverge Area</i>						
Exit 30 to Route 2A and service plaza	AM	No-Build	35.2	51.2	0.87	E
		Alt 2	35.2	51.2	0.87	C
	PM	No-Build	38.9	51.0	0.95	E
		Alt 2	38.9	51.0	0.95	D
<i>HCM Analysis Type: Weaving Segment<sup>d</sup></i>						
I-95 northbound between Exit 29 and Exit 30	AM	No-Build	N/A	N/A	1.16	F
		Alt 2	N/A	N/A	1.16	F
	PM	No-Build	42.4	42.2	0.94	E
		Alt 2	42.4	42.2	0.94	E

<sup>a</sup> Estimated demand flow rate of 8,800 vph was used as the PM peak volume for all 2030 analyses. It did not develop from existing conditions. The roadway is at capacity and peak spreading is likely to occur when this is the case.

<sup>b</sup> Uses an acceleration lane of 1,500 feet as an approximation for a full auxiliary lane in the Alternative 2 merge and diverge models.

<sup>c</sup> HCM does not provide density and speed data for scenarios that result in LOS F.

<sup>d</sup> Uses a weaving segment of five lanes for No-Build and six lanes for Alt 2 to approximate the effect of an added lane.

HCM = Highway Capacity Manual; LOS = level of service; mph = miles per hour; pc/lane mile = passenger cars per lane mile; V/C = volume-to-capacity; vph = vehicles per hour

### 4.6.1 Effectiveness and Cost of Alternative 1

A Crash Modification Factor (CMF) is an estimate of the change in crashes expected after implementation of a countermeasure. Using CMFs from the Highway Safety Manual (HSM) and the CMF Clearinghouse for lengthening an acceleration lane show that Alternative 1 would reduce crashes at the merge

area by 10 to 20 percent.<sup>11,12</sup> In addition, Alternative 1 would have a positive, albeit small, effect on traffic operations in the bottleneck. Alternative 1 would not improve the diverge maneuver at Exit 30, the basic freeway capacity, or weaving operations.

Implementing the changes in Alternative 1 would only require restriping the existing Exit 29 ramp area. No right-of-way acquisition, pavement widening, or alignment changes would be required. Alternative 1 is estimated to cost between \$10,000 and \$20,000 to construct and would require restriping lanes and lengthening the acceleration lane on I-95 northbound.

#### 4.6.2 Effectiveness and Cost of Alternative 2

Using CMFs from the Clearinghouse show that adding continuous auxiliary lane for weaving between entrance ramp and exit ramp would reduce crashes by 20 to 25 percent. Alternative 2 would significantly improve performance in this area, particularly at the Route 2A off-ramp. The LOS for Exit 30 would improve from E to C during the AM peak and from E to D during the PM peak. However, the merge from Route 2 would remain at LOS D in the AM peak and LOS F in the PM peak.

As with Alternative 1, weaving is the limiting factor with the lowest LOS. Alternative 2 does improve LOS for PM weaving from E to D, although according to the model the segment is still over its weaving capacity for the AM peak.

Implementing the changes in Alternative 2 would require restriping to shift the northbound highway alignment to the left by approximately four feet, beginning at Exit 29 and extending through Exit 30. No right-of-way acquisition, pavement widening, or alignment changes should be required. Alternative 2 is estimated to cost between \$50,000 and \$75,000 to construct and would require restriping lanes, pavement widening, relocating existing guide signs or installing new guide signs, and pavement markings.

#### 4.6.3 Effectiveness and Cost of Alternative 3

Using CMF from the Clearinghouse, Alternative 3 is expected to reduce crashes by up to 20 percent. Alternative 3 would significantly improve safety but would have limited effect on traffic operations in the bottleneck. Alternative 3 is estimated to cost between \$10,000 and \$20,000 to construct. This estimate

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<sup>11</sup> American Association of State Highway and Transportation Officials. Highway Safety Manual. Washington, DC, 2010.

<sup>12</sup> Crash Modification Factors Clearinghouse, [www.cmfclearinghouse.org/index.cfm](http://www.cmfclearinghouse.org/index.cfm).

includes the cost of installing new signs on overhead gantries, retrofitting existing sign assemblies, and relocating signs.

#### **4.7 RECOMMENDATIONS**

MPO staff recommends Alternative 2 in conjunction with Alternative 3 because of their beneficial effects on safety and operational efficiency. Alternative 2 removes entering and exiting traffic from the mainline travel lanes to the auxiliary lane. On the other hand, Alternative 1 forces traffic to merge onto the mainline as well as diverge from the mainline to exit the freeway, interrupting traffic flow.

# Chapter 5—Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way) and Exit 37B (I-95) in Woburn and Reading

Location 2 is on the I-93 southbound barrel before the I-95 interchange in Woburn. Figure 1 shows the location of the bottleneck within the MPO region. The affected section, approximately one-mile long, extends from the beginning of Commerce Way to Exit 37B (I-95 southbound). The interchange and roadways are under the jurisdiction of MassDOT Highway Division, which are located in District 4.

## 5.1 EXISTING FREEWAY CHARACTERISTICS

Operations at this bottleneck are associated with the freeway components described below.

### 5.1.1 BASIC FREEWAY SECTION

The basic freeway section on I-93 southbound has four 12-foot travel lanes, a two- to three-foot left shoulder, and an 11- to 12-foot right shoulder. During the AM peak period, I-93 southbound carries as many as 7,500 vehicles per hour upstream of the section under study.<sup>13</sup> The posted speed limit is 65 mph. As a result of recent resurfacing, neither side of I-93 southbound at this location is equipped with a rumble strip.

The basic freeway section on the adjacent I-95 southbound has three 12-foot travel lanes in the interchange that increase to four lanes after the merge from Exit 37B. It carries up to 6,800 vehicles per hour during the AM peak period and has a posted speed limit of 55 mph. The paved shoulder between ramps is about 10 feet wide.

### 5.1.2 Entrance Ramps

There are two merge facilities relevant to congestion at this bottleneck location. The ramp following Exit 37C on I-93 southbound is an on-ramp with access from Commerce Way. It is a one-way, one-lane roadway with a generous 1,100-foot

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<sup>13</sup> The AM peak period is 6:00 AM to 10:00 AM, and the PM peak period is 3:00 PM to 7:00 PM. Source: Central Transportation Planning Staff.



acceleration lane.<sup>14</sup> During the peak period, however, it only carries a merging volume of 150 vehicles per hour. Even though the percentage of heavy vehicles is high (10.9 percent), the demand at this ramp is too small to affect operations at the bottleneck.

The ramp following Exit 36 on I-95 southbound is an on-ramp that connects to the southern end of Commerce Way. It has a 730-foot acceleration lane, a posted speed limit of 30 mph, and a peak volume of 1,200 vehicles per hour. It is considered as part of this analysis because of the high peak volume and because the widespread congestion near the I-93/I-95 interchange is likely the result of several interconnected bottlenecks.

### 5.1.3 Exit Ramps

At Exit 37B, the exit ramp to I-95 southbound is a one-way, one-lane roadway. It carries as many as 1,900 vehicles per hour during the AM peak period. The length of the deceleration lane is 980 feet. Based on the highway design and exit ramp curve design speeds, the length of the deceleration lane meets MassDOT's standards. The posted speed limit on the exit ramp curve to I-93 is 30 mph.

Exit 36 on I-95 southbound is a low-volume ramp (600 vehicles per hour) that directly follows the merge from I-93 southbound. While the volume makes it unlikely to contribute to bottleneck conditions, it is important to note that recent restriping, which removed a lane upstream from this exit, means drivers now have to execute two lane changes within 1,500 feet to access this exit.

## 5.2 PROBLEMS

The high volume of traffic using Exit 37B during the AM peak period causes queues of exiting vehicles that stretch one-half mile or longer up the rightmost lanes of I-93 southbound. These queues frequently exceed the length of the deceleration lane. As a result of this, some drivers cross the rumble strip and queue in the right side shoulder. Other drivers stay in the main travel lanes and attempt to merge into the queue closer to the exit, either because of the lack of familiarity with the queues or the desire to cut ahead. This behavior interrupts the flow of through traffic on the southbound barrel.

## 5.3 CAUSES

MPO staff identified two factors that contribute to the bottleneck:

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<sup>14</sup> Acceleration and deceleration lanes are measured from the point where the lane reaches 12 feet wide to the first controlling curve. Source: *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2004. Chapter 10 Grade Separations and Interchanges.

- A high volume of traffic using Exit 37B to I-95 southbound during the AM peak period
- Insufficient queueing space for the ramp for Exit 37B

### 5.3.1 High Volume of Traffic

Figure 7 shows the traffic flows during the AM peak period. MassDOT ATR counts indicate that as many as 1,900 vehicles per hour are served by the Exit 37B ramp. However, vehicle speed data (see Section 5.4.2) and field observations show that there are significant queues present at this ramp during morning hours. This suggests that demand for the facility is likely greater than the capacity of the ramp. MPO staff estimates that the presence of a queue in this location adds 200 vehicles per hour to the peak value, bringing total peak ramp demand to 2,100 vehicles per hour.<sup>15</sup>

In addition to disrupting traffic on I-93 southbound, the high volume of traffic using Exit 37B also affects motorists on I-95 southbound. Merging vehicles interrupt the through traffic on I-95 southbound and force drivers to switch out of the right lane.

### 5.3.2 Insufficient Queueing Space

While the 980-foot deceleration lane is adequate for safe braking, it can only accommodate a queue of about 50 vehicles. Longer queues typically develop during the AM peak period, causing stopped traffic to spill into the breakdown or through lanes. This stopped traffic both interrupts smooth southbound flow and creates a safety hazard.

## 5.4 IMPACTS

### 5.4.1 Crashes

A summary of the crashes is presented in Table 6. There were 47 crashes in this section between 2010 and 2014 (Appendix C). Figure 8 shows the location of these crashes. The majority, 43 of the crashes, occurred in the vicinity of the diverge area at Exit 37B.

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<sup>15</sup> 200 vehicles per hour estimate uses a one-mile queue of vehicles spaced with 25-foot headways.

**TABLE 6.**  
**Crash Summary (2010–14):**  
**Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way)**  
**and Exit 37B (I-95)**

<b>Crash Variable</b>	<b>Number of Crashes</b>		
	<b>At Merge</b>	<b>At Diverge</b>	<b>Total</b>
<b>Crash severity</b>			
Fatal injury	0	0	0
Nonfatal injury	0	13	13
Property damage only	3	29	32
Not reported/unknown	1	1	2
<b>Manner of collision</b>			
Angle	2	4	6
Rear-end	0	23	23
Sideswipe, same direction	1	9	10
Single-vehicle crash	1	7	8
<b>Road surface conditions</b>			
Dry	3	38	41
Wet	0	2	2
Snow	1	1	2
Ice	0	1	1
Other	0	1	1
<b>Ambient light conditions</b>			
Daylight	0	34	34
Dark: lighted roadway	1	4	5
Dark: nonlighted roadway	3	4	7
Dark: unknown roadway lighting	0	1	1
<b>Weather conditions</b>			
Clear	1	28	29
Cloudy	1	4	5
Rain	0	3	3
Snow	1	1	2
Not reported/unknown	1	7	8
<b>Travel period</b>			
Peak	2	33	35
Off-peak	2	10	12
<b>Total crashes</b>	<b>4</b>	<b>43</b>	<b>47</b>
Five-year average (rounded)	1	9	9

Below is a summary of the crashes in this segment:

- 28 percent of the crashes resulted in injury
- 49 percent of the crashes were rear-end collisions, the largest share among collision types
- 87 percent of the crashes occurred under dry roadway conditions
- 28 percent of the crashes occurred outside daylight conditions
- 74 percent of the crashes occurred at peak travel periods

MPO staff believes that many of the rear-end and sideswipe crashes were caused by drivers slowing down to exit the freeway to I-95 or by drivers changing lanes. It appears that the short deceleration lane at this location may be contributing to poor traffic operations and the high number of crashes.

#### 5.4.2 Travel Speed

Figure 9 is a congestion scan that shows the average travel speeds on I-93 southbound at the bottleneck location ahead of Exit 37B. The bottleneck present at the I-95 interchange reduces travel speeds to less than 35 mph between the hours of 6 AM and 7 AM. Vehicle speeds this far below free-flow correlate with LOS F conditions on the freeway. Speeds can fall to less than 25 mph for up to half an hour at a time.

Figure 10 is a congestion scan that shows average travel speeds on I-95 southbound, which runs adjacent to the bottleneck at location 2. Conditions during the AM peak period are even worse on I-95 southbound, falling less than 25 mph between the hours of 7 AM and 9 AM. Importantly, the congestion scan shows that slowdowns worsen further down I-95 southbound. This suggests that the I-93 interchange is not the main cause of the congestion and that more issues are present further downstream on I-95.

#### 5.4.3 Level of Service

MPO staff conducted traffic operations analyses consistent with HCM methodologies. Using the MassDOT data, MPO staff built traffic analysis networks for the AM peak hours with the HCS suite to assess the capacity and quality of traffic flow at the bottleneck area.<sup>16</sup> Full HCS reports are included in Appendix D.

Table 7 presents the results of the LOS analyses for existing conditions at the bottleneck on I-93 southbound. The primary bottleneck is located at the diverge area at Exit 37B, but operations at nearby facilities are also included in Table 7.

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<sup>16</sup> Highway Capacity Software 7, Version 7.3, McTrans Center, PO Box 116585, Gainesville, Florida, 2017.

In addition, components of I-95 southbound were considered as part of the analysis as they affect merge conditions at the end of the Exit 37B ramp. Some simplifications were necessary to fit the HCS model more closely with observed conditions and are stated in the table notes.

**TABLE 7.**  
**LOS Analysis–Existing Conditions:**  
**Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way)**  
**and Exit 37B (I-95)**

<b>Location</b>	<b>Density (pc/lane mile)</b>	<b>Speed (mph)<sup>a</sup></b>	<b>V/C Ratio</b>	<b>LOS<sup>b</sup></b>
<i>HCM Analysis Type: Basic Freeway Segment</i>				
I-93 southbound: Between Exit 37C and Exit 37B	32.7	59.3	0.84	D
I-95 southbound: Between Exit 37 and Exit 36	29.5	51.3	0.68	D
<i>HCM Analysis Type: Merge Area<sup>c</sup></i>				
I-93 southbound: Ramp from Commerce Way	33.5	57.2	0.83	C
I-95 southbound: Ramp from I-93 southbound <sup>d,e</sup>	N/A <sup>f</sup>	N/A	0.74	F
I-95 southbound: Ramp from Commerce Way	36.6	49.4	0.81	D
<i>HCM Analysis Type: Diverge Area</i>				
I-93 southbound: Exit 37B to I-95 southbound	N/A	N/A	0.83	F
I-95 southbound: Exit 36 to Commerce Way	31.7	47.9	0.79	C
<i>HCM Analysis Type: Weaving Segment</i>				
I-95 southbound: Between Exit 37 and Exit 36 <sup>g</sup>	N/A	N/A	1.13	F

<sup>a</sup> Refers to ramp influence area speed for merge/diverge areas.

<sup>b</sup> LOS A through LOS D represent acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity).

<sup>c</sup> In HCM merge and diverge analyses, acceleration and deceleration lanes are measured from the tip of the painted gore to the end of the taper. This may differ from the AASHTO length.

<sup>d</sup> Uses maximum acceleration lane length of 1,500 feet to approximate a lane addition at this merge.

<sup>e</sup> Estimated demand flow rate of 2,100 vph used for Exit 37B ramp volumes in all existing condition analyses (see Section 5.3.1).

<sup>f</sup> HCM does not provide density and speed data for scenarios that result in LOS F.

<sup>g</sup> Uses a weaving segment of five lanes; therefore, limiting factor is weaving behavior and not mainline capacity. (HCM weaving analysis assumes a lane drop after the merge.)

HCM = Highway Capacity Manual; LOS = level of service; mph = miles per hour; pc/lane mile = passenger cars per lane mile; V/C = volume-to-capacity; vph = vehicles per hour

Table 7 shows that the Exit 37B ramp from I-93 southbound operates at LOS F at both ends (the diverge on I-93 and the merge on I-95). However, the volume-to-capacity (V/C) ratio for both of these facilities is well below 1.0, indicating that the capacity to serve merging and diverging maneuvers is not exceeded. The reason these facilities fail is because the ramp itself is over capacity: the ramp roadway has a V/C ratio of 1.14, meaning the volume experienced on this ramp is 14 percent above the theoretical maximum throughput of a ramp with the given characteristics. (Any V/C ratio above 1.0 causes LOS F operations.) All other facilities operate at LOS D or above.

## 5.5 IMPROVEMENT ALTERNATIVES

MPO staff developed the following improvements to address safety and operational issues at the bottleneck:

- Alternative 1: On I-93 southbound, create an auxiliary lane for merging and diverging traffic at Exit 37B (Figure 11)
- Alternative 2: On I-95 southbound, lengthen the acceleration lane at the merge from Commerce Way (Figure 12)
- Alternative 3: On the ramp connecting Exit 37B to I-95 southbound: consider employing a two-lane exit ramp (Figure 13)

The alternatives were analyzed using projected year 2030 traffic volumes. MPO staff estimated a five percent total background growth from 2017 to 2030.

### 5.5.1 Alternative 1: Create an Auxiliary Lane for Merging and Diverging Traffic at Exit 37B

Alternative 1 would extend the deceleration lane and create a full-width auxiliary lane between the on- and off-ramps. This lane would provide drivers with ample distance to decelerate safely and comfortably enter and exit the freeway. More importantly, it would also increase the available space for vehicles queueing for Exit 37B, keeping them sheltered from the high-speed traffic on the main southbound barrel.

Figure 11 shows the improvements recommended in Alternative 1:

- Add a 12-foot auxiliary lane in the southbound direction for a distance of approximately one mile between Exit 37C and Exit 37B. Use the available 12-foot shoulder for this auxiliary lane, and add an additional one- to two-feet of pavement widening where necessary to provide for a minimum two-foot shoulder.
- Relocate existing guide signs or install new guide signs and pavement markings to direct drivers to merge onto the mainline or to use Exit 37B.
- Modify pavement markings to delineate the auxiliary lane from the mainline travel lanes.

Because widening will not be possible on the bridge over West Street, a minor leftward shift (one to two feet) of the highway alignment may be necessary in this area if the right shoulder cannot provide enough width. There is plenty of clearance on the left shoulder on the bridge to allow for this shift.

### 5.5.2 Alternative 2: Lengthen the Acceleration Lane at the Merge from Commerce Way

I-95 southbound experiences chronic congestion during the AM peak period. While the merge from Commerce Way is not directly adjacent to the problem area, it is possible that it contributes to congested conditions on I-95, which may in turn reduce the capacity of the Exit 37B ramp.

While the existing acceleration lane is adequate according to MassDOT design standards, the ramp serves a high volume of traffic (1,200 vehicles per hour) during the AM peak. Extending the acceleration lane would help this traffic merge onto the I-95 mainline safely and efficiently.

Figure 12 shows the improvements recommended in Alternative 2:

- Extend the full-width acceleration lane at the Exit 36 on-ramp by 460 feet, lengthening it from 700 feet to 1,160 feet. Use the existing right-hand shoulder width (about 10 feet) and shift the highway alignment to the left by up to four feet where necessary to yield space for the 12-foot acceleration lane extension and two-foot shoulder. Shift the alignment into the existing 10-foot left shoulder where necessary.
- Modify pavement markings in accordance with the new acceleration lane geometry.

### 5.5.3 Alternative 3: Use a Two-Lane Ramp at Exit 37B

Because the demand flow rate at Exit 37B (2,100 vehicles per hour) exceeds the capacity for a single-lane roadway, it is likely that the ramp itself is the limiting factor at this interchange. For this reason, the MPO staff decided to compare the advantages of this higher-cost alternative that would have the potential to increase capacity on the exit ramp.

Using a two-lane ramp at Exit 37B would require significant geometric changes on both I-93 southbound and I-95 southbound. Figure 13 shows the improvements recommended in Alternative 3:

- Create an auxiliary lane as in Alternative 1 on I-93 southbound
- Use a two-lane exit consisting of two exit-only lanes: the abovementioned auxiliary lane and the fourth lane (second from right)

- Drop the rightmost lane for the bridge over I-95, and re-add the lane at the merge from I-95 southbound
- Use existing shoulder space to widen the freeway to five lanes between exits 37 and 36 on I-95 southbound, establishing lane balance in this stretch. The right-most lane would become an exit-only lane and would be dropped at Exit 36

While all of the other modifications mentioned above would be relatively minor in scale, the expansion of the ramp would require construction and, possibly, land takings, both at significant cost. The existing ramp is tightly spaced: directly abutting it to the left is the on-ramp from I-95 southbound, while the nearest property line is only approximately 50 feet from the edge of the pavement. There is also a fairly significant downgrade in this direction, meaning adding a lane on the right side of the ramp would probably require fill, and the resulting embankment could extend beyond the existing right-of-way.

## 5.6 EFFECTIVENESS AND COST OF THE IMPROVEMENTS

Table 8 presents the 2030 future LOS analyses compiled using the HCS software. Results for the no-build scenario are compared against Alternative 1, Alternative 2, and Alternative 3 for all facilities where modifications affect system operations. All scenarios use a uniform five percent growth for 2030 traffic volumes. Approximations made as part of the HCM analysis are given where applicable.

**TABLE 8.**  
**LOS Analysis–Improvement Alternatives:**  
**Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way)**  
**and Exit 37B (I-95)**

Location	Scenario	Density (pc/lane mile)	Speed (mph)	V/C Ratio	LOS
<i>HCM Analysis Type: Basic Freeway Segment</i>					
I-93 southbound: Between Exit 37C and Exit 37B	No-Build	35.2	57.8	0.88	E
	Alt 1	26.3	62.0	0.70	D
I-93 southbound: After Exit 37B	No-Build	24.4	62.2	0.65	C
	Alt 3	35.0	57.9	0.87	D
I-95 southbound: Between Exit 37 and Exit 36	No-Build	34.0	51.3	0.79	D
	Alt 3	27.6	50.7	0.63	D
<i>HCM Analysis Type: Merge Area</i>					
I-93 southbound: Ramp from Commerce Way <sup>a</sup>	No-Build	35.5	56.8	0.87	C
	Alt 1	35.3	57.4	0.87	C
I-95 southbound: Ramp from	No-Build	38.8	49.0	0.85	D



Commerce Way	Alt 2	38.6	49.4	0.85	C
I-95 southbound: Ramp from	No-Build	N/A <sup>b</sup>	N/A	0.78	F
I-93 southbound	Alt 3	34.0	51.2	0.78	A
<i>HCM Analysis Type: Diverge Area</i>					
I-93 southbound: Exit 37B to	No-Build	N/A	N/A	0.87	F
I-95 southbound	Alt 1	N/A	N/A	0.87	F
	Alt 3 <sup>c</sup>	35.7	48.9	0.87	A
I-95 southbound: Exit 36 to	No-Build	33.5	47.8	0.83	D
Commerce Way	Alt 3	35.2	47.8	0.87	C
<i>HCM Analysis Type: Weaving Segment<sup>d</sup></i>					
I-95 southbound: Between	No-Build	N/A	N/A	1.19	F
Exit 37 and Exit 36	Alt 3	N/A	N/A	1.19	F

<sup>a</sup> Uses an acceleration lane of 1,500 feet as an approximation for a full auxiliary lane in the Alternative 1 and Alternative 3 merge and diverge models.

<sup>b</sup> HCM does not provide density and speed data for scenarios that result in LOS F.

<sup>c</sup> Uses a diverge segment of four through lanes for Alternative 3; therefore, limiting factor is diverge capacity and not mainline capacity. (HCM analysis assumes lanes are never dropped after diverge.)

<sup>d</sup> Uses a weaving segment of five lanes; therefore, limiting factor is weaving behavior and not mainline capacity. (HCM weaving analysis assumes a lane drop after the merge.)

HCM = Highway Capacity Manual; LOS = level of service; mph = miles per hour; pc/lane mile = passenger cars per lane mile; V/C = volume-to-capacity

### 5.6.1 Effectiveness and Cost of Alternative 1

CMF from HSM and the CMF Clearinghouse shows that adding a continuous auxiliary lane for weaving between entrance ramp and exit ramp would reduce crashes by 20 to 25 percent. Alternative 1 was able to improve the LOS of the basic freeway segment on I-93 southbound from LOS E to LOS D, meaning capacity of the facility was significantly improved.

The LOS experienced by motorists using Exit 37B remains unchanged at LOS F because the ramp capacity is unaffected. The V/C ratio of the Exit 37B ramp roadway increases from 1.14 to 1.20 under 2030 no-build conditions, resulting in LOS F performance for both the diverge at Exit 37B and the merge with I-93 southbound at the end of the ramp. However, these metrics do not take into account the safety and driver comfort provided by the additional queue space present under Alternative 1.

Alternative 1 is estimated to cost between \$100,000 to \$200,000 to construct. This estimate includes preparing the shoulder for a travel lane, restriping travel lanes, relocation and installation of signs, new rumble strips, and pavement markings. New paving may be required if an emergency pullover area is necessary.

### 5.6.2 Effectiveness and Cost of Alternative 2

CMF from HSM and the CMF Clearinghouse shows that lengthening an acceleration lane would reduce crashes by 10 to 20 percent. Alternative 2 was able to increase LOS at the on-ramp at Exit 36 (from Commerce Way to I-95 southbound) from D to C, even though the speed and density at this merge were essentially unchanged. This may lead to an improvement, albeit small, in the overall capacity of I-95 southbound in this area. While this may also lead to improved operations at the I-93 interchange and consequently at the bottleneck on I-93 southbound, HCM analysis methods are unable to directly correlate these two outcomes.

Alternative 2 is estimated to cost between \$50,000 and \$75,000 to construct and would require lengthening the acceleration lane, restriping travel lanes, minor paving, and relocating rumble strips.

### 5.6.3 Effectiveness and Cost of Alternative 3

CMF for converting a single-lane exit into a two-lane exit shows that Alternative 2 would reduce crashes at Exit 37B by up to 30 percent. Alternative 3 was the only option able to improve the LOS on the facilities at Exit 37B. Both the merge and diverge area change from LOS F to LOS A when the ramp is widened to two lanes. Accordingly, the V/C ratio for the ramp roadway is cut in half, improving from 1.20 to 0.60. This configuration required removing a lane on I-93 southbound downstream from the exit, which lowered the LOS in this area from C to D.

While the projected LOS improvements under Alternative 3 are significant, in reality induced demand as direct result of the improvements could lower the LOS from A to B or C. Alternative 3 is estimated to cost approximately \$ 1.0million, which would include widening on the ramp to two lanes, reconfiguring travel lanes on both I-93 and I-95, installing new signs, preparing the shoulder on I-95 southbound for a travel lane, and new paving and rumble strips.

## 5.7 LONG-TERM PLAN FOR I-93/I-95 INTERCHANGE

The Massachusetts Office of Transportation Planning has a long-range plan for the I-93/I-95 interchange because of its chronic problems.<sup>17</sup> Conceptual alternatives for this plan are focused around adding flyovers or underpasses for some of the ramps at the interchange. Although it would keep all ramps with a single lane, this design would reduce the number of merge areas and make all

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<sup>17</sup> I-93/I-95 Interchange Transportation Study, produced by the Massachusetts Executive Office of Transportation Office of Transportation Planning, June 2007.

ramps high speed, both of which would greatly increase overall capacity at the interchange. The new configuration would also reduce traffic noise experienced in neighboring residential communities by increasing clearance and adding noise barriers. The potential major investment planned at this interchange should be taken into account when deciding on short-term solutions.

## 5.8 RECOMMENDATIONS

MPO staff recommends Alternatives 1 and 2, both of which are low-cost solutions. Together, they would produce maximum operational benefits as Alternative 2 would reduce a downstream bottleneck and allow the auxiliary lane to function well. Because the I-93 and I-95 interchange already has a long-term improvement planned for it, the low-cost improvements identified in Alternatives 1 and 2 align with the objectives and vision for the interchange. Although Alternative 3 improves the LOS on the exit ramp, it is costly and will affect the abutting properties, and must be considered while taking into account the long-term plans for the interchange.

# Chapter 6—Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93) in Randolph, Canton, and Stoughton

Location 3 is a stretch of Route 24 northbound leading up to its northern terminus at the interchange with Interstate 93 (Route 24, Exit 21). Figure 1 shows the location of the bottleneck within the MPO region. The high volumes at this merge are the main cause for poor operating conditions. During the AM peak period, congestion can extend south for more than five miles, all the way into Avon.<sup>18</sup> The segment in question begins in Stoughton, which is in MassDOT Highway Division, District 5, and continues north through Canton and Randolph, which are both in MassDOT Highway Division, District 6.

## 6.1 EXISTING FREEWAY CHARACTERISTICS

Operations at this bottleneck are associated with the freeway components described below.

### 6.1.1 BASIC FREEWAY SECTION

Route 24 northbound is a freeway segment with three 12-foot travel lanes, a 12- to 13-foot right shoulder, and a two- to three-foot left shoulder. This segment carries volumes of up to 4,600 vehicles per hour during the AM peak because of the severe bottleneck at the interchange with I-93, with trucks comprising a not insignificant amount of the volume at approximately five percent. The posted speed limit is 65 mph on the Route 24 northbound mainline and decreases to 50 mph at the ramps. Rumble strips are present on the right side of the northbound barrel.

### 6.1.2 Major Diverge Area

A major diverge occurs when a basic freeway segment with three or more lanes splits into two multilane roadways. This is the case at the end of Route 24 northbound, where the main barrel splits into two two-lane, high-speed ramp segments that connect to I-93 northbound and southbound. The speed limit decreases from 65 mph to 50 mph at the connector ramps.

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<sup>18</sup> The AM peak period is 6:00 AM to 10:00 AM, and the PM peak period is 3:00 PM to 7:00 PM. Source: Central Transportation Planning Staff.

### 6.1.3 Merge Areas

The right branch of Route 24 northbound merges with I-93 northbound at a major merge area. Figure 14 shows the lane configuration at this location. Here, the two-lane ramp merges into the right side of the three-lane main barrel. These five total lanes become a four-lane freeway by combining the two center lanes. This ramp serves approximately 2,300 vehicles per hour during the AM peak period.

The left branch of Route 24 northbound merges with I-93 southbound on the left-hand side, and continues in its own lane as shown in Figure 15. Approximately 1,200 feet before the merge with I-93, however, the two-lane traffic on the ramp is forced to merge into a single travel lane. This is the result of restriping that took place between 2010 and 2013.<sup>19</sup> This ramp serves approximately 2,300 vehicles per hour during the AM peak period.

## 6.2 PROBLEMS

The existing bottleneck creates intense interruption of traffic flow during the AM peak travel period. During these hours, queues of up to five miles long form as drivers wait to merge onto I-93 southbound. These waiting drivers back up onto the Route 24 northbound mainline and prevent vehicles from accessing the otherwise uncongested ramp to I-93 northbound. This scenario results in slow speeds and low LOS that affect virtually all drivers using the facility. The bottleneck also likely contributes to crashes in this area.

## 6.3 CAUSES

MPO staff identified four primary factors contributing to this bottleneck:

- A high volume of traffic using Exit 21 to I-93 during the AM peak period
- A short diverge length where the two ramps split at the I-93 interchange
- The forced merge to a single lane on the I-93 southbound ramp
- A short merge length at the I-93 northbound ramp

### 6.3.1 High Volume of Traffic

Figure 14 shows the hourly traffic flow during the AM peak period. Usage of both the I-93 ramps is very high, especially in the AM peak as traffic flows north towards Boston and the business areas located along Route 128. The merging and diverging maneuvers of these vehicles interrupt traffic flow and reduce capacity, resulting in a traffic bottleneck.

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<sup>19</sup> I-93 and I-95 Transportation Improvement Project. This project, which is currently under construction, added a lane in each direction to I-93 and I-95 from Randolph to Wellesley.

### 6.3.2 Short Widening Distance at Major Diverge

The three-lane Route 24 northbound barrel begins to widen to four lanes only approximately 190 feet ahead of the painted gore nose at the I-93 ramps. The short maneuvering distance available causes sudden maneuvers, reducing speeds and producing unsafe conditions.

### 6.3.3 Merge to Single Lane on I-93 Southbound Ramp

The ramp to I-93 southbound serves up to 2,300 vehicles per hour during the AM peak. On most mornings there is also a queue of vehicles waiting to use the ramp that can extend for up to five miles down Route 24. MPO staff estimate that the presence of a queue in this location adds 700 vehicles per hour to the peak value, bringing total peak demand for the I-93 southbound ramp to 3,000 vehicles per hour.<sup>20</sup>

According to the HCM, the capacity for a single lane ramp roadway segment with a free-flow speed of 50 mph is 2,200 vehicles per hour.<sup>21</sup> Therefore the practical capacity of this ramp is exceeded even before queued vehicles are considered. This leads to severe congestion and is the largest contributor to bottleneck conditions at this location.

### 6.3.4 Geometry at I-93 Northbound Merge

At major merge locations with lane drops, MassDOT design standards recommend that only the rightmost lanes be forced to merge. This is not the case at the I-93 northbound merge, where the middle lanes merge. Merging these lanes instead of the exterior lanes causes safety issues because of the higher vehicle speeds, and also may lead to confusion regarding who has the right of way. The merge also begins only 90 feet from the end of the gore area, forcing drivers to make very rapid maneuvers.

Because of the proximity to the next off-ramp (the ramp to Route 28 southbound begins to diverge only 1,450 feet downstream from the Route 24 merge), the only option for changing the geometry at this merge is to add an auxiliary lane covering the full distance between the two ramps. The existing shoulder along this stretch is not adequate to accommodate a fifth travel lane; creating an auxiliary lane would require extensive paving and fill, making this a high-cost option and, therefore, outside of the scope of this report. An analysis of an auxiliary lane on this segment of I-93 northbound can be found in the Boston

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<sup>20</sup> 700 vehicles per hour estimate uses a five-mile queue of vehicles spaced with 25-foot headways, spread over 1.5 lanes, and dispersed over the course of two hours.

<sup>21</sup> Highway Capacity Manual 2010, Transportation Research Board of the National Academies, Washington, DC, December 2010. 13-18.

MPO's 2007 memorandum "Safety and Operational Improvements for the I-93/Route 24 Interchange."<sup>22</sup>

## 6.4 IMPACTS

### 6.4.1 Crashes

A summary of the crashes in this segment is presented in Table 9. There were 96 crashes in this area between 2010 and 2014 (Appendix C). Figure 15 shows the location of these crashes. The majority (63 crashes) occurred leading up to the diverge at the I-93 interchange.

**TABLE 9.**  
**Crash Summary (2010–14):**  
**Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93)**

Crash Variable	Number of Crashes			Total
	Rte. 24 NB Exit 21 (Diverge)	Merge with I-93 NB	Merge with I-93 SB	
<b>Crash severity</b>				
Fatal injury	1	0	0	1
Non-fatal injury	22	7	4	33
Property damage only	32	10	10	52
Not reported	8	1	1	10
<b>Manner of collision</b>				
Angle	1	3	1	5
Head-on	0	0	1	1
Rear-end	24	9	4	37
Sideswipe, same direction	10	2	2	14
Single-vehicle crash	28	4	7	39
<b>Road surface conditions</b>				
Dry	52	13	10	75
Snow	3	0	1	4
Wet	8	5	4	17
<b>Ambient light conditions</b>				
Dawn	3	1	0	4
Daylight	38	11	12	61
Dusk	2	1	1	4

<sup>22</sup> Seth Asante, MPO staff, memorandum to the Transportation Planning and Programming Committee of the Boston Region MPO, "Safety and Operational Improvements for the I-93/Route 24 Interchange," September 2007.

Dark: lighted roadway	3	2	1	6
Dark: roadway not lighted	16	3	1	20
Dark: unknown lighting	1	0	0	1
<b>Weather conditions</b>				
Clear	41	11	7	59
Cloudy	10	0	3	13
Rain	1	3	2	6
Snow	4	0	1	5
Not reported	7	4	2	13
<b>Travel period</b>				
Peak	27	7	8	42
Off-peak	36	11	7	54
<b>Total crashes</b>	<b>63</b>	<b>18</b>	<b>15</b>	<b>96</b>
Five-year average (rounded)	13	4	3	19

NB = northbound; SB = southbound

Below is a summary of the crashes in this area:

- 35 percent of the crashes resulted in injury, including one fatal injury
- 41 percent of the crashes were single-vehicle collisions, the largest share among collision types
- 44 percent of the crashes occurred during the peak travel period
- 28 percent of the crashes occurred outside daylight conditions
- 78 percent of the crashes occurred under dry roadway conditions

### 6.4.2 Travel Speed

Figure 16 is a congestion scan that shows the average travel speeds on Route 24 northbound ahead of the bottleneck at the I-93 interchange. Congestion at this location reduces travel speeds to less than 35 mph between the hours of 6 AM and 9 AM. Vehicle speeds this far below free-flow correlate with a freeway LOS of F. Speeds on this segment can fall to less than 25 mph for up to 45 minutes at a time. Varying levels of congestion extend for more than six miles down Route 24. One notable feature of the congestion scan is that speeds begin to improve slightly approximately one-half mile ahead of the interchange. This is the result of traffic headed to I-93 northbound finally being able to pass the queue for I-93 southbound when they near the ramps. No congestion develops outside of AM peak hours.

Travel on I-93 is also affected by this bottleneck. Figure 17 shows a congestion scan for I-93 northbound near Route 24, and Figure 18 shows a congestion scan for I-93 southbound near Route 24. The congestion scans show moderate congestion on these roadways during the AM peak period. On I-93 northbound,



traffic near the Route 24 interchange slows less than 45 mph between the hours of 8 AM and 9 AM. However, the scan shows that this is the tail end of congestion that originates further north on I-93. On I-93 southbound, congestion present between 7 AM and 9 AM slows travel speeds to less than 45 mph. Unlike the congestion in the northbound direction, this slowdown peaks around the Route 24 interchanges and begins to dissipate soon afterwards, suggesting that this interchange is the cause.

### 6.4.3 Level of Service

MPO staff conducted traffic operations analyses consistent with HCM methodologies. Using the MassDOT data, MPO staff built traffic analysis networks for the AM peak hours with the HCS suite to assess the capacity and quality of traffic flow at the bottleneck area.<sup>23</sup> Full HCS reports are included in Appendix D.

Unfortunately, the HCM is unable to model performance effectively for major merge or diverge areas. LOS can be approximated by checking capacities of each component segment as basic freeway segments. However, using a basic freeway segment tends to overestimate the capacity of merge or diverge areas because merging maneuvers are ignored and because traffic is assumed to be evenly distributed across all lanes. The results of the analysis are shown in Table 10.

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<sup>23</sup> Highway Capacity Software 7, Version 7.3, McTrans Center, PO Box 116585, Gainesville, Florida, 2017.

**TABLE 10.**  
**LOS Analysis–Existing Conditions:**  
**Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and**  
**Exit 21 (I-93)**

Location	Density (pc/lane mile)	Speed (mph) <sup>a</sup>	V/C Ratio	LOS <sup>b</sup>
<i>HCM Analysis Type: Basic Freeway Segment</i>				
Route 24 northbound at diverge	25.9	62.5	0.70	C
<i>HCM Analysis Type: Merge Area<sup>c</sup></i>				
Merge with I-93 southbound	N/A <sup>d</sup>	N/A	0.79	F
<i>HCM Analysis Type: Basic Freeway Segment</i>				
I-93 southbound downstream from merge	33.9	51.8	0.79	D

<sup>a</sup> Refers to ramp influence area speed for merge/diverge areas.

<sup>b</sup> LOS A through LOS D represent acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity).

<sup>c</sup> Uses maximum acceleration lane length of 1,500 feet and a four-lane mainline to approximate a lane addition at this merge.

<sup>d</sup> HCM does not provide density and speed data for scenarios that result in LOS F.

HCM = Highway Capacity Manual; LOS = level of service; mph = miles per hour; pc/lane mile = passenger cars per lane mile; V/C = volume-to-capacity

Table 10 shows that the merge to I-93 southbound operates at LOS F during the AM peak period. However, the V/C ratio for this facility is well below 1.0, indicating that its capacity to accommodate merge maneuvers is not exceeded. The reason the facility fails is because the ramp itself is over capacity: the ramp roadway has a V/C ratio of 1.16, meaning the volume experienced on this ramp is 16 percent above the theoretical maximum throughput of a ramp with the given characteristics. (Any V/C ratio above 1.0 causes LOS F operations.) The merge area operates at LOS C during the AM peak, although, as stated before, this model is an approximation that will generally predict a LOS better than that experienced by drivers.

## 6.5 IMPROVEMENT ALTERNATIVES

MPO staff developed the following improvements to address safety and operational issues at the bottleneck:

- Alternative 1: Widen Route 24 northbound to four lanes for a stretch of approximately 1,200 feet between the I-93 interchange and the horse bridge (Figure 19).
- Alternative 2: Widen Route 24 northbound to four lanes in a similar manner to Alternative 1, but continue the extra lane south until the Canton Street bridge for a total length of approximately 4,000 feet (Figure 20).
- Alternative 3: Remove the merge on the ramp to I-93 southbound (Figure 21).

The alternatives were analyzed using projected year 2030 traffic volumes. MPO staff estimated a five percent total background growth from 2017 to 2030.

### 6.5.1 Alternative 1: Widen Route 24 Northbound to Four Lanes between I-93 and Horse Bridge

The 36-foot, three-lane mainline of Route 24 northbound widens to a 48-foot, four-lane diverge section only approximately 200 feet before the tip of the merge gore area. MPO staff recommends extending the four lanes present on the ramp for 1,200 feet down Route 24.

Figure 19 shows the improvements recommended in Alternative 1:

- Begin a taper shortly after the existing horse bridge that expands the right-hand travel lane to two 12-foot lanes over a distance of 600 feet.
- Continue these four lanes for 1,200 feet up through the diverge at the I-93 ramps. There is adequate paved shoulder on the right-hand side to accommodate the extra travel lane and maintain a two-foot right shoulder along this distance.
- Switch to exit-only lanes one-half mile upstream from the diverge. Indicate this change using overhead signage and a wide dotted line between the middle two lanes, as can be seen at the diverge between I-93 northbound and Route 3 southbound at the Braintree split.
- Create one emergency pullover area using new paving to address incidents and safety concerns related to the use of the shoulder as a travel lane.

### 6.5.2 Alternative 2: Widen Route 24 Northbound to Four Lanes between I-93 and Canton Street

The modifications present in Alternative 1 help to address the vehicle slowdowns and safety risks that come as a result of turbulence ahead of the Exit 21 diverge. What is not addressed, however, is the fact that the queue for I-93 southbound inhibits vehicles from using the ramp to I-93 northbound. Since Alternative 1 only proposes a fourth lane across a distance of approximately one-quarter mile, any queues longer than this still have the potential to block access to the northbound ramp.

Alternative 2 would extend the fourth travel lane nearly one mile down to the bridge over Canton Street in Randolph. This would provide more room for approximately 400 vehicles to queue in the left two lanes for I-93 southbound without interrupting other traffic. While there is adequate right-hand side shoulder space for a fourth lane along almost this entire stretch, accommodating the horse

bridge that passes over Route 24 may require a slight shift to the left of the traveled way.

Figure 20 shows the improvements recommended in Alternative 2:

- Begin a taper shortly after the existing bridge over Canton Street that expands the right-hand travel lane to two 12-foot lanes over a distance of 600 feet.
- Continue these four travel lanes for 4,000 feet through the diverge at the I-93 ramps. Use the existing right-hand side paved shoulder for this new lane, and maintain a two-foot right shoulder.
- Shift the highway alignment to the left slightly, starting 400 feet upstream from the horse bridge and ending 400 feet downstream from it. This shift is required because of decreased right-hand shoulder space near the bridge footing. The maximum shift would be two feet and would occur as Route 24 passes under the horse bridge. Use the existing left-hand side paved shoulder to accommodate this shift. Relocate the existing left guardrail.
- Switch to exit-only lanes one-half mile upstream from the diverge. Indicate this change using overhead signage and a wide dotted line between the middle two lanes, as can be seen at the diverge between I-93 northbound and Route 3 southbound at the Braintree split.

### 6.5.3 Alternative 3: Remove the Merge on the Ramp to I-93 Southbound

The ramp from Route 24 northbound to I-93 southbound is wide enough to accommodate two travel lanes and was previously striped in this way. MPO staff recommends returning to a two-lane ramp to better meet the demand during the AM peak period.

Figure 21 shows the improvements recommended in Alternative 3:

- Remove the merge on the ramp from Route 24 northbound to I-93 southbound. Use the hatched area on the right side of the ramp to continue the second ramp lane.
- Add a 1,000-foot acceleration lane for the leftmost ramp lane. This is the distance the MassDOT design guide recommends before forcing a lane drop at a major merge area. Shift the I-93 southbound highway alignment to the right along this distance to accommodate a fifth 12-foot travel lane. Use the existing paved area on both the left and right shoulders to provide the required additional width. The left shoulder would be reduced from 10 feet to two feet, and the right shoulder would be reduced as needed by up to three feet from approximately 10 feet to seven feet. Follow the acceleration lane with a 500-foot taper.

- Shift the left-hand and right-hand rumble strips along this stretch to match the new lane configuration.
- Add new guide signs and appropriate MUTCD-compliant pavement markings to direct drivers to merge right from the acceleration lane.

The length of the acceleration lane and subsequent taper may be limited by the culvert structure that carries the Blue Hill River.

## 6.6 EFFECTIVENESS AND COST OF THE IMPROVEMENTS

Table 11 presents the 2030 future LOS analyses compiled using the HCS software. Results for the no-build scenario are compared against Alternatives 1 and 2 combined and Alternative 3 for all facilities where modifications affect system operations. (The main difference between Alternative 1 and Alternative 2 is the queue length they can accommodate, and because this does not affect HCM analysis they are combined in Table 11.) All scenarios use a uniform five percent growth for 2030 traffic volumes. Approximations made as part of the HCM analysis are given where applicable.

**TABLE 11.**  
**LOS Analysis–Improvement Alternatives:**  
**Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93)**

Location	Scenario	Density (pc/lane mile)	Speed (mph)	V/C Ratio	LOS
<i>HCM Analysis Type: Basic Freeway Segment</i>					
Route 24 northbound at diverge	No-Build	27.4	62.0	0.73	D
	Alt 1 and 2	20.7	61.5	0.55	C
I-93 southbound after merge	No-Build	35.6	51.8	0.83	E
<i>HCM Analysis Type: Merge Area<sup>a</sup></i>					
Merge with I-93 southbound	No-Build	N/A <sup>b</sup>	N/A	0.83	F
	Alt 3	36.6	51.0	0.83	B

<sup>a</sup> Uses maximum acceleration lane length of 1,500 feet and a four-lane mainline to approximate a lane addition at this merge.

<sup>b</sup> HCM does not provide density and speed data for scenarios that result in LOS F.  
HCM = Highway Capacity Manual; LOS = level of service; mph = miles per hour; pc/lane mile = passenger cars per lane mile; V/C = volume-to-capacity

### 6.6.1 Effectiveness and Cost of Alternative 1

A CMF is an estimate of the change in crashes expected after implementation of a countermeasure. Using CMFs from the CMF Clearinghouse for installing an additional lane for an urban freeway shows that Alternative 1 would reduce

crashes at the diverge area by up to 20 percent.<sup>24,25</sup> As mentioned before, the only methodology HCM provides to study major diverge areas is to model them as basic freeway segments. Table 11 compares an analysis of a three-lane basic freeway segment at the diverge with a four-lane basic freeway segment. The additional lane improves LOS by one level over the no-build scenario, bringing it to LOS C from LOS D during the AM peak period.

The basic freeway segment analysis can be misleading because the real cause of the bottleneck is diverging vehicles and not the base capacity of the freeway. However, the analysis demonstrates that adding the lane significantly increases capacity. This increased capacity will help to offset the capacity reduction resulting from the diverge. The extra lanes will also help avoid driver confusion at the split lane, and allow traffic heading to I-93 northbound to bypass the queued traffic heading to I-93 southbound during the AM peak period.

Alternative 1 is estimated to cost between \$100,000 and \$200,000 to construct. This estimate includes preparing the shoulder for a travel lane, restriping travel lanes, relocation and installation of signs, and minor pavement markings. It may require a DER for using a less-than-minimal right shoulder. New paving may be required if an emergency pullover area is necessary.

### 6.6.2 Effectiveness and Cost of Alternative 2

Alternative 2 is expected to reduce crashes by the same percentage as in Alternative 1. Based on parameters that HCM methodology can measure, Alternative 2 performs the same as Alternative 1. However, the extended fourth travel lane will increase capacity on Route 24 over a longer distance and allow more drivers to use this extra lane to skip morning queues that develop in advance of the I-93 southbound merge. Alternative 2 is estimated to cost between \$300,000 and \$400,000 to construct. Similar to Alternative 1, Alternative 2 may require a DER for using a less-than-minimal right shoulder, and new paving may be required if an emergency pullover area is necessary.

### 6.6.3 Effectiveness and Cost of Alternative 3

Using CMFs from the HSM and the CMF Clearinghouse for lengthening an acceleration lane show that Alternative 3 would reduce crashes at the merge area by 10 to 20 percent.<sup>26,27</sup> Using estimates for ramp roadway capacity, the

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<sup>24</sup> American Association of State Highway and Transportation Officials. Highway Safety Manual. Washington, DC, 2010.

<sup>25</sup> Crash Modification Factors Clearinghouse, [www.cmfclearinghouse.org/index.cfm](http://www.cmfclearinghouse.org/index.cfm)

<sup>26</sup> American Association of State Highway and Transportation Officials. Highway Safety Manual. Washington, DC, 2010.

<sup>27</sup> Crash Modification Factors Clearinghouse, [www.cmfclearinghouse.org/index.cfm](http://www.cmfclearinghouse.org/index.cfm)

single lane I-93 southbound ramp will be at a V/C ratio of 1.21 under the 2030 no-build scenario. A V/C ratio higher than 1.0 indicates that not only is user experience very poor, but that the facility cannot meet demand and extensive queues will form. This may lead to problems on nearby facilities. With a two-lane ramp, the V/C ratio drops to 0.61, demonstrating that two lanes are sufficient to meet the projected future demand.

The one- and two-lane ramps were also compared as traditional merge segments. Using this analysis, the two-lane ramp improved from LOS F to LOS B. However, the downstream basic freeway segment (after I-93 southbound returns to four travel lanes) has a LOS of E in 2030 and will not be changed by either proposed alternative. Therefore the downstream freeway segment is the limiting factor, meaning that only merging vehicles will see improved operations and through traffic will experience no change from Alternative 3.

Alternative 3 is estimated to cost between \$100,000 and \$200,000 to construct. This estimate consists of restriping the connector ramp, pavement markings, and preparing a short segment of shoulder on I-93 southbound to allow a two-lane entry from Route 24 northbound to I-93 southbound.

## 6.7 RECOMMENDATIONS

MPO staff recommends implementation of both Alternative 2 and Alternative 3 to improve operational efficiency for all traffic on Route 24 northbound. For a more in-depth discussion of alternatives affecting this bottleneck, including right-hand ramps and auxiliary lane additions, refer to the Boston MPO's 2007 report on this location.<sup>28</sup>

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<sup>28</sup> Safety and Operational Improvements for the I-93/Route 24 Interchange, produced by the Central Transportation Planning Staff of the Boston Region MPO, September 2007.

# Chapter 7—Location 4: Route 24 Southbound Segment between Exit 21 (I-93) and Exit 20 (Route 139) in Randolph, Canton, and Stoughton

Location 4 is on Route 24 southbound after the Interstate 93 interchange. Figure 1 shows the location of the bottleneck within the MPO region. The high volumes at these ramps are the main cause of poor operating conditions. Heavy congestion is usually present on both the Route 24 southbound ramps for the entire duration of the PM peak period.<sup>29</sup> The study area begins at the I-93 interchange in Randolph (I-93 Exit 4) and extends southward through Canton to the Route 139 ramp in Stoughton (Route 24 Exit 20). Randolph and Canton are part of MassDOT Highway Division, District 6 and Stoughton is part of District 5. This bottleneck parallels Location 3 in the southbound direction.

## 7.1 EXISTING FREEWAY CHARACTERISTICS

Operations at this bottleneck are associated with the freeway components described below.

### 7.1.1 Major Diverge Areas

A major diverge occurs when a basic freeway segment with three or more lanes splits into two multilane primary freeway segments. The off-ramps leading to Route 24 southbound are two-lane ramps splitting from a four-lane freeway, qualifying them as major diverge areas. Both geometries use a center lane that splits into two at the diverge, and both ramps have a speed limit of 50 mph. However, the ramp from I-93 southbound is a left-hand side diverge while the northbound ramp is a right-hand side diverge. Demand for these ramps is highest during the PM peak, with up to 2,700 vehicles per hour using the ramp from I-93 northbound and up to 2,600 vehicles per hour using the ramp from I-93 southbound.

### 7.1.2 Major Merge Area

The two Route 24 southbound ramps meet at a major merge area. The configuration at this location has two two-lane ramps merging to become the

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<sup>29</sup> The AM peak period is 6:00 AM to 10:00 AM, and the PM peak period is 3:00 PM to 7:00 PM. Source: Central Transportation Planning Staff.



three-lane Route 24 southbound barrel. Lane balance is achieved by combining the two center lanes. This junction serves 6,200 vehicles per hour during the PM peak period.

### 7.1.3 Basic Freeway Section

Route 24 southbound is a freeway segment with three 12-foot travel lanes, a 12- to 13-foot right shoulder, and a two- to three-foot left shoulder. The posted speed limit is 65 mph on the Route 24 southbound mainline. Rumble strips are present on the right side of the southern barrel.

## 7.2 PROBLEMS

The existing bottleneck creates intense interruption of traffic flow during the PM peak travel period. During these hours, travel speeds are reduced and queues back up on both ramps leading to Route 24 southbound. These waiting drivers can spill onto both branches of I-93 and interfere with through traffic. In addition, the bottleneck likely contributes to crashes in this area.

## 7.3 CAUSES

MPO staff identified two primary factors contributing to this bottleneck:

- A generally high volume of traffic using I-93 Exit 4 to Route 24 during the PM peak period
- Suboptimal merge geometry at the start of Route 24 southbound

### 7.3.1 High Volume of Traffic

Figure 22 shows the hourly traffic flow during the PM peak periods. Usage of both the I-93 ramps is very high in the evening hours as traffic flows south out of Boston. The merging and diverging maneuvers of these vehicles interrupt traffic flow and reduce capacity, resulting in a traffic bottleneck.

### 7.3.2 Geometry at the Major Merge

The geometry where the ramps from I-93 merge is problematic for two reasons. First, the merge distance is very short. The 48-foot width present where the four ramp lanes meet begins to narrow and merge into three lanes immediately after the end of the painted gore nose. Drivers using the two center lanes are forced to make merge decisions quickly as they negotiate for space with drivers in the opposite lane. This effect is amplified by the high-posted speed (50 mph) present on the ramps. The result is sudden merge maneuvers that lead to braking, reduced speeds, and unsafe conditions.

Second, the practice of merging the two center lanes at a major merge is not recommended. Unlike with a left- or right-hand side merge where vehicles in the

merging lane must yield to through traffic, with a center merge neither movement has a clear right of way. Communication errors can lead to angle crashes when a driver refuses to yield and rear-end crashes when a driver yields unexpectedly. Where a lane drop at a major merge is necessary, the current MassDOT design guide recommends instead continuing all travel lanes for at least 1,000 feet and then merging the rightmost lane into the main barrel.

## 7.4 IMPACTS

### 7.4.1 Crashes

A summary of the crashes in this segment is presented in Table 12. There were 238 crashes in this area between 2010 and 2014 (Appendix C). Figure 23 shows the location of these crashes. Crashes were very high at all three locations studied, with both I-93 exits registering almost 100 crashes each.

**TABLE 12.**  
**Crash Summary (2010–14):**  
**Location 4: Route 24 Southbound Segment between Exit 21 (I-93) and**  
**Exit 20 (Route 139)**

Crash Variable	Number of Crashes			Total
	Rte. 24 SB at Merge	I-93 NB Exit 4 to Rte. 24 SB	I-93 SB Exit 4 to Rte. 24 SB	
<b>Crash severity</b>				
Fatal injury	0	0	0	0
Non-fatal injury	14	25	25	64
Property damage only	42	61	65	168
Not reported	2	2	2	6
<b>Manner of collision</b>				
Rear-end	20	58	51	129
Sideswipe, same direction	9	10	16	35
Single-vehicle crash	23	14	19	56
Angle	5	4	4	13
Head-on	0	1	1	2
Not reported	1	1	1	3
<b>Road surface conditions</b>				
Snow	0	1	0	1
Wet	13	13	26	52
Dry	45	74	64	183
Not reported	0	0	2	2
<b>Ambient light conditions</b>				
Dawn	0	0	3	3

Daylight	31	50	58	139
Dusk	1	2	2	5
Dark: lighted roadway	18	27	20	65
Dark: roadway not lighted	7	9	8	24
Dark: unknown lighting	1	0	0	1
Not reported	0	0	1	1
<b>Weather conditions</b>				
Clear	33	51	55	139
Cloudy	5	7	15	27
Rain	10	9	14	33
Snow	0	1	0	1
Not reported	10	20	8	38
<b>Travel period</b>				
Peak	22	58	52	132
Off-peak	36	30	40	106
<b>Total crashes</b>	<b>58</b>	<b>88</b>	<b>92</b>	<b>238</b>
Five-year average (rounded)	12	18	18	48

NB = northbound; SB = southbound

Below is a summary of the crashes in this segment:

- 27 percent of the crashes resulted in injury, including one fatal injury
- 54 percent of the crashes were rear end collisions, the largest share among collision types
- 55 percent of the crashes occurred during the peak travel period
- 38 percent of the crashes occurred outside daylight conditions
- 77 percent of the crashes occurred under dry roadway conditions

## 7.4.2 Travel Speed

Figure 24 is a congestion scan that shows the average travel speeds on Route 24 southbound at the bottleneck location. Congestion at this location reduces travel speeds near the merge to less than 50 mph between the hours of 4 PM and 5 PM. These vehicle speeds correspond to LOS E conditions. Congestion begins to dissipate rapidly once the merge is passed and is almost entirely cleared two miles south of the I-93 interchange.

Figure 17 and Figure 18 contain congestion scans for I-93 northbound and I-93 southbound respectively. These figures demonstrate that the evening traffic peak lasts much longer than the morning peak, as congestion is present near Route 24 on I-93 northbound and southbound between 4 PM and 7 PM. In both directions, travel speeds are decreased to less than 35 mph for three hours at a

time. However, traffic on I-93 begins to clear once Route 24 is passed and travel speeds rapidly return to free-flow speed, especially in the southbound direction.

### 7.4.3 Level of Service

MPO staff conducted traffic operations analyses consistent with HCM methodologies. Using the MassDOT data, MPO staff built traffic analysis networks for the PM peak hours with the HCS suite to assess the capacity and quality of traffic flow at the bottleneck area.<sup>30</sup> Full HCS reports are included in Appendix D.

As mentioned in the previous chapter, the HCM is unable to model performance effectively for major merge or diverge areas. LOS can be approximated by checking capacities of each component segment as basic freeway segments. Using a basic freeway segment ignores merging maneuvers and distributes traffic evenly across all lanes, leading to an overstated capacity for these facilities. The results of the analysis are shown in Table 13.

**TABLE 13.**  
**LOS Analysis–Existing Conditions:**  
**Location 4: Route 24 Southbound Segment between Exit 21 (I-93) and Exit 20 (Route 139)**

Location	Density (pc/lane mile)	Speed (mph) <sup>a</sup>	V/C Ratio	LOS <sup>b</sup>
<i>HCM Analysis Type: Basic Freeway Segment</i>				
Route 24 southbound at merge	28.8	61.5	0.76	D

<sup>a</sup> Refers to ramp influence area speed for merge/diverge areas.

<sup>b</sup> LOS A through LOS D represent acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity). HCM = Highway Capacity Manual; LOS = level of service; mph = miles per hour; pc/lane mile = passenger cars per lane mile; V/C = volume-to-capacity

Table 13 shows LOS D for the merge segment, although as mentioned above this is an approximation. Speed data and field observations show much slower speeds indicative of LOS E or LOS F.

Unlike in Location 3, ramp roadway capacity is not a limiting factor at Route 24 southbound. Both of the ramps at this bottleneck location use a two-lane design that has a theoretical capacity of 4,400 vehicles per hour.<sup>31</sup> This means that the

<sup>30</sup> Highway Capacity Software 7, Version 7.3, McTrans Center, PO Box 116585, Gainesville, Florida, 2017.

<sup>31</sup> Highway Capacity Manual 2010, Transportation Research Board of the National Academies, Washington, DC, December 2010. 13-18.

capacity of the ramp roadway facilities at Location 4 is well above the demand flow rate and does not become a limiting factor in system performance.

## 7.5 IMPROVEMENT ALTERNATIVE

MPO staff identified a low-cost improvement to address safety and operational issues at the bottleneck:

- Alternative 1: Lengthen the merge distance at the ramp junction (Figure 25).

The alternative was analyzed using projected year 2030 traffic volumes. MPO staff estimated a five percent total background growth from 2015 to 2030.

### 7.5.1 Alternative 1: Lengthen the Merge Distance at the Ramp Junction

The 48-foot width present where the ramps intersect begins to narrow almost immediately after the painted gore nose. The freeway becomes a 36-foot, three-lane segment within approximately 400 feet. MPO staff recommends bringing this merge in line with the MassDOT standards by extending the four lanes present on the ramps for approximately 1,000 feet down Route 24 and by using a right-hand lane drop.

Figure 25 shows the improvements recommended in Alternative 1:

- Use the existing right-hand paved shoulder to add a fourth travel lane beginning at the merge and continuing 1,000 feet downstream. Continue the existing four ramp lanes down this stretch, and reduce the right shoulder width to two feet.
- Restripe the merge area with wide-dotted lines and add new signage after 500 feet to alert the travelers in the right-hand lane to merge left.
- Begin a 500-foot taper that drops the rightmost lane after 1,000 feet, leaving three southbound lanes.

## 7.6 EFFECTIVENESS AND COST OF THE IMPROVEMENT

Table 14 presents the 2030 future LOS analysis compiled using the HCS software. Results for the no-build scenario are compared against Alternative 1. Both scenarios use a uniform five percent growth for 2030 traffic volumes.

**TABLE 14.  
LOS Analysis–Improvement Alternatives:  
Location 4: Route 24 Southbound Segment between Exit 21 (I-93) and  
Exit 20 (Route 139)**

<b>Location</b>	<b>Scenario</b>	<b>Density (pc/lane mile)</b>	<b>Speed (mph)</b>	<b>V/C Ratio</b>	<b>LOS</b>
<i>HCM Analysis Type: Basic Freeway Segment</i>					
Route 24 southbound at merge	No-Build	30.7	60.6	0.80	D
	Alt 1	22.7	61.5	0.60	C

HCM = Highway Capacity Manual; LOS = level of service; mph = miles per hour; pc/lane mile = passenger cars per lane mile; V/C = volume-to-capacity

### 7.6.1 Effectiveness and Cost of Alternative 1

Using CMFs from the CMF Clearinghouse for installing an additional lane for an urban freeway shows that Alternative 3 would reduce crashes at the merge area by up to 20 percent. In addition, Table 14 compares an analysis of a three-lane basic freeway segment at the merge with a four-lane basic freeway segment. The additional lane improves LOS by one level over the no-build scenario, from LOS D to LOS C in the PM peak.

The basic freeway segment analysis can be misleading because the real cause of the bottleneck is merging maneuvers of vehicles and not the base capacity of the freeway. However, the HCM model does show that adding the lane increases capacity significantly. This increased capacity will help mitigate the capacity reduction resulting from merge maneuvers. Changing the center merge to an exterior merge will also improve safety and bring the geometry at the interchange in line with MassDOT standards.

Alternative 1 is estimated to cost between \$100,000 and \$200,000 to construct. This estimate includes preparing the shoulder for travel lane, restriping travel lanes, relocation and installation of signs, and minor pavement markings. New paving may be required if an emergency pullover area is found to be necessary.

## 7.7 RECOMMENDATIONS

MPO staff recommends implementation of Alternative 1 to improve operational efficiency and safety for all traffic headed to Route 24 southbound.

## Chapter 8—Conclusion and Next Steps

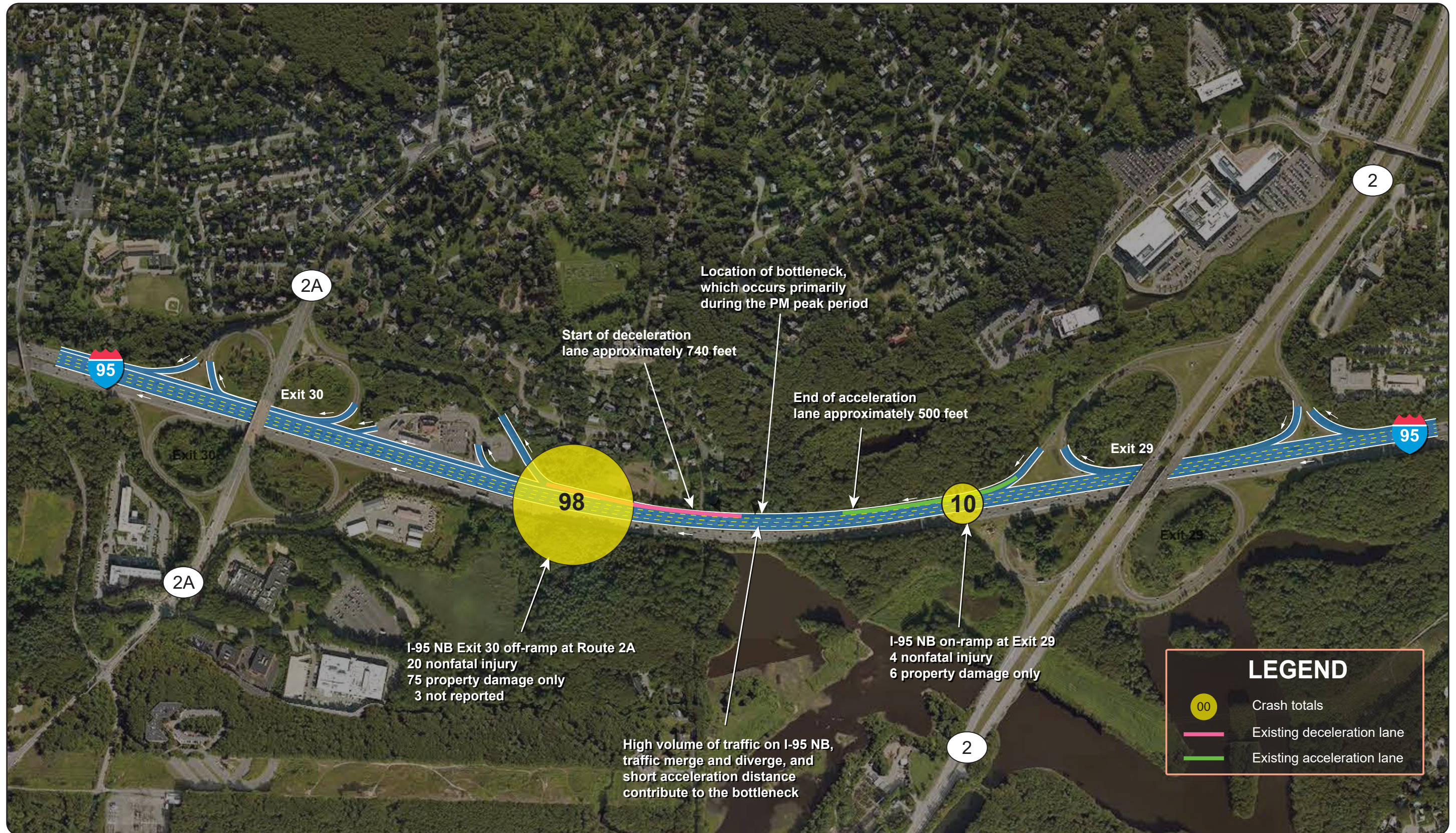
MPO staff, working in conjunction with the MassDOT Highway staff, identified, developed, and evaluated improvements for four bottleneck locations in the MPO region. The study provides the MassDOT Highway Division with an opportunity to begin identifying the needs at the four bottleneck locations and to start planning design and engineering efforts. If implemented, these low-cost, short-term improvements would increase traffic safety, make traffic operations more efficient, and reduce congestion at the bottlenecks. The study aligns with the MPO goals of managing capacity and improving mobility, and increasing safety on the region's highway system.



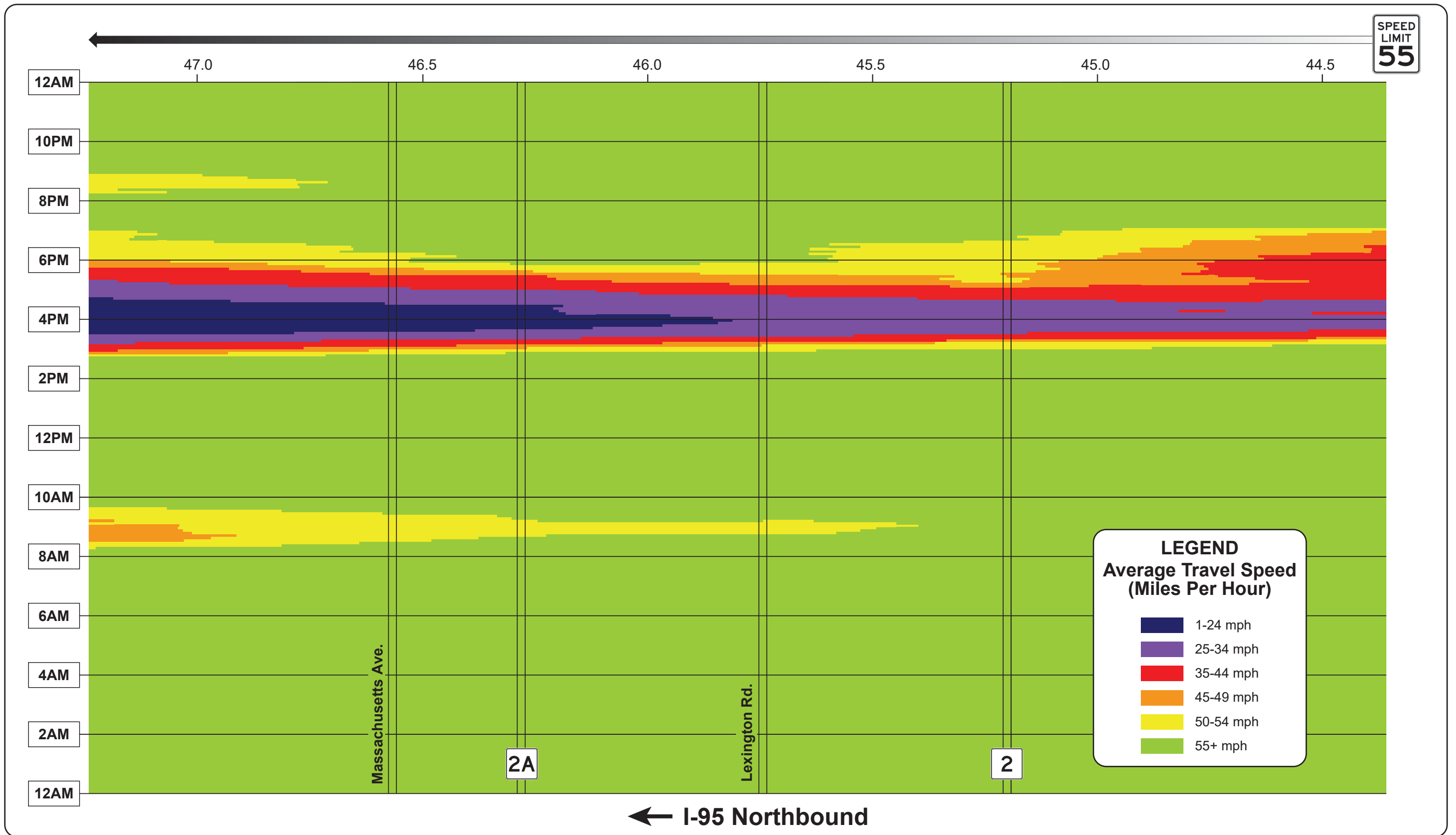




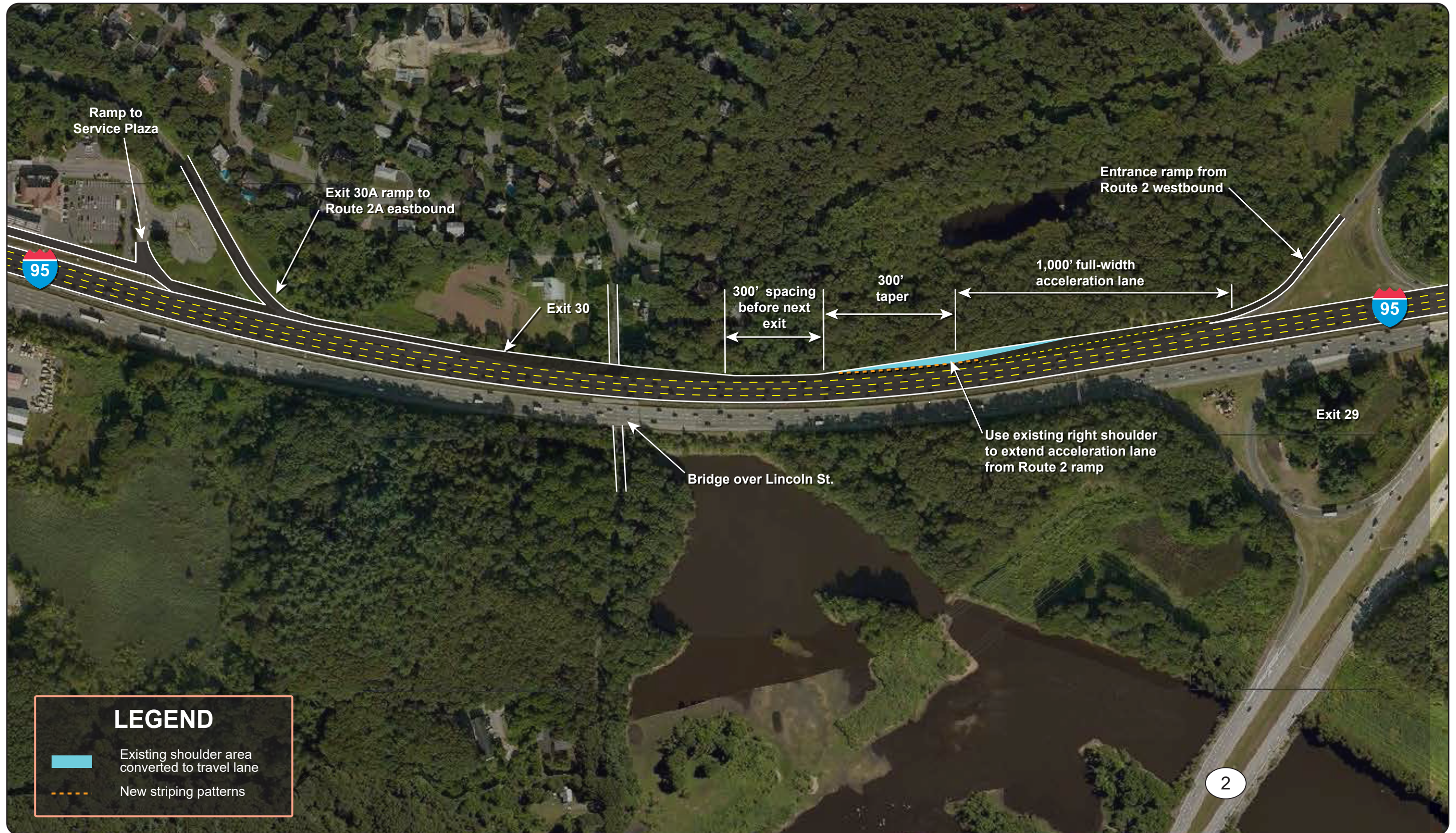
**Figure 2**  
Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza):  
Peak Period Traffic Volumes



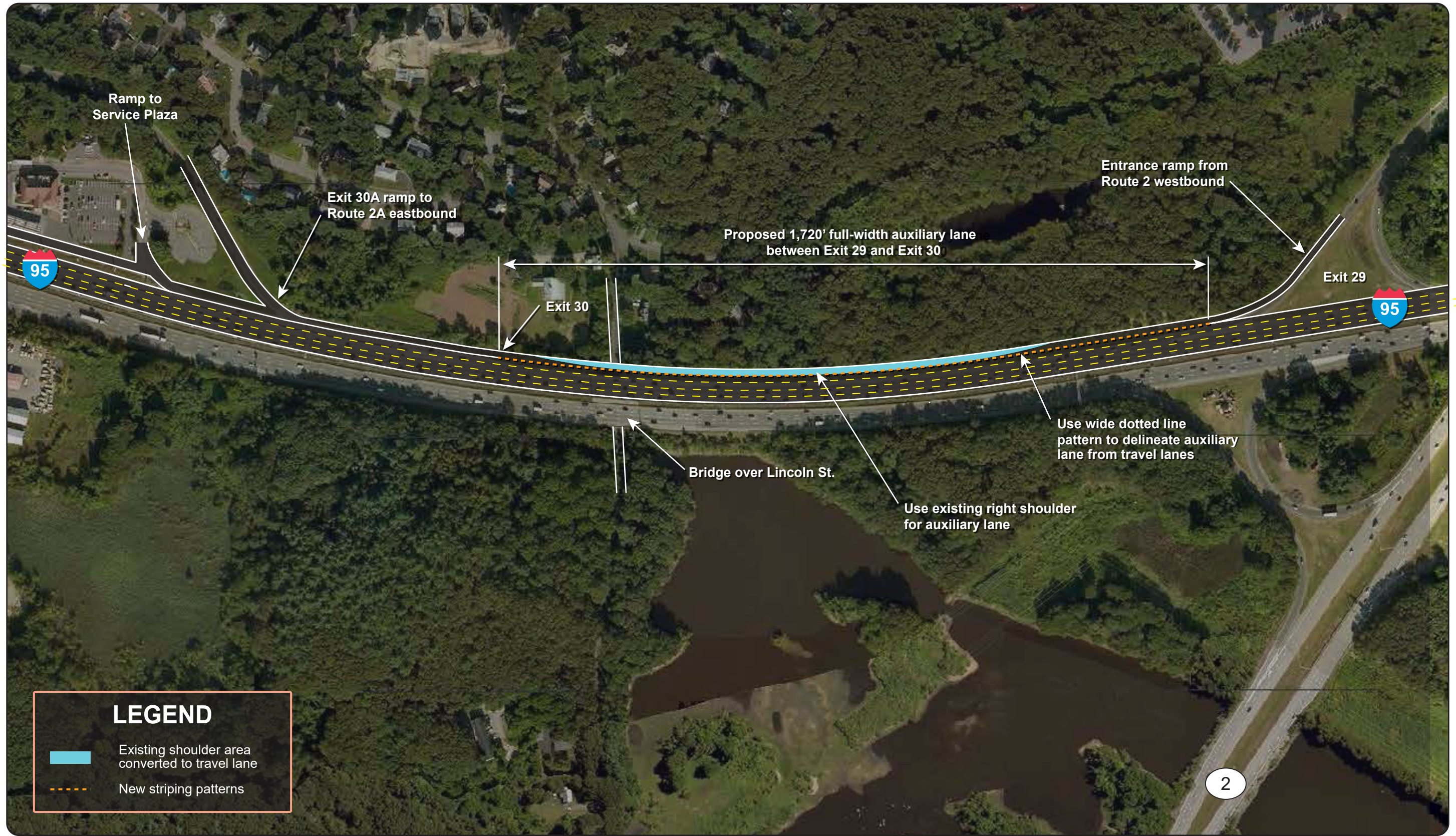
**Figure 3**  
Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza):  
Location and Number of Crashes



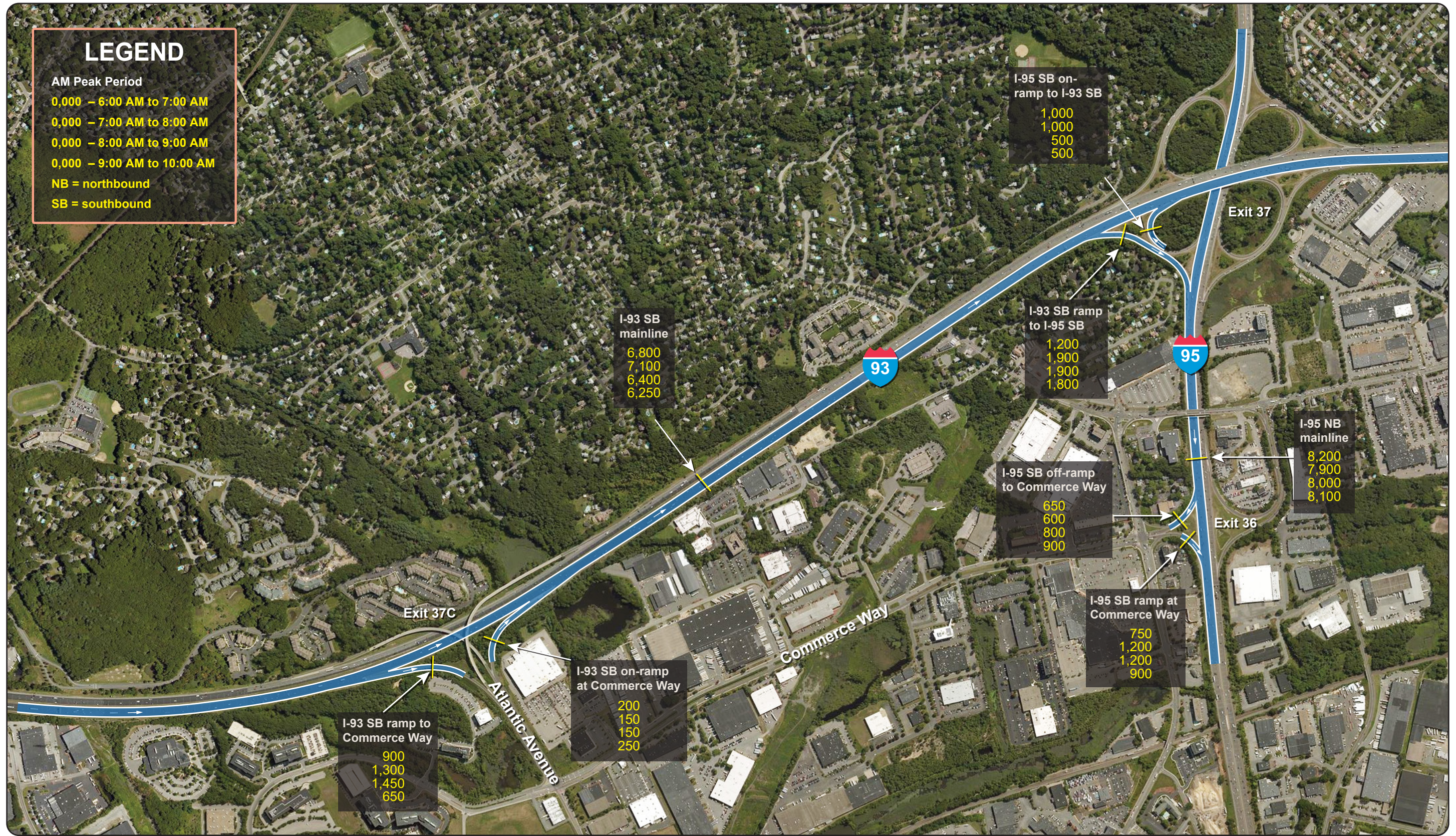
**Figure 4**  
Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza):  
Congestion Scan



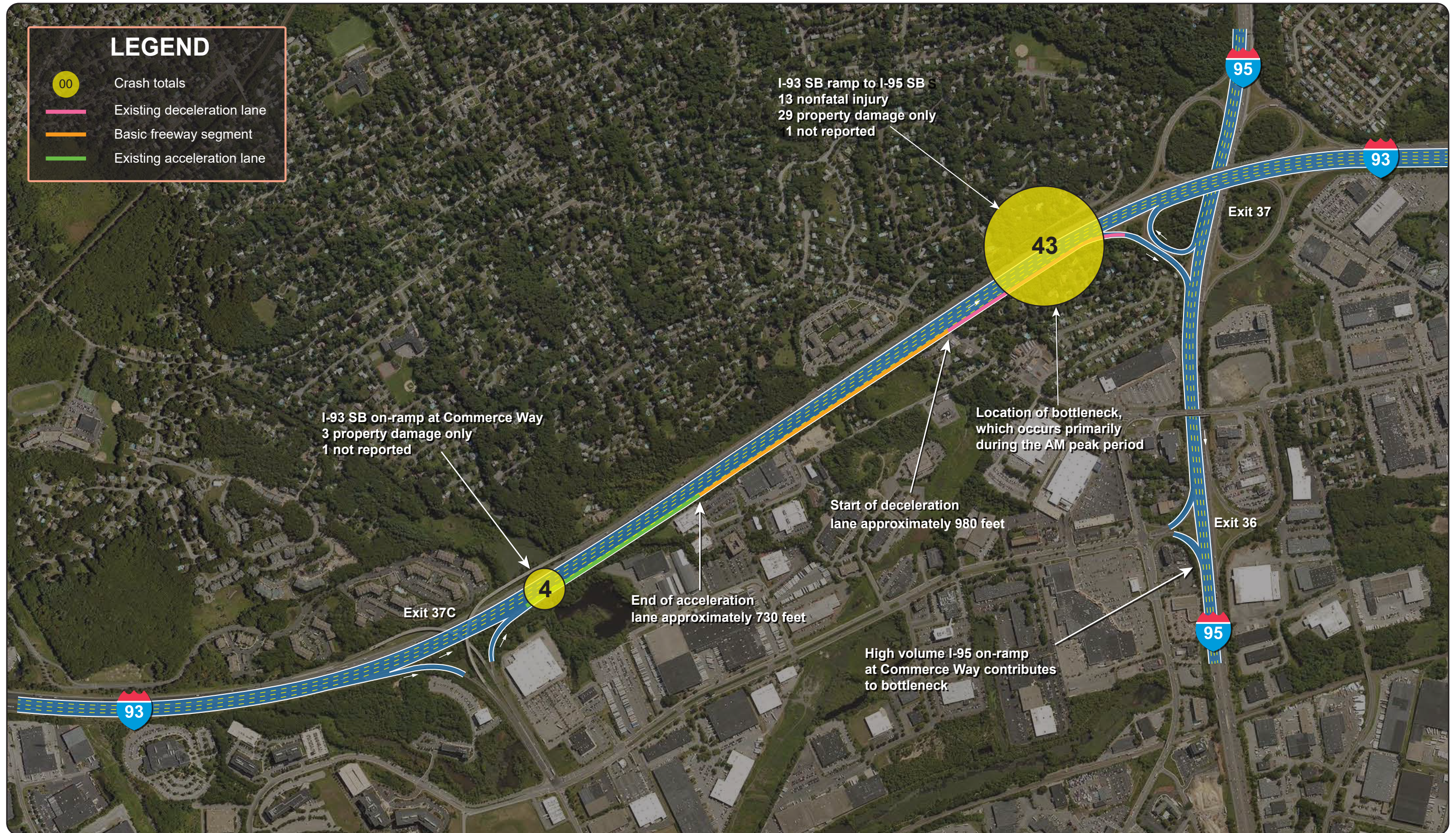
**Figure 5**  
**Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza):**  
**Alternative 1—Lengthen Acceleration Lane at Exit 29**



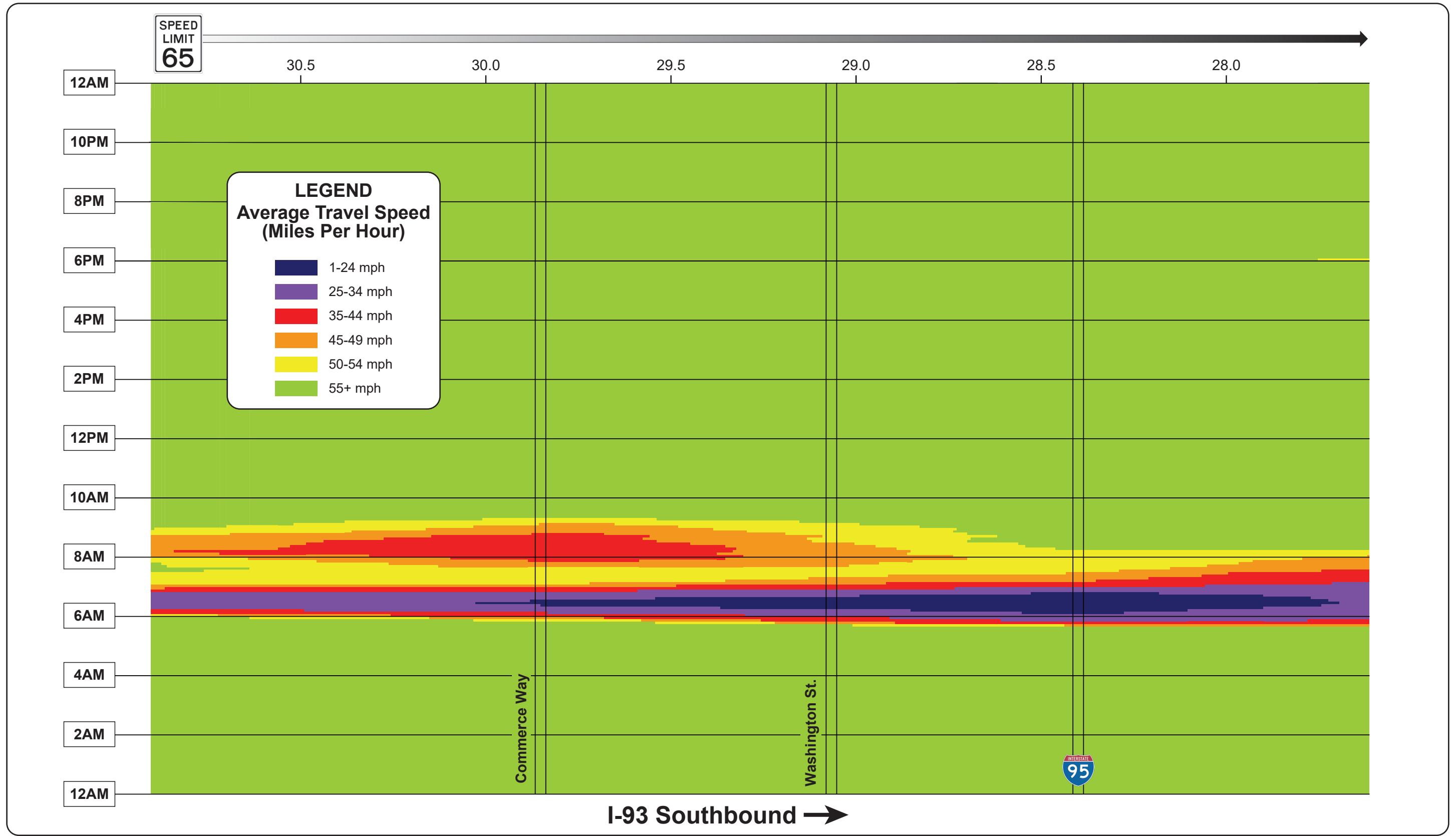
**Figure 6**  
**Location 1: I-95 Northbound Segment between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza):**  
**Alternative 2—Create an Auxiliary Lane**



**Figure 7**  
Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way) and Exit 37B (I-95):  
Peak Period Traffic Volumes

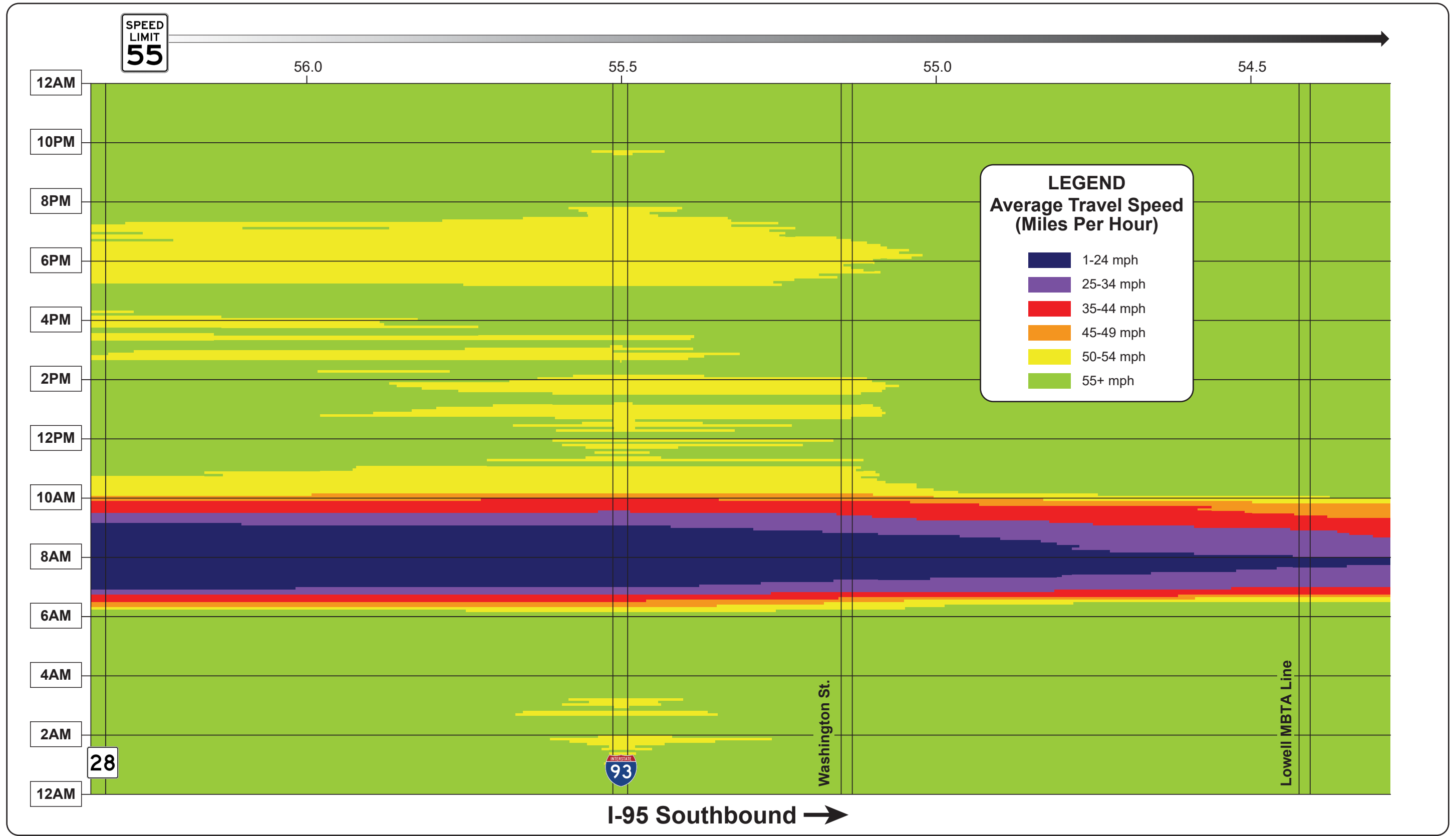


**Figure 8**  
Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way) and Exit 37B (I-95):  
Location and Number of Crashes



**Figure 9**  
Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way) and Exit 37B (I-95):  
Congestion Scan

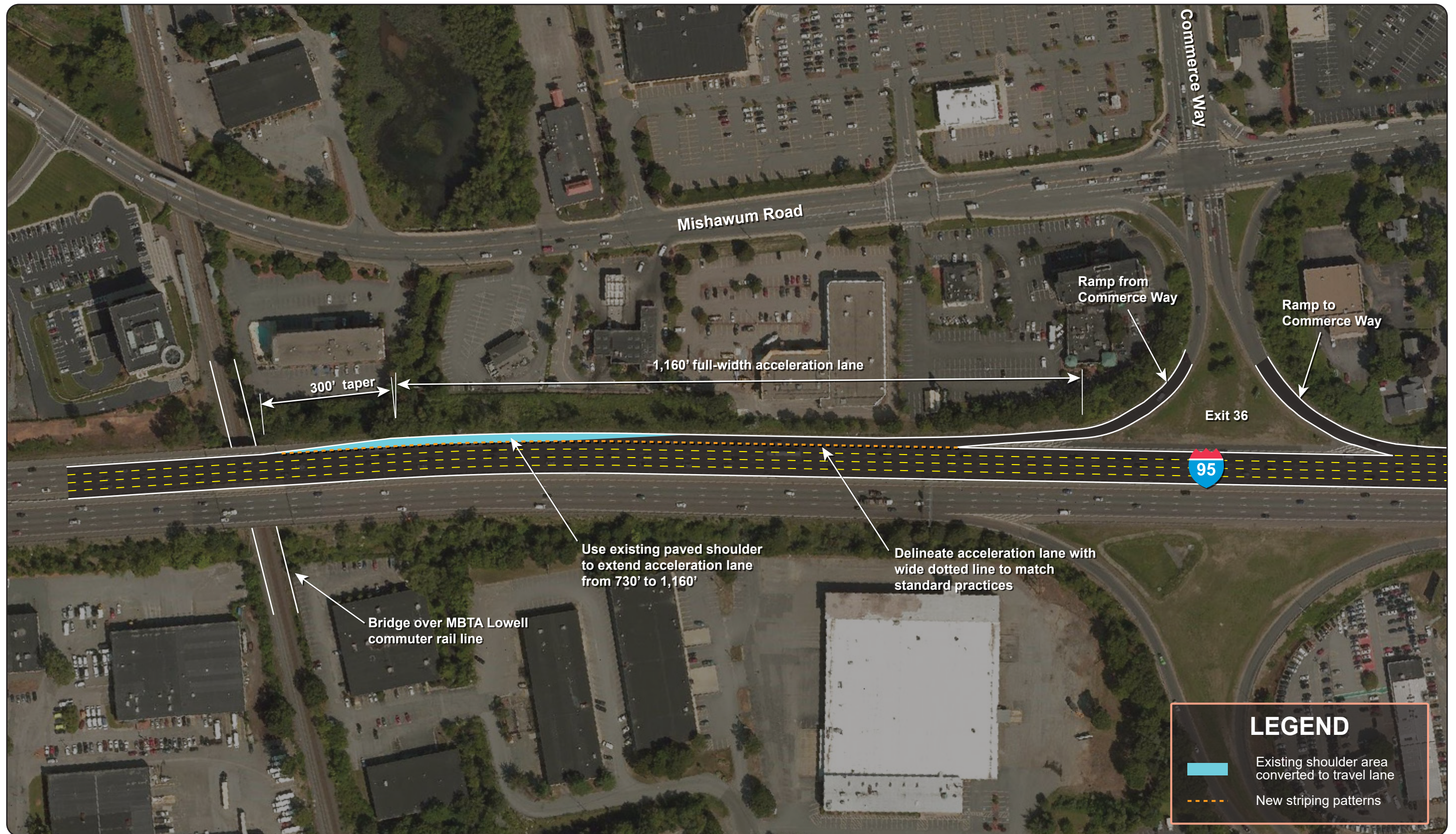




**Figure 10**  
Location 2: I-95 Southbound Segment between Exit 38 (Route 28) and Lowell MBTA Line:  
Congestion Scan



**Figure 11**  
**Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way) and Exit 37B (I-95):**  
**Alternative 1—Create an Auxiliary Lane on I-93 Southbound**



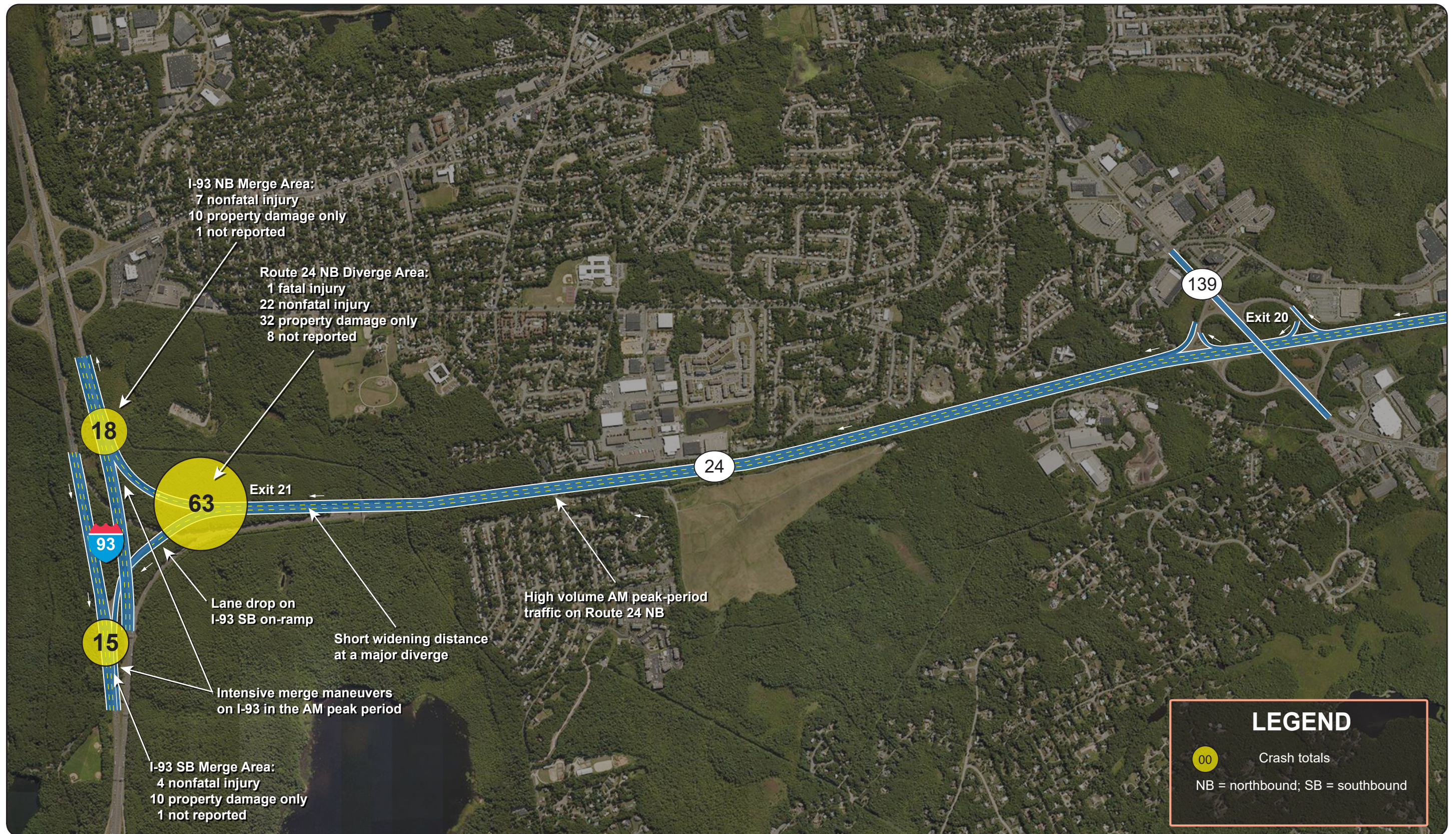
**Figure 12**  
**Location 2: I-95 Southbound Segment between Exit 38 (Route 28) and Lowell MBTA Line:**  
**Alternative 2—Lengthen the Acceleration Lane at I-95 Southbound Exit 36**



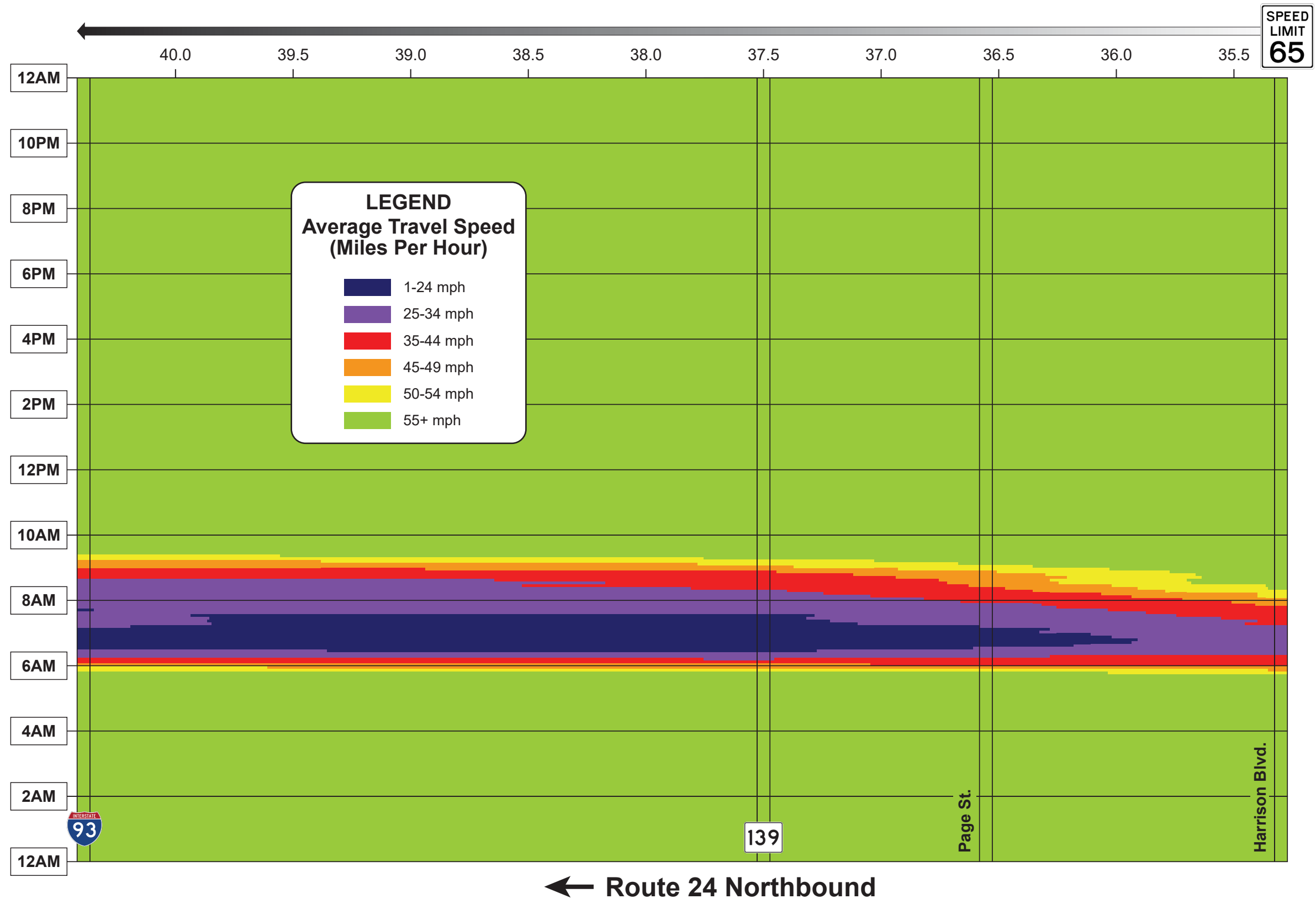
**Figure 13**  
**Location 2: I-93 Southbound Segment between Exit 37C (Commerce Way) and Exit 37B (I-95):**  
**Alternative 3—Two-lane Ramp at Exit 37B**



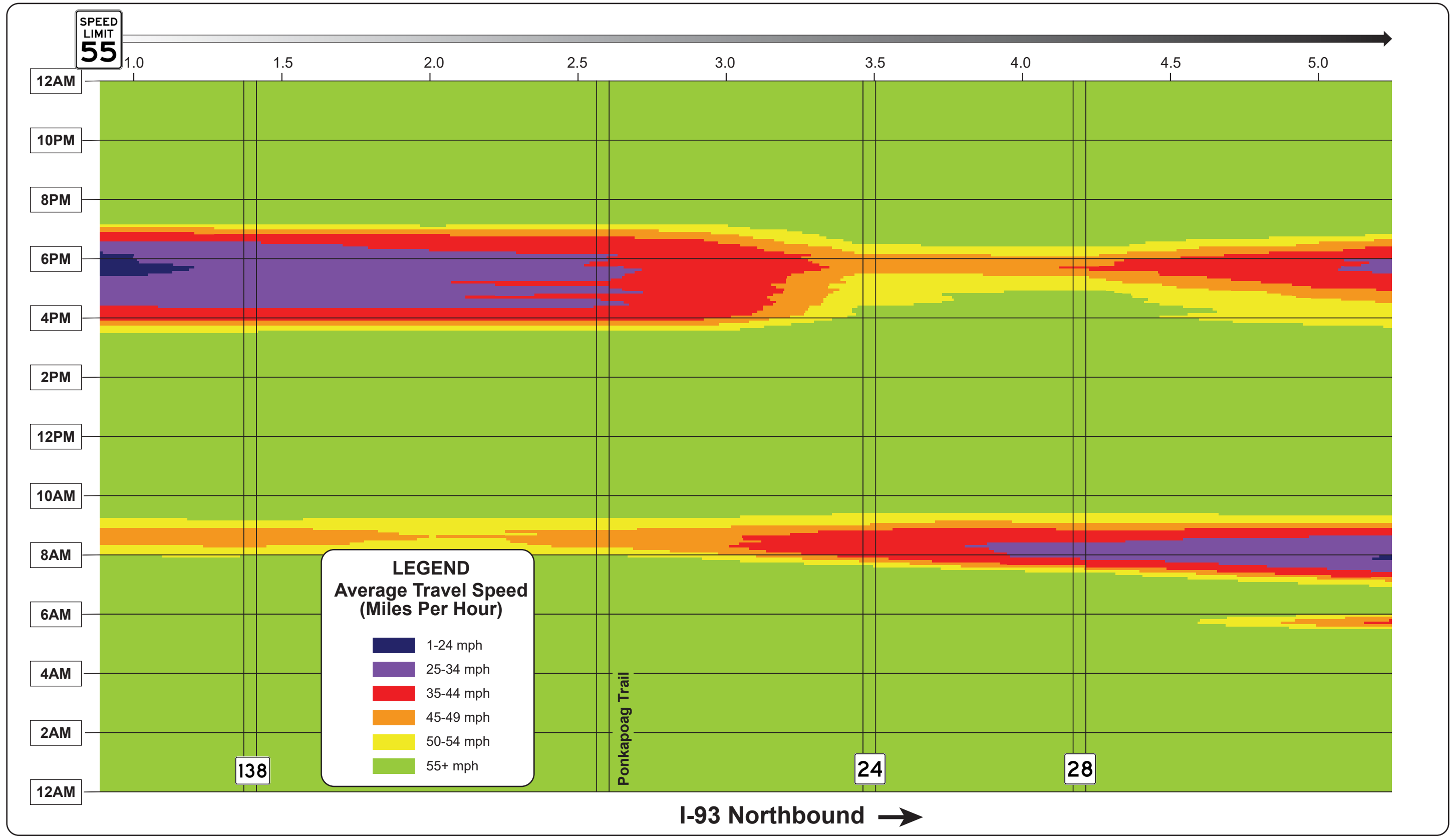
**Figure 14**  
 Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93):  
 Peak Period Traffic Volumes



**Figure 15**  
**Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93):**  
**Location and Number of Crashes**

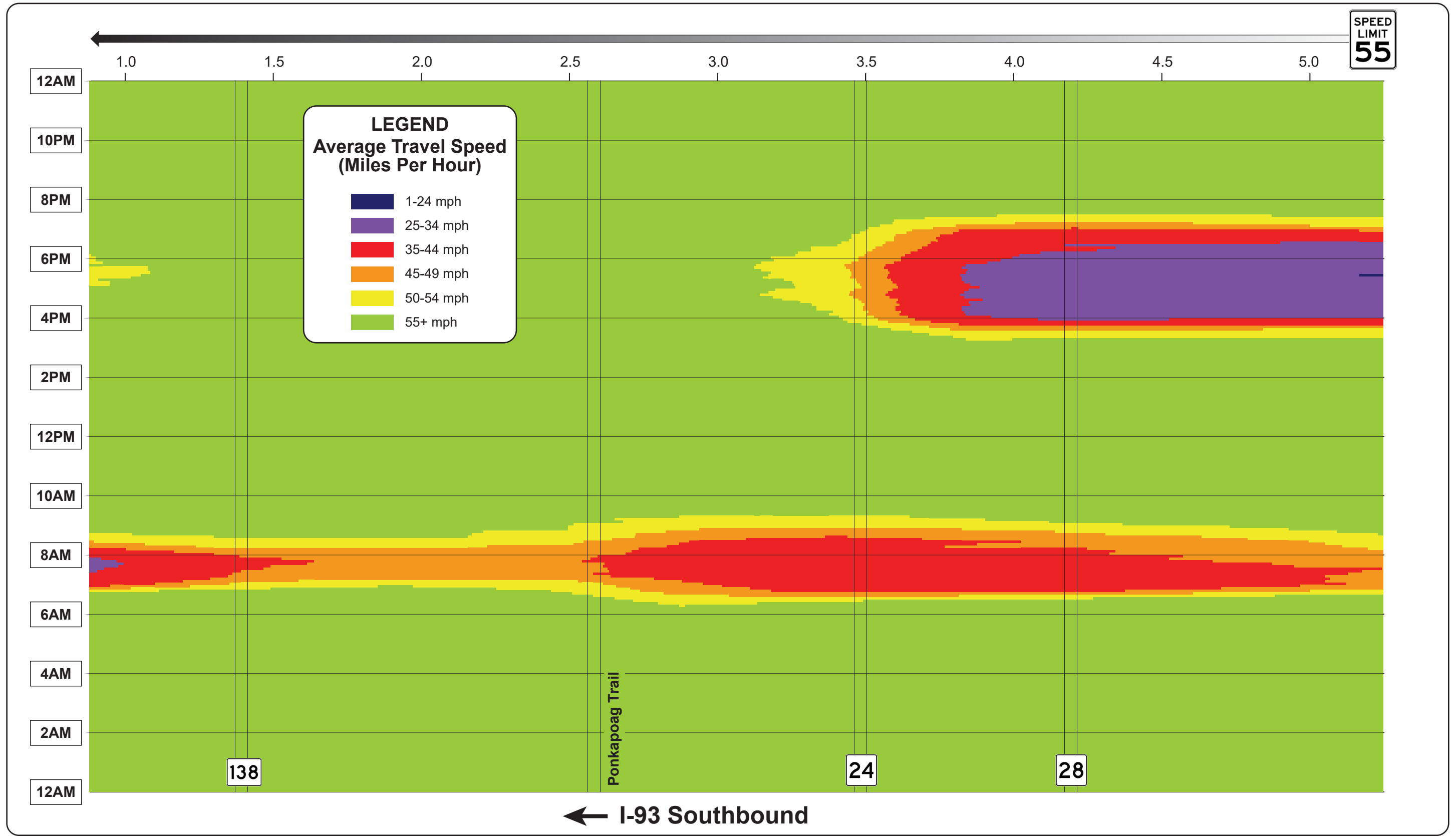


**Figure 16**  
Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93):  
Congestion Scan

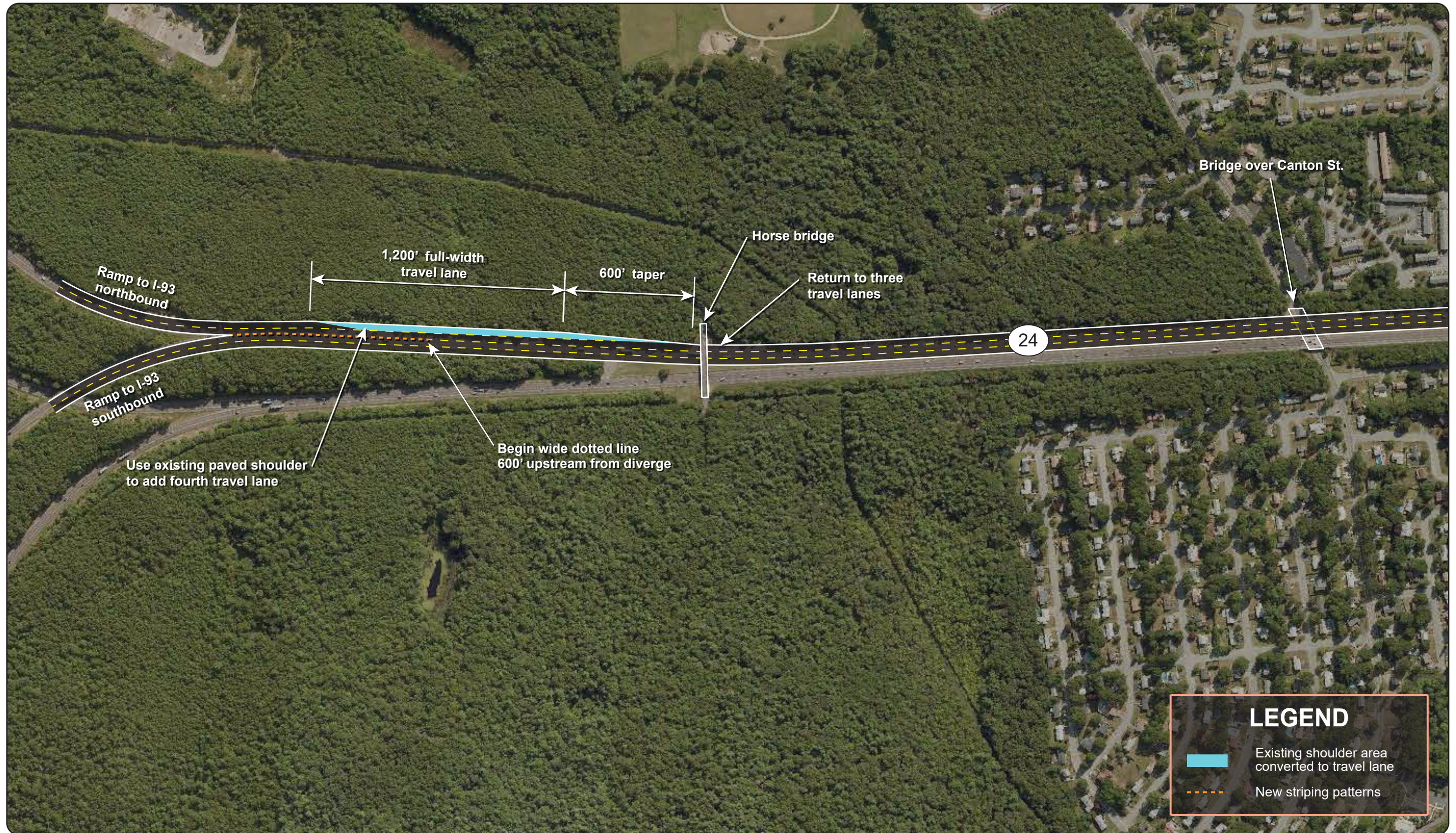


**Figure 17**  
Location 3: I-93 Northbound Segment between Exit 2 (Route 138) and Exit 5 (Route 28):  
Congestion Scan

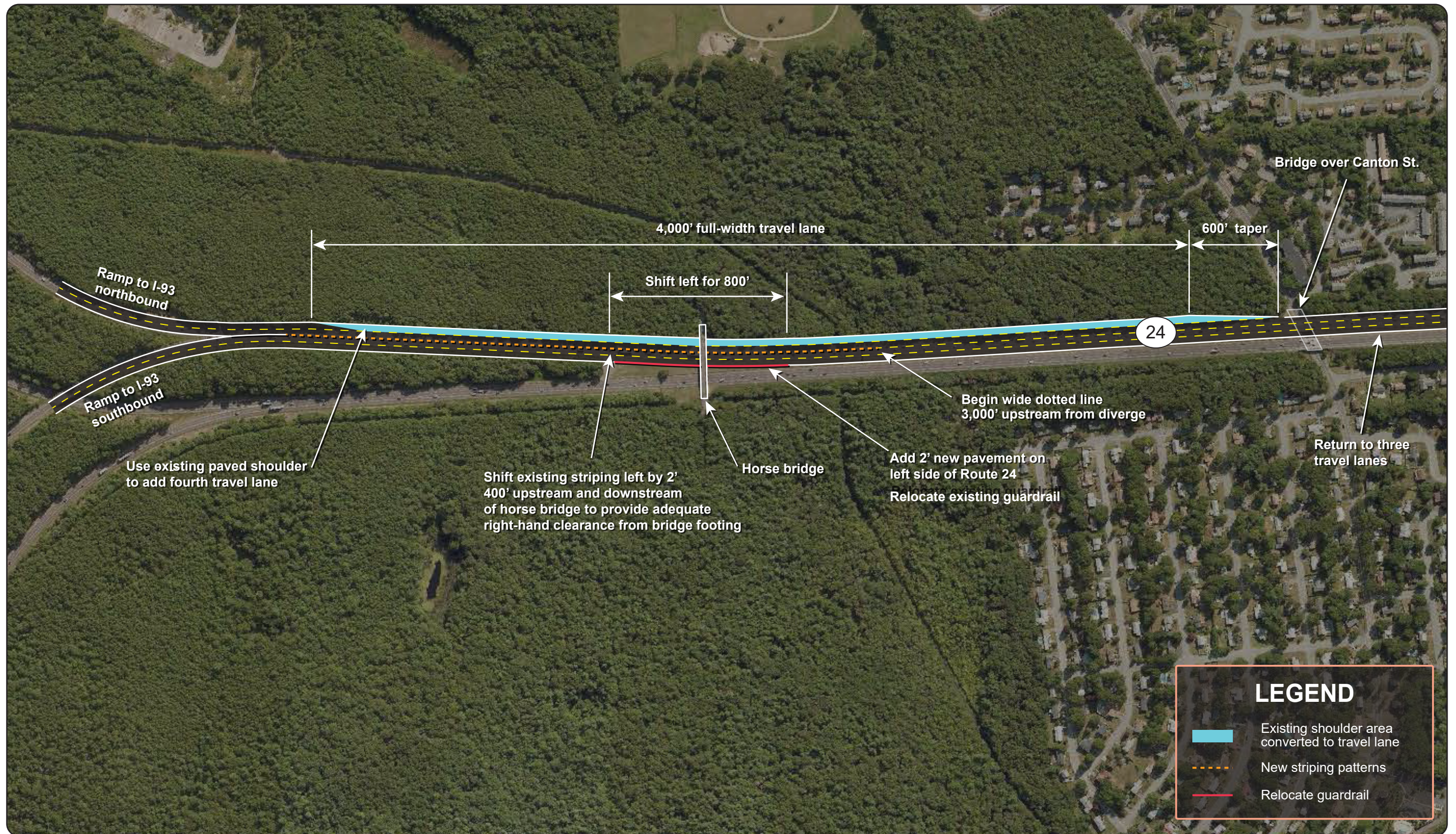




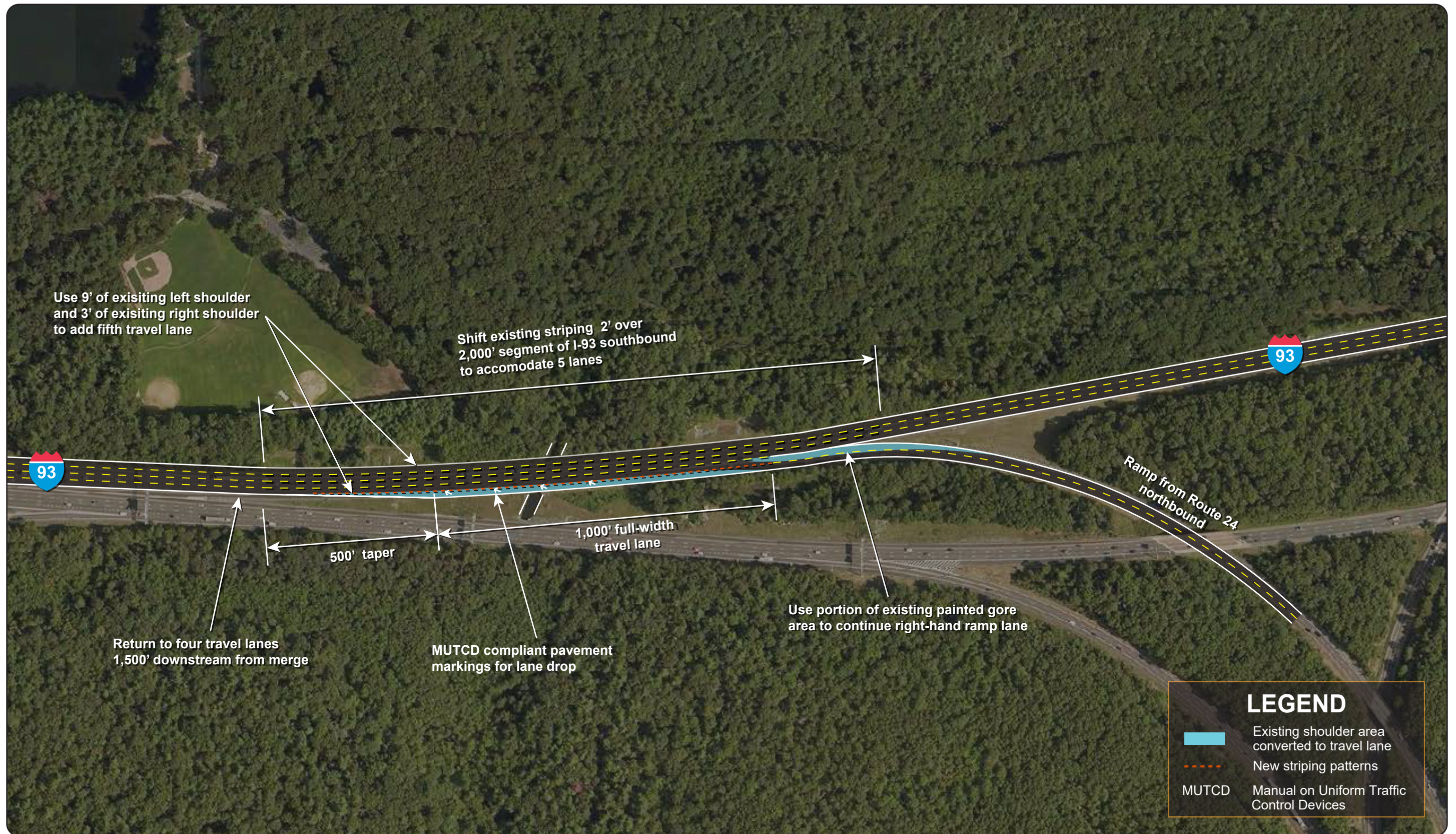
**Figure 18**  
Location 3: I-93 Southbound Segment between Exit 5 (Route 28) and Exit 2 (Route 138):  
Congestion Scan



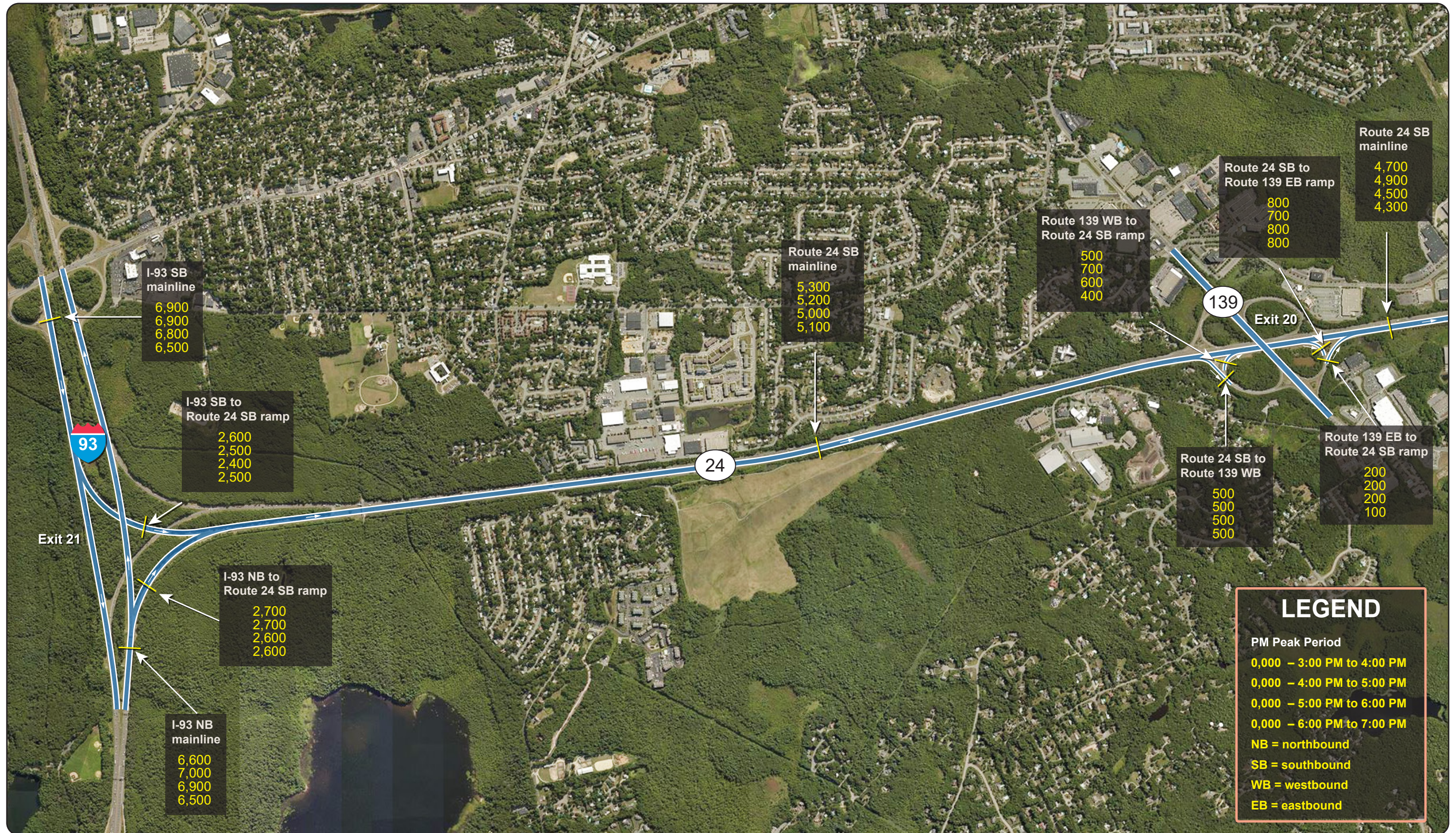
**Figure 19**  
**Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93):**  
**Alternative 1—Widen to Four Lanes After Horse Bridge**



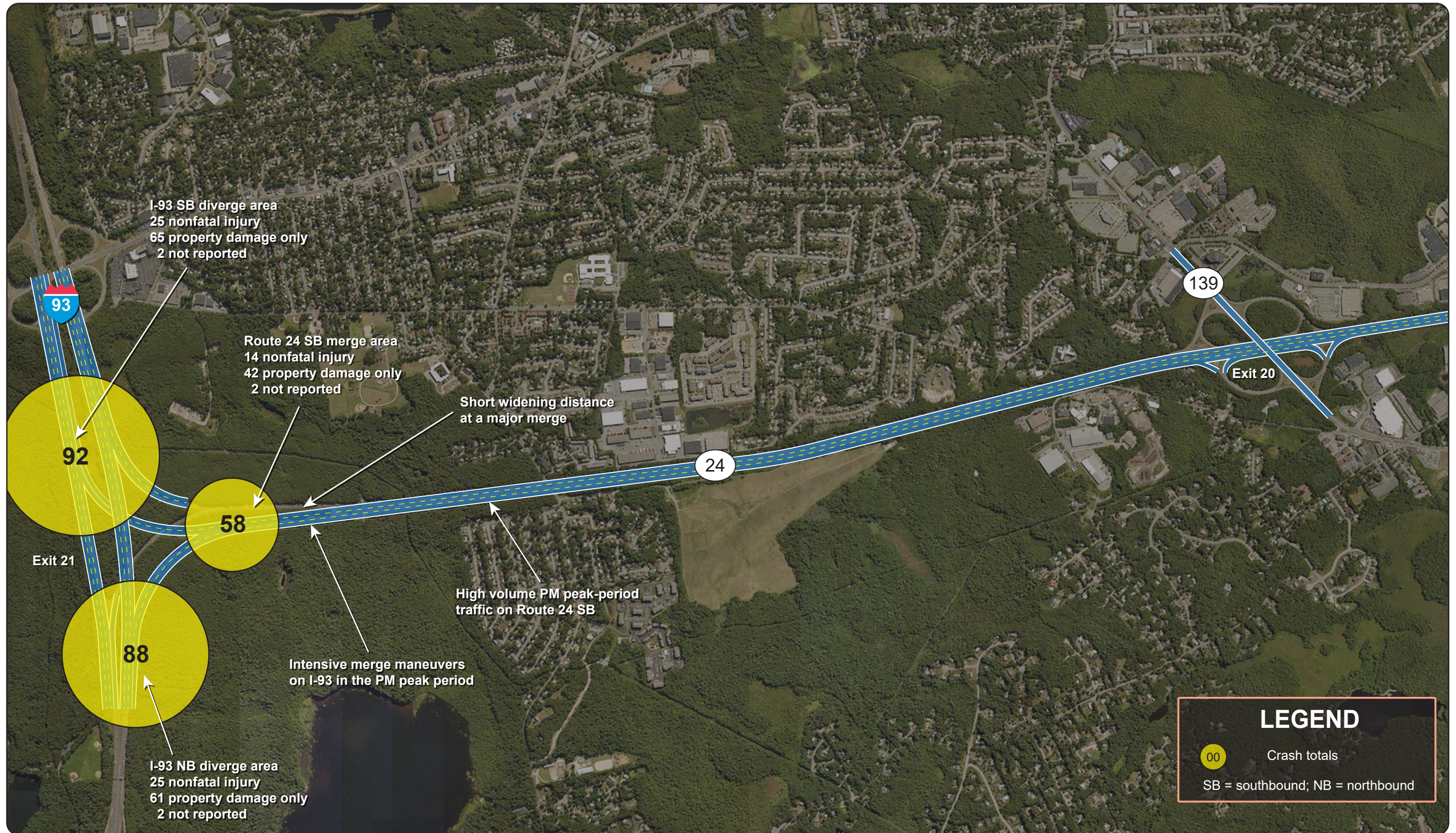
**Figure 20**  
**Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93):**  
**Alternative 2—Widen to Four Lanes After Canton Street Bridge**



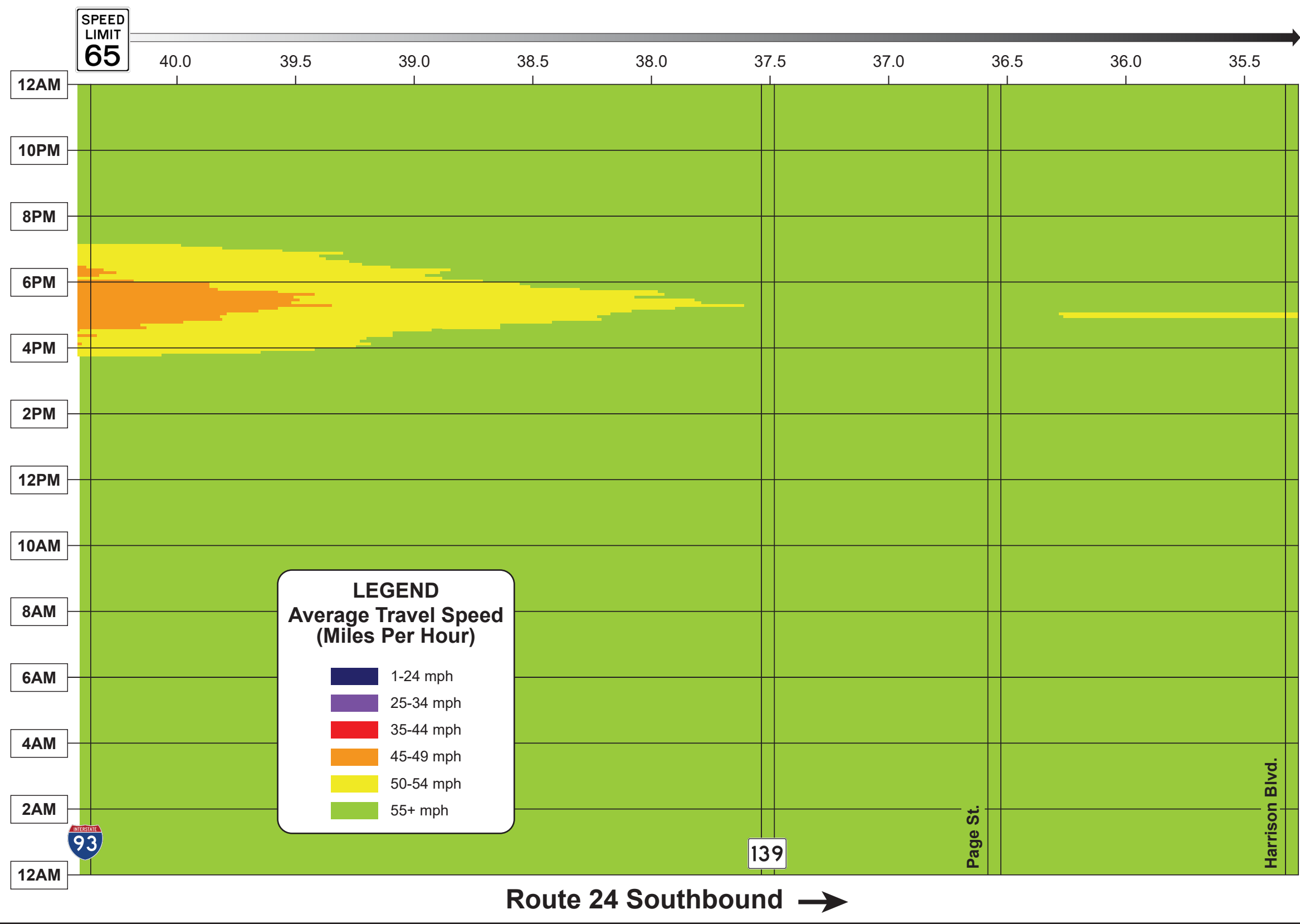
**Figure 21**  
**Location 3: Route 24 Northbound Segment between Exit 20 (Route 139) and Exit 21 (I-93):**  
**Alternative 3—Remove Merge in Ramp to I-93 Southbound**



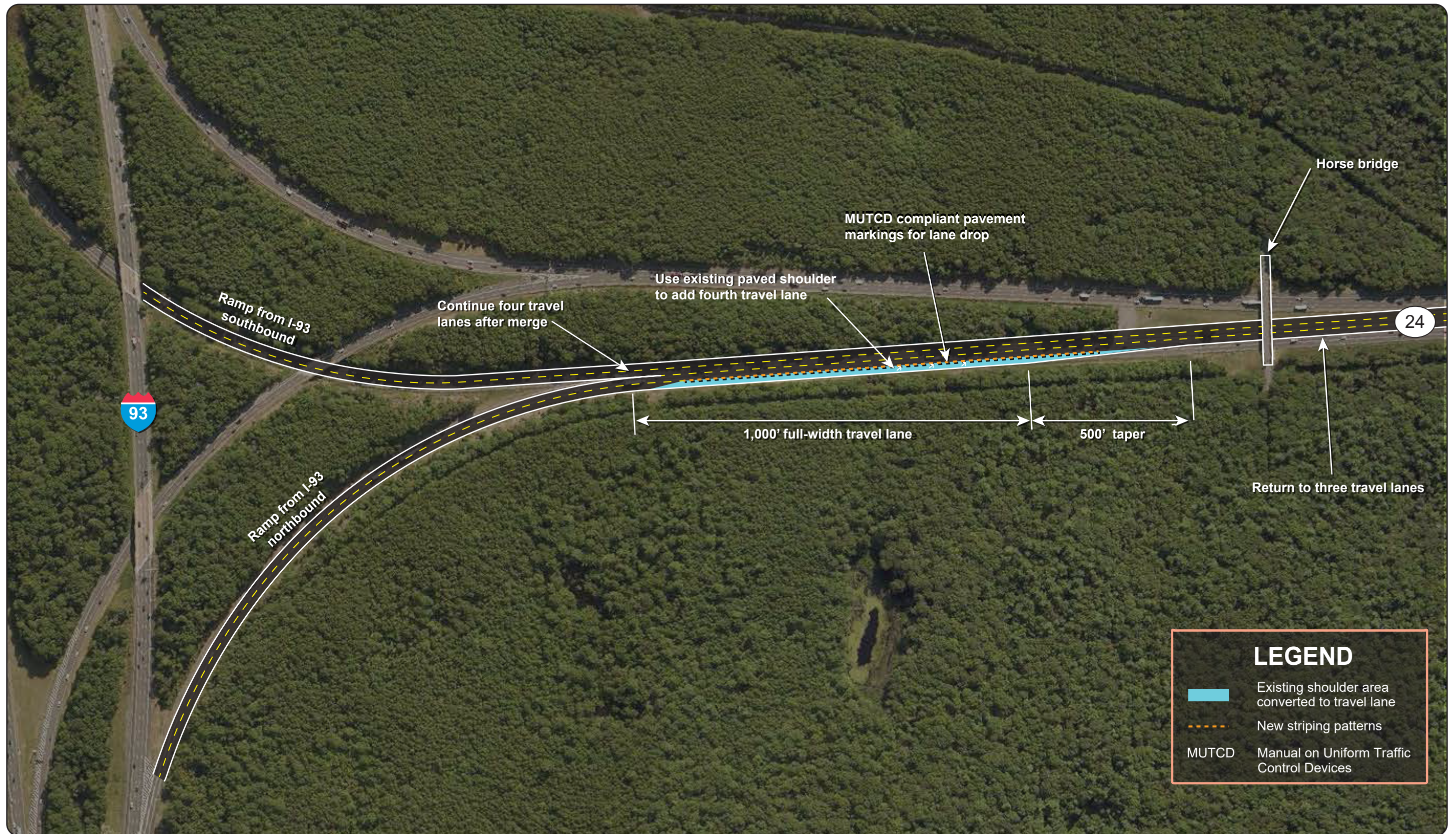
**Figure 22**  
 Location 4: Route 24 Southbound Segment between Exit 21 (I-93) and Exit 20 (Route 139):  
 Peak Period Traffic Volumes



**Figure 23**  
Location 4: Route 24 Southbound Segment between Exit 21 (I-93) and Exit 20 (Route 139):  
Location and Number of Crashes



**Figure 24**  
Location 4: Route 24 Southbound Segment between Exit 21 (I-93) and Exit 20 (Route 139): Congestion Scan



**Figure 25**  
**Location 4: Route 24 Southbound Segment between Exit 21 (I-93) and Exit 20 (Route 139):**  
**Alternative 1—Lengthen Merge Distance at Ramp Junction**



# Appendixes

Appendix A: Review Comments and Selection Process

Appendix B: ATR and Classification Data

Appendix C: Crash Tables

Appendix D: HCS Printouts

# APPENDIX A

1. Review Comments
2. Selection Process

## 1. Review Comments

## Seth Asante

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**From:** Raphael, Connie (DOT)  
**Sent:** Wednesday, November 29, 2017 3:45 PM  
**To:** Seth Asante  
**Cc:** Chen-Yuan Wang; Suszynski, Frank (DOT)  
**Subject:** FW: Low-Cost Improvements to Express-Highway Bottleneck Locations Study

Hi Seth,

Here are some comments on this study from Brian Fallon, our Projects Engineer.

Below the comments I have sent an excerpt from our weekly report with a blurb on the I-95 NB to Route 3 NB exit work and a picture. Thought you would like to know how well your recommendations are working!

### Location 1 - Lexington Auxiliary Lane from Route 2 on ramp to the Service area CD road

An auxiliary Lane in this area would improve the traffic flow.

The existing right shoulder in this area is approximately 10 feet wide.

There are stormwater improvement structures behind the guardrail just south of the Lincoln Street Bridge.

If the 12 foot auxiliary lane and 2 foot right shoulder (assumed cross section) are proposed, then the left shoulder would need to be reduced to avoid widening.

If the left shoulder reduction is proposed, then a highway alignment shift would be required.

If widening is proposed, there would be impacts to the stormwater structure (underground chambers) and possibly wetland impacts. The cost of the work would be higher.

### Location 2 – Reading & Woburn Auxiliary Lane from Commerce Way on ramp to the I95 Southbound On Ramp

An auxiliary Lane on I93 would improve the traffic flow.

The existing right shoulder in this area is approximately 12 feet wide.

If the 12 foot auxiliary lane and 2 foot right shoulder (assumed cross section) are proposed, then a minor one to two foot widening would be required for the majority of the auxiliary lane.

A reduced auxiliary lane would need to be proposed on the I93 over West Street Bridge.

### Location 2 –Woburn Extending the I95 Acceleration lane from Commerce Way

A lengthened Acceleration Lane in this area would improve the traffic flow.

The existing right shoulder in this area is approximately 10 feet wide.

If the 12 foot auxiliary lane and 2 foot right shoulder (assumed cross section) are proposed, then the left shoulder would need to be reduced to avoid widening.

If the left shoulder reduction is proposed, then a highway alignment shift would be required.

If widening is proposed, there would be construction impacts due to the steep highway side slopes and possibly wetland impacts. The cost of the work would be higher.

Lexington/Burlington - Route I-95 resurfacing – as part of an Interstate Maintenance resurfacing contract covering this section of I-95, several of the ramps at the I-95/Route 3/Middlesex Turnpike interchange were widened to improve operations. The improvements were based on the results of a past CTPS study that evaluated regional bottleneck locations. Since the work was completed in mid-October, there has been a noticeable improvement in traffic operations and a significant reduction in vehicle queueing, particularly during the weekday afternoon peak period. The photo below shows the newly widened ramp on Route I-95 NB providing two formal exit lanes to Route 3 NB.



Connie

## Seth Asante

---

**From:** Lipton, Amitai (DOT)  
**Sent:** Thursday, December 7, 2017 10:19 AM  
**To:** Seth Asante  
**Cc:** Mark Abbott; Kulen, Raj (DOT); Patel, Hasmukh (DOT); Vatan, Geraldine (DOT); Polin, Bonnie (DOT); Belanger, David (DOT)  
**Subject:** RE: Low-Cost Improvements to Express-Highway Bottleneck Locations Study

Good morning Seth,

District 6 Traffic section would like to add a few comments:

- Consider evaluating the relative safety effects of the recommended alternatives, compared with the existing conditions.
- Section 1.2 - The term "subtract-a-lane" was only used internally.
- Section 2.2 (Location 3) & Chapter 6 - Route 24 NB queue length is described inconsistently. It sometimes backs up as far as Brockton, well beyond Route 139. For some reason, the heaviest volumes on Route 24 NB are often found earlier in the morning than other locations along the 128 corridor, with queues forming as early as 5 AM and dissipating by 9 AM.
- Section 6.5.1 (3rd bullet) and 6.5.2 (4th bullet) - Replace term "distinct dash pattern" with "wide dotted line" per current MUTCD requirements. Also, please note that on recent projects, these pavement markings have started 1/2 mile upstream of a split, rather than 3000 feet as described in the text and Figure 20, and 600 feet as described in Figure 19.
- Section 6.5.3 - (Typo) Figure 21 shows the recommendations in Alternative 3, rather than Alternative 2.
- Section 6.6.3 - Alternative 3 costs should be roughly equivalent to Alternative 1, since all existing rumble strips and pavement markings would need to be removed and replaced over similar distances.
- Section 7.5.1 (2nd bullet) - Replace term "distinct striping pattern" with "appropriate MUTCD-compliant pavement markings", since current requirements disallow use of a distinct striping pattern for this application. Revises Figures 21 and 25 for consistency (note that we've recently been using three arrows spaced at 120 feet to indicate a mainline lane reduction).
- Figure 14 - Some volumes on Route 24 ramps to I-93 NB and SB are inconsistent with those described in Chapter 6. Also, the volumes on Route 24 mainline do not equal the sum of the volumes on the ramps to I-93.
- Figures 17 & 18 - Would it be possible to reverse the direction of these figures? E.g. on Figure 17, I-93 NB is actually heading easterly, so it might be more intuitive to have the direction of travel be from left-to-right.

Thank you,

Amitai

---

**From:** Vatan, Geraldine (DOT)  
**Sent:** Thursday, December 7, 2017 08:19  
**To:** Seth Asante

**Cc:** Mark Abbott; Boudreau, Neil (DOT); Danila, James (DOT); Raphael, Connie (DOT); Gregg, John (DOT); Timoner, Sara (DOT); Kulen, Raj (DOT); Lipton, Amitai (DOT); Patel, Hasmukh (DOT); Clark, Michael (DOT); Pounds, Bryan (DOT); Gascon, Cassandra (DOT); Paul, Andrew (DOT)

**Subject:** RE: Low-Cost Improvements to Express-Highway Bottleneck Locations Study

Hello Seth,

Thank you for this report. I have a few comments:

- In chapters 4-7 MassDOT 'Districts' are referred to as 'Divisions', please correct
- Section 6.7 Recommendations – Alternatives 1 & 2 are recommended, my understanding is that Alt 1 is contained within Alt2, should this be Alternatives 1 & 3?

Thanks,

Geri

**Geraldine Vatan | District 6 Project Development Engineer**

185 Kneeland Street Boston, MA 02111 | Office (857) 368-6115 | Cell (508) 330-1078

MassDOT Highway Division [geraldine.vatan@dot.state.ma.us](mailto:geraldine.vatan@dot.state.ma.us)

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**From:** Seth Asante [<mailto:sasante@ctps.org>]

**Sent:** Monday, November 20, 2017 3:20 PM

**To:** Boudreau, Neil (DOT); Danila, James (DOT); Raphael, Connie (DOT); Gregg, John (DOT); Timoner, Sara (DOT); Vatan, Geraldine (DOT); Kulen, Raj (DOT); Lipton, Amitai (DOT); Patel, Hasmukh (DOT); Clark, Michael (DOT); Pounds, Bryan (DOT); Gascon, Cassandra (DOT); Paul, Andrew (DOT)

**Cc:** Mark Abbott

**Subject:** Low-Cost Improvements to Express-Highway Bottleneck Locations Study

Good afternoon,

The attached report—Low-Cost Improvements to Express-Highway Bottleneck Locations is available for review.

MPO staff analyzed four bottleneck locations in the study:

- Location 1: Interstate-95 northbound between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza) in Lexington
- Location 2: Interstate-93 southbound between Exit 37C (Commerce Way) and Exit 37B (I-95) in Woburn and Reading
- Location 3: Route 24 northbound between Exit 20 (Route 139) and Exit 21 (I-93) in Randolph, Canton, and Stoughton
- Location 4: Route 24 southbound between Exit 21 (I-93) and Exit 20 (Route 139) in Randolph, Canton, and Stoughton

The study results for Locations 1 and 2, which are in MassDOT Highway District 4, are presented in Chapters 4 and 5 of the report. The study results for Locations 3 and 4, which are in MassDOT Highway District 6, are presented in Chapters 6 and 7 of the report.

Please review the attached report and provide me with comments by **December 7, 2017**.

## Seth Asante

---

**From:** Vatan, Geraldine (DOT)  
**Sent:** Thursday, December 7, 2017 8:19 AM  
**To:** Seth Asante  
**Cc:** Mark Abbott; Boudreau, Neil (DOT); Danila, James (DOT); Raphael, Connie (DOT); Gregg, John (DOT); Timoner, Sara (DOT); Kulen, Raj (DOT); Lipton, Amitai (DOT); Patel, Hasmukh (DOT); Clark, Michael (DOT); Pounds, Bryan (DOT); Gascon, Cassandra (DOT); Paul, Andrew (DOT)  
**Subject:** RE: Low-Cost Improvements to Express-Highway Bottleneck Locations Study

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Thanks,

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185 Kneeland Street Boston, MA 02111 | Office (857) 368-6115 | Cell (508) 330-1078  
MassDOT Highway Division [geraldine.vatan@dot.state.ma.us](mailto:geraldine.vatan@dot.state.ma.us)

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**From:** Seth Asante [mailto:sasante@ctps.org]  
**Sent:** Monday, November 20, 2017 3:20 PM  
**To:** Boudreau, Neil (DOT); Danila, James (DOT); Raphael, Connie (DOT); Gregg, John (DOT); Timoner, Sara (DOT); Vatan, Geraldine (DOT); Kulen, Raj (DOT); Lipton, Amitai (DOT); Patel, Hasmukh (DOT); Clark, Michael (DOT); Pounds, Bryan (DOT); Gascon, Cassandra (DOT); Paul, Andrew (DOT)  
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Please review the attached report and provide me with comments by **December 7, 2017**.

Thank you,  
Seth

**Seth Asante**

---

**From:** Gascon, Cassandra (DOT)  
**Sent:** Monday, December 4, 2017 12:59 PM  
**To:** Seth Asante  
**Subject:** RE: Low-Cost Improvements to Express-Highway Bottleneck Locations Study

Hi Seth,

Please see below OTP's comments on the Bottleneck Study:

- p. 12 – “would result in...” should be more along the lines of “expected to result in...”
- 1.2, Background, is written kind of sloppily on p. 12.
  - So is 2.1, Screening Criteria, on p. 15—consider a bit of revision to both parts
- Consider taking the time to note what is included or not included in the projected costs. We are assuming they don't include ROW acquisition but this is not made clear. This would provide clarity for some of the cost estimates, particularly how Alt. 3 for Location 1 (signage improvements) is projected to cost more than the other two
- Alt. 3 for Location 2 – Even though the alternatives are measured against 2030 model conditions, to expect LOS on the I-93 SB to I-95 SB off-ramp to go from F to A as a result of adding a second lane is ignoring induced demand and seems very unrealistic. It should be acknowledged that induced demand may result in 2030 conditions not meeting the expectations set by the model, even if a more nuanced projection can't be made.
- p. 41 – the long-term improvement at the I-93/I-95 interchange seems like it could be important to this study but is only acknowledged as a footnote. This should be brought into the body of the report and discussed in context of the proposed alternatives

And a few typos we noticed:

- p. 4 last paragraph, third line, should read “location” not “locations”
- p. 16 – “the” PM peak period
- p. 19 – don't start sentence with an acronym
- Some labels from Figure 11 carry over to Figure 12
- p. 38 – “I-93” is termed as “1-93”
- p. 41 third to last line- should read “affect” not “affects”

Lastly, as CTPS moves forward with other studies, we have a suggestion for the formatting/organization of the report. It's really tricky to flip back and forth between the text and the graphics/figures at the end of the study. We recommend integrating most, if not all, of graphics and figures into the report text itself to make it simpler to read and understand.

We hope this is helpful to your editing efforts. If you have questions on these, give me or Michael Clark (he made most of these comments) a call.

Thanks,

Cassandra

**Cassandra Gascon**

Transportation Program Planner II  
Office of Transportation Planning  
Massachusetts Department of Transportation  
10 Park Plaza | Suite 4150 | Boston, MA 02116  
857-368-8852 | cassandra.gascon@dot.state.ma.us

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**From:** Seth Asante [mailto:sasante@ctps.org]  
**Sent:** Monday, November 20, 2017 3:20 PM  
**To:** Boudreau, Neil (DOT); Danila, James (DOT); Raphael, Connie (DOT); Gregg, John (DOT); Timoner, Sara (DOT); Vatan, Geraldine (DOT); Kulen, Raj (DOT); Lipton, Amitai (DOT); Patel, Hasmukh (DOT); Clark, Michael (DOT); Pounds, Bryan (DOT); Gascon, Cassandra (DOT); Paul, Andrew (DOT)  
**Cc:** Mark Abbott  
**Subject:** Low-Cost Improvements to Express-Highway Bottleneck Locations Study

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- Location 4: Route 24 southbound between Exit 21 (I-93) and Exit 20 (Route 139) in Randolph, Canton, and Stoughton

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Please review the attached report and provide me with comments by **December 7, 2017**.

Thank you,  
Seth

## 2. Selection Process

**BOSTON REGION METROPOLITAN PLANNING ORGANIZATION**

Stephanie Pollack, MassDOT Secretary and CEO and MPO Chair  
Karl H. Quackenbush, Executive Director, MPO Staff

**TECHNICAL MEMORANDUM**

**DATE:** March 30, 2017  
**TO:** Boston Region Metropolitan Planning Organization (MPO)  
**FROM:** Seth Asante, MPO Staff  
**RE:** Low-Cost Improvements to Express-Highway Bottleneck Locations  
Selection of Study Locations

**1 BACKGROUND**

This memorandum presents the results of Task 2—screen bottleneck locations and select locations for analysis—of the work program for Low-Cost Improvements to Express-Highway Bottleneck Locations: federal fiscal year (FFY) 2017.<sup>1</sup> In Task 2, MPO staff indicated that we will present the results to the MPO for discussion.

According to the Federal Highway Administration (FHWA), “Much of recurring congestion is due to physical bottlenecks—potentially correctible points on the highway system where traffic flow is restricted. While many of the nation’s bottlenecks can only be addressed through costly major construction projects, there is a significant opportunity for the application of operational and low-cost infrastructure solutions to bring about relief at these chokepoints.”<sup>2</sup>

In the past, MPO staff analyzed several express-highway bottleneck locations in three studies, which were very well received by the Massachusetts Department of Transportation (MassDOT) and FHWA.<sup>3,4,5</sup> Previous study locations included

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<sup>1</sup> Karl H Quackenbush, CTPS Executive Director, work program to the Boston Region Metropolitan Organization, “Low-Cost Improvements to Express-Highway Bottleneck Locations: FFY 2017,” December 15, 2016.

<sup>2</sup> Federal Highway Administration, *Recurring Traffic Bottlenecks: A Primer: Focus on Low-Cost Operations Improvements*, US Department of Transportation, Federal Highway Administration, June 2009, p. 1.

<sup>3</sup> Seth Asante, MPO staff, memorandum to the Transportation Planning and Programming Committee of the Boston Region Metropolitan Planning Organization, “Low-Cost Improvements to Bottleneck Locations, Phase I,” June 2, 2011.

<sup>4</sup> Chen-Yuan Wang, MPO staff, memorandum to the Transportation Planning and Programming Committee of the Boston Region Metropolitan Planning Organization, “Low-Cost Improvements to Bottleneck Locations, Phase II,” dated March 12, 2012.

<sup>5</sup> Seth Asante, Seth Asante, MPO staff, memorandum to the Transportation Planning and Programming Committee of the Boston Region Metropolitan Planning Organization, “Low-Cost Improvements to Express-Highway Bottleneck Locations,” December 3, 2015.

sections of I-95 in Burlington, Lexington, and Weston; sections of I-93 in Woburn; and sections of Route 3 in Braintree. Some of the recommendations from those studies have been executed, such as the I-95 northbound and southbound subtract-a-lane at Interchange 24 in Weston; I-95/Route 3/Middlesex Turnpike Interchange in Lexington and Burlington; and FHWA has interviewed MPO staff about these successful implementations.

The cause and duration of highway bottlenecks vary. In general, recurring bottlenecks, the subject of this work program, are influenced by the design or operation present at the point where the bottleneck begins, for example: merges, diverges, lane drops, traffic weaving, abrupt changes in highway alignment, low-clearance structures, lane narrowing, intended disruption of traffic for management purposes, and less-than-optimal express-highway design.

This memorandum presents the process used to select the bottleneck study locations. MPO staff will submit this proposal to the MPO for discussion and approval.

## **2 SELECTION OF STUDY LOCATIONS**

Selection of study locations was a two-stage process that comprised inventorying and screening candidate locations.

### **2.1 Inventorying Candidate Locations**

MPO staff developed an initial list of candidate locations in the MPO region based on the following parameters:

- Consultations with MassDOT Highway Division
- Staff knowledge of bottleneck locations in the Boston MPO region
- Review of congestion management process (CMP) monitoring data, and recent MPO and other planning studies

The inventory process yielded 14 bottleneck locations for screening, which are presented in the following table. Nine of the locations are in the Boston Region MPO area and five are located in the Merrimack Valley Planning Commission (MVPC).

### Inventory of Express-Highway Bottleneck Locations for Screening

Location Number	City / Town	MPO Region	MassDOT District	Express-Highway Section	Problem
1	Lexington*	Boston Region	4	I-95 northbound between Exit 29 (Rte 2) and Exit 30 (Rte 2A/ Service Plaza)	Merge/ diverge
2	Woburn/ Reading*	Boston Region	4	I-93 southbound between Commerce Way and I-95	Merge/ diverge
3	Randolph/ Canton*	Boston Region	6	Rte 24 northbound between Exit 20 (Rte 139) and Exit 21 (I-93)	Merge/ diverge
4	Randolph/ Canton*	Boston Region	6	Rte 24 southbound between Exit 20 (Rte 139) and Exit 21 (I-93)	Merge/ diverge
5	Medford	Boston Region	4	I-93 southbound between Rte 16 on-ramp and Exit 31 (Rte 16 off-ramp)	Weave
6	Wilmington	Boston Region	4	I-93 northbound between Exit 40 (Rte 62) and Exit 41 (Rte 125)	Merge/ diverge
7	Canton / Randolph	Boston Region	6	I-93 northbound between Exit 1 (I-95) and Exit 4 (Rte 24)	Merge/ diverge/ weave
8	Canton / Randolph	Boston Region	6	I-93 southbound between Exit 1 (I-95) and Exit 4 (Rte 24)	Merge/ diverge/ weave
9	Reading	Boston Region	4	I-95 northbound between Exit 37 (I-93) and Exit 38 (Rte 28)	Weave
10	Andover/ Lawrence	MVPC	4	I-495 northbound between Exit 41 (Rte 28) and Exit 42 (Route 114)	Merge/ diverge
11	North Andover/ Lawrence	MVPC	4	I-495 northbound between Exit 42 (Rte 114) and Exit 43 (Massachusetts Avenue)	Merge/ diverge
12	North Andover/ Lawrence	MVPC	4	I-495 southbound between Exit 42 (Rte 114) and Exit 43 (Massachusetts Ave)	Merge/ diverge Acceleration/ deceleration lane lengths
13	Methuen	MVPC	4	I-495 northbound Exit 47 (Rte 213)	Acceleration/ deceleration lane lengths
14	Methuen	MVPC	4	I-495 southbound Exit 47 (Rte 213)	Acceleration/ deceleration lane lengths

Source: Central Transportation Planning Staff.

MVPC = Merrimack Valley Planning Commission

Note: Asterisks and bolding denote locations selected for analysis.

## 2.2 Screening Candidate Locations

MPO staff selected four bottleneck locations for analysis in FFY 2017 (the first four locations cited in the table above). After consulting with the MassDOT Highway Division, staff determined that these four locations likely could be corrected with low-cost mitigation strategies. The other bottlenecks in the Boston Region MPO area also could be corrected in a low-cost manner, but were not selected because of funding resources—these locations would be considered in future bottleneck studies. However, location 9 in the table above likely could not be correctible in a low-cost manner.

MPO staff used the following criteria to screen the bottleneck locations:

- Does the location qualify as a bottleneck? A long traffic queue upstream trailing free-flowing traffic downstream usually characterizes the location as a bottleneck. In addition, the upstream congestion must be recurring—in other words, the location experiences routine and predictable congestion because traffic volume exceeds the available capacity at that location.
- Is a physical design constraint or operational conflict that is inherent in the location the cause of the bottleneck? Examples of these are:
  - Lane drop—one or more travel lanes are lost, requiring traffic to merge
  - Weaving area—drivers must merge across one or more lanes in order to access an entry or exit ramp
  - Merge area—on-ramp traffic merges with mainline traffic in order to enter the freeway
  - Major interchanges—high-volume traffic is directed from one freeway to another
  - Horizontal curves—abrupt changes in highway alignment force drivers to slow down because of safety concerns
- Can the bottleneck be fixed with low-cost operational and geometric improvements? These would exclude costly long-term solutions such as expansion and major transit investments that alter drivers' mode choice. Examples of low-cost operational and geometric improvements are:
  - Using a short section of shoulder as an additional travel lane, an auxiliary lane, or for lengthening an acceleration or deceleration lane
  - Restriping merge and diverge areas to better serve traffic demand
  - Providing better traveler information to allow drivers to respond to temporary changes in lane assignment, such as using a shoulder as an additional travel lane during peak periods
  - Providing all-purpose reversible lanes
  - Changing or adding signs and striping

Based on the screening criteria and consultations with MassDOT Highway Division officials, MPO staff selected locations 1, 2, 3 and 4 for study. Below is staff's rationale for not selecting locations 9 through 14:

***Location 9: I-95 Northbound between Exit 37 (I-93) and Exit 38 (Route 28) in Reading***

This section of highway frequently is congested because of a lane drop, intensive weaving, and merging and diverging activities, especially during the PM peak period, which slows down mainline traffic. During that time, The I-95 northbound



mainline carries about 6,000 vehicles per hour, the Exit 37 off-ramps carry about 3,000 vehicles per hour, and the Exit 37 on-ramps carry about 2,600 vehicles per hour. Adding an auxiliary lane northbound on I-95 would provide more room for the merging and diverging activities and reduce disturbance to mainline traffic. Staff did not select this location because the weave problem at Exit 37 could not be corrected in low-cost manner and an auxiliary lane would need to be extended for a long distance (about three-to-four interchanges downstream) to reduce congestion and queue, which could be expensive.

#### ***Locations 10, 11, 12, 13, and 14***

These bottleneck locations are in the MVPC area; they were not screened or considered in the selection process because they are not in the Boston Region MPO area.

### **3 SELECTED BOTTLENECK LOCATIONS FOR STUDY**

#### ***Location 1: I-95 Northbound between Exit 29 (Route 2) and Exit 30 (Route 2A/Service Plaza) in Lexington***

This section of highway, about 0.75 miles long, frequently is congested because of merging and diverging activities, especially during the PM peak period. The northbound on- and off-ramps connect to and from Route 2 (Concord Turnpike), Route 2A (Merrett Road), and the service plaza. During peak periods, I-95 northbound carries about 6,100 vehicles per hour; the on-ramp from Route 2 westbound carries about 1,000 vehicles per hour; and about 600 vehicles per hour exit to Route 2A at Exit 30 and the service plaza. The merging and diverging activities of these vehicles slow down I-95 northbound mainline traffic upstream of the Route 2A interchange, which makes it difficult to enter I-95 northbound for the Route 2 traffic.

#### ***Location 2: I-93 Southbound between Commerce Way and I-95 in Woburn and Reading***

This bottleneck is located on I-93 southbound in the section where traffic diverges onto I-95 southbound. During the AM peak period, traffic going to I-95 southbound backs up that ramp onto I-93 mainline traffic, thus impacting flow on the rightmost low-speed southbound lane. As a result, motorists attempt to get into the breakdown lane as soon as possible to stay clear of the low-speed lane, but usually vehicles are still queuing on the low-speed lane. The other three southbound lanes are almost in free flow conditions (that is, uncongested conditions with drivers traveling at posted speeds) during this period. In the segment, the four I-93 southbound lanes carry between 6,500 and 7,000 vehicles per hour of which about 2,000 vehicles exit to I-95 southbound.

***Location 3: Route 24 Northbound between Exit 20 (Route 139) and Exit 21 (I-93) in Randolph, Canton, and Stoughton***

This bottleneck is located on Route 24 northbound at the point where traffic diverges onto I-93 northbound and southbound during AM peak periods. The impact of the bottleneck extends from I-93 in Randolph to Route 139 in Stoughton, about two miles long. During this period, Route 24 northbound carries about 6,000 vehicles per hour, of which 2,500 vehicles exit to I-93 southbound and 3,500 to I-93 northbound. The merging activity of these vehicles on I-93 slows down traffic on the Route 24 connector ramps and backs up traffic on Route 24.

***Location 4: Route 24 Southbound between Exit 20 (Route 139) and Exit 21 (I-93) in Randolph, Canton, and Stoughton***

This bottleneck is located on Route 24 southbound at the point where traffic from the I-93 connector ramps merge onto Route 24 southbound during PM peak periods. The merging activity of these vehicles creates a bottleneck that causes a traffic queue to extend from the Canton Street Bridge under Route 24 onto the I-93 northbound and southbound lanes, creating a bottleneck about a mile long. During this period, Route 24 southbound carries about 6,000 vehicles per hour of which about 3,000 vehicles enter from I-93 southbound and another 3,000 from I-93 northbound.

## 4 SUMMARY

By identifying and evaluating a comprehensive list of potential improvements at the four locations, MPO staff will rely on their technical expertise and judgment regarding the nature of bottlenecks. MPO staff will seek input from MassDOT Highway Division staff that are familiar with the region's express-highway system operations.

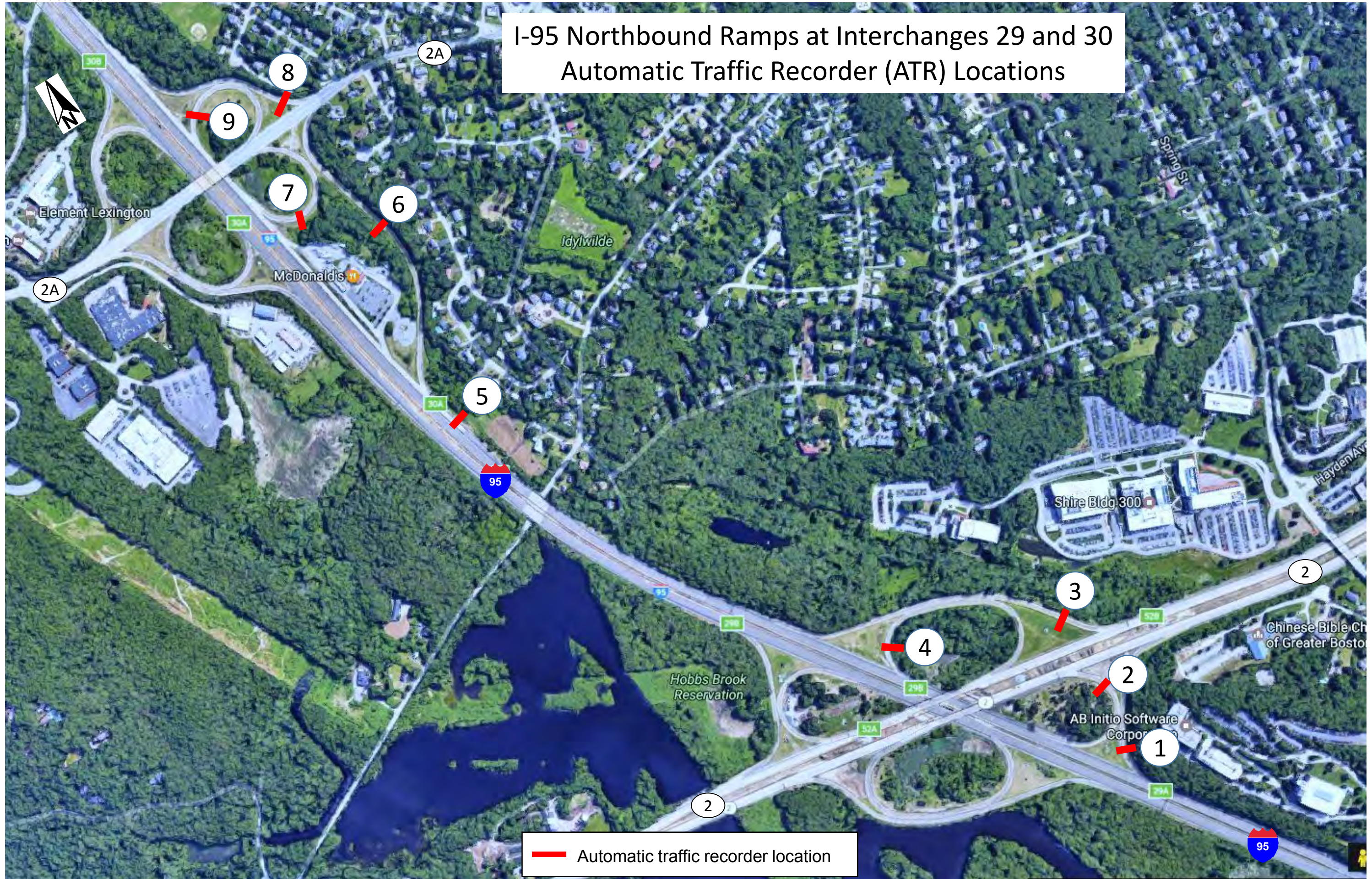
This study addresses the MPO's goal of reducing congestion and increasing safety on the region's express-highway system. MPO staff will submit this proposal to the MPO for discussion and approval. If the MPO approves these locations for study, staff will meet with officials from MassDOT to discuss specifics, conduct field visits, collect data, and perform various analyses.

SAA/saa

# APPENDIX B

1. ATR data
2. Classification data

# I-95 Northbound Ramps at Interchanges 29 and 30 Automatic Traffic Recorder (ATR) Locations



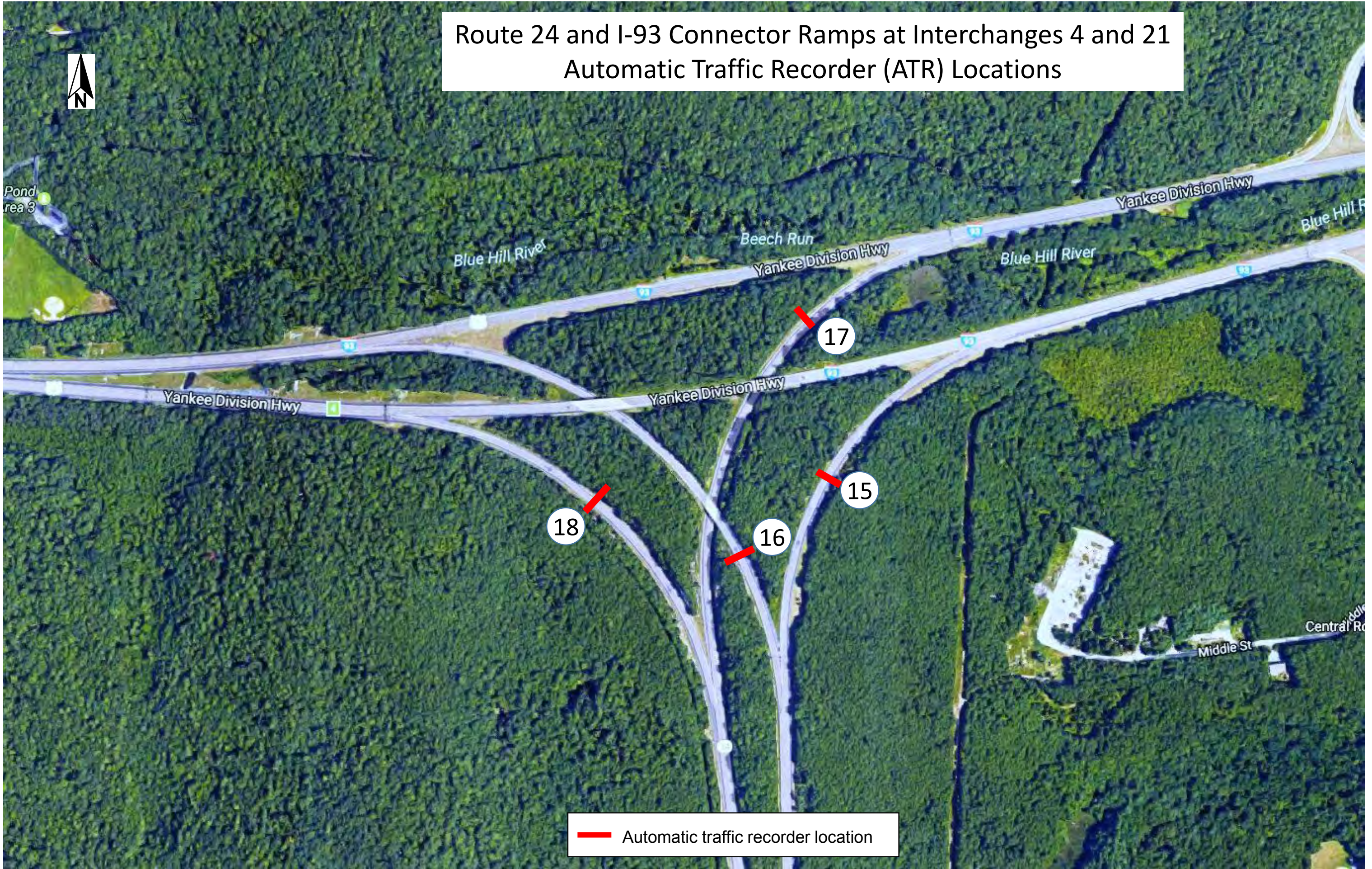
— Automatic traffic recorder location

# I-93 Southbound Ramps at Interchanges 36 and 37 Automatic Traffic Recorder (ATR) Locations



— Automatic traffic recorder location

Route 24 and I-93 Connector Ramps at Interchanges 4 and 21  
Automatic Traffic Recorder (ATR) Locations



— Automatic traffic recorder location

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 3

Site Reference: 170170000822  
 Site ID: 000000021742  
 Location: RTE.2 WB Exit 52B TO I-95 N. PEABODY  
 Direction: ROAD TOTAL

File: R21742.prn  
 City: LEXINGTON  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		125	136	110	114	121			121	485
02:00		46	54	57	47	51			51	204
03:00		20	36	23	47	31			31	126
04:00		14	20	24	21	19			19	79
05:00		31	44	41	42	39			39	158
06:00		197	202	190	178	191			191	767
07:00		605	609	597	526	584			584	2337
08:00		1511	1464	1471	1399	1461			1461	5845
09:00		1547	1521	1507	1537	1528			1528	6112
10:00		1160	1189	1229	1054	1158			1158	4632
11:00		874	838	864	888	866			866	3464
12:00		788	766	810		788			788	2364
13:00	803	866	834	966		867			867	3469
14:00	797	829	925	982		883			883	3533
15:00	957	1065	1059	866		986			986	3947
16:00	891	877	950	976		923			923	3694
17:00	793	836	925	875		857			857	3429
18:00	816	1071	979	974		960			960	3840
19:00	1123	1082	1088	1154		1111			1111	4447
20:00	714	877	921	911		855			855	3423
21:00	468	522	547	545		520			520	2082
22:00	392	414	521	448		443			443	1775
23:00	302	378	360	359		349			349	1399
24:00	197	266	237	232		233			233	932
<hr/>										
TOTALS	8253	16001	16225	16211	5853	15824	0	0	15824	62543
% AVG WKDY	52.1	101.1	102.5	102.4	36.9					
% AVG WEEK	52.1	101.1	102.5	102.4	36.9					
AM Times		09:00	09:00	09:00	09:00	09:00			09:00	
AM Peaks		1547	1521	1507	1537	1528			1528	
PM Times	19:00	19:00	19:00	19:00		19:00			19:00	
PM Peaks	1123	1082	1088	1154		1111			1111	
D%	100	100	100	100	100					
K%	14	10	9	9	26					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 4

Site Reference: 170170000461  
 Site ID: 000000012637  
 Location: I-95 NB to RTE.2WB EXIT 29B TO  
 Direction: ROAD TOTAL

File: R12637.prn  
 City: LEXINGTON  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		108	85	90	84	91			91	367
02:00		31	42	28	52	38			38	153
03:00		29	34	46	42	37			37	151
04:00		22	24	33	37	29			29	116
05:00		66	49	72	49	59			59	236
06:00		151	160	173	150	158			158	634
07:00		372	381	366	383	375			375	1502
08:00		450	518	490	476	483			483	1934
09:00		525	507	514	542	522			522	2088
10:00		498	552	499	598	536			536	2147
11:00		518	508	532	674	558			558	2232
12:00		522	536	523		527			527	1581
13:00	533	555	581	582		562			562	2251
14:00	588	607	628	616		609			609	2439
15:00	723	781	688	671		715			715	2863
16:00	706	682	641	595		656			656	2624
17:00	613	648	603	603		616			616	2467
18:00	621	582	579	527		577			577	2309
19:00	592	659	659	635		636			636	2545
20:00	481	533	614	570		549			549	2198
21:00	386	366	449	418		404			404	1619
22:00	303	325	390	396		353			353	1414
23:00	230	228	275	268		250			250	1001
24:00	129	148	151	166		148			148	594
<hr/>										
TOTALS	5905	9406	9654	9413	3087	9488	0	0	9488	37465
% AVG WKDY	62.2	99.1	101.7	99.2	32.5					
% AVG WEEK	62.2	99.1	101.7	99.2	32.5					
AM Times		09:00	10:00	11:00	11:00	11:00			11:00	
AM Peaks		525	552	532	674	558			558	
PM Times	15:00	15:00	15:00	15:00		15:00			15:00	
PM Peaks	723	781	688	671		715			715	
D%	100	100	100	100	100					
K%	12	8	7	7	22					



MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 5

Site Reference: 170170000821  
 Site ID: 000000012638  
 Location: I95NB EX30 TO RT2A E.CONCORD/SERVICE PLZ  
 Direction: ROAD TOTAL

File: R12638.prn  
 City: LEXINGTON  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		69	76	76	65	71			71	286
02:00		30	53	34	47	41			41	164
03:00		24	29	30	40	30			30	123
04:00		17	39	29	38	30			30	123
05:00		60	72	74	75	70			70	281
06:00		342	298	316	270	306			306	1226
07:00		685	762	758	603	702			702	2808
08:00		1041	1091	1011	996	1034			1034	4139
09:00		1069	1080	1101	1008	1064			1064	4258
10:00		880	885	919	790	868			868	3474
11:00		657	679	684	567	646			646	2587
12:00		625	595	601		607			607	1821
13:00	644	646	670	699		664			664	2659
14:00	581	587	693	651		628			628	2512
15:00	803	858	812	1048		880			880	3521
16:00	1260	1242	1196	1222		1230			1230	4920
17:00	1261	1233	1269	1355		1279			1279	5118
18:00	1097	963	994	1167		1055			1055	4221
19:00	809	659	710	793		742			742	2971
20:00	477	393	418	506		448			448	1794
21:00	272	241	341	338		298			298	1192
22:00	214	188	233	262		224			224	897
23:00	184	200	217	182		195			195	783
24:00	79	142	114	133		117			117	468
TOTALS	7681	12851	13326	13989	4499	13229	0	0	13229	52346
% AVG WKDY	58	97.1	100.7	105.7	34					
% AVG WEEK	58	97.1	100.7	105.7	34					
AM Times		09:00	08:00	09:00	09:00	09:00			09:00	
AM Peaks		1069	1091	1101	1008	1064			1064	
PM Times	17:00	16:00	17:00	17:00		17:00			17:00	
PM Peaks	1261	1242	1269	1355		1279			1279	
D%	100	100	100	100	100					
K%	16	10	10	10	22					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 6

Site Reference: 170170000560  
 Site ID: 000000012639  
 Location: I95NB EX.30A TO RTE2A E.CONCORD/E. LEX  
 Direction: ROAD TOTAL

File: R12639.prn  
 City: LEXINGTON  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		15	11	8	13	11			11	47
02:00		3	11	8	4	6			6	26
03:00		0	3	3	4	2			2	10
04:00		3	4	4	3	3			3	14
05:00		6	7	6	8	6			6	27
06:00		21	23	15	18	19			19	77
07:00		71	81	91	66	77			77	309
08:00		147	152	132	166	149			149	597
09:00		151	156	154	152	153			153	613
10:00		142	152	157	137	147			147	588
11:00		141	168	180	123	153			153	612
12:00		146	166	178		163			163	490
13:00	149	161	171	167		162			162	648
14:00	132	151	147	147		144			144	577
15:00	207	215	207	284		228			228	913
16:00	296	263	247	265		267			267	1071
17:00	337	345	378	444		376			376	1504
18:00	497	367	387	471		430			430	1722
19:00	293	242	302	288		281			281	1125
20:00	160	156	142	181		159			159	639
21:00	100	104	124	120		112			112	448
22:00	71	53	72	89		71			71	285
23:00	40	47	58	52		49			49	197
24:00	11	35	20	22		22			22	88
TOTALS	2293	2985	3189	3466	694	3190	0	0	3190	12627
% AVG WKDY	71.8	93.5	99.9	108.6	21.7					
% AVG WEEK	71.8	93.5	99.9	108.6	21.7					
AM Times		09:00	11:00	11:00	08:00	12:00			12:00	
AM Peaks		151	168	180	166	163			163	
PM Times	18:00	18:00	18:00	18:00		18:00			18:00	
PM Peaks	497	367	387	471		430			430	
D%	100	100	100	100	100					
K%	22	12	12	14	24					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 7

Site Reference: 000000000671  
 Site ID: 000000012640  
 Location: RTE.2A EB ON-RAMP TO I-95N  
 Direction: ROAD TOTAL

File: R12640.prn  
 City: LEXINGTON  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		17	17	14	9	14			14	57
02:00		3	8	10	10	7			7	31
03:00		2	2	3	5	3			3	12
04:00		4	4	3	3	3			3	14
05:00		8	10	12	13	10			10	43
06:00		48	47	45	41	45			45	181
07:00		190	179	199	171	184			184	739
08:00		339	326	357	265	321			321	1287
09:00		334	380	344	245	325			325	1303
10:00		311	265	307	215	274			274	1098
11:00		213	205	184	178	195			195	780
12:00		186	172	181		179			179	539
13:00	163	186	179	195		180			180	723
14:00	184	201	230	177		198			198	792
15:00	203	190	213	132		184			184	738
16:00	177	185	206	176		186			186	744
17:00	124	119	134	112		122			122	489
18:00	147	162	141	93		135			135	543
19:00	101	140	146	152		134			134	539
20:00	89	110	113	129		110			110	441
21:00	78	76	141	72		91			91	367
22:00	37	53	62	64		54			54	216
23:00	37	38	50	36		40			40	161
24:00	36	28	35	45		36			36	144
TOTALS	1376	3143	3265	3042	1155	3030	0	0	3030	11981
% AVG WKDY	45.4	103.7	107.7	100.3	38.1					
% AVG WEEK	45.4	103.7	107.7	100.3	38.1					
AM Times		08:00	09:00	08:00	08:00	09:00			09:00	
AM Peaks		339	380	357	265	325			325	
PM Times	15:00	14:00	14:00	13:00		14:00			14:00	
PM Peaks	203	201	230	195		198			198	
D%	100	100	100	100	100					
K%	15	11	12	12	23					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA 8

Site Reference: 170170000717  
 Site ID: 000000012642  
 Location: RTE.2A WB ON-RAMP TO I-95N  
 Direction: ROAD TOTAL

File: R12642.prn  
 City: LEXINGTON  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		6	0	8	4	4			4	18
02:00		1	2	3	3	2			2	9
03:00		5	4	2	2	3			3	13
04:00		1	2	1	1	1			1	5
05:00		8	2	5	4	4			4	19
06:00		22	22	12	18	18			18	74
07:00		49	61	52	46	52			52	208
08:00		114	132	122	105	118			118	473
09:00		201	185	187	172	186			186	745
10:00		117	118	114	126	118			118	475
11:00		94	78	81	92	86			86	345
12:00		101	88	89		92			92	278
13:00	110	102	98	104		103			103	414
14:00	81	99	92	87		89			89	359
15:00	80	80	120	140		105			105	420
16:00	124	115	242	193		168			168	674
17:00	95	84	101	84		91			91	364
18:00	64	110	64	83		80			80	321
19:00	83	75	80	69		76			76	307
20:00	53	62	81	75		67			67	271
21:00	47	58	81	88		68			68	274
22:00	33	31	27	35		31			31	126
23:00	13	14	21	14		15			15	62
24:00	3	8	10	7		7			7	28
TOTALS	786	1557	1711	1655	573	1584	0	0	1584	6282
% AVG WKDY	49.6	98.2	108	104.4	36.1					
% AVG WEEK	49.6	98.2	108	104.4	36.1					
AM Times		09:00	09:00	09:00	09:00	09:00			09:00	
AM Peaks		201	185	187	172	186			186	
PM Times	16:00	16:00	16:00	16:00		16:00			16:00	
PM Peaks	124	115	242	193		168			168	
D%	100	100	100	100	100					
K%	16	13	14	12	30					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 9

Site Reference: 170170000519  
 Site ID: 000000012641  
 Location: I95NB EX.30B TO RT2A W.CONCORD/EAST LEX  
 Direction: ROAD TOTAL

File: R12641.prn  
 City: LEXINGTON  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		27	38	24	22	27			27	111
02:00		12	23	12	19	16			16	66
03:00		12	8	12	16	12			12	48
04:00		10	8	11	16	11			11	45
05:00		32	25	25	27	27			27	109
06:00		203	181	190	152	181			181	726
07:00		480	493	486	387	461			461	1846
08:00		728	744	689	632	698			698	2793
09:00		723	725	712	649	702			702	2809
10:00		513	523	528	450	503			503	2014
11:00		298	283	256	244	270			270	1081
12:00		213	225	221		219			219	659
13:00	210	231	273	264		244			244	978
14:00	250	196	252	250		237			237	948
15:00	296	307	279	460		335			335	1342
16:00	454	454	420	423		437			437	1751
17:00	433	420	367	377		399			399	1597
18:00	371	359	364	384		369			369	1478
19:00	356	278	256	333		305			305	1223
20:00	243	153	147	181		181			181	724
21:00	100	82	136	116		108			108	434
22:00	88	76	80	89		83			83	333
23:00	81	88	86	64		79			79	319
24:00	35	47	51	47		45			45	180
<hr/>										
TOTALS	2917	5942	5987	6154	2614	5949	0	0	5949	23614
% AVG WKDY	49	99.8	100.6	103.4	43.9					
% AVG WEEK	49	99.8	100.6	103.4	43.9					
AM Times		08:00	08:00	09:00	09:00	09:00			09:00	
AM Peaks		728	744	712	649	702			702	
PM Times	16:00	16:00	16:00	15:00		16:00			16:00	
PM Peaks	454	454	420	460		437			437	
D%	100	100	100	100	100					
K%	16	12	12	12	25					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 10

Site Reference: 170170000611  
 Site ID: 000000012252  
 Location: I93 SB EXIT 37C COMMERCE WAY/ATLANTIC AV  
 Direction: ROAD TOTAL

File: R12252.prn  
 City: WOBURN  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		6	10	8	10	8			8	34
02:00		13	15	12	15	13			13	55
03:00		45	38	49	42	43			43	174
04:00		74	86	105	73	84			84	338
05:00		152	142	144	142	145			145	580
06:00		477	509	529	493	502			502	2008
07:00		924	922	886	801	883			883	3533
08:00		1297	1365	1437	1223	1330			1330	5322
09:00		1285	1286	1479	970	1255			1255	5020
10:00		645	657	772	539	653			653	2613
11:00		288	357	367	373	346			346	1385
12:00		282	306	336		308			308	924
13:00	218	273	285	631		351			351	1407
14:00	237	246	291	343		279			279	1117
15:00	274	330	352	447		350			350	1403
16:00	212	244	281	267		251			251	1004
17:00	202	226	265	276		242			242	969
18:00	337	261	334	277		302			302	1209
19:00	213	206	269	236		231			231	924
20:00	135	140	181	169		156			156	625
21:00	116	121	139	117		123			123	493
22:00	74	80	100	99		88			88	353
23:00	46	42	49	50		46			46	187
24:00	43	51	59	49		50			50	202
TOTALS	2107	7708	8298	9085	4681	8039	0	0	8039	31879
% AVG WKDY	26.2	95.8	103.2	113	58.2					
% AVG WEEK	26.2	95.8	103.2	113	58.2					
AM Times		08:00	08:00	09:00	08:00	08:00			08:00	
AM Peaks		1297	1365	1479	1223	1330			1330	
PM Times	18:00	15:00	15:00	13:00		13:00			13:00	
PM Peaks	337	330	352	631		351			351	
D%	100	100	100	100	100					
K%	16	17	16	16	26					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 11

Site Reference: 170170000747  
 Site ID: 000000012253  
 Location: COMMERCE WAY ON RAMP TO I93 SB  
 Direction: ROAD TOTAL

File: R12253.prn  
 City: WOBURN  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		33	29	39	31	33			33	132
02:00		28	24	26	27	26			26	105
03:00		20	23	21	16	20			20	80
04:00		34	37	46	58	43			43	175
05:00		54	36	47	44	45			45	181
06:00		107	117	111	135	117			117	470
07:00		176	201	182	194	188			188	753
08:00		183	173	151	171	169			169	678
09:00		160	175	143	175	163			163	653
10:00		264	206	226	264	240			240	960
11:00		316	383	298	311	327			327	1308
12:00		434	401	457		430			430	1292
13:00	470	461	476	557		491			491	1964
14:00	443	427	432	497		449			449	1799
15:00	487	489	559	542		519			519	2077
16:00	515	519	490	487		502			502	2011
17:00	730	773	744	756		750			750	3003
18:00	948	974	964	990		969			969	3876
19:00	527	609	584	575		573			573	2295
20:00	363	375	337	342		354			354	1417
21:00	272	265	256	259		263			263	1052
22:00	150	179	230	169		182			182	728
23:00	102	103	110	137		113			113	452
24:00	105	118	96	106		106			106	425
TOTALS	5112	7101	7083	7164	1426	7072	0	0	7072	27886
% AVG WKDY	72.2	100.4	100.1	101.3	20.1					
% AVG WEEK	72.2	100.4	100.1	101.3	20.1					
AM Times		12:00	12:00	12:00	11:00	12:00			12:00	
AM Peaks		434	401	457	311	430			430	
PM Times	18:00	18:00	18:00	18:00		18:00			18:00	
PM Peaks	948	974	964	990		969			969	
D%	100	100	100	100	100					
K%	19	14	14	14	22					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 12

Site Reference: 170170000672  
 Site ID: 000000012175  
 Location: I93 SB EX 37B TO I-95 S. WALTHAM  
 Direction: ROAD TOTAL

File: R12175.prn  
 City: WOBURN  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		85	83	90	85	85			85	343
02:00		56	72	85	77	72			72	290
03:00		67	72	72	77	72			72	288
04:00		111	128	124	119	120			120	482
05:00		256	251	278	283	267			267	1068
06:00		815	851	859	794	829			829	3319
07:00		1151	1136	1186	1459	1233			1233	4932
08:00		1798	1913	1801	1906	1854			1854	7418
09:00		1865	1884	1932	2015	1924			1924	7696
10:00		1894	1903	1792	1688	1819			1819	7277
11:00		1401	1525	1483	1266	1418			1418	5675
12:00		1256	1343	1512		1370			1370	4111
13:00	975	1259	1328	1454		1254			1254	5016
14:00	1066	1165	1138	1520		1222			1222	4889
15:00	1193	1115	1237	1471		1254			1254	5016
16:00	945	958	1071	1192		1041			1041	4166
17:00	1230	1207	1330	1421		1297			1297	5188
18:00	1377	1262	1442	1425		1376			1376	5506
19:00	1064	1081	1297	1173		1153			1153	4615
20:00	628	572	779	770		687			687	2749
21:00	478	458	531	513		495			495	1980
22:00	309	363	439	372		370			370	1483
23:00	270	280	298	329		294			294	1177
24:00	164	162	180	189		173			173	695
-----										
TOTALS	9699	20637	22231	23043	9769	21679	0	0	21679	85379
-----										
% AVG WKDY	44.7	95.1	102.5	106.2	45					
% AVG WEEK	44.7	95.1	102.5	106.2	45					
-----										
AM Times		10:00	08:00	09:00	09:00	09:00			09:00	
AM Peaks		1894	1913	1932	2015	1924			1924	
-----										
PM Times	18:00	18:00	18:00	14:00		18:00			18:00	
PM Peaks	1377	1262	1442	1520		1376			1376	
-----										
D%	100	100	100	100	100					
K%	14	9	9	8	21					



MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA 13

Site Reference: 170170000483  
 Site ID: 000000012664  
 Location: I95 SB EX 36B TO COMMERCE WAY/WASHINGTON  
 Direction: ROAD TOTAL

File: R12664.prn  
 City: WOBURN  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		79	77	50	69	68			68	275
02:00		50	54	58	55	54			54	217
03:00		60	65	64	68	64			64	257
04:00		94	91	92	102	94			94	379
05:00		221	207	220	207	213			213	855
06:00		673	667	654	588	645			645	2582
07:00		635	596	598	760	647			647	2589
08:00		504	538	579	832	613			613	2453
09:00		615	684	729	914	735			735	2942
10:00		865	925	768	1062	905			905	3620
11:00		929	924	772	943	892			892	3568
12:00		950	892	636		826			826	2478
13:00	935	954	996	682		891			891	3567
14:00	892	889	910	705		849			849	3396
15:00	904	910	846	731		847			847	3391
16:00	822	795	814	634		766			766	3065
17:00	705	746	739	643		708			708	2833
18:00	681	762	753	642		709			709	2838
19:00	581	615	651	595		610			610	2442
20:00	456	467	503	479		476			476	1905
21:00	364	364	359	385		368			368	1472
22:00	267	244	272	265		262			262	1048
23:00	167	150	137	164		154			154	618
24:00	128	124	111	115		119			119	478
TOTALS	6902	12695	12811	11260	5600	12515	0	0	12515	49268
% AVG WKDY	55.1	101.4	102.3	89.9	44.7					
% AVG WEEK	55.1	101.4	102.3	89.9	44.7					
AM Times		12:00	10:00	11:00	10:00	10:00			10:00	
AM Peaks		950	925	772	1062	905			905	
PM Times	13:00	13:00	13:00	15:00		13:00			13:00	
PM Peaks	935	954	996	731		891			891	
D%	100	100	100	100	100					
K%	14	8	8	7	19					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 14

Site Reference: 170170000718  
 Site ID: 000000012665  
 Location: WASHINGTON ST. ON-RAMP TO I-95 S  
 Direction: ROAD TOTAL

File: R12665.prn  
 City: WOBURN  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		74	57	54	52	59			59	237
02:00		37	32	36	32	34			34	137
03:00		13	22	29	34	24			24	98
04:00		67	63	52	59	60			60	241
05:00		78	78	77	82	78			78	315
06:00		303	223	246	195	241			241	967
07:00		817	820	798	604	759			759	3039
08:00		1454	1264	1306	882	1226			1226	4906
09:00		1436	1204	1074	906	1155			1155	4620
10:00		982	900	948	833	915			915	3663
11:00		836	852	928	855	867			867	3471
12:00		909	891	1141		980			980	2941
13:00	806	987	902	1279		993			993	3974
14:00	921	947	992	1255		1028			1028	4115
15:00	940	916	1003	1121		995			995	3980
16:00	983	918	887	1034		955			955	3822
17:00	896	914	919	922		912			912	3651
18:00	1010	992	1009	918		982			982	3929
19:00	877	855	911	862		876			876	3505
20:00	578	599	643	659		619			619	2479
21:00	560	484	537	530		527			527	2111
22:00	288	273	374	397		333			333	1332
23:00	175	197	244	211		206			206	827
24:00	130	120	137	138		131			131	525
TOTALS	8164	15208	14964	16015	4534	14955	0	0	14955	58885
% AVG WKDY	54.5	101.6	100	107	30.3					
% AVG WEEK	54.5	101.6	100	107	30.3					
AM Times		08:00	08:00	08:00	09:00	08:00			08:00	
AM Peaks		1454	1264	1306	906	1226			1226	
PM Times	18:00	18:00	18:00	13:00		14:00			14:00	
PM Peaks	1010	992	1009	1279		1028			1028	
D%	100	100	100	100	100					
K%	12	10	8	8	20					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 15

Site Reference: 170170000692  
 Site ID: 000000022550  
 Location: RTE.24 NB EXIT21A TO 93 N BOSTON  
 Direction: ROAD TOTAL

File: R22550.prn  
 City: RANDOLPH  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		343	283	361	307	323			323	1294
02:00		245	231	241	255	243			243	972
03:00		234	251	249	303	259			259	1037
04:00		410	413	463	421	426			426	1707
05:00		1326	1247	1275	1166	1253			1253	5014
06:00		3062	3049	3042	3029	3045			3045	12182
07:00		2071	2256	2196	2278	2200			2200	8801
08:00		2189	2168	2303	2493	2288			2288	9153
09:00		2228	2223	2228	1246	1981			1981	7925
10:00		2365	2472	2603	2623	2515			2515	10063
11:00		2327	2454	2457		2412			2412	7238
12:00	2472	2357	2356	2479		2416			2416	9664
13:00	2527	2461	2479	2314		2445			2445	9781
14:00	2291	2375	2439	2346		2362			2362	9451
15:00	2168	2198	2248	2222		2209			2209	8836
16:00	2150	2083	2150	2060		2110			2110	8443
17:00	2076	2053	2034	2083		2061			2061	8246
18:00	1962	2090	1963	2060		2018			2018	8075
19:00	1690	1776	1675	1813		1738			1738	6954
20:00	1525	1487	1471	1512		1498			1498	5995
21:00	1436	1351	1401	1485		1418			1418	5673
22:00	1211	1147	1288	1424		1267			1267	5070
23:00	931	918	1035	1045		982			982	3929
24:00	505	518	543	601		541			541	2167
-----										
TOTALS	22944	39614	40129	40862	14121	40010	0	0	40010	157670
-----										
% AVG WKDY	57.3	99	100.2	102.1	35.2					
% AVG WEEK	57.3	99	100.2	102.1	35.2					
-----										
AM Times	12:00	06:00	06:00	06:00	06:00	06:00			06:00	
AM Peaks	2472	3062	3049	3042	3029	3045			3045	
-----										
PM Times	13:00	13:00	13:00	14:00		13:00			13:00	
PM Peaks	2527	2461	2479	2346		2445			2445	
-----										
D%	100	100	100	100	100					
K%	11	8	8	7	21					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 16

Site Reference: 170170000573  
 Site ID: 000000022549  
 Location: RTE.24 NB EXIT21B TO 93 S  
 Direction: ROAD TOTAL

File: R22549.prn  
 City: RANDOLPH  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		188	152	159	196	173			173	695
02:00		112	138	123	126	124			124	499
03:00		131	127	106	143	126			126	507
04:00		190	162	184	198	183			183	734
05:00		614	577	606	578	593			593	2375
06:00		2388	2341	2400	2298	2356			2356	9427
07:00		2238	2474	2488	2487	2421			2421	9687
08:00		2196	2208	2273	2479	2289			2289	9156
09:00		2296	2254	2316	1270	2034			2034	8136
10:00		2265	2295	2216	2130	2226			2226	8906
11:00		1901	1882	2012		1931			1931	5795
12:00	1656	1585	1736	1743		1680			1680	6720
13:00	1566	1626	1668	1736		1649			1649	6596
14:00	1744	1666	1734	1783		1731			1731	6927
15:00	1927	1932	1956	1969		1946			1946	7784
16:00	1813	1896	1846	1792		1836			1836	7347
17:00	1774	1847	1895	1779		1823			1823	7295
18:00	1789	1769	1801	1768		1781			1781	7127
19:00	1332	1322	1367	1428		1362			1362	5449
20:00	1011	942	985	1108		1011			1011	4046
21:00	814	758	754	798		781			781	3124
22:00	679	699	691	762		707			707	2831
23:00	566	605	595	572		584			584	2338
24:00	313	292	294	341		310			310	1240
TOTALS	16984	31458	31932	32462	11905	31657	0	0	31657	124741
% AVG WKDY	53.6	99.3	100.8	102.5	37.6					
% AVG WEEK	53.6	99.3	100.8	102.5	37.6					
AM Times	12:00	06:00	07:00	07:00	07:00	07:00			07:00	
AM Peaks	1656	2388	2474	2488	2487	2421			2421	
PM Times	15:00	15:00	15:00	15:00		15:00			15:00	
PM Peaks	1927	1932	1956	1969		1946			1946	
D%	100	100	100	100	100					
K%	11	8	8	8	21					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 17

Site Reference: 170170000430  
 Site ID: 000000012024  
 Location: I93 SB EXIT 4 TO RTE. 24 S. FALL RIVE  
 Direction: ROAD TOTAL

File: R12024.prn  
 City: RANDOLPH  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		813	740	652	747	738			738	2952
02:00		423	369	409	477	419			419	1678
03:00		239	321	323	406	322			322	1289
04:00		244	259	264	280	261			261	1047
05:00		398	413	393	413	404			404	1617
06:00		896	891	907	891	896			896	3585
07:00		1420	1472	1475	1436	1450			1450	5803
08:00		1816	1882	1953	1907	1889			1889	7558
09:00		1828	1808	1857	1759	1813			1813	7252
10:00		1593	1767	1795	1834	1747			1747	6989
11:00		1899	1828	1647		1791			1791	5374
12:00	2288	2228	2187	2410		2278			2278	9113
13:00	2376	2311	2451	2450		2397			2397	9588
14:00	2419	2613	2496	2599		2531			2531	10127
15:00	2892	1835	2458	2772		2489			2489	9957
16:00	2734	2504	2637	2576		2612			2612	10451
17:00	2558	2479	2518	2488		2510			2510	10043
18:00	2542	2319	2229	2536		2406			2406	9626
19:00	2539	2539	2531	2523		2533			2533	10132
20:00	2513	2536	2557	2575		2545			2545	10181
21:00	2158	1915	2135	2139		2086			2086	8347
22:00	1874	1657	1747	1987		1816			1816	7265
23:00	1446	1367	1476	1442		1432			1432	5731
24:00	1057	1227	1212	1188		1171			1171	4684
TOTALS	29396	39099	40384	41360	10150	40536	0	0	40536	160389
% AVG WKDY	72.5	96.4	99.6	102	25					
% AVG WEEK	72.5	96.4	99.6	102	25					
AM Times	12:00	12:00	12:00	12:00	08:00	12:00			12:00	
AM Peaks	2288	2228	2187	2410	1907	2278			2278	
PM Times	15:00	14:00	16:00	15:00		16:00			16:00	
PM Peaks	2892	2613	2637	2772		2612			2612	
D%	100	100	100	100	100					
K%	10	7	7	7	19					

MassDOT Highway Division  
 WEEKLY SUMMARY FOR LANE  
 Starting: 6/12/2017

STA. 18

Site Reference: 170070000494  
 Site ID: 000000012007  
 Location: I93 NB EXIT 4 TO RTE. 24 S. FALL RIVE  
 Direction: ROAD TOTAL



File: R12007.prn  
 City: RANDOLPH  
 County: VOLUME-RAMP

TIME	MON 12	TUE 13	WED 14	THU 15	FRI 16	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		362	328	332	334	339			339	1356
02:00		214	202	204	243	215			215	863
03:00		140	149	145	149	145			145	583
04:00		128	115	136	118	124			124	497
05:00		180	191	203	224	199			199	798
06:00		558	542	542	490	533			533	2132
07:00		1026	1028	1121	1037	1053			1053	4212
08:00		1457	1465	1470	1494	1471			1471	5886
09:00		1526	1596	1536	1554	1553			1553	6212
10:00		1393	1446	1373	1461	1418			1418	5673
11:00		1565	1495	1428		1496			1496	4488
12:00	1596	1578	1612	1511		1574			1574	6297
13:00	1694	1723	1630	1773		1705			1705	6820
14:00	1843	1909	1879	2000		1907			1907	7631
15:00	2389	2500	2406	2534		2457			2457	9829
16:00	2701	2832	2642	2765		2735			2735	10940
17:00	2632	2664	2708	2724		2682			2682	10728
18:00	2654	2575	2493	2726		2612			2612	10448
19:00	2465	2607	2610	2628		2577			2577	10310
20:00	1620	1728	2058	2210		1904			1904	7616
21:00	1192	1203	1429	1383		1301			1301	5207
22:00	889	1271	1110	1039		1077			1077	4309
23:00	616	733	712	755		704			704	2816
24:00	546	631	616	629		605			605	2422
<hr/>										
TOTALS	22837	32503	32462	33167	7104	32386	0	0	32386	128073
<hr/>										
% AVG WKDY	70.5	100.3	100.2	102.4	21.9					
% AVG WEEK	70.5	100.3	100.2	102.4	21.9					
<hr/>										
AM Times	12:00	12:00	12:00	09:00	09:00	12:00			12:00	
AM Peaks	1596	1578	1612	1536	1554	1574			1574	
<hr/>										
PM Times	16:00	16:00	17:00	16:00		16:00			16:00	
PM Peaks	2701	2832	2708	2765		2735			2735	
<hr/>										
D%	100	100	100	100	100					
K%	12	9	8	8	22					

# Volume Count Report

LOCATION INFO	
Location ID	6227_NB
Type	SPOT
Funct'l Class	1
Located On	YANKEE DIVISION HIGHWAY
Loc On Alias	
Direction	NB
County	NORFOLK
Community	RANDOLPH
MPO ID	
HPMS ID	189014800900
Agency	MHD



COUNT DATA INFO	
Count Status	Accepted
Start Date	Mon 11/9/2015
End Date	Tue 11/10/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Station	100000000475
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:60-MIN	
Time	Hourly Count
 0:00-1:00	540
1:00-2:00	367
2:00-3:00	357
3:00-4:00	427
4:00-5:00	1,094
5:00-6:00	4,202
6:00-7:00	7,314
7:00-8:00	7,559
8:00-9:00	7,292
9:00-10:00	6,194
10:00-11:00	4,983
11:00-12:00	4,900
12:00-13:00	5,081
13:00-14:00	5,212
14:00-15:00	5,847
15:00-16:00	5,741
16:00-17:00	5,133
17:00-18:00	5,315
18:00-19:00	4,653
19:00-20:00	3,225
20:00-21:00	2,582
21:00-22:00	2,094
22:00-23:00	1,565
23:00-24:00 	1,008
<b>Total</b>	<b>92,685</b>
<b>AADT</b>	<b>84,494</b>
<b>AM Peak</b>	07:00-08:00 7,559
<b>PM Peak</b>	14:00-15:00 5,847

# Volume Count Report

LOCATION INFO	
Location ID	6227_SB
Type	SPOT
Funct'l Class	1
Located On	YANKEE DIVISION HIGHWAY
Loc On Alias	
Direction	SB
County	NORFOLK
Community	RANDOLPH
MPO ID	
HPMS ID	189014800900
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Mon 11/9/2015
End Date	Tue 11/10/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Station	000000000988
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube



INTERVAL:60-MIN	
Time	Hourly Count
 0:00-1:00	679
1:00-2:00	487
2:00-3:00	386
3:00-4:00	485
4:00-5:00	1,197
5:00-6:00	2,823
6:00-7:00	3,918
7:00-8:00	4,868
8:00-9:00	4,969
9:00-10:00	4,517
10:00-11:00	4,335
11:00-12:00	4,233
12:00-13:00	4,588
13:00-14:00	4,787
14:00-15:00	5,669
15:00-16:00	6,869
16:00-17:00	6,770
17:00-18:00	7,036
18:00-19:00	6,085
19:00-20:00	3,547
20:00-21:00	2,795
21:00-22:00	2,250
22:00-23:00	1,588
23:00-24:00 	1,214
<b>Total</b>	<b>86,095</b>
<b>AADT</b>	<b>78,486</b>
<b>AM Peak</b>	08:00-09:00 4,969
<b>PM Peak</b>	17:00-18:00 7,036



# Volume Count Report

LOCATION INFO	
Location ID	4065_NB
Type	SPOT
Funct'l Class	1
Located On	YANKEE DIVISION HIGHWAY
SOUTH OF	RAMP-RT 2 EB TO RT 95 SB
Direction	NB
County	MIDDLESEX
Community	LEXINGTON
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Wed 10/11/2017
End Date	Thu 10/12/2017
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Station	000000406501
Study	
Speed Limit	
Description	
Sensor Type	

INTERVAL:60-MIN	
Time	Hourly Count
 0:00-1:00	473
1:00-2:00	287
2:00-3:00	191
3:00-4:00	236
4:00-5:00	599
5:00-6:00	2,498
6:00-7:00	5,407
7:00-8:00	6,650
8:00-9:00	6,405
9:00-10:00	5,812
10:00-11:00	5,011
11:00-12:00	4,999
12:00-13:00	5,211
13:00-14:00	5,630
14:00-15:00	6,891
15:00-16:00	7,210
16:00-17:00	7,320
17:00-18:00	7,291
18:00-19:00	6,405
19:00-20:00	4,756
20:00-21:00	3,267
21:00-22:00	2,468
22:00-23:00	1,634
23:00-24:00 	968
<b>Total</b>	<b>97,619</b>
<b>AM Peak</b>	07:00-08:00 6,650
<b>PM Peak</b>	16:00-17:00 7,320

# Volume Count Report

LOCATION INFO	
Location ID	H8456_SB
Type	SPOT
Funct'l Class	1
Located On	I-93
Loc On Alias	I-93, 0.3 mile N. of West St
Direction	SB
County	MIDDLESEX
Community	
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Wed 5/24/2017
End Date	Thu 5/25/2017
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Station	H8456
Study	
Speed Limit	
Description	
Sensor Type	

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	144	125	129	92	490
1:00-2:00	89	110	112	112	423
2:00-3:00	112	118	104	135	469
3:00-4:00	128	170	225	232	755
4:00-5:00	278	392	537	679	1,886
5:00-6:00	1,095	1,624	1,692	1,771	6,182
6:00-7:00	1,750	1,746	1,758	1,750	7,004
7:00-8:00	1,785	1,837	1,791	1,727	7,140
8:00-9:00	1,727	1,675	1,725	1,757	6,884
9:00-10:00	1,780	1,532	1,608	1,503	6,423
10:00-11:00	1,421	1,407	1,408	1,312	5,548
11:00-12:00	1,270	1,244	1,291	1,042	4,847
12:00-13:00	1,155	1,363	1,278	1,198	4,994
13:00-14:00	1,106	1,176	1,240	1,251	4,773
14:00-15:00	1,357	1,328	1,370	1,369	5,424
15:00-16:00	1,299	1,304	1,345	1,407	5,355
16:00-17:00	1,301	1,470	1,575	1,598	5,944
17:00-18:00	1,783	1,800	1,753	1,698	7,034
18:00-19:00	1,526	1,398	1,347	1,276	5,547
19:00-20:00	1,087	884	844	808	3,623
20:00-21:00	803	723	699	634	2,859
21:00-22:00	584	595	481	458	2,118
22:00-23:00	451	371	381	354	1,557
23:00-24:00	304	254	251	207	1,016
<b>Total</b>					98,295
<b>AM Peak</b>					06:45-07:45 7,163
<b>PM Peak</b>					17:00-18:00 7,034

# Volume Count Report

LOCATION INFO	
Location ID	H8516_SB
Type	SPOT
Funct'l Class	1
Located On	I-95
Loc On Alias	I-95, 280 feet N. of Washington St
Direction	SB
County	MIDDLESEX
Community	
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/23/2017
End Date	Wed 5/24/2017
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Station	H8516
Study	
Speed Limit	
Description	
Sensor Type	

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	241	210	218	213	882
1:00-2:00	120	157	152	168	597
2:00-3:00	164	157	166	154	641
3:00-4:00	247	165	163	241	816
4:00-5:00	235	329	367	470	1,401
5:00-6:00	629	940	1,395	1,629	4,593
6:00-7:00	1,855	2,077	2,180	2,090	8,202
7:00-8:00	2,000	2,017	1,912	1,979	7,908
8:00-9:00	1,972	1,947	1,995	2,117	8,031
9:00-10:00	2,033	1,996	2,039	2,010	8,078
10:00-11:00	1,856	1,809	1,745	1,732	7,142
11:00-12:00	1,742	1,691	1,699	1,747	6,879
12:00-13:00	1,733	1,794	1,813	1,702	7,042
13:00-14:00	1,684	1,719	1,685	1,668	6,756
14:00-15:00	1,790	1,895	1,840	1,841	7,366
15:00-16:00	1,794	1,701	1,688	1,683	6,866
16:00-17:00	1,572	1,612	1,654	1,628	6,466
17:00-18:00	1,612	1,566	1,561	1,524	6,263
18:00-19:00	1,379	1,543	1,480	1,317	5,719
19:00-20:00	1,239	1,177	1,168	1,003	4,587
20:00-21:00	841	885	804	794	3,324
21:00-22:00	764	695	606	589	2,654
22:00-23:00	522	518	466	461	1,967
23:00-24:00	380	457	372	263	1,472
<b>Total</b>					115,652
<b>AM Peak</b>					06:15-07:15 8,347
<b>PM Peak</b>					14:15-15:15 7,370



# Volume Count Report

LOCATION INFO	
Location ID	R22546
Type	SPOT
Funct'l Class	2
Located On	24
	Route 139 EB On-Ramp
Direction	RAMP
Community	-
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000000057
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	5	3	11	6	25
1:00-2:00	1	5	4	3	13
2:00-3:00	5	1	10	3	19
3:00-4:00	7	5	4	7	23
4:00-5:00	7	10	9	17	43
5:00-6:00	24	45	50	66	185
6:00-7:00	101	93	97	109	400
7:00-8:00	111	100	108	68	387
8:00-9:00	90	88	112	95	385
9:00-10:00	106	98	75	114	393
10:00-11:00	79	100	96	102	377
11:00-12:00	103	91	106	118	418
12:00-13:00	105	122	105	114	446
13:00-14:00	115	125	107	96	443
14:00-15:00	100	117	114	76	407
15:00-16:00	92	88	108	94	382
16:00-17:00	116	73	114	96	399
17:00-18:00	141	103	81	73	398
18:00-19:00	89	73	74	84	320
19:00-20:00	72	63	63	46	244
20:00-21:00	56	62	58	52	228
21:00-22:00	40	47	41	39	167
22:00-23:00	48	37	25	33	143
23:00-24:00	19	20	17	24	80
<b>Total</b>					6,325
<b>AADT</b>					5,766
<b>AM Peak</b>					11:30-12:30 451
<b>PM Peak</b>					12:45-13:45 461



# Volume Count Report

LOCATION INFO	
Location ID	R22548
Type	SPOT
Funct'l Class	2
Located On	24
	Route 139 WB On-Ramp
Direction	RAMP
Community	-
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000000766
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	4	11	21	6	42
1:00-2:00	7	10	9	4	30
2:00-3:00	10	17	17	12	56
3:00-4:00	14	8	12	19	53
4:00-5:00	9	11	25	32	77
5:00-6:00	39	73	74	95	281
6:00-7:00	89	109	96	119	413
7:00-8:00	114	107	91	76	388
8:00-9:00	88	66	81	75	310
9:00-10:00	100	85	75	75	335
10:00-11:00	73	74	78	47	272
11:00-12:00	71	66	61	61	259
12:00-13:00	69	72	71	65	277
13:00-14:00	82	90	91	84	347
14:00-15:00	83	82	76	91	332
15:00-16:00	88	73	117	59	337
16:00-17:00	75	83	100	88	346
17:00-18:00	96	87	75	60	318
18:00-19:00	91	68	61	44	264
19:00-20:00	51	58	58	37	204
20:00-21:00	43	40	52	28	163
21:00-22:00	59	34	57	53	203
22:00-23:00	30	32	36	19	117
23:00-24:00	30	17	11	11	69
<b>Total</b>					5,493
<b>AADT</b>					5,008
<b>AM Peak</b>					06:15-07:15 438
<b>PM Peak</b>					16:30-17:30 371



# Volume Count Report

LOCATION INFO	
Location ID	H8462_NB
Type	SPOT
Funct'l Class	2
Located On	SR-24
Loc On Alias	SR-24, 1.0 mile N. of Lindelof Ave (Rt. 139)
Direction	NB
Community	
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Wed 3/29/2017
End Date	Thu 3/30/2017
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	H8462
Weather	
Study	
Speed Limit	
Description	
Sensor Type	

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	120	96	97	68	381
1:00-2:00	64	100	90	85	339
2:00-3:00	69	77	76	69	291
3:00-4:00	81	120	132	137	470
4:00-5:00	220	323	425	652	1,620
5:00-6:00	995	1,196	1,290	1,205	4,686
6:00-7:00	1,168	1,201	1,182	1,115	4,666
7:00-8:00	1,192	1,087	1,140	1,110	4,529
8:00-9:00	1,076	1,162	1,137	1,167	4,542
9:00-10:00	1,124	1,042	1,031	962	4,159
10:00-11:00	888	886	829	842	3,445
11:00-12:00	801	855	931	872	3,459
12:00-13:00	868	874	875	860	3,477
13:00-14:00	770	904	860	807	3,341
14:00-15:00	901	911	904	830	3,546
15:00-16:00	790	847	926	801	3,364
16:00-17:00	800	799	837	842	3,278
17:00-18:00	848	880	825	819	3,372
18:00-19:00	774	661	603	542	2,580
19:00-20:00	579	520	550	448	2,097
20:00-21:00	475	459	451	396	1,781
21:00-22:00	379	411	348	260	1,398
22:00-23:00	274	372	314	239	1,199
23:00-24:00	232	181	164	144	721
<b>Total</b>					62,741
<b>AM Peak</b>					05:30-06:30 4,864
<b>PM Peak</b>					14:00-15:00 3,546



# Volume Count Report

LOCATION INFO	
Location ID	R22545
Type	SPOT
Funct'l Class	2
Located On	24
	Exit 20A Route 139 East Randolph
Direction	RAMP
Community	-
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000000402
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	18	7	11	6	42
1:00-2:00	8	5	10	8	31
2:00-3:00	4	4	6	11	25
3:00-4:00	7	5	6	6	24
4:00-5:00	7	14	18	24	63
5:00-6:00	40	57	66	59	222
6:00-7:00	59	58	92	85	294
7:00-8:00	86	104	142	181	513
8:00-9:00	199	177	152	124	652
9:00-10:00	81	64	70	67	282
10:00-11:00	64	72	76	79	291
11:00-12:00	82	91	65	86	324
12:00-13:00	80	64	88	79	311
13:00-14:00	71	92	74	94	331
14:00-15:00	68	86	104	95	353
15:00-16:00	78	88	99	120	385
16:00-17:00	103	103	90	79	375
17:00-18:00	87	109	106	98	400
18:00-19:00	90	78	80	65	313
19:00-20:00	67	69	63	72	271
20:00-21:00	70	55	70	43	238
21:00-22:00	47	38	46	25	156
22:00-23:00	37	19	18	27	101
23:00-24:00	12	17	18	16	63
<b>Total</b>					6,060
<b>AADT</b>					5,524
<b>AM Peak</b>					07:45-08:45 709
<b>PM Peak</b>					15:30-16:30 425



# Volume Count Report

LOCATION INFO	
Location ID	R22547
Type	SPOT
Funct'l Class	2
Located On	24
	Exit 20B Route 139 West Stoughton
Direction	RAMP
Community	-
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000000545
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	2	2	0	1	5
1:00-2:00	2	1	1	0	4
2:00-3:00	0	0	2	1	3
3:00-4:00	2	4	1	0	7
4:00-5:00	1	4	3	8	16
5:00-6:00	22	15	14	9	60
6:00-7:00	5	8	20	13	46
7:00-8:00	23	24	35	49	131
8:00-9:00	60	50	34	35	179
9:00-10:00	29	31	32	22	114
10:00-11:00	27	21	22	34	104
11:00-12:00	26	21	24	25	96
12:00-13:00	35	26	23	28	112
13:00-14:00	31	20	21	21	93
14:00-15:00	22	19	16	24	81
15:00-16:00	25	20	16	31	92
16:00-17:00	33	31	24	27	115
17:00-18:00	31	25	40	24	120
18:00-19:00	27	22	23	29	101
19:00-20:00	22	14	29	16	81
20:00-21:00	6	11	14	18	49
21:00-22:00	5	5	5	4	19
22:00-23:00	5	3	3	5	16
23:00-24:00	1	3	1	4	9
<b>Total</b>					1,653
<b>AADT</b>					1,507
<b>AM Peak</b>					07:30-08:30 194
<b>PM Peak</b>					16:45-17:45 123





# Volume Count Report

LOCATION INFO	
Location ID	6278_NB
Type	SPOT
Funct'l Class	1
Located On	INTERSTATE 93
Loc On Alias	
	BTWN. RTES.24 & 28
Direction	NB
Community	RANDOLPH
MPO ID	
HPMS ID	244021801220
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 11/10/2015
End Date	Wed 11/11/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	100000000624
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:60-MIN	
Time	Hourly Count
0:00-1:00	1,053
1:00-2:00	532
2:00-3:00	434
3:00-4:00	417
4:00-5:00	1,027
5:00-6:00	3,348
6:00-7:00	6,648
7:00-8:00	7,256
8:00-9:00	6,780
9:00-10:00	5,852
10:00-11:00	5,438
11:00-12:00	5,345
12:00-13:00	5,885
13:00-14:00	6,618
14:00-15:00	7,192
15:00-16:00	6,063
16:00-17:00	6,227
17:00-18:00	6,532
18:00-19:00	5,999
19:00-20:00	4,987
20:00-21:00	3,911
21:00-22:00	3,176
22:00-23:00	2,508
23:00-24:00	1,796
<b>Total</b>	<b>105,024</b>
<b>AADT</b>	<b>92,306</b>
<b>AM Peak</b>	07:00-08:00 7,256
<b>PM Peak</b>	14:00-15:00 7,192



# Volume Count Report

LOCATION INFO	
Location ID	252107_SB
Type	SPOT
Funct'l Class	2
Located On	RAMP-RT 93 NB TO RT 24 SB
	INTERSTATE 93
Direction	SB
Community	RANDOLPH
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 9/20/2005
End Date	Wed 9/21/2005
Start Time	5:15:00 AM
End Time	5:15:00 AM
Direction	2
Notes	
Count Source	
Weather	
Study	MassHighway Special Counts
Speed Limit	
Description	
Sensor Type	

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	91	92	62	58	303
1:00-2:00	36	44	25	30	135
2:00-3:00	34	36	37	27	134
3:00-4:00	31	21	30	33	115
4:00-5:00	30	51	40	48	169
5:00-6:00	68	97	138	155	458
6:00-7:00	169	221	297	359	1,046
7:00-8:00	349	392	440	399	1,580
8:00-9:00	362	392	341	378	1,473
9:00-10:00	317	342	333	342	1,334
10:00-11:00	358	372	318	371	1,419
11:00-12:00	334	315	354	343	1,346
12:00-13:00	330	309	369	348	1,356
13:00-14:00	378	404	399	356	1,537
14:00-15:00	392	454	472	513	1,831
15:00-16:00	639	683	727	713	2,762
16:00-17:00	745	748	774	730	2,997
17:00-18:00	692	771	723	694	2,880
18:00-19:00	591	551	512	479	2,133
19:00-20:00	387	371	333	289	1,380
20:00-21:00	238	224	256	223	941
21:00-22:00	220	194	197	162	773
22:00-23:00	155	134	125	115	529
23:00-24:00	115	134	132	93	474
<b>Total</b>					29,105
<b>AM Peak</b>					07:15-08:15 1,593
<b>PM Peak</b>					16:00-17:00 2,997



# Volume Count Report

LOCATION INFO	
Location ID	6227_NB
Type	SPOT
Funct'l Class	1
Located On	YANKEE DIVISION HIGHWAY
Loc On Alias	
	BETWEEN RTE.24 AND PONKAPOAG RD.
Direction	NB
Community	RANDOLPH
MPO ID	
HPMS ID	189014800900
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 11/10/2015
End Date	Wed 11/11/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	100000000475
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:60-MIN	
Time	Hourly Count
0:00-1:00	687
1:00-2:00	329
2:00-3:00	351
3:00-4:00	438
4:00-5:00	1,135
5:00-6:00	4,609
6:00-7:00	7,608
7:00-8:00	7,802
8:00-9:00	7,551
9:00-10:00	6,250
10:00-11:00	5,213
11:00-12:00	5,012
12:00-13:00	5,076
13:00-14:00	5,501
14:00-15:00	6,031
15:00-16:00	5,166
16:00-17:00	5,238
17:00-18:00	5,525
18:00-19:00	4,604
19:00-20:00	3,619
20:00-21:00	2,835
21:00-22:00	2,300
22:00-23:00	1,890
23:00-24:00	1,174
<b>Total</b>	<b>95,944</b>
<b>AADT</b>	<b>84,325</b>
<b>AM Peak</b>	07:00-08:00 7,802
<b>PM Peak</b>	14:00-15:00 6,031



# Volume Count Report

LOCATION INFO	
Location ID	691_SB
Type	SPOT
Funct'l Class	1
Located On	YANKEE DIVISION HIGHWAY
NORTH OF	RTE.28
Direction	SB
Community	QUINCY
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 3/7/2017
End Date	Wed 3/8/2017
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000069102
Weather	
Study	
Speed Limit	
Description	
Sensor Type	

INTERVAL:60-MIN		
Time	Hourly Count	
0:00-1:00	1,028	
1:00-2:00	535	
2:00-3:00	408	
3:00-4:00	413	
4:00-5:00	872	
5:00-6:00	2,849	
6:00-7:00	5,916	
7:00-8:00	6,583	
8:00-9:00	6,513	
9:00-10:00	5,579	
10:00-11:00	5,019	
11:00-12:00	5,483	
12:00-13:00	5,864	
13:00-14:00	6,085	
14:00-15:00	6,872	
15:00-16:00	6,720	
16:00-17:00	5,795	
17:00-18:00	5,950	
18:00-19:00	5,871	
19:00-20:00	5,170	
20:00-21:00	4,056	
21:00-22:00	3,301	
22:00-23:00	2,380	
23:00-24:00	1,856	
<b>Total</b>	101,118	
<b>AM Peak</b>	07:00-08:00	6,583
<b>PM Peak</b>	14:00-15:00	6,872



# Volume Count Report

LOCATION INFO	
Location ID	6227_SB
Type	SPOT
Funct'l Class	1
Located On	YANKEE DIVISION HIGHWAY
Loc On Alias	
	BETWEEN RTE.24 AND PONKAPOAG RD.
Direction	SB
Community	RANDOLPH
MPO ID	
HPMS ID	189014800900
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 11/10/2015
End Date	Wed 11/11/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000000988
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:60-MIN		
Time	Hourly Count	
0:00-1:00	688	
1:00-2:00	437	
2:00-3:00	373	
3:00-4:00	516	
4:00-5:00	1,246	
5:00-6:00	2,788	
6:00-7:00	3,834	
7:00-8:00	5,000	
8:00-9:00	4,913	
9:00-10:00	4,530	
10:00-11:00	4,358	
11:00-12:00	4,390	
12:00-13:00	5,005	
13:00-14:00	5,149	
14:00-15:00	5,954	
15:00-16:00	6,507	
16:00-17:00	6,937	
17:00-18:00	6,770	
18:00-19:00	6,388	
19:00-20:00	4,294	
20:00-21:00	3,029	
21:00-22:00	2,546	
22:00-23:00	1,846	
23:00-24:00	1,311	
<b>Total</b>	<b>88,809</b>	
<b>AADT</b>	<b>78,054</b>	
<b>AM Peak</b>	07:00-08:00	5,000
<b>PM Peak</b>	16:00-17:00	6,937



# Volume Count Report

LOCATION INFO	
Location ID	R22554
Type	SPOT
Funct'l Class	2
Located On	24
	Route 139 EB On-Ramp
Direction	RAMP
Community	-
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000000595
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	4	0	1	3	8
1:00-2:00	2	0	2	1	5
2:00-3:00	0	0	1	1	2
3:00-4:00	3	1	4	0	8
4:00-5:00	1	1	1	3	6
5:00-6:00	4	1	13	7	25
6:00-7:00	9	8	20	21	58
7:00-8:00	19	28	27	26	100
8:00-9:00	27	24	30	22	103
9:00-10:00	13	28	25	24	90
10:00-11:00	28	32	30	28	118
11:00-12:00	24	29	33	23	109
12:00-13:00	39	33	33	39	144
13:00-14:00	38	41	33	39	151
14:00-15:00	31	29	31	36	127
15:00-16:00	51	45	48	44	188
16:00-17:00	38	42	62	55	197
17:00-18:00	66	68	49	42	225
18:00-19:00	53	26	29	30	138
19:00-20:00	37	21	20	18	96
20:00-21:00	36	28	27	10	101
21:00-22:00	19	15	11	16	61
22:00-23:00	14	13	12	8	47
23:00-24:00	15	8	3	2	28
<b>Total</b>					2,135
<b>AADT</b>					1,946
<b>AM Peak</b>					11:30-12:30 128
<b>PM Peak</b>					16:30-17:30 251



# Volume Count Report

LOCATION INFO	
Location ID	R22552
Type	SPOT
Funct'l Class	2
Located On	24
	Route 139 WB On-Ramp
Direction	RAMP
Community	-
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000000616
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	9	19	16	9	53
1:00-2:00	10	4	5	4	23
2:00-3:00	5	5	11	5	26
3:00-4:00	8	6	8	12	34
4:00-5:00	7	3	4	14	28
5:00-6:00	17	16	23	22	78
6:00-7:00	40	62	61	86	249
7:00-8:00	78	63	81	88	310
8:00-9:00	65	69	83	71	288
9:00-10:00	68	78	68	59	273
10:00-11:00	63	51	66	65	245
11:00-12:00	59	57	67	69	252
12:00-13:00	64	79	84	74	301
13:00-14:00	69	83	83	96	331
14:00-15:00	108	106	118	117	449
15:00-16:00	112	118	137	128	495
16:00-17:00	181	157	169	170	677
17:00-18:00	162	153	146	99	560
18:00-19:00	142	115	66	82	405
19:00-20:00	96	61	65	51	273
20:00-21:00	66	62	68	71	267
21:00-22:00	49	40	40	34	163
22:00-23:00	47	30	39	29	145
23:00-24:00	41	22	18	14	95
<b>Total</b>					6,020
<b>AADT</b>					5,488
<b>AM Peak</b>					07:00-08:00 310
<b>PM Peak</b>					16:00-17:00 677



# Volume Count Report

LOCATION INFO	
Location ID	R22553
Type	SPOT
Funct'l Class	3
Located On	24
	Exit 20A Route 139 East Randolph
Direction	RAMP
Community	-
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000000493
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	30	38	32	32	132
1:00-2:00	29	38	26	32	125
2:00-3:00	20	17	16	20	73
3:00-4:00	15	12	12	12	51
4:00-5:00	12	16	8	33	69
5:00-6:00	17	31	41	40	129
6:00-7:00	52	63	88	98	301
7:00-8:00	90	127	145	131	493
8:00-9:00	149	157	127	130	563
9:00-10:00	117	108	99	116	440
10:00-11:00	94	117	110	128	449
11:00-12:00	114	164	150	157	585
12:00-13:00	162	152	145	147	606
13:00-14:00	172	123	128	185	608
14:00-15:00	145	175	180	196	696
15:00-16:00	204	195	194	183	776
16:00-17:00	210	170	157	148	685
17:00-18:00	187	196	194	223	800
18:00-19:00	188	178	214	214	794
19:00-20:00	174	160	181	160	675
20:00-21:00	109	143	114	160	526
21:00-22:00	111	133	174	167	585
22:00-23:00	151	136	72	70	429
23:00-24:00	62	71	71	73	277
<b>Total</b>					10,867
<b>AADT</b>					9,489
<b>AM Peak</b>					11:15-12:15 633
<b>PM Peak</b>					17:45-18:45 803





# Volume Count Report

LOCATION INFO	
Location ID	R22551
Type	SPOT
Funct'l Class	2
Located On	24
	Exit 20B Route 139 West Stoughton
Direction	RAMP
Community	-
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000000429
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Axle/Tube

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	18	11	21	18	68
1:00-2:00	14	9	8	6	37
2:00-3:00	12	11	11	8	42
3:00-4:00	6	11	10	5	32
4:00-5:00	4	4	16	24	48
5:00-6:00	26	45	78	73	222
6:00-7:00	71	73	98	106	348
7:00-8:00	91	97	107	86	381
8:00-9:00	110	105	78	98	391
9:00-10:00	94	85	101	99	379
10:00-11:00	111	118	115	119	463
11:00-12:00	90	125	118	114	447
12:00-13:00	112	109	104	96	421
13:00-14:00	109	98	85	114	406
14:00-15:00	112	137	124	169	542
15:00-16:00	133	144	139	100	516
16:00-17:00	123	131	131	89	474
17:00-18:00	145	114	129	104	492
18:00-19:00	145	132	125	103	505
19:00-20:00	90	101	77	75	343
20:00-21:00	99	74	76	74	323
21:00-22:00	52	54	54	59	219
22:00-23:00	47	40	46	35	168
23:00-24:00	42	42	33	23	140
<b>Total</b>					7,407
<b>AADT</b>					6,752
<b>AM Peak</b>					11:15-12:15 469
<b>PM Peak</b>					14:45-15:45 585



# Volume Count Report

LOCATION INFO	
Location ID	H8462_SB
Type	SPOT
Funct'l Class	2
Located On	SR-24
Loc On Alias	SR-24, 1.0 mile N. of Lindelof Ave (Rt. 139)
Direction	SB
Community	
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Wed 3/29/2017
End Date	Thu 3/30/2017
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	H8462
Weather	
Study	
Speed Limit	
Description	
Sensor Type	

INTERVAL:15-MIN					
Time	15-min Interval				Hourly Count
	1st	2nd	3rd	4th	
0:00-1:00	309	278	242	227	1,056
1:00-2:00	186	157	136	120	599
2:00-3:00	118	100	98	64	380
3:00-4:00	79	87	83	81	330
4:00-5:00	91	123	137	173	524
5:00-6:00	237	315	367	481	1,400
6:00-7:00	454	499	629	791	2,373
7:00-8:00	725	864	904	977	3,470
8:00-9:00	884	885	915	809	3,493
9:00-10:00	759	746	774	845	3,124
10:00-11:00	798	808	863	878	3,347
11:00-12:00	866	875	939	874	3,554
12:00-13:00	991	991	955	965	3,902
13:00-14:00	1,022	1,056	1,149	1,239	4,466
14:00-15:00	1,230	1,288	1,440	1,411	5,369
15:00-16:00	1,472	1,482	1,319	1,094	5,367
16:00-17:00	1,333	1,485	1,403	1,453	5,674
17:00-18:00	1,355	1,378	1,409	1,455	5,597
18:00-19:00	1,322	1,224	1,244	1,259	5,049
19:00-20:00	958	1,058	878	851	3,745
20:00-21:00	883	766	778	744	3,171
21:00-22:00	720	665	634	564	2,583
22:00-23:00	461	538	513	519	2,031
23:00-24:00	458	455	352	302	1,567
<b>Total</b>					72,171
<b>AM Peak</b>					11:45-12:45 3,811
<b>PM Peak</b>					14:30-15:30 5,805



# Volume Count Report

LOCATION INFO	
Location ID	614_SB
Type	SPOT
Funct'l Class	2
Located On	AMVETS MEMORIAL HIGHWAY ON SO. & NO. RAMPS OF RTE. I-93
Direction	SB
Community	RANDOLPH
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Wed 2/15/2017
End Date	Thu 2/16/2017
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000061402
Weather	
Study	
Speed Limit	
Description	
Sensor Type	

INTERVAL:60-MIN	
Time	Hourly Count
0:00-1:00	1,014
1:00-2:00	530
2:00-3:00	319
3:00-4:00	276
4:00-5:00	459
5:00-6:00	1,175
6:00-7:00	2,262
7:00-8:00	3,117
8:00-9:00	3,453
9:00-10:00	3,009
10:00-11:00	2,912
11:00-12:00	3,354
12:00-13:00	3,618
13:00-14:00	3,954
14:00-15:00	5,009
15:00-16:00	5,138
16:00-17:00	4,559
17:00-18:00	4,363
18:00-19:00	4,524
19:00-20:00	4,306
20:00-21:00	3,051
21:00-22:00	2,470
22:00-23:00	1,882
23:00-24:00	1,441
<b>Total</b>	<b>66,195</b>
<b>AM Peak</b>	08:00-09:00 3,453
<b>PM Peak</b>	15:00-16:00 5,138



# Volume Count Report

LOCATION INFO	
Location ID	614_SB
Type	SPOT
Funct'l Class	2
Located On	AMVETS MEMORIAL HIGHWAY ON SO. & NO. RAMPS OF RTE. I-93
Direction	SB
Community	RANDOLPH
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	
Notes	
Count Source	000000061402
Weather	
Study	
Speed Limit	
Description	
Sensor Type	

INTERVAL:60-MIN	
Time	Hourly Count
0:00-1:00	810
1:00-2:00	430
2:00-3:00	276
3:00-4:00	257
4:00-5:00	429
5:00-6:00	1,115
6:00-7:00	2,364
7:00-8:00	3,275
8:00-9:00	3,134
9:00-10:00	2,760
10:00-11:00	3,009
11:00-12:00	3,216
12:00-13:00	3,409
13:00-14:00	3,632
14:00-15:00	5,127
15:00-16:00	5,737
16:00-17:00	5,639
17:00-18:00	5,595
18:00-19:00	5,217
19:00-20:00	3,915
20:00-21:00	3,050
21:00-22:00	2,513
22:00-23:00	2,087
23:00-24:00	1,525
<b>Total</b>	<b>68,521</b>
<b>AADT</b>	<b>64,067</b>
<b>AM Peak</b>	07:00-08:00 3,275
<b>PM Peak</b>	15:00-16:00 5,737



# Volume Count Report

LOCATION INFO	
Location ID	6237_SB
Type	SPOT
Funct'l Class	2
Located On	AMVETS MEMORIAL HIGHWAY
SOUTH OF	RTE.139
Direction	SB
Community	STOUGHTON
MPO ID	
HPMS ID	
Agency	MHD

COUNT DATA INFO	
Count Status	Accepted
Start Date	Tue 5/5/2015
End Date	Wed 5/6/2015
Start Time	12:00:00 AM
End Time	12:00:00 AM
Direction	SB
Notes	
Count Source	
Weather	
Study	
Speed Limit	
Description	
Sensor Type	Loop

INTERVAL:60-MIN		
Time	Hourly Count	
0:00-1:00	776	
1:00-2:00	354	
2:00-3:00	252	
3:00-4:00	249	
4:00-5:00	368	
5:00-6:00	860	
6:00-7:00	2,127	
7:00-8:00	2,947	
8:00-9:00	2,854	
9:00-10:00	2,568	
10:00-11:00	2,658	
11:00-12:00	2,780	
12:00-13:00	3,096	
13:00-14:00	3,341	
14:00-15:00	4,728	
15:00-16:00	5,348	
16:00-17:00	5,590	
17:00-18:00	5,421	
18:00-19:00	4,940	
19:00-20:00	3,619	
20:00-21:00	2,858	
21:00-22:00	2,273	
22:00-23:00	1,878	
23:00-24:00	1,418	
<b>Total</b>	<b>63,303</b>	
<b>AADT</b>	<b>59,188</b>	
<b>AM Peak</b>	07:00-08:00	2,947
<b>PM Peak</b>	16:00-17:00	5,590

# APPENDIX C

## 1. Crash Tables

Study Location	Area of Crash	Count	Crash Number	Crash Year	Crash Time	Crash Date	Crash Severity	Number of Vehicles	Nonfatal Injuries	Fatal Injuries	Manner of Collision	Vehicle Travelled Direction	Road Surface Condition	Ambient Light Condition	Weather Condition
1	Exit 29 (from Route 2)	1	2553682	2010	6:20 PM	1/9/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Dark - roadway not lighted	Cloudy
1	Exit 29 (from Route 2)	2	2657960	2010	7:56 AM	11/5/2010	Non-fatal injury	4	1	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Daylight	Rain
1	Exit 29 (from Route 2)	3	2701711	2011	12:27 PM	2/24/2011	Non-fatal injury	2	3	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 29 (from Route 2)	4	3175559	2012	6:10 PM	2/22/2012	Property damage only	2	0	0	Rear-end	V1:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 29 (from Route 2)	5	3246604	2012	3:18 PM	8/15/2012	Non-fatal injury	2	1	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
1	Exit 29 (from Route 2)	6	3257816	2012	10:54 PM	8/31/2012	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Clear
1	Exit 29 (from Route 2)	7	3655172	2013	6:56 PM	10/25/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 29 (from Route 2)	8	3655176	2013	12:00 AM	11/1/2013	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound / V3:Northbound	Wet	Dark - unknown roadway light	Rain
1	Exit 29 (from Route 2)	9	3752728	2014	11:20 AM	2/27/2014	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 29 (from Route 2)	10	3950070	2014	9:00 AM	9/10/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	1	2566650	2010	4:10 PM	2/11/2010	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	2	2575282	2010	6:35 AM	3/1/2010	Non-fatal injury	3	1	0	Sideswipe, same direction	V1:Northbound	Wet	Daylight	Rain
1	Exit 30 (Route 2A/Service Plaza)	3	2576747	2010	12:50 PM	3/12/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	4	2590398	2010	6:10 AM	4/5/2010	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	5	2590444	2010	3:50 PM	4/14/2010	Property damage only	5	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	6	2592555	2010	3:44 PM	4/21/2010	Property damage only	3	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	7	2600091	2010	4:11 AM	5/3/2010	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	8	2600978	2010	4:11 AM	5/3/2010	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	9	2608067	2010	8:55 PM	6/3/2010	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Dark - roadway not lighted	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	10	2622743	2010	9:05 AM	7/7/2010	Property damage only	3	0	0	Angle	V1:Northbound / V2:Northbound	Dry	Daylight	Not Reported
1	Exit 30 (Route 2A/Service Plaza)	11	2645138	2010	3:53 PM	9/22/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	12	2643855	2010	12:00 AM	9/26/2010	Property damage only	2	0	0	Rear-end	V1:Westbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	13	2652741	2010	1:35 PM	10/6/2010	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Wet	Daylight	Cloudy/Rain
1	Exit 30 (Route 2A/Service Plaza)	14	2657956	2010	3:43 PM	11/2/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	15	2659107	2010	6:40 PM	11/4/2010	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Wet	Dark - roadway not lighted	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	16	2668189	2010	1:30 PM	11/24/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	17	2667890	2010	5:55 PM	11/30/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Dark - lighted roadway	Clear
1	Exit 30 (Route 2A/Service Plaza)	18	2667894	2010	6:30 PM	12/1/2010	Property damage only	4	0	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Dark - lighted roadway	Rain
1	Exit 30 (Route 2A/Service Plaza)	19	2673802	2010	6:15 AM	12/10/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	20	2671292	2010	10:07 AM	12/13/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Wet	Daylight	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	21	2690290	2011	6:40 PM	1/6/2011	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	22	2682396	2011	11:18 AM	1/10/2011	Non-fatal injury	2	1	0	Angle	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	23	2689420	2011	5:02 PM	1/11/2011	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dusk	Clear
1	Exit 30 (Route 2A/Service Plaza)	24	2690294	2011	8:00 AM	1/12/2011	Property damage only	2	0	0	Angle	V1:Northbound / V2:Northbound / V3:Northbound	Snow	Daylight	Not Reported
1	Exit 30 (Route 2A/Service Plaza)	25	2689422	2011	3:10 PM	1/14/2011	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	26	2689426	2011	6:25 AM	1/20/2011	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound / V3:Northbound	Wet	Dawn	Clear
1	Exit 30 (Route 2A/Service Plaza)	27	2690308	2011	7:24 PM	1/20/2011	Property damage only	3	0	0	Rear-end	V1:Northbound	Wet	Dark - lighted roadway	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	28	2701695	2011	2:36 AM	1/27/2011	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Snow	Dark - roadway not lighted	Snow
1	Exit 30 (Route 2A/Service Plaza)	29	2701701	2011	5:57 AM	2/3/2011	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Dry	Dawn	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	30	2703451	2011	4:35 PM	3/4/2011	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	31	2702745	2011	3:54 PM	3/8/2011	Non-fatal injury	2	2	0	Angle	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	32	2703453	2011	5:50 PM	3/10/2011	Non-fatal injury	3	1	0	Rear-end	V1:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	33	2703543	2011	9:05 PM	3/11/2011	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Wet	Dark - lighted roadway	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	34	2727549	2011	4:30 PM	4/15/2011	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	35	2727551	2011	3:20 PM	4/28/2011	Non-fatal injury	2	1	0	Angle	V1:Northbound / V2:Northbound	Dry	Daylight	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	36	2754001	2011	10:29 PM	7/29/2011	Non-fatal injury	2	1	0	Not reported	V1:Northbound / V2:Northbound	Wet	Dark - roadway not lighted	Cloudy/Rain
1	Exit 30 (Route 2A/Service Plaza)	37	2754543	2011	5:08 PM	8/12/2011	Property damage only	2	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	38	2752978	2011	4:20 AM	8/13/2011	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	39	2756716	2011	6:26 AM	8/28/2011	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Wet	Daylight	Cloudy/Rain
1	Exit 30 (Route 2A/Service Plaza)	40	2841957	2011	8:17 AM	9/4/2011	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	41	2782933	2011	4:50 PM	9/23/2011	Property damage only	2	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	42	3371935	2011	4:56 AM	11/5/2011	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Clear
1	Exit 30 (Route 2A/Service Plaza)	43	2832813	2011	8:39 AM	12/2/2011	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	44	2891186	2012	4:55 PM	1/6/2012	Property damage only	2	0	0	Rear-end	V1:Northbound	Dry	Dark - lighted roadway	Clear
1	Exit 30 (Route 2A/Service Plaza)	45	2882437	2012	11:51 AM	1/17/2012	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Wet	Daylight	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	46	2932754	2012	4:13 PM	2/8/2012	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	47	2949190	2012	9:07 AM	2/13/2012	Property damage only	2	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	48	2932756	2012	8:16 PM	2/13/2012	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	49	2949192	2012	6:17 PM	2/17/2012	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	50	2966301	2012	6:55 PM	3/16/2012	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Wet	Dusk	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	51	3079862	2012	8:13 PM	4/15/2012	Not Reported	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Not Reported
1	Exit 30 (Route 2A/Service Plaza)	52	3097939	2012	4:40 PM	5/3/2012	Not Reported	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	53	3125766	2012	4:42 PM	6/8/2012	Not Reported	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	54	3152876	2012	5:10 PM	6/19/2012	Property damage only	2	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear

Study Location	Area of Crash	Count	Crash Number	Crash Year	Crash Time	Crash Date	Crash Severity	Number of Vehicles	Nonfatal Injuries	Fatal Injuries	Manner of Collision	Vehicle Travelled Direction	Road Surface Condition	Ambient Light Condition	Weather Condition
1	Exit 30 (Route 2A/Service Plaza)	55	3240531	2012	3:06 PM	7/24/2012	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Wet	Daylight	Rain
1	Exit 30 (Route 2A/Service Plaza)	56	3288538	2012	10:23 AM	10/30/2012	Non-fatal injury	2	1	0	Angle	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Wet	Daylight	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	57	3293150	2012	4:54 PM	11/16/2012	Property damage only	4	0	0	Rear-end	V1:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	58	3305576	2012	1:51 PM	12/1/2012	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Wet	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	59	3364515	2013	9:06 AM	2/6/2013	Non-fatal injury	4	1	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Daylight	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	60	3362354	2013	3:15 PM	2/15/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	61	3364187	2013	4:11 PM	2/26/2013	Property damage only	3	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	62	3369059	2013	4:00 PM	3/3/2013	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Dry	Daylight	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	63	3391524	2013	4:55 PM	4/1/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Daylight	Not Reported
1	Exit 30 (Route 2A/Service Plaza)	64	3394432	2013	5:40 PM	4/23/2013	Property damage only	4	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Wet	Daylight	Rain
1	Exit 30 (Route 2A/Service Plaza)	65	3548335	2013	3:35 PM	7/23/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Wet	Daylight	Rain
1	Exit 30 (Route 2A/Service Plaza)	66	3561252	2013	12:50 PM	8/10/2013	Property damage only	4	0	0	Rear-to-rear	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	67	3598958	2013	3:55 PM	9/10/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	68	3616729	2013	3:42 PM	10/7/2013	Property damage only	2	0	0	Rear-end	V1:Westbound / V2:Westbound	Dry	Daylight	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	69	3655174	2013	8:06 PM	10/29/2013	Property damage only	5	0	0	Rear-end	V1:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	70	3664844	2013	3:24 PM	11/19/2013	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	71	3709210	2013	4:49 PM	11/22/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Dusk	Clear
1	Exit 30 (Route 2A/Service Plaza)	72	3674682	2013	4:45 PM	12/3/2013	Non-fatal injury	5	1	0	Rear-end	V1:Northbound	Dry	Dark - lighted roadway	Clear
1	Exit 30 (Route 2A/Service Plaza)	73	3712094	2013	3:10 AM	12/15/2013	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Snow	Dark - roadway not lighted	Snow/Other
1	Exit 30 (Route 2A/Service Plaza)	74	3724021	2014	10:13 PM	1/21/2014	Property damage only	2	0	0	Angle	V1:Northbound	Snow	Dark - roadway not lighted	Snow
1	Exit 30 (Route 2A/Service Plaza)	75	3772221	2014	2:55 PM	3/7/2014	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	76	3789242	2014	3:20 PM	4/2/2014	Non-fatal injury	3	1	0	Sideswipe, same direction	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	77	3800820	2014	5:00 PM	5/5/2014	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	78	3850237	2014	12:00 AM	6/17/2014	Non-fatal injury	3	2	0	Not reported	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	79	3883585	2014	11:25 AM	7/17/2014	Property damage only	2	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	80	3887788	2014	1:05 PM	7/18/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	81	3896025	2014	10:40 PM	7/25/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Cloudy
1	Exit 30 (Route 2A/Service Plaza)	82	3890233	2014	1:27 AM	7/28/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
1	Exit 30 (Route 2A/Service Plaza)	83	3950337	2014	3:25 PM	9/15/2014	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	84	3950077	2014	8:31 AM	9/17/2014	Property damage only	2	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	85	3962187	2014	11:32 PM	10/4/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound / V3:Northbound	Wet	Dark - lighted roadway	Not Reported
1	Exit 30 (Route 2A/Service Plaza)	86	3970274	2014	4:36 PM	10/7/2014	Non-fatal injury	3	1	0	Angle	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	87	3970827	2014	2:45 PM	10/10/2014	Property damage only	3	0	0	Rear-to-rear	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	88	3971201	2014	8:32 PM	10/22/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Wet	Dark - roadway not lighted	Rain
1	Exit 30 (Route 2A/Service Plaza)	89	3971219	2014	9:00 AM	10/28/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	90	3975859	2014	4:50 PM	10/31/2014	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	91	3975862	2014	3:11 PM	11/5/2014	Property damage only	2	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	92	3984686	2014	7:36 AM	11/24/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Wet	Daylight	Cloudy/Rain
1	Exit 30 (Route 2A/Service Plaza)	93	3979910	2014	6:10 AM	11/28/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Snow	Dawn	Snow
1	Exit 30 (Route 2A/Service Plaza)	94	3979912	2014	1:55 AM	12/1/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Dark - lighted roadway	Clear
1	Exit 30 (Route 2A/Service Plaza)	95	3980692	2014	9:40 PM	12/2/2014	Property damage only	4	0	0	Not reported	V1:Northbound / V2:Northbound	Wet	Dark - lighted roadway	Snow
1	Exit 30 (Route 2A/Service Plaza)	96	3984744	2014	9:41 PM	12/2/2014	Property damage only	2	0	0	Angle	V1:Northbound / V2:Northbound	Snow	Dark - roadway not lighted	Snow
1	Exit 30 (Route 2A/Service Plaza)	97	3987639	2014	1:10 PM	12/4/2014	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound / V3:Northbound	Wet	Daylight	Clear
1	Exit 30 (Route 2A/Service Plaza)	98	3988003	2014	4:30 PM	12/23/2014	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Dusk	Rain
2	Exit 37B (to I-95)	1	2602779	2010	4:05 PM	5/20/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	2	2628477	2010	1:29 PM	8/12/2010	Property damage only	3	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	3	2639290	2010	8:00 AM	8/30/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Not Reported
2	Exit 37B (to I-95)	4	2662859	2010	9:00 AM	11/13/2010	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	5	2673680	2010	7:50 AM	12/14/2010	Property damage only	3	0	0	Rear-end	V1:Northbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	6	2782601	2011	1:47 PM	10/13/2011	Property damage only	2	0	0	Angle	V1:Southbound / V2:Northbound	Wet	Daylight	Rain
2	Exit 37B (to I-95)	7	3376968	2012	8:20 AM	1/11/2012	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	8	3168167	2012	9:00 AM	2/25/2012	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Not Reported
2	Exit 37B (to I-95)	9	3027277	2012	7:51 PM	4/10/2012	Property damage only	3	0	0	Rear-end	V1:Southbound	Dry	Dark - roadway not lighted	Clear
2	Exit 37B (to I-95)	10	3175587	2012	10:11 AM	4/15/2012	Property damage only	1	0	0	Single vehicle crash	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	11	3229544	2012	11:50 AM	6/2/2012	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Not Reported
2	Exit 37B (to I-95)	12	3150248	2012	5:39 PM	6/16/2012	Not Reported	1	0	0	Single vehicle crash	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	13	3245391	2012	8:15 AM	8/8/2012	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	14	3248536	2012	6:50 AM	8/27/2012	Property damage only	3	0	0	Rear-end	V1:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	15	3299081	2012	7:33 AM	11/19/2012	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound / V2:Southbound / V3:Southbound / V4:Southbound	Dry	Daylight	Not Reported
2	Exit 37B (to I-95)	16	3301795	2012	6:13 PM	12/6/2012	Property damage only	5	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Dark - lighted roadway	Clear
2	Exit 37B (to I-95)	17	3328535	2013	8:45 AM	1/7/2013	Property damage only	3	0	0	Angle	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	18	3347125	2013	5:53 PM	1/25/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
2	Exit 37B (to I-95)	19	3351197	2013	6:17 PM	1/30/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - roadway not lighted	Cloudy
2	Exit 37B (to I-95)	20	3384399	2013	8:55 AM	2/6/2013	Property damage only	2	0	0	Rear-end	V1:Southbound	Dry	Daylight	Clear



Study Location	Area of Crash	Count	Crash Number	Crash Year	Crash Time	Crash Date	Crash Severity	Number of Vehicles	Nonfatal Injuries	Fatal Injuries	Manner of Collision	Vehicle Travelled Direction	Road Surface Condition	Ambient Light Condition	Weather Condition
2	Exit 37B (to I-95)	21	3361062	2013	8:05 AM	2/17/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound / V2:Southbound	Ice	Daylight	Snow
2	Exit 37B (to I-95)	22	3369692	2013	8:00 AM	3/8/2013	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Snow	Daylight	Not Reported
2	Exit 37B (to I-95)	23	3395078	2013	6:05 AM	4/25/2013	Non-fatal injury	2	1	0	Rear-end	V1:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	24	3497232	2013	6:30 AM	7/1/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	25	3585372	2013	9:00 AM	9/5/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	26	3600365	2013	12:50 PM	9/29/2013	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Not Reported
2	Exit 37B (to I-95)	27	3610966	2013	6:45 PM	10/16/2013	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
2	Exit 37B (to I-95)	28	3694862	2013	12:00 AM	12/11/2013	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Dark - roadway not lighted	Cloudy
2	Exit 37B (to I-95)	29	3723430	2014	6:36 PM	1/24/2014	Non-fatal injury	2	2	0	Rear-end	V1:Northbound / V2:Northbound / V3:Not reported / V4:Not reported	Dry	Dark - roadway not lighted	Clear
2	Exit 37B (to I-95)	30	3803013	2014	8:34 AM	4/22/2014	Property damage only	4	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Cloudy
2	Exit 37B (to I-95)	31	3795757	2014	9:40 AM	4/30/2014	Non-fatal injury	3	1	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Daylight	Cloudy/Rain
2	Exit 37B (to I-95)	32	3797825	2014	6:25 PM	5/1/2014	Property damage only	2	0	0	Rear-end	V1:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	33	3820587	2014	9:59 AM	5/24/2014	Non-fatal injury	1	2	0	Single vehicle crash	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	34	3827135	2014	12:00 PM	6/1/2014	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	35	3862576	2014	4:50 PM	6/12/2014	Property damage only	2	0	0	Angle	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	36	3866679	2014	8:05 AM	6/27/2014	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	37	3886251	2014	8:26 AM	7/9/2014	Property damage only	3	0	0	Rear-end	V1:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	38	3949302	2014	4:14 PM	9/15/2014	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	39	3962120	2014	10:59 AM	9/30/2014	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Other	Daylight	Rain
2	Exit 37B (to I-95)	40	3983385	2014	8:02 AM	11/13/2014	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
2	Exit 37B (to I-95)	41	3973116	2014	6:10 PM	11/14/2014	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - unknown roadway light	Not Reported
2	Exit 37B (to I-95)	42	3979814	2014	8:11 AM	12/2/2014	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Cloudy
2	Exit 37B (to I-95)	43	3988830	2014	4:05 AM	12/19/2014	Non-fatal injury	2	1	0	Angle	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
2	Exit 37C (to Commerce Way)	1	2690273	2011	2:20 AM	2/12/2011	Property damage only	1	0	0	Single vehicle crash	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
2	Exit 37C (to Commerce Way)	2	2932746	2012	6:15 PM	2/11/2012	Property damage only	2	0	0	Angle	V1:Southbound / V2:Southbound	Dry	Dark - roadway not lighted	Cloudy
2	Exit 37C (to Commerce Way)	3	3136445	2012	8:44 PM	6/12/2012	Not Reported	2	0	0	Sideswipe, same direction	V1:Southbound	Dry	Dark - roadway not lighted	Not Reported
2	Exit 37C (to Commerce Way)	4	3711154	2014	4:30 PM	1/2/2014	Property damage only	2	0	0	Angle	V1:Southbound / V2:Southbound	Snow	Dark - roadway not lighted	Snow/Blowing sand, s
3	Rt. 24 NB Exit 21 (at Diverge)	1	2553155	2,010	9:45 AM	1/2/2010	Not Reported	1	0	0	Single vehicle crash	V1:Northbound	Snow	Daylight	Cloudy/Snow
3	Rt. 24 NB Exit 21 (at Diverge)	2	2560611	2,010	11:08 PM	1/8/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	3	2560634	2,010	9:46 AM	1/13/2010	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	4	2591158	2,010	6:00 PM	4/25/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Cloudy
3	Rt. 24 NB Exit 21 (at Diverge)	5	2606002	2,010	7:45 PM	6/4/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Dusk	Cloudy
3	Rt. 24 NB Exit 21 (at Diverge)	6	2614573	2,010	6:40 PM	6/21/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Not Reported
3	Rt. 24 NB Exit 21 (at Diverge)	7	2621042	2,010	1:56 AM	6/23/2010	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Cloudy
3	Rt. 24 NB Exit 21 (at Diverge)	8	2617746	2,010	5:36 AM	7/6/2010	Not Reported	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	9	2617749	2,010	5:55 PM	7/6/2010	Not Reported	1	0	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	10	2618267	2,010	2:00 PM	7/12/2010	Not Reported	2	0	0	Rear-end	V1:Not reported / V2:Not reported	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	11	2621515	2,010	8:10 AM	7/20/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	12	2631656	2,010	8:25 PM	8/15/2010	Not Reported	2	0	0	Sideswipe, same direction	V1:Not reported / V2:Not reported	Dry	Dusk	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	13	2659293	2,010	2:14 AM	10/27/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	14	2689779	2,011	8:10 AM	2/11/2011	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	15	2727011	2,011	4:22 AM	5/14/2011	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - unknown roadway light	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	16	2756106	2,011	11:11 PM	8/13/2011	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	17	3375428	2,011	1:34 AM	10/16/2011	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	18	3163130	2,012	2:30 AM	2/11/2012	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Cloudy
3	Rt. 24 NB Exit 21 (at Diverge)	19	3384349	2,012	1:14 PM	3/30/2012	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	20	3067913	2,012	6:25 AM	4/30/2012	Not Reported	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	21	3182469	2,012	12:00 AM	7/2/2012	Not Reported	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Not Reported
3	Rt. 24 NB Exit 21 (at Diverge)	22	3207200	2,012	4:42 AM	7/18/2012	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	23	3384378	2,012	10:30 AM	9/2/2012	Property damage only	3	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	24	3266895	2,012	10:15 AM	9/24/2012	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	25	3296541	2,012	11:35 PM	10/5/2012	Not Reported	1	0	0	Single vehicle crash	V1:Eastbound	Dry	Dark - lighted roadway	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	26	3335946	2,013	10:45 PM	1/4/2013	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Not Reported
3	Rt. 24 NB Exit 21 (at Diverge)	27	3362875	2,013	11:25 AM	2/12/2013	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Wet	Daylight	Not Reported
3	Rt. 24 NB Exit 21 (at Diverge)	28	3361097	2,013	7:55 AM	2/19/2013	Property damage only	4	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound / V3:Northbound / V4:Not reported	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	29	3384669	2,013	2:12 AM	2/24/2013	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Wet	Dark - roadway not lighted	Rain
3	Rt. 24 NB Exit 21 (at Diverge)	30	3367285	2,013	8:45 AM	3/7/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Snow	Daylight	Snow/Sleet, hail (free
3	Rt. 24 NB Exit 21 (at Diverge)	31	3367070	2,013	3:00 PM	3/7/2013	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Wet	Daylight	Cloudy/Snow
3	Rt. 24 NB Exit 21 (at Diverge)	32	3426393	2,013	8:35 AM	4/3/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	33	3427223	2,013	8:56 AM	4/18/2013	Non-fatal injury	2	2	0	Angle	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	34	3396325	2,013	8:09 AM	4/30/2013	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	35	3422731	2,013	3:10 PM	5/13/2013	Non-fatal injury	1	1	0	Single vehicle crash	V1:Westbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	36	3439992	2,013	1:25 PM	5/31/2013	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Not Reported
3	Rt. 24 NB Exit 21 (at Diverge)	37	3453206	2,013	9:20 AM	6/3/2013	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear

Study Location	Area of Crash	Count	Crash Number	Crash Year	Crash Time	Crash Date	Crash Severity	Number of Vehicles	Nonfatal Injuries	Fatal Injuries	Manner of Collision	Vehicle Travelled Direction	Road Surface Condition	Ambient Light Condition	Weather Condition
3	Rt. 24 NB Exit 21 (at Diverge)	38	3560865	2,013	8:40 AM	7/31/2013	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	39	3561457	2,013	12:00 AM	8/10/2013	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - lighted roadway	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	40	3594178	2,013	8:35 AM	9/17/2013	Non-fatal injury	3	2	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	41	3599018	2,013	8:50 AM	9/23/2013	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	42	3604044	2,013	5:59 AM	9/27/2013	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Cloudy
3	Rt. 24 NB Exit 21 (at Diverge)	43	3604258	2,013	3:18 AM	9/29/2013	Property damage only	2	0	0	Single vehicle crash	V1:Northbound / V2:Not reported	Dry	Dark - roadway not lighted	Fog, smog, smoke
3	Rt. 24 NB Exit 21 (at Diverge)	44	3623333	2,013	1:32 PM	10/19/2013	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	45	3656640	2,013	6:45 PM	11/7/2013	Property damage only	3	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound / V3:Northbound	Wet	Dark - roadway not lighted	Not Reported
3	Rt. 24 NB Exit 21 (at Diverge)	46	3713444	2,013	5:30 AM	12/19/2013	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Wet	Dark - roadway not lighted	Cloudy
3	Rt. 24 NB Exit 21 (at Diverge)	47	3715423	2,014	12:00 PM	1/7/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	48	3782666	2,014	1:53 PM	3/4/2014	Non-fatal injury	1	2	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	49	3804748	2,014	7:42 AM	4/24/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	50	3826752	2,014	5:30 PM	5/17/2014	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	51	3899701	2,014	10:54 AM	5/20/2014	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	52	3896047	2,014	5:54 PM	5/28/2014	Fatal injury	2	1	1	Rear-end	V1:Northbound / V2:Northbound	Wet	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	53	3862692	2,014	12:00 AM	6/8/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	54	3923779	2,014	4:55 PM	8/23/2014	Non-fatal injury	3	3	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	55	3930444	2,014	8:11 PM	9/8/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	56	3963926	2,014	8:30 AM	10/1/2014	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Not reported	Wet	Daylight	Not Reported
3	Rt. 24 NB Exit 21 (at Diverge)	57	3972157	2,014	5:35 AM	10/10/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dawn	Cloudy
3	Rt. 24 NB Exit 21 (at Diverge)	58	3972186	2,014	6:20 AM	10/21/2014	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Wet	Dawn	Cloudy
3	Rt. 24 NB Exit 21 (at Diverge)	59	3973140	2,014	12:00 AM	11/5/2014	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - lighted roadway	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	60	3975942	2,014	6:55 AM	11/18/2014	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	61	4028980	2,014	3:38 AM	12/5/2014	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Cloudy
3	Rt. 24 NB Exit 21 (at Diverge)	62	3987252	2,014	12:00 AM	12/18/2014	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB Exit 21 (at Diverge)	63	3999146	2,014	5:25 AM	12/21/2014	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Snow	Dawn	Cloudy/Snow
3	Rt. 24 NB merge with I-93 NB	1	2563635	2,010	1:50 AM	2/4/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Dark - lighted roadway	Clear
3	Rt. 24 NB merge with I-93 NB	2	2734431	2,010	3:30 PM	11/19/2010	Non-fatal injury	3	1	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 NB	3	2736942	2,011	5:50 PM	6/29/2011	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 NB	4	3013909	2,012	2:15 PM	3/29/2012	Non-fatal injury	2	2	0	Angle	V1:Not reported / V2:Not reported	Dry	Daylight	Not Reported
3	Rt. 24 NB merge with I-93 NB	5	3291270	2,012	1:17 AM	7/29/2012	Property damage only	7	0	0	Single vehicle crash	V1:Not reported / V2:Northbound / V3:Northbound / V4:Nc	Wet	Dark - roadway not lighted	Rain
3	Rt. 24 NB merge with I-93 NB	6	3249283	2,012	1:25 PM	8/26/2012	Property damage only	2	0	0	Rear-end	V1:Eastbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 NB	7	3248919	2,012	5:33 AM	9/4/2012	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Dawn	Rain
3	Rt. 24 NB merge with I-93 NB	8	3349121	2,012	12:15 PM	12/20/2012	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 NB	9	3369758	2,013	2:13 PM	2/10/2013	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Wet	Daylight	Not Reported
3	Rt. 24 NB merge with I-93 NB	10	3369915	2,013	1:59 PM	2/12/2013	Non-fatal injury	2	2	0	Angle	V1:Northbound / V2:Northbound	Wet	Daylight	Not Reported
3	Rt. 24 NB merge with I-93 NB	11	3584155	2,013	6:00 PM	3/12/2013	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Dusk	Rain
3	Rt. 24 NB merge with I-93 NB	12	3578978	2,013	2:15 PM	8/30/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 NB	13	3708805	2,013	8:01 PM	12/21/2013	Not Reported	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB merge with I-93 NB	14	3737864	2,014	6:01 PM	2/14/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB merge with I-93 NB	15	3743802	2,014	6:07 PM	2/22/2014	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Not Reported
3	Rt. 24 NB merge with I-93 NB	16	3791671	2,014	8:25 AM	3/10/2014	Property damage only	2	0	0	Angle	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 NB	17	3923769	2,014	9:15 PM	6/23/2014	Non-fatal injury	2	1	0	Rear-end	V1:Not reported / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 NB	18	3973499	2,014	7:40 AM	9/18/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 SB	1	2561294	2,010	5:13 PM	1/30/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 SB	2	2607085	2,010	12:30 PM	5/20/2010	Property damage only	4	0	0	Angle	V1:Southbound / V2:Southbound / V3:Southbound / V4:Sou	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 SB	3	2621262	2,010	11:50 AM	6/26/2010	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 SB	4	2634871	2,010	7:56 AM	7/29/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Daylight	Cloudy/Rain
3	Rt. 24 NB merge with I-93 SB	5	2645544	2,010	3:55 PM	9/27/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Cloudy
3	Rt. 24 NB merge with I-93 SB	6	2653968	2,010	9:40 AM	10/18/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 SB	7	2718180	2,011	10:15 AM	4/21/2011	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 SB	8	3242552	2,012	5:11 PM	8/1/2012	Non-fatal injury	1	3	0	Single vehicle crash	V1:Southbound	Wet	Daylight	Cloudy
3	Rt. 24 NB merge with I-93 SB	9	3369127	2,013	4:34 PM	2/17/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Snow	Dusk	Snow
3	Rt. 24 NB merge with I-93 SB	10	3560866	2,013	11:05 PM	8/1/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Dark - lighted roadway	Not Reported
3	Rt. 24 NB merge with I-93 SB	11	3718384	2,014	3:03 PM	1/4/2014	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
3	Rt. 24 NB merge with I-93 SB	12	3972165	2,014	9:48 AM	10/13/2014	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Not Reported
3	Rt. 24 NB merge with I-93 SB	13	3972185	2,014	1:40 AM	10/21/2014	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Dark - roadway not lighted	Clear
3	Rt. 24 NB merge with I-93 SB	14	3972191	2,014	2:30 PM	10/23/2014	Non-fatal injury	2	2	0	Head-on	V1:Southbound / V2:Southbound	Wet	Daylight	Rain
3	Rt. 24 NB merge with I-93 SB	15	3984907	2,014	1:11 PM	11/25/2014	Not Reported	2	0	0	Rear-end	V1:Northbound / V2:Not reported	Dry	Daylight	Cloudy
4	Rt. 24 SB at Merge	1	2553183	2,010	5:45 AM	1/5/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	2	2560670	2,010	10:30 AM	1/18/2010	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Daylight	Cloudy/Sleet, hail (fre
4	Rt. 24 SB at Merge	3	2591138	2,010	11:24 PM	3/25/2010	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - roadway not lighted	Clear
4	Rt. 24 SB at Merge	4	2604889	2,010	4:20 PM	5/15/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Not reported / V2:Not reported	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	5	2608600	2,010	4:05 PM	5/24/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear

Study Location	Area of Crash	Count	Crash Number	Crash Year	Crash Time	Crash Date	Crash Severity	Number of Vehicles	Nonfatal Injuries	Fatal Injuries	Manner of Collision	Vehicle Travelled Direction	Road Surface Condition	Ambient Light Condition	Weather Condition
4	Rt. 24 SB at Merge	6	2621034	2,010	3:11 AM	5/27/2010	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	7	2628285	2,010	6:15 AM	8/15/2010	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Not Reported
4	Rt. 24 SB at Merge	8	2632982	2,010	2:55 PM	8/18/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	9	2663239	2,010	12:50 PM	11/4/2010	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Daylight	Cloudy/Rain
4	Rt. 24 SB at Merge	10	2659367	2,010	2:25 PM	11/4/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Wet	Daylight	Rain
4	Rt. 24 SB at Merge	11	2680263	2,011	1:30 PM	1/9/2011	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Northbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	12	2704177	2,011	2:20 PM	2/24/2011	Non-fatal injury	4	3	0	Angle	V1:Southbound / V2:Not reported / V3:Not reported / V4:N	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	13	2751996	2,011	6:10 PM	7/29/2011	Non-fatal injury	2	3	0	Angle	V1:Southbound / V2:Southbound	Dry	Daylight	Not Reported
4	Rt. 24 SB at Merge	14	2751083	2,011	7:00 PM	7/29/2011	Property damage only	2	0	0	Angle	V1:Southbound / V2:Southbound	Dry	Dark - roadway not lighted	Not Reported
4	Rt. 24 SB at Merge	15	2778180	2,011	10:38 PM	9/23/2011	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Dark - lighted roadway	Rain
4	Rt. 24 SB at Merge	16	2793398	2,011	2:20 PM	10/27/2011	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Daylight	Cloudy/Rain
4	Rt. 24 SB at Merge	17	2790641	2,011	1:24 AM	10/29/2011	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	18	2850964	2,011	4:50 PM	12/19/2011	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Dark - lighted roadway	Not Reported
4	Rt. 24 SB at Merge	19	2903991	2,012	2:03 AM	2/4/2012	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - lighted roadway	Cloudy
4	Rt. 24 SB at Merge	20	3013911	2,012	4:30 AM	3/31/2012	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Dark - roadway not lighted	Rain
4	Rt. 24 SB at Merge	21	3098021	2,012	3:38 PM	4/27/2012	Not Reported	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	22	3384355	2,012	7:00 AM	5/10/2012	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Wet	Daylight	Not Reported
4	Rt. 24 SB at Merge	23	3138890	2,012	9:54 PM	6/11/2012	Not Reported	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - lighted roadway	Not Reported
4	Rt. 24 SB at Merge	24	3272335	2,012	1:17 AM	6/27/2012	Non-fatal injury	4	3	0	Angle	V1:Eastbound / V2:Northbound / V3:Southbound / V4:South	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	25	3384371	2,012	5:40 AM	7/25/2012	Non-fatal injury	2	1	0	Angle	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	26	3277578	2,012	2:49 AM	10/13/2012	Non-fatal injury	2	2	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	27	3384456	2,012	11:30 PM	12/30/2012	Property damage only	2	0	0	Single vehicle crash	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Not Reported
4	Rt. 24 SB at Merge	28	3344289	2,013	1:50 PM	1/21/2013	Non-fatal injury	1	2	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	29	3359764	2,013	8:34 AM	2/4/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	30	3356450	2,013	3:30 PM	2/7/2013	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	31	3404655	2,013	6:35 AM	4/25/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Cloudy
4	Rt. 24 SB at Merge	32	3414363	2,013	10:08 PM	5/1/2013	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	33	3428394	2,013	9:20 AM	5/14/2013	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	34	3453204	2,013	6:45 PM	6/1/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	35	3436736	2,013	1:45 AM	6/2/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	36	3473039	2,013	3:00 AM	6/9/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	37	3543882	2,013	1:45 AM	7/6/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	38	3545942	2,013	10:45 PM	7/24/2013	Property damage only	2	0	0	Single vehicle crash	V1:Southbound / V2:Not reported	Dry	Dark - roadway not lighted	Cloudy
4	Rt. 24 SB at Merge	39	3572431	2,013	6:06 PM	8/12/2013	Property damage only	3	0	0	Not reported	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	40	3569915	2,013	8:26 PM	8/21/2013	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Dark - roadway not lighted	Clear
4	Rt. 24 SB at Merge	41	3590995	2,013	5:49 PM	9/5/2013	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Not Reported
4	Rt. 24 SB at Merge	42	3710732	2,013	12:00 AM	10/26/2013	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	43	3665092	2,013	11:44 PM	11/13/2013	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	44	3710787	2,013	12:45 PM	11/22/2013	Property damage only	5	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound / V4:Sou	Wet	Daylight	Rain
4	Rt. 24 SB at Merge	45	3665168	2,013	10:50 PM	11/22/2013	Non-fatal injury	1	1	0	Rear-end	V1:Southbound	Dry	Dark - lighted roadway	Cloudy
4	Rt. 24 SB at Merge	46	3685216	2,013	1:00 AM	12/5/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - roadway not lighted	Cloudy
4	Rt. 24 SB at Merge	47	3713381	2,013	11:39 PM	12/19/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Dark - roadway not lighted	Not Reported
4	Rt. 24 SB at Merge	48	3700167	2,013	5:07 PM	12/23/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Northbound	Wet	Dark - unknown roadway light	Rain
4	Rt. 24 SB at Merge	49	3724128	2,014	9:03 AM	1/9/2014	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	50	3743796	2,014	9:50 PM	2/21/2014	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Dark - lighted roadway	Clear
4	Rt. 24 SB at Merge	51	3782670	2,014	5:10 PM	3/30/2014	Property damage only	4	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound / V4:Sou	Wet	Daylight	Rain
4	Rt. 24 SB at Merge	52	3871550	2,014	5:26 PM	7/2/2014	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	53	3900183	2,014	6:08 PM	8/5/2014	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	54	3972136	2,014	1:00 PM	8/15/2014	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	55	3928348	2,014	4:15 PM	8/23/2014	Property damage only	2	0	0	Sideswipe, same direction	V1:Not reported / V2:Southbound	Dry	Daylight	Not Reported
4	Rt. 24 SB at Merge	56	3974358	2,014	12:30 PM	11/3/2014	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	Rt. 24 SB at Merge	57	3977871	2,014	8:00 PM	11/12/2014	Property damage only	1	0	0	Sideswipe, same direction	V1:Southbound	Dry	Dusk	Clear
4	Rt. 24 SB at Merge	58	3988827	2,014	3:35 PM	12/22/2014	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Daylight	Rain
4	I-93 NB Exit 4 to Rt. 24 SB	1	2553817	2,010	4:00 PM	1/5/2010	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	2	2576443	2,010	8:36 PM	3/15/2010	Non-fatal injury	2	1	0	Not reported	V1:Northbound / V2:Northbound	Wet	Dark - lighted roadway	Rain
4	I-93 NB Exit 4 to Rt. 24 SB	3	2591150	2,010	1:40 PM	4/2/2010	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	4	2591264	2,010	6:45 PM	4/5/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Cloudy
4	I-93 NB Exit 4 to Rt. 24 SB	5	2591354	2,010	11:58 PM	4/11/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Dry	Dark - roadway not lighted	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	6	2591352	2,010	7:25 AM	4/13/2010	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	7	2591351	2,010	5:23 PM	4/13/2010	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	8	2621069	2,010	11:15 PM	7/11/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	9	2624778	2,010	3:30 PM	8/3/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	10	2643439	2,010	7:00 AM	9/16/2010	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear/Other
4	I-93 NB Exit 4 to Rt. 24 SB	11	2643441	2,010	2:10 PM	9/18/2010	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear

Study Location	Area of Crash	Count	Crash Number	Crash Year	Crash Time	Crash Date	Crash Severity	Number of Vehicles	Nonfatal Injuries	Fatal Injuries	Manner of Collision	Vehicle Travelled Direction	Road Surface Condition	Ambient Light Condition	Weather Condition
4	I-93 NB Exit 4 to Rt. 24 SB	12	2649795	2,010	3:28 PM	9/22/2010	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Cloudy
4	I-93 NB Exit 4 to Rt. 24 SB	13	2650231	2,010	11:13 PM	9/25/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	14	2669023	2,010	5:31 PM	11/15/2010	Non-fatal injury	4	2	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	15	2663264	2,010	5:15 PM	11/18/2010	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	16	2664293	2,010	6:00 PM	11/19/2010	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Dark - lighted roadway	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	17	2672098	2,010	5:10 PM	12/16/2010	Property damage only	3	0	0	Angle	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Dark - lighted roadway	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	18	2689763	2,011	8:00 AM	1/10/2011	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Cloudy
4	I-93 NB Exit 4 to Rt. 24 SB	19	2689681	2,011	5:10 PM	1/31/2011	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	20	2713269	2,011	5:15 PM	4/1/2011	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	21	2715350	2,011	3:05 PM	4/14/2011	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	22	2715351	2,011	5:46 PM	4/14/2011	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	23	2727009	2,011	9:52 PM	5/11/2011	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - roadway not lighted	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	24	2728166	2,011	5:12 PM	5/12/2011	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	25	2727013	2,011	11:38 PM	5/14/2011	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	26	2757494	2,011	8:25 AM	6/13/2011	Non-fatal injury	3	2	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	27	2733897	2,011	4:18 PM	6/15/2011	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	28	2751484	2,011	12:47 PM	7/22/2011	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	29	2759779	2,011	4:50 PM	8/29/2011	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Not reported / V3:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	30	2782666	2,011	2:38 AM	10/1/2011	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Wet	Dark - lighted roadway	Rain
4	I-93 NB Exit 4 to Rt. 24 SB	31	2790953	2,011	5:05 PM	10/24/2011	Non-fatal injury	4	1	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Daylight	Cloudy
4	I-93 NB Exit 4 to Rt. 24 SB	32	2789046	2,011	6:22 PM	10/25/2011	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Dark - roadway not lighted	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	33	2788858	2,011	4:15 PM	10/27/2011	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Daylight	Rain
4	I-93 NB Exit 4 to Rt. 24 SB	34	2834193	2,011	4:25 PM	12/19/2011	Non-fatal injury	4	1	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	35	2861712	2,012	8:45 AM	1/12/2012	Property damage only	2	0	0	Angle	V1:Northbound / V2:Northbound	Wet	Daylight	Cloudy/Rain
4	I-93 NB Exit 4 to Rt. 24 SB	36	2885389	2,012	11:27 PM	1/19/2012	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Snow	Dark - lighted roadway	Snow
4	I-93 NB Exit 4 to Rt. 24 SB	37	2891333	2,012	4:00 PM	1/31/2012	Property damage only	4	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Dusk	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	38	2903990	2,012	5:05 AM	2/1/2012	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	39	2942738	2,012	11:00 PM	3/2/2012	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	40	2976126	2,012	3:40 PM	3/6/2012	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	41	2976231	2,012	3:47 PM	3/19/2012	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	42	3013910	2,012	4:21 PM	3/30/2012	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Cloudy
4	I-93 NB Exit 4 to Rt. 24 SB	43	3027199	2,012	10:30 PM	4/13/2012	Property damage only	2	0	0	Single vehicle crash	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	44	3098027	2,012	3:35 AM	5/13/2012	Not Reported	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	45	3163132	2,012	3:56 PM	6/14/2012	Non-fatal injury	4	1	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	46	3208045	2,012	4:20 PM	6/18/2012	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	47	3153181	2,012	5:46 PM	6/21/2012	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	48	3390290	2,012	1:00 PM	7/17/2012	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	49	3198592	2,012	7:55 AM	7/18/2012	Non-fatal injury	3	1	0	Rear-end	V1:Northbound / V2:Northbound / V3:Eastbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	50	3280766	2,012	4:46 PM	10/4/2012	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Daylight	Cloudy
4	I-93 NB Exit 4 to Rt. 24 SB	51	3339369	2,012	5:55 AM	11/4/2012	Not Reported	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	52	3297460	2,012	5:26 PM	11/5/2012	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	53	3292062	2,012	10:21 PM	11/9/2012	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	54	3321487	2,012	5:28 PM	12/14/2012	Property damage only	2	0	0	Angle	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	55	3337071	2,013	7:45 AM	1/9/2013	Property damage only	1	0	0	Head-on	V1:Northbound	Wet	Daylight	Clear/Cloudy
4	I-93 NB Exit 4 to Rt. 24 SB	56	3340472	2,013	4:55 PM	1/11/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Dark - roadway not lighted	Rain
4	I-93 NB Exit 4 to Rt. 24 SB	57	3349170	2,013	6:06 PM	2/1/2013	Non-fatal injury	2	2	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - roadway not lighted	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	58	3362677	2,013	8:38 PM	2/23/2013	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Wet	Dark - lighted roadway	Cloudy/Rain
4	I-93 NB Exit 4 to Rt. 24 SB	59	3369133	2,013	2:58 PM	3/12/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	60	3385798	2,013	3:25 PM	4/4/2013	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	61	3393633	2,013	4:10 PM	4/9/2013	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	62	3414471	2,013	4:55 PM	4/23/2013	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	63	3430268	2,013	4:29 PM	4/30/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	64	3430521	2,013	9:47 PM	5/20/2013	Non-fatal injury	3	1	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	65	3453248	2,013	11:41 PM	5/31/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	66	3495738	2,013	5:05 PM	6/19/2013	Non-fatal injury	4	2	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound / V4:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	67	3548970	2,013	10:45 PM	7/16/2013	Property damage only	3	0	0	Sideswipe, same direction	V1:Northbound / V2:Southbound / V3:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	68	3548896	2,013	7:10 PM	7/25/2013	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	69	3548975	2,013	5:33 PM	8/2/2013	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	70	3548899	2,013	9:40 PM	8/3/2013	Property damage only	1	0	0	Single vehicle crash	V1:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	71	3651275	2,013	2:18 PM	8/30/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	72	3655449	2,013	2:20 PM	10/26/2013	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	73	3651464	2,013	4:08 PM	11/1/2013	Property damage only	3	0	0	Angle	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Not Reported
4	I-93 NB Exit 4 to Rt. 24 SB	74	3710734	2,013	10:17 AM	11/18/2013	Non-fatal injury	2	1	0	Rear-end	V1:Northbound / V2:Northbound	Wet	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	75	3665098	2,013	4:45 PM	11/27/2013	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Wet	Dark - roadway not lighted	Cloudy/Rain

Study Location	Area of Crash	Count	Crash Number	Crash Year	Crash Time	Crash Date	Crash Severity	Number of Vehicles	Nonfatal Injuries	Fatal Injuries	Manner of Collision	Vehicle Travelled Direction	Road Surface Condition	Ambient Light Condition	Weather Condition
4	I-93 NB Exit 4 to Rt. 24 SB	76	3686343	2,013	5:20 PM	12/12/2013	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	77	3726716	2,014	5:20 PM	1/24/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	78	3785242	2,014	5:00 PM	4/2/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	79	3785156	2,014	5:50 PM	4/3/2014	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	80	3823114	2,014	6:10 PM	5/31/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	81	3896247	2,014	4:30 PM	7/8/2014	Property damage only	2	0	0	Sideswipe, same direction	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	82	3922725	2,014	9:00 PM	8/22/2014	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	83	3972649	2,014	1:45 AM	11/2/2014	Non-fatal injury	1	2	0	Single vehicle crash	V1:Northbound	Wet	Dark - roadway not lighted	Rain
4	I-93 NB Exit 4 to Rt. 24 SB	84	3972212	2,014	3:55 PM	11/3/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Dusk	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	85	3972213	2,014	6:14 PM	11/4/2014	Property damage only	4	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound / V4:Sou	Dry	Dark - roadway not lighted	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	86	3972218	2,014	5:25 PM	11/12/2014	Property damage only	3	0	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Dark - lighted roadway	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	87	3981774	2,014	6:43 PM	12/2/2014	Property damage only	2	0	0	Rear-end	V1:Northbound / V2:Northbound	Dry	Daylight	Clear
4	I-93 NB Exit 4 to Rt. 24 SB	88	3987249	2,014	4:50 PM	12/16/2014	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Dark - lighted roadway	Cloudy/Rain
4	I-93 SB Exit 4 to Rt. 24 SB	1	2566582	2,010	8:25 AM	2/7/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	2	2574744	2,010	5:30 PM	2/24/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Dusk	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	3	2573848	2,010	5:15 PM	3/5/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Dry	Dusk	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	4	2591271	2,010	7:20 AM	4/15/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	5	2608173	2,010	5:50 PM	6/8/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	6	2611367	2,010	7:00 PM	6/9/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Daylight	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	7	2621055	2,010	8:30 AM	6/30/2010	Property damage only	4	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound / V4:Sou	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	8	2628437	2,010	1:00 PM	7/29/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	9	2631011	2,010	8:20 AM	8/3/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	10	2634383	2,010	11:00 AM	8/12/2010	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	11	2638752	2,010	10:23 AM	9/11/2010	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	12	2649059	2,010	10:37 PM	9/16/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Wet	Dark - lighted roadway	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	13	2647652	2,010	11:18 PM	9/29/2010	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - lighted roadway	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	14	2648305	2,010	11:19 AM	10/6/2010	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	15	2660477	2,010	2:35 AM	10/15/2010	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Dark - roadway not lighted	Cloudy/Rain
4	I-93 SB Exit 4 to Rt. 24 SB	16	2657371	2,010	3:29 PM	10/23/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Not Reported
4	I-93 SB Exit 4 to Rt. 24 SB	17	2657374	2,010	8:45 PM	10/27/2010	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Dark - lighted roadway	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	18	2668836	2,010	11:30 PM	11/2/2010	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Dark - roadway not lighted	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	19	2664301	2,010	5:36 PM	11/11/2010	Property damage only	4	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound / V4:Sou	Dry	Dark - lighted roadway	Not Reported
4	I-93 SB Exit 4 to Rt. 24 SB	20	2666804	2,010	1:24 AM	11/19/2010	Property damage only	2	0	0	Not reported	V1:Southbound / V2:Southbound	Not reported	Not reported	Not Reported
4	I-93 SB Exit 4 to Rt. 24 SB	21	2664066	2,010	1:25 PM	11/20/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	22	2665500	2,010	12:00 AM	11/22/2010	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - roadway not lighted	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	23	2664403	2,010	1:10 AM	11/22/2010	Property damage only	3	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Dark - roadway not lighted	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	24	2670348	2,010	1:33 AM	11/26/2010	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	25	2668689	2,010	7:10 PM	12/1/2010	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Wet	Dark - lighted roadway	Rain
4	I-93 SB Exit 4 to Rt. 24 SB	26	2673852	2,010	5:35 PM	12/21/2010	Property damage only	4	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound / V4:Sou	Wet	Dark - lighted roadway	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	27	2677332	2,010	7:25 AM	12/29/2010	Property damage only	3	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Wet	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	28	2676865	2,011	6:35 PM	1/2/2011	Non-fatal injury	2	3	0	Head-on	V1:Southbound / V2:Southbound	Wet	Dark - lighted roadway	Rain
4	I-93 SB Exit 4 to Rt. 24 SB	29	2701462	2,011	2:14 AM	1/31/2011	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	30	2727758	2,011	1:49 AM	4/17/2011	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Dark - lighted roadway	Cloudy/Rain
4	I-93 SB Exit 4 to Rt. 24 SB	31	2728892	2,011	8:00 AM	5/25/2011	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Northbound / V3:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	32	2727016	2,011	7:50 AM	5/26/2011	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	33	2738115	2,011	9:16 PM	6/30/2011	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - roadway not lighted	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	34	3377504	2,011	10:30 AM	8/7/2011	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	35	2751501	2,011	3:23 PM	8/7/2011	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Wet	Daylight	Cloudy/Rain
4	I-93 SB Exit 4 to Rt. 24 SB	36	2756840	2,011	9:56 PM	8/20/2011	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	37	2759862	2,011	9:34 PM	9/4/2011	Property damage only	1	0	0	Sideswipe, same direction	V1:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	38	3375409	2,011	6:56 AM	9/8/2011	Non-fatal injury	1	1	0	Single vehicle crash	V1:Southbound	Wet	Daylight	Cloudy/Rain
4	I-93 SB Exit 4 to Rt. 24 SB	39	2763615	2,011	5:00 PM	9/18/2011	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Not Reported
4	I-93 SB Exit 4 to Rt. 24 SB	40	2767502	2,011	2:25 PM	9/24/2011	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Wet	Daylight	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	41	2778897	2,011	3:55 PM	10/7/2011	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Not Reported
4	I-93 SB Exit 4 to Rt. 24 SB	42	2790275	2,011	4:35 PM	10/22/2011	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	43	2788859	2,011	3:10 PM	10/29/2011	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Daylight	Cloudy/Rain
4	I-93 SB Exit 4 to Rt. 24 SB	44	2817088	2,011	7:33 AM	11/23/2011	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Daylight	Cloudy/Rain
4	I-93 SB Exit 4 to Rt. 24 SB	45	2827626	2,011	6:25 PM	12/7/2011	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Wet	Dark - lighted roadway	Rain
4	I-93 SB Exit 4 to Rt. 24 SB	46	2839036	2,011	5:35 PM	12/27/2011	Non-fatal injury	2	3	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	47	2861709	2,012	3:28 PM	1/12/2012	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Daylight	Not Reported
4	I-93 SB Exit 4 to Rt. 24 SB	48	2926398	2,012	7:55 AM	2/21/2012	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	49	2972766	2,012	4:10 PM	3/15/2012	Non-fatal injury	2	2	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	50	2995144	2,012	4:13 PM	3/26/2012	Non-fatal injury	3	1	0	Rear-end	V1:Northbound / V2:Northbound / V3:Northbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	51	3038691	2,012	12:00 AM	4/6/2012	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Dark - roadway not lighted	Clear

Study Location	Area of Crash	Count	Crash Number	Crash Year	Crash Time	Crash Date	Crash Severity	Number of Vehicles	Nonfatal Injuries	Fatal Injuries	Manner of Collision	Vehicle Travelled Direction	Road Surface Condition	Ambient Light Condition	Weather Condition
4	I-93 SB Exit 4 to Rt. 24 SB	52	3107264	2,012	2:15 AM	4/23/2012	Not Reported	1	0	0	Single vehicle crash	V1:Southbound	Wet	Dark - lighted roadway	Rain
4	I-93 SB Exit 4 to Rt. 24 SB	53	3121135	2,012	2:55 PM	6/1/2012	Not Reported	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	54	3384369	2,012	2:31 AM	7/15/2012	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	55	3219191	2,012	8:15 AM	7/19/2012	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	56	3384442	2,012	8:21 AM	7/26/2012	Property damage only	3	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	57	3242555	2,012	5:49 PM	8/9/2012	Non-fatal injury	3	2	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	58	3244510	2,012	1:00 PM	8/18/2012	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Daylight	Rain
4	I-93 SB Exit 4 to Rt. 24 SB	59	3248555	2,012	2:55 PM	8/30/2012	Property damage only	2	0	0	Angle	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	60	3299709	2,012	4:40 PM	11/14/2012	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	61	3341779	2,012	7:18 AM	11/28/2012	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	62	3304280	2,012	7:46 AM	12/2/2012	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Daylight	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	63	3298910	2,012	6:25 PM	12/4/2012	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Dark - lighted roadway	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	64	3321625	2,012	3:05 PM	12/9/2012	Non-fatal injury	2	1	0	Angle	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	65	3312164	2,012	6:50 AM	12/10/2012	Property damage only	3	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Wet	Dawn	Rain
4	I-93 SB Exit 4 to Rt. 24 SB	66	3359762	2,013	8:13 AM	1/31/2013	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Wet	Daylight	Cloudy/Rain
4	I-93 SB Exit 4 to Rt. 24 SB	67	3384759	2,013	5:02 AM	2/24/2013	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Wet	Dark - roadway not lighted	Rain/Fog, smog, smol
4	I-93 SB Exit 4 to Rt. 24 SB	68	3391683	2,013	9:05 AM	4/8/2013	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Southbound / V2:Not reported	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	69	3430383	2,013	10:20 AM	5/27/2013	Non-fatal injury	3	1	0	Sideswipe, same direction	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	70	3453208	2,013	5:13 AM	6/4/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Dawn	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	71	3471478	2,013	7:10 PM	6/8/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	72	3479533	2,013	7:40 AM	6/19/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	73	3534501	2,013	7:30 AM	7/15/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	74	3548897	2,013	4:35 PM	7/31/2013	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	75	3560990	2,013	6:45 AM	8/1/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	76	3560868	2,013	3:45 PM	8/14/2013	Non-fatal injury	2	1	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	77	3584731	2,013	9:46 PM	9/5/2013	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	78	3651613	2,013	9:00 AM	9/16/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	79	3603414	2,013	3:10 PM	9/20/2013	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Not Reported
4	I-93 SB Exit 4 to Rt. 24 SB	80	3594182	2,013	12:15 PM	9/22/2013	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Daylight	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	81	3599019	2,013	10:00 AM	9/23/2013	Non-fatal injury	1	1	0	Single vehicle crash	V1:Northbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	82	3607529	2,013	6:50 AM	10/10/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Dawn	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	83	3626672	2,013	11:15 PM	10/10/2013	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Dark - lighted roadway	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	84	3611128	2,013	5:30 PM	10/12/2013	Property damage only	1	0	0	Single vehicle crash	V1:Southbound	Wet	Daylight	Cloudy/Rain
4	I-93 SB Exit 4 to Rt. 24 SB	85	3651465	2,013	12:00 PM	11/2/2013	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Northbound	Dry	Daylight	Not Reported
4	I-93 SB Exit 4 to Rt. 24 SB	86	3655820	2,013	7:35 PM	11/6/2013	Property damage only	2	0	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Dry	Dark - roadway not lighted	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	87	3667326	2,013	9:35 AM	11/26/2013	Property damage only	2	0	0	Angle	V1:Southbound / V2:Southbound	Dry	Daylight	Cloudy
4	I-93 SB Exit 4 to Rt. 24 SB	88	3728536	2,014	10:20 AM	1/23/2014	Non-fatal injury	2	1	0	Sideswipe, same direction	V1:Southbound / V2:Southbound	Other	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	89	3862599	2,014	5:15 PM	6/12/2014	Property damage only	3	0	0	Rear-end	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	90	3880598	2,014	11:00 AM	7/12/2014	Property damage only	3	0	0	Angle	V1:Southbound / V2:Southbound / V3:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	91	3922711	2,014	7:50 AM	7/22/2014	Property damage only	2	0	0	Rear-end	V1:Southbound / V2:Southbound	Dry	Daylight	Clear
4	I-93 SB Exit 4 to Rt. 24 SB	92	3987251	2,014	8:50 PM	12/17/2014	Property damage only	1	0	0	Rear-end	V1:Southbound	Wet	Dark - lighted roadway	Cloudy

# APPENDIX D

## 1. HCS Printouts

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4	1	I-95 NB	2030 No-Build	Diverge Analysis	PM
5	1	I-95 NB	2030 No-Build	Merge Analysis	AM
6	1	I-95 NB	2030 No-Build	Merge Analysis	PM
7	1	I-95 NB	2030 No-Build	Weaving Analysis	AM
8	1	I-95 NB	2030 No-Build	Weaving Analysis	PM
9	1	I-95 NB	Alternative 1	Merge Analysis	AM
10	1	I-95 NB	Alternative 1	Merge Analysis	PM
11	1	I-95 NB	Alternative 2	Basic Freeway Segment	AM
12	1	I-95 NB	Alternative 2	Basic Freeway Segment	PM
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15	1	I-95 NB	Alternative 2	Merge Analysis	AM
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17	1	I-95 NB	Alternative 2	Weaving Analysis	AM
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19	1	I-95 NB	Existing Conditions	Basic Freeway Segment	AM
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21	1	I-95 NB	Existing Conditions	Diverge Analysis	AM
22	1	I-95 NB	Existing Conditions	Diverge Analysis	PM
23	1	I-95 NB	Existing Conditions	Merge Analysis	AM
24	1	I-95 NB	Existing Conditions	Merge Analysis	PM
25	1	I-95 NB	Existing Conditions	Weaving Analysis	AM
27	1	I-95 NB	Existing Conditions	Weaving Analysis	PM
28	2	I-93 SB	2030 No Build	Diverge Analysis	AM
29	2	I-93 SB	2030 No Build	Merge Analysis	AM
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33	2	I-93 SB	Alternative 3	Basic Freeway Segment 2 (After 37B)	AM
34	2	I-93 SB	Alternative 3	Diverge Analysis	AM
35	2	I-93 SB	Existing Conditions	Basic Freeway Segment	AM
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37	2	I-93 SB	Existing Conditions	Merge Analysis	AM
38	2	I-95 SB	2030 No Build	Basic Freeway Segment 2 (Before 36)	AM
39	2	I-95 SB	2030 No Build	Diverge Analysis (Commerce)	AM
40	2	I-95 SB	2030 No Build	Merge Analysis (Commerce)	AM
41	2	I-95 SB	2030 No Build	Merge Analysis (I-93)	AM
42	2	I-95 SB	2030 No Build	Weaving Segment	AM
43	2	I-95 SB	Alternative 2	Merge Analysis (Commerce)	AM
44	2	I-95 SB	Alternative 3	Basic Freeway Segment 2 (Before 36)	AM
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48	2	I-95 SB	Existing Conditions	Merge Analysis (I-93)	AM
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60	4	Route 24 SB	Alternative 1	Basic Freeway Segment	PM
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## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - 2030 No-Build - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.83
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.2
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	7980	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	2044
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2322
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2322
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.88
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	57.6
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	35.5
Total Ramp Density Adjustment	2.8	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.2		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - 2030 No-Build - Basic Freeway Segment - PM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.83
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.2
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	8800	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	2238
Total Trucks, %	1.70	Capacity (c), pc/h/ln	2322
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2322
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.96
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	53.7
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	41.7
Total Ramp Density Adjustment	2.8	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.2		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - 2030 No-Build - Diverge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	860	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7980	1155
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	2.50	1.70
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.983
Flow Rate (v <sub>i</sub> ), pc/h	8176	1175
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.87	0.62

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	35.2
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (D <sub>S</sub> )	0.599
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1975
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	51.2
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	67.5
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	4227	Ramp Junction Speed (S), mi/h	58.0
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	35.2
Level of Service (LOS)	E		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - 2030 No-Build - Diverge Analysis - PM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	860	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	8800	1260
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.70	1.70
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.983
Flow Rate (v <sub>i</sub> ), pc/h	8952	1282
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.95	0.67

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	38.6
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (D <sub>S</sub> )	0.608
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2163
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	51.0
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	66.8
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	4626	Ramp Junction Speed (S), mi/h	57.6
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	38.9
Level of Service (LOS)	E		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - 2030 No-Build - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	25.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	860	620
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	6405	1575
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.985
Flow Rate (v <sub>i</sub> ), pc/h	6562	1599
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.87	0.84

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	33.9
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	0.556
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1969
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	52.2
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.018	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	59.7
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	2625	Ramp Junction Speed (S), mi/h	55.6
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4224	Average Density (D), pc/mi/ln	36.7
Level of Service (LOS)	D		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - 2030 No-Build - Merge Analysis - PM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	25.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	860	620
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	8800	945
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.70	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.980
Flow Rate (v <sub>i</sub> ), pc/h	8952	964
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	1.05	0.51

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2686
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.097	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	56.2
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3581	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4545	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

## HCS7 Freeway Weaving Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - 2030 No-Build - Weaving Analysis - AM		

**Geometric Data**

Number of Lanes (N), ln	5	Segment Type	Freeway
Short Length (L <sub>s</sub> ), ft	1720	Number of Maneuver Lanes (N <sub>WL</sub> ), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC <sub>RF</sub> ), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC <sub>FR</sub> ), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC <sub>RR</sub> ), lc	0
Interchange Density (ID), int/mi	0.83	Cross Weaving Managed Lane	No

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

	FF	RF	RR	FR
Volume (V <sub>i</sub> ), veh/h	5250	1575	0	1155
Peak Hour Factor (PHF)	1.00	1.00	1.00	1.00
Total Trucks, %	2.50	1.50	0.00	1.70
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.985	1.000	0.983
Flow Rate (v <sub>i</sub> ), pc/h	5379	1599	0	1175
Weaving Flow Rate (v <sub>w</sub> ), pc/h	2774	Freeway Max Capacity (c <sub>FL</sub> ), pc/h/ln		2350
Non-Weaving Flow Rate (v <sub>NW</sub> ), pc/h	5379	Density-Based Capacity (c <sub>DWL</sub> ), pc/h/ln		2021
Total Flow Rate (v), pc/h	8153	Demand Flow-Based Capacity (c <sub>DW</sub> ), pc/h		7059
Volume Ratio (VR)	0.340	Weaving Segment Capacity (c <sub>w</sub> ), veh/h		6889
Minimum Lane Change Rate (LC <sub>MIN</sub> ), lc/h	0	Adjusted Weaving Area Capacity (c <sub>wa</sub> ), veh/h		6889
Maximum Weaving Length (L <sub>MAX</sub> ), ft	6017	Volume-to-Capacity Ratio (v/c)		1.16

**Speed and Density**

Non-Weaving Vehicle Index (I <sub>NW</sub> )	-	Average Weaving Speed (S <sub>w</sub> ), mi/h	-
Non-Weaving Lane Change Rate (LC <sub>NW</sub> ), lc/h	-	Average Non-Weaving Speed (S <sub>NW</sub> ), mi/h	-
Weaving Lane Change Rate (LC <sub>w</sub> ), lc/h	-	Average Speed (S), mi/h	-
Total Lane Change Rate (LC <sub>ALL</sub> ), lc/h	-	Density (D), pc/mi/ln	-
Weaving Intensity Factor (W)	-	Level of Service (LOS)	F

## HCS7 Freeway Weaving Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - 2030 No-Build - Weaving Analysis - PM		

**Geometric Data**

Number of Lanes (N), ln	5	Segment Type	Freeway
Short Length (L <sub>s</sub> ), ft	1720	Number of Maneuver Lanes (N <sub>WL</sub> ), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC <sub>RF</sub> ), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC <sub>FR</sub> ), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC <sub>RR</sub> ), lc	0
Interchange Density (ID), int/mi	0.83	Cross Weaving Managed Lane	No

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

	FF	RF	RR	FR
Volume (V <sub>i</sub> ), veh/h	6595	945	0	1260
Peak Hour Factor (PHF)	1.00	1.00	1.00	1.00
Total Trucks, %	1.70	2.00	0.00	1.70
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.980	1.000	0.983
Flow Rate (v <sub>i</sub> ), pc/h	6709	964	0	1282
Weaving Flow Rate (v <sub>w</sub> ), pc/h	2246	Freeway Max Capacity (c <sub>FL</sub> ), pc/h/ln		2350
Non-Weaving Flow Rate (v <sub>NW</sub> ), pc/h	6709	Density-Based Capacity (c <sub>DWL</sub> ), pc/h/ln		2094
Total Flow Rate (v), pc/h	8955	Demand Flow-Based Capacity (c <sub>DW</sub> ), pc/h		9562
Volume Ratio (VR)	0.251	Weaving Segment Capacity (c <sub>w</sub> ), veh/h		9399
Minimum Lane Change Rate (LC <sub>MIN</sub> ), lc/h	2246	Adjusted Weaving Area Capacity (c <sub>wa</sub> ), veh/h		9399
Maximum Weaving Length (L <sub>MAX</sub> ), ft	5064	Volume-to-Capacity Ratio (v/c)		0.94

**Speed and Density**

Non-Weaving Vehicle Index (I <sub>NW</sub> )	958	Average Weaving Speed (S <sub>w</sub> ), mi/h	49.3
Non-Weaving Lane Change Rate (LC <sub>NW</sub> ), lc/h	1351	Average Non-Weaving Speed (S <sub>NW</sub> ), mi/h	40.2
Weaving Lane Change Rate (LC <sub>w</sub> ), lc/h	2842	Average Speed (S), mi/h	42.2
Total Lane Change Rate (LC <sub>ALL</sub> ), lc/h	4193	Density (D), pc/mi/ln	42.4
Weaving Intensity Factor (W)	0.457	Level of Service (LOS)	E



## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 1 - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	25.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	950	890
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	6405	1575
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.985
Flow Rate (v <sub>i</sub> ), pc/h	6562	1599
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.87	0.84

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	32.2
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	0.543
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1969
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	52.5
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.018	Outer Lanes Freeway Speed (S <sub>o</sub> ), mi/h	59.7
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	2625	Ramp Junction Speed (S), mi/h	55.7
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4224	Average Density (D), pc/mi/ln	36.6
Level of Service (LOS)	D		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 1 - Merge Analysis - PM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	25.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	950	890
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	8800	945
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.70	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.980
Flow Rate (v <sub>i</sub> ), pc/h	8952	964
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	1.05	0.51

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2686
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.097	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	56.2
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3581	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4545	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 2 - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	5	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.83
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	61.6
Right-Side Lateral Clearance, ft	0		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	7980	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1635
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2316
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2316
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.71
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	61.4
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.6	Density (D), pc/mi/ln	26.6
Total Ramp Density Adjustment	2.8	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	61.6		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 2 - Basic Freeway Segment - PM		

**Geometric Data**

Number of Lanes (N), ln	5	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.83
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	61.6
Right-Side Lateral Clearance, ft	0		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	8800	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1790
Total Trucks, %	1.70	Capacity (c), pc/h/ln	2316
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2316
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.77
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	60.5
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.6	Density (D), pc/mi/ln	29.6
Total Ramp Density Adjustment	2.8	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	61.6		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 2 - Diverge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7980	1155
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	2.50	1.70
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.983
Flow Rate (v <sub>i</sub> ), pc/h	8176	1175
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.87	0.62

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	27.1
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (D <sub>S</sub> )	0.599
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1975
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	51.2
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	67.5
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	4227	Ramp Junction Speed (S), mi/h	58.0
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	35.2
Level of Service (LOS)	C		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 2 - Diverge Analysis - PM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	8800	1260
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.70	1.70
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.983
Flow Rate (v <sub>i</sub> ), pc/h	8952	1282
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.95	0.67

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	30.5
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (D <sub>S</sub> )	0.608
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2163
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	51.0
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	66.8
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	4626	Ramp Junction Speed (S), mi/h	57.6
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	38.9
Level of Service (LOS)	D		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 2 - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	25.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	6405	1575
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.985
Flow Rate (v <sub>i</sub> ), pc/h	6562	1599
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.87	0.84

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	28.4
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	0.512
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1969
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	53.2
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.018	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	59.7
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	2625	Ramp Junction Speed (S), mi/h	56.1
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4224	Average Density (D), pc/mi/ln	36.4
Level of Service (LOS)	D		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 2 - Merge Analysis - PM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	25.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	8800	945
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.70	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.980
Flow Rate (v <sub>i</sub> ), pc/h	8952	964
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	1.05	0.51

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2686
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.097	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	56.2
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3581	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4545	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		



## HCS7 Freeway Weaving Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 2 - Weaving Analysis - AM		

**Geometric Data**

Number of Lanes (N), ln	6	Segment Type	Freeway
Short Length (L <sub>s</sub> ), ft	1720	Number of Maneuver Lanes (N <sub>WL</sub> ), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC <sub>RF</sub> ), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC <sub>FR</sub> ), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC <sub>RR</sub> ), lc	0
Interchange Density (ID), int/mi	0.83	Cross Weaving Managed Lane	No

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

	FF	RF	RR	FR
Volume (V <sub>i</sub> ), veh/h	5250	1575	0	1155
Peak Hour Factor (PHF)	1.00	1.00	1.00	1.00
Total Trucks, %	2.50	1.50	0.00	1.70
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.985	1.000	0.983
Flow Rate (v <sub>i</sub> ), pc/h	5379	1599	0	1175
Weaving Flow Rate (v <sub>w</sub> ), pc/h	2774	Freeway Max Capacity (c <sub>FL</sub> ), pc/h/ln		2350
Non-Weaving Flow Rate (v <sub>NW</sub> ), pc/h	5379	Density-Based Capacity (c <sub>DWL</sub> ), pc/h/ln		2021
Total Flow Rate (v), pc/h	8153	Demand Flow-Based Capacity (c <sub>DW</sub> ), pc/h		7059
Volume Ratio (VR)	0.340	Weaving Segment Capacity (c <sub>w</sub> ), veh/h		6889
Minimum Lane Change Rate (LC <sub>MIN</sub> ), lc/h	0	Adjusted Weaving Area Capacity (c <sub>wa</sub> ), veh/h		6889
Maximum Weaving Length (L <sub>MAX</sub> ), ft	6017	Volume-to-Capacity Ratio (v/c)		1.16

**Speed and Density**

Non-Weaving Vehicle Index (I <sub>NW</sub> )	-	Average Weaving Speed (S <sub>w</sub> ), mi/h	-
Non-Weaving Lane Change Rate (LC <sub>NW</sub> ), lc/h	-	Average Non-Weaving Speed (S <sub>NW</sub> ), mi/h	-
Weaving Lane Change Rate (LC <sub>w</sub> ), lc/h	-	Average Speed (S), mi/h	-
Total Lane Change Rate (LC <sub>ALL</sub> ), lc/h	-	Density (D), pc/mi/ln	-
Weaving Intensity Factor (W)	-	Level of Service (LOS)	F

## HCS7 Freeway Weaving Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Alternative 2 - Weaving Analysis - PM		

**Geometric Data**

Number of Lanes (N), ln	5	Segment Type	Freeway
Short Length (L <sub>s</sub> ), ft	1720	Number of Maneuver Lanes (N <sub>WL</sub> ), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC <sub>RF</sub> ), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC <sub>FR</sub> ), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC <sub>RR</sub> ), lc	0
Interchange Density (ID), int/mi	0.83	Cross Weaving Managed Lane	No

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

	FF	RF	RR	FR
Volume (V <sub>i</sub> ), veh/h	6595	945	0	1260
Peak Hour Factor (PHF)	1.00	1.00	1.00	1.00
Total Trucks, %	1.70	2.00	0.00	1.70
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.980	1.000	0.983
Flow Rate (v <sub>i</sub> ), pc/h	6709	964	0	1282
Weaving Flow Rate (v <sub>w</sub> ), pc/h	2246	Freeway Max Capacity (c <sub>FL</sub> ), pc/h/ln		2350
Non-Weaving Flow Rate (v <sub>NW</sub> ), pc/h	6709	Density-Based Capacity (c <sub>NWL</sub> ), pc/h/ln		2094
Total Flow Rate (v), pc/h	8955	Demand Flow-Based Capacity (c <sub>DW</sub> ), pc/h		9562
Volume Ratio (VR)	0.251	Weaving Segment Capacity (c <sub>w</sub> ), veh/h		9399
Minimum Lane Change Rate (LC <sub>MIN</sub> ), lc/h	2246	Adjusted Weaving Area Capacity (c <sub>wa</sub> ), veh/h		9399
Maximum Weaving Length (L <sub>MAX</sub> ), ft	5064	Volume-to-Capacity Ratio (v/c)		0.94

**Speed and Density**

Non-Weaving Vehicle Index (I <sub>NW</sub> )	958	Average Weaving Speed (S <sub>w</sub> ), mi/h	49.3
Non-Weaving Lane Change Rate (LC <sub>NW</sub> ), lc/h	1351	Average Non-Weaving Speed (S <sub>NW</sub> ), mi/h	40.2
Weaving Lane Change Rate (LC <sub>w</sub> ), lc/h	2842	Average Speed (S), mi/h	42.2
Total Lane Change Rate (LC <sub>ALL</sub> ), lc/h	4193	Density (D), pc/mi/ln	42.4
Weaving Intensity Factor (W)	0.457	Level of Service (LOS)	E

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Existing Conditions - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.83
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.2
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	7600	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1947
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2322
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2322
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.84
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	59.1
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	32.9
Total Ramp Density Adjustment	2.8	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.2		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Existing Conditions - Basic Freeway Segment - PM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.83
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.2
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	8800	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	2238
Total Trucks, %	1.70	Capacity (c), pc/h/ln	2322
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2322
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.96
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	53.7
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	41.7
Total Ramp Density Adjustment	2.8	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.2		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Existing Conditions - Diverge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	860	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7600	1100
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	2.50	1.70
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.983
Flow Rate (v <sub>i</sub> ), pc/h	7787	1119
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.83	0.59

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	33.5
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (D <sub>S</sub> )	0.594
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1881
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	51.3
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	67.9
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	4026	Ramp Junction Speed (S), mi/h	58.2
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	33.4
Level of Service (LOS)	D		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Existing Conditions - Diverge Analysis - PM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	860	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	8800	1200
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.70	1.70
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.983
Flow Rate (v <sub>i</sub> ), pc/h	8952	1221
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.95	0.64

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	38.3
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (D <sub>S</sub> )	0.603
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2180
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	51.1
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	66.7
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	4592	Ramp Junction Speed (S), mi/h	57.7
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	38.8
Level of Service (LOS)	E		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Existing Conditions - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	25.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	860	620
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	6100	1500
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.985
Flow Rate (v <sub>i</sub> ), pc/h	6250	1523
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.83	0.80

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	32.3
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	0.508
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1875
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	53.3
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.027	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	60.0
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	2500	Ramp Junction Speed (S), mi/h	56.3
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4023	Average Density (D), pc/mi/ln	34.5
Level of Service (LOS)	D		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Existing Conditions - Merge Analysis - PM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	25.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	860	620
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	8800	900
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.70	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.980
Flow Rate (v <sub>i</sub> ), pc/h	8952	918
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	1.05	0.48

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2686
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.103	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	56.2
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3581	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4499	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		



## HCS7 Freeway Weaving Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Existing Conditions - Weaving Analysis - AM		

**Geometric Data**

Number of Lanes (N), ln	5	Segment Type	Freeway
Short Length (L <sub>s</sub> ), ft	1720	Number of Maneuver Lanes (N <sub>WL</sub> ), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC <sub>RF</sub> ), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC <sub>FR</sub> ), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC <sub>RR</sub> ), lc	0
Interchange Density (ID), int/mi	0.83	Cross Weaving Managed Lane	No

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

	FF	RF	RR	FR
Volume (V <sub>i</sub> ), veh/h	5000	1500	0	1100
Peak Hour Factor (PHF)	1.00	1.00	1.00	1.00
Total Trucks, %	2.50	1.50	0.00	1.70
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.976	0.985	1.000	0.983
Flow Rate (v <sub>i</sub> ), pc/h	5123	1523	0	1119
Weaving Flow Rate (v <sub>w</sub> ), pc/h	2642	Freeway Max Capacity (c <sub>FL</sub> ), pc/h/ln		2350
Non-Weaving Flow Rate (v <sub>NW</sub> ), pc/h	5123	Density-Based Capacity (c <sub>DWL</sub> ), pc/h/ln		2021
Total Flow Rate (v), pc/h	7765	Demand Flow-Based Capacity (c <sub>DW</sub> ), pc/h		7059
Volume Ratio (VR)	0.340	Weaving Segment Capacity (c <sub>w</sub> ), veh/h		6889
Minimum Lane Change Rate (LC <sub>MIN</sub> ), lc/h	0	Adjusted Weaving Area Capacity (c <sub>wa</sub> ), veh/h		6889
Maximum Weaving Length (L <sub>MAX</sub> ), ft	6017	Volume-to-Capacity Ratio (v/c)		1.10

**Speed and Density**

Non-Weaving Vehicle Index (I <sub>NW</sub> )	-	Average Weaving Speed (S <sub>w</sub> ), mi/h	-
Non-Weaving Lane Change Rate (LC <sub>NW</sub> ), lc/h	-	Average Non-Weaving Speed (S <sub>NW</sub> ), mi/h	-
Weaving Lane Change Rate (LC <sub>w</sub> ), lc/h	-	Average Speed (S), mi/h	-
Total Lane Change Rate (LC <sub>ALL</sub> ), lc/h	-	Density (D), pc/mi/ln	-
Weaving Intensity Factor (W)	-	Level of Service (LOS)	F

**Managed Lane Geometric Data**

Managed Lane Type	Continuous Access	Free-Flow Speed (FFS), mi/h	75.4
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Number of Managed Lanes, ln	1	Terrain Type	Level
Managed Lane Length, ft	5280	Percent Grade, %	-
<b>Managed Lane Adjustment Factors</b>			
Driver Population	All Familiar	Driver Population CAF	1.000
Weather Type	Non-Severe Weather	Weather Type CAF	1.000
Driver Population SAF	1.000	Final Speed Adjustment Factor (SAF)	1.000
Weather Type SAF	1.000	Final Capacity Adjustment Factor (CAF)	1.000
Demand Adjustment Factor (DAF)	1.000		
<b>Managed Lane Demand and Capacity</b>			
Volume ( $V_{ML}$ ), veh/h	0	Heavy Vehicle Adjustment Factor ( $f_{HV}$ )	1.000
Peak Hour Factor	0.94	Flow Rate ( $V_{p,ML}$ ), pc/h/ln	0
Total Trucks, %	0.00	Capacity (c), pc/h/ln	1804
Single-Unit Trucks (SUT), %	-	Adjusted Capacity ( $c_{adj}$ ), pc/h/ln	1804
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.00
Passenger Car Equivalent ( $E_T$ )	2.000		
<b>Managed Lane Speed and Density</b>			
Breakpoint ( $BP_{ML}$ )	501	Indicator Variable	0
Speed 1 ( $S_1$ ), mi/h	75.4	Average Speed ( $S_{ML}$ ), mi/h	75.4
Speed 2 ( $S_2$ ), mi/h	0.0	Density ( $D_{ML}$ ), pc/mi/ln	0.0
Speed 2 ( $S_3$ ), mi/h	0.0	Level of Service (LOS)	A

## HCS7 Freeway Weaving Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 1 - I-95 NB - Existing Conditions - Weaving Analysis - PM		

**Geometric Data**

Number of Lanes (N), ln	5	Segment Type	Freeway
Short Length (L <sub>s</sub> ), ft	1720	Number of Maneuver Lanes (N <sub>WL</sub> ), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC <sub>RF</sub> ), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC <sub>FR</sub> ), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC <sub>RR</sub> ), lc	0
Interchange Density (ID), int/mi	0.83	Cross Weaving Managed Lane	No

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

	FF	RF	RR	FR
Volume (V <sub>i</sub> ), veh/h	6700	900	0	1200
Peak Hour Factor (PHF)	1.00	1.00	1.00	1.00
Total Trucks, %	1.70	2.00	0.00	1.70
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.983	0.980	1.000	0.983
Flow Rate (v <sub>i</sub> ), pc/h	6816	918	0	1221
Weaving Flow Rate (v <sub>w</sub> ), pc/h	2139	Freeway Max Capacity (c <sub>FL</sub> ), pc/h/ln		2350
Non-Weaving Flow Rate (v <sub>NW</sub> ), pc/h	6816	Density-Based Capacity (c <sub>NWL</sub> ), pc/h/ln		2104
Total Flow Rate (v), pc/h	8955	Demand Flow-Based Capacity (c <sub>DW</sub> ), pc/h		10042
Volume Ratio (VR)	0.239	Weaving Segment Capacity (c <sub>w</sub> ), veh/h		9871
Minimum Lane Change Rate (LC <sub>MIN</sub> ), lc/h	2139	Adjusted Weaving Area Capacity (c <sub>wa</sub> ), veh/h		9871
Maximum Weaving Length (L <sub>MAX</sub> ), ft	4939	Volume-to-Capacity Ratio (v/c)		0.89

**Speed and Density**

Non-Weaving Vehicle Index (I <sub>NW</sub> )	973	Average Weaving Speed (S <sub>w</sub> ), mi/h	49.5
Non-Weaving Lane Change Rate (LC <sub>NW</sub> ), lc/h	1373	Average Non-Weaving Speed (S <sub>NW</sub> ), mi/h	41.0
Weaving Lane Change Rate (LC <sub>w</sub> ), lc/h	2735	Average Speed (S), mi/h	42.8
Total Lane Change Rate (LC <sub>ALL</sub> ), lc/h	4108	Density (D), pc/mi/ln	41.8
Weaving Intensity Factor (W)	0.449	Level of Service (LOS)	E

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - 2030 No Build - Diverge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	1240
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7875	2205
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	3.40	3.40
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967	0.967
Flow Rate (v <sub>i</sub> ), pc/h	8144	2280
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.87	1.20

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (D <sub>S</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1654
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	10000	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	68.8
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	4837	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - 2030 No Build - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	35.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1100
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7718	158
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	3.40	10.90
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967	0.902
Flow Rate (v <sub>i</sub> ), pc/h	7981	175
Capacity (c), pc/h	9400	2000
Volume-to-Capacity Ratio (v/c)	0.87	0.09

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	24.8
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	0.357
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2395
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	56.8
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.196	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	57.9
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3192	Ramp Junction Speed (S), mi/h	57.4
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	3367	Average Density (D), pc/mi/ln	35.5
Level of Service (LOS)	C		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - Alternative 1 - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	5	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.83
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.2
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	7875	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1629
Total Trucks, %	3.40	Capacity (c), pc/h/ln	2322
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2322
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.70
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	62.0
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	26.3
Total Ramp Density Adjustment	2.8	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.2		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - Alternative 1 - Diverge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7875	2205
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	3.40	3.40
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967	0.967
Flow Rate (v <sub>i</sub> ), pc/h	8144	2280
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.87	1.20

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (D <sub>S</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1654
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	10000	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	68.8
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	4837	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - Alternative 1 - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	35.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7718	158
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	3.40	10.90
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967	0.902
Flow Rate (v <sub>i</sub> ), pc/h	7981	175
Capacity (c), pc/h	9400	2000
Volume-to-Capacity Ratio (v/c)	0.87	0.09

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	22.3
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	0.329
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2395
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	57.4
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.196	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	57.9
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3192	Ramp Junction Speed (S), mi/h	57.7
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	3367	Average Density (D), pc/mi/ln	35.3
Level of Service (LOS)	C		



## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - Alternative 3 - Basic Freeway Segment 2 (After 37B) - AM		

**Geometric Data**

Number of Lanes (N), ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.83
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.2
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	5880	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	2027
Total Trucks, %	3.40	Capacity (c), pc/h/ln	2322
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2322
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.87
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	57.9
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	35.0
Total Ramp Density Adjustment	2.8	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.2		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - Alternative 3 - Diverge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	2
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	3980
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7875	2205
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	3.40	3.40
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967	0.967
Flow Rate (v <sub>i</sub> ), pc/h	8144	2280
Capacity (c), pc/h	9400	3800
Volume-to-Capacity Ratio (v/c)	0.87	0.60

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	1.2
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (D <sub>S</sub> )	0.698
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2170
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	10000	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	48.9
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.260	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	66.7
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3805	Ramp Junction Speed (S), mi/h	57.0
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	35.7
Level of Service (LOS)	A		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - Existing Conditions - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.83
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.2
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	7500	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1939
Total Trucks, %	3.40	Capacity (c), pc/h/ln	2322
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2322
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.84
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	59.3
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	32.7
Total Ramp Density Adjustment	2.8	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.2		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - Existing Conditions - Diverge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	1240
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7500	2100
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	3.40	3.40
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967	0.967
Flow Rate (v <sub>i</sub> ), pc/h	7756	2172
Capacity (c), pc/h	9400	1900
Volume-to-Capacity Ratio (v/c)	0.83	1.14

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (D <sub>S</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1575
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	10000	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	69.1
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	4607	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-93 SB - Existing Conditions - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	65.0	35.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1100
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7350	150
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	3.40	10.90
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.967	0.902
Flow Rate (v <sub>i</sub> ), pc/h	7601	166
Capacity (c), pc/h	9400	2000
Volume-to-Capacity Ratio (v/c)	0.83	0.08

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	23.6
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	10000	Speed Index (M <sub>s</sub> )	0.340
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	2281
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	57.2
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.197	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	58.6
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3040	Ramp Junction Speed (S), mi/h	58.0
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	3206	Average Density (D), pc/mi/ln	33.5
Level of Service (LOS)	C		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	8/30/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - 2030 No Build - Basic Freeway Segment 2 (Before 36) - AM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	55.0	Total Ramp Density (TRD), ramps/mi	1.17
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	51.3
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	6930	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1746
Total Trucks, %	0.80	Capacity (c), pc/h/ln	2213
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2213
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.79
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	51.3
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	34.0
Total Ramp Density Adjustment	3.7	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	51.3		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - 2030 No Build - Diverge Analysis (Commerce) - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	485
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	6930	630
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	0.80	0.80
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992	0.992
Flow Rate (v <sub>i</sub> ), pc/h	6986	635
Capacity (c), pc/h	8400	1900
Volume-to-Capacity Ratio (v/c)	0.83	0.33

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	29.2
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (D <sub>S</sub> )	0.550
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1791
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	47.8
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	57.3
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3404	Ramp Junction Speed (S), mi/h	52.2
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	33.5
Level of Service (LOS)	D		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	8/30/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - 2030 No Build - Merge Analysis (Commerce) - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	730
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	6300	1260
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	0.80	3.80
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992	0.963
Flow Rate (v <sub>i</sub> ), pc/h	6351	1308
Capacity (c), pc/h	9000	1900
Volume-to-Capacity Ratio (v/c)	0.85	0.69

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	30.4
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (M <sub>s</sub> )	0.460
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1906
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	49.0
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.054	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	49.9
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	2540	Ramp Junction Speed (S), mi/h	49.4
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	3848	Average Density (D), pc/mi/ln	38.8
Level of Service (LOS)	D		



## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	8/30/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - 2030 No Build - Merge Analysis (I-93) - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	4725	2205
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	0.80	0.80
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992	0.992
Flow Rate (v <sub>i</sub> ), pc/h	4763	2223
Capacity (c), pc/h	9000	1900
Volume-to-Capacity Ratio (v/c)	0.78	1.17

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (M <sub>s</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1429
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.000	Outer Lanes Freeway Speed (S <sub>o</sub> ), mi/h	51.7
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	1905	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4128	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

## HCS7 Freeway Weaving Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - 2030 No Build - Weaving Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	5	Segment Type	Freeway
Short Length (L <sub>s</sub> ), ft	1450	Number of Maneuver Lanes (N <sub>WL</sub> ), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC <sub>RF</sub> ), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC <sub>FR</sub> ), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC <sub>RR</sub> ), lc	0
Interchange Density (ID), int/mi	1.17	Cross Weaving Managed Lane	No

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

	FF	RF	RR	FR
Volume (V <sub>i</sub> ), veh/h	4095	2205	0	630
Peak Hour Factor (PHF)	1.00	1.00	1.00	1.00
Total Trucks, %	0.80	0.80	0.00	0.80
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992	0.992	1.000	0.992
Flow Rate (v <sub>i</sub> ), pc/h	4128	2223	0	635
Weaving Flow Rate (v <sub>w</sub> ), pc/h	2858	Freeway Max Capacity (c <sub>FL</sub> ), pc/h/ln		2250
Non-Weaving Flow Rate (v <sub>NW</sub> ), pc/h	4128	Density-Based Capacity (c <sub>DWL</sub> ), pc/h/ln		1842
Total Flow Rate (v), pc/h	6986	Demand Flow-Based Capacity (c <sub>DW</sub> ), pc/h		5868
Volume Ratio (VR)	0.409	Weaving Segment Capacity (c <sub>w</sub> ), veh/h		5821
Minimum Lane Change Rate (LC <sub>MIN</sub> ), lc/h	0	Adjusted Weaving Area Capacity (c <sub>wa</sub> ), veh/h		5821
Maximum Weaving Length (L <sub>MAX</sub> ), ft	6782	Volume-to-Capacity Ratio (v/c)		1.19

**Speed and Density**

Non-Weaving Vehicle Index (I <sub>NW</sub> )	-	Average Weaving Speed (S <sub>w</sub> ), mi/h	-
Non-Weaving Lane Change Rate (LC <sub>NW</sub> ), lc/h	-	Average Non-Weaving Speed (S <sub>NW</sub> ), mi/h	-
Weaving Lane Change Rate (LC <sub>w</sub> ), lc/h	-	Average Speed (S), mi/h	-
Total Lane Change Rate (LC <sub>ALL</sub> ), lc/h	-	Density (D), pc/mi/ln	-
Weaving Intensity Factor (W)	-	Level of Service (LOS)	F

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	8/30/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - Alternative 2 - Merge Analysis (Commerce) - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1230
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	6300	1260
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	0.80	3.80
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992	0.963
Flow Rate (v <sub>i</sub> ), pc/h	6351	1308
Capacity (c), pc/h	9000	1900
Volume-to-Capacity Ratio (v/c)	0.85	0.69

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	27.2
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (M <sub>s</sub> )	0.430
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1906
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	49.4
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.054	Outer Lanes Freeway Speed (S <sub>o</sub> ), mi/h	49.9
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	2540	Ramp Junction Speed (S), mi/h	49.6
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	3848	Average Density (D), pc/mi/ln	38.6
Level of Service (LOS)	C		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	8/30/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - Alternative 3 - Basic Freeway Segment 2 (Before 36) - AM		

**Geometric Data**

Number of Lanes (N), ln	5	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	55.0	Total Ramp Density (TRD), ramps/mi	1.17
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	50.7
Right-Side Lateral Clearance, ft	0		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	6930	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1397
Total Trucks, %	0.80	Capacity (c), pc/h/ln	2207
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2207
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.63
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	50.7
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.6	Density (D), pc/mi/ln	27.6
Total Ramp Density Adjustment	3.7	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	50.7		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - Alternative 3 - Diverge Analysis (Commerce) - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Highway/CD Roadway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7277	662
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	0.80	0.80
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992	0.992
Flow Rate (v <sub>i</sub> ), pc/h	7336	667
Capacity (c), pc/h	8400	1900
Volume-to-Capacity Ratio (v/c)	0.87	0.35

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	21.5
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (D <sub>s</sub> )	0.553
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1881
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	47.8
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.436	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	56.9
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3575	Ramp Junction Speed (S), mi/h	52.1
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	35.2
Level of Service (LOS)	C		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	8/30/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - Alternative 3 - Merge Analysis (I-93) - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	2
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	4500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	4725	2205
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	0.80	0.80
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992	0.992
Flow Rate (v <sub>i</sub> ), pc/h	4763	2223
Capacity (c), pc/h	9000	3800
Volume-to-Capacity Ratio (v/c)	0.78	0.59

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	8.5
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (M <sub>s</sub> )	0.293
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1429
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	51.2
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.209	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	51.7
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	1905	Ramp Junction Speed (S), mi/h	51.4
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	4128	Average Density (D), pc/mi/ln	34.0
Level of Service (LOS)	A		

## HCS7 Freeway Weaving Report

**Project Information**

Analyst		Date	9/1/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - Alternative 3 - Weaving Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	5	Segment Type	Freeway
Short Length (L <sub>s</sub> ), ft	1450	Number of Maneuver Lanes (N <sub>WL</sub> ), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC <sub>RF</sub> ), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC <sub>FR</sub> ), lc	2
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC <sub>RR</sub> ), lc	0
Interchange Density (ID), int/mi	1.17	Cross Weaving Managed Lane	No

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

	FF	RF	RR	FR
Volume (V <sub>i</sub> ), veh/h	4095	2205	0	630
Peak Hour Factor (PHF)	1.00	1.00	1.00	1.00
Total Trucks, %	0.80	0.80	0.00	0.80
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992	0.992	1.000	0.992
Flow Rate (v <sub>i</sub> ), pc/h	4128	2223	0	635
Weaving Flow Rate (v <sub>w</sub> ), pc/h	2858	Freeway Max Capacity (c <sub>FL</sub> ), pc/h/ln		2250
Non-Weaving Flow Rate (v <sub>NW</sub> ), pc/h	4128	Density-Based Capacity (c <sub>DWL</sub> ), pc/h/ln		1842
Total Flow Rate (v), pc/h	6986	Demand Flow-Based Capacity (c <sub>DW</sub> ), pc/h		5868
Volume Ratio (VR)	0.409	Weaving Segment Capacity (c <sub>w</sub> ), veh/h		5821
Minimum Lane Change Rate (LC <sub>MIN</sub> ), lc/h	0	Adjusted Weaving Area Capacity (c <sub>wa</sub> ), veh/h		5821
Maximum Weaving Length (L <sub>MAX</sub> ), ft	6782	Volume-to-Capacity Ratio (v/c)		1.19

**Speed and Density**

Non-Weaving Vehicle Index (I <sub>NW</sub> )	-	Average Weaving Speed (S <sub>w</sub> ), mi/h	-
Non-Weaving Lane Change Rate (LC <sub>NW</sub> ), lc/h	-	Average Non-Weaving Speed (S <sub>NW</sub> ), mi/h	-
Weaving Lane Change Rate (LC <sub>w</sub> ), lc/h	-	Average Speed (S), mi/h	-
Total Lane Change Rate (LC <sub>ALL</sub> ), lc/h	-	Density (D), pc/mi/ln	-
Weaving Intensity Factor (W)	-	Level of Service (LOS)	F

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	8/30/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 2 - I-95 SB - Existing Conditions - Merge Analysis (I-93) - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	55.0	30.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	4500	2100
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	0.80	0.80
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.992	0.992
Flow Rate (v <sub>i</sub> ), pc/h	4536	2117
Capacity (c), pc/h	9000	1900
Volume-to-Capacity Ratio (v/c)	0.74	1.11

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (M <sub>s</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1361
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FM</sub> )	0.000	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	51.9
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	1814	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	3931	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		



## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/11/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 3 - I-93 SB - 2030 No Build - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	55.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	51.8
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	7245	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.982
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1844
Total Trucks, %	1.80	Capacity (c), pc/h/ln	2218
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2218
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.83
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	51.8
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	35.6
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	51.8		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/11/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 3 - I-93 SB - 2030 No Build - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	55.0	50.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1000
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Left

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	4830	2415
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.80	5.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.982	0.948
Flow Rate (v <sub>i</sub> ), pc/h	4919	2547
Capacity (c), pc/h	9000	2100
Volume-to-Capacity Ratio (v/c)	0.83	1.21

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (M <sub>s</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1476
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 3 and 4 (P <sub>FM</sub> )	0.000	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	51.5
Flow in Lanes 3 and 4 (v <sub>34</sub> ), pc/h	1968	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R34</sub> ), pc/h	4515	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/11/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 3 - I-93 SB - Alternative 3 - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	2
Free-Flow Speed (FFS), mi/h	55.0	50.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	3000	3500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Left

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	4830	2415
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.80	5.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.982	0.948
Flow Rate (v <sub>i</sub> ), pc/h	4919	2547
Capacity (c), pc/h	9000	4200
Volume-to-Capacity Ratio (v/c)	0.83	0.61

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	17.6
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (M <sub>s</sub> )	0.327
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1476
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	50.7
Prop. Freeway Vehicles in Lane 3 and 4 (P <sub>FM</sub> )	0.209	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	51.5
Flow in Lanes 3 and 4 (v <sub>34</sub> ), pc/h	1968	Ramp Junction Speed (S), mi/h	51.0
Flow Entering Ramp-Infl. Area (v <sub>R34</sub> ), pc/h	4515	Average Density (D), pc/mi/ln	36.6
Level of Service (LOS)	B		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/11/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 3 - I-93 SB - Existing Conditions - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	55.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	51.8
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	6900	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.982
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1756
Total Trucks, %	1.80	Capacity (c), pc/h/ln	2218
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2218
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.79
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	51.8
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	33.9
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	51.8		

## HCS7 Freeway Merge Report

**Project Information**

Analyst		Date	9/11/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 3 - I-93 SB - Existing Conditions - Merge Analysis - AM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	1
Free-Flow Speed (FFS), mi/h	55.0	50.0
Segment Length (L) / Acceleration Length (L <sub>A</sub> ), ft	1500	1500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Left

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	4600	2300
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.80	5.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.982	0.948
Flow Rate (v <sub>i</sub> ), pc/h	4684	2426
Capacity (c), pc/h	9000	2100
Volume-to-Capacity Ratio (v/c)	0.79	1.16

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	-
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (M <sub>s</sub> )	-
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1405
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	On-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	-
Prop. Freeway Vehicles in Lane 3 and 4 (P <sub>FM</sub> )	0.000	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	51.7
Flow in Lanes 3 and 4 (v <sub>34</sub> ), pc/h	1874	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (v <sub>R34</sub> ), pc/h	4300	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 3 - Route 24 NB - 2030 No Build - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.67
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.7
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	4830	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.948
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1698
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2327
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2327
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.73
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	62.0
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	27.4
Total Ramp Density Adjustment	2.3	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.7		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 3 - Route 24 NB - Alternative 1 & 2 - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.67
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	61.5
Right-Side Lateral Clearance, ft	0		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	4830	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.948
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1274
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2315
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2315
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.55
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	61.5
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	1.2	Density (D), pc/mi/ln	20.7
Total Ramp Density Adjustment	2.3	Level of Service (LOS)	C
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	61.5		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 3 - Route 24 NB - Existing Conditions - Basic Freeway Segment - AM		

**Geometric Data**

Number of Lanes (N), ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.67
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.7
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	4600	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.948
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1617
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2327
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2327
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.70
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	62.5
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	25.9
Total Ramp Density Adjustment	2.3	Level of Service (LOS)	C
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.7		



## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/13/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 4 - I-93 NB - Existing Conditions - Diverge Analysis - PM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	2
Free-Flow Speed (FFS), mi/h	55.0	50.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	2500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Right

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	6600	2700
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	4.20	0.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.960	0.995
Flow Rate (v <sub>i</sub> ), pc/h	6875	2714
Capacity (c), pc/h	9000	4200
Volume-to-Capacity Ratio (v/c)	0.76	0.65

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	14.4
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (D <sub>s</sub> )	0.477
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1540
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	48.8
Prop. Freeway Vehicles in Lane 1 and 2 (P <sub>FD</sub> )	0.260	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	58.2
Flow in Lanes 1 and 2 (v <sub>12</sub> ), pc/h	3796	Ramp Junction Speed (S), mi/h	52.6
Flow Entering Ramp-Infl. Area (v <sub>R12</sub> ), pc/h	-	Average Density (D), pc/mi/ln	32.7
Level of Service (LOS)	B		

## HCS7 Freeway Diverge Report

**Project Information**

Analyst		Date	9/13/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 4 - I-93 SB - Existing Conditions - Diverge Analysis - PM		

**Geometric Data**

	Freeway	Ramp
Number of Lanes (N)	4	2
Free-Flow Speed (FFS), mi/h	55.0	50.0
Segment Length (L) / Deceleration Length (L <sub>D</sub> ), ft	1500	2500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Side	Freeway	Left

**Adjustment Factors**

Driver Population	All Familiar	All Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	1.000	1.000
Final Capacity Adjustment Factor (CAF)	1.000	1.000
Demand Adjustment Factor (DAF)	1.000	1.000

**Demand and Capacity**

Volume (V <sub>i</sub> ), veh/h	7800	2600
Peak Hour Factor (PHF)	1.00	1.00
Total Trucks, %	1.80	0.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.982	0.995
Flow Rate (v <sub>i</sub> ), pc/h	7943	2613
Capacity (c), pc/h	9000	4200
Volume-to-Capacity Ratio (v/c)	0.88	0.62

**Speed and Density**

Upstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Density in Ramp Influence Area (D <sub>R</sub> ), pc/mi/ln	19.6
Distance to Upstream Ramp (L <sub>UP</sub> ), ft	-	Speed Index (D <sub>s</sub> )	0.468
Downstream Equilibrium Distance (L <sub>EQ</sub> ), ft	-	Flow Outer Lanes (v <sub>OA</sub> ), pc/h/ln	1772
Distance to Downstream Ramp (L <sub>DOWN</sub> ), ft	-	Off-Ramp Influence Area Speed (S <sub>R</sub> ), mi/h	48.9
Prop. Freeway Vehicles in Lane 3 and 4 (P <sub>FD</sub> )	0.260	Outer Lanes Freeway Speed (S <sub>O</sub> ), mi/h	57.3
Flow in Lanes 3 and 4 (v <sub>34</sub> ), pc/h	4399	Ramp Junction Speed (S), mi/h	52.3
Flow Entering Ramp-Infl. Area (v <sub>R34</sub> ), pc/h	-	Average Density (D), pc/mi/ln	38.0
Level of Service (LOS)	B		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 4 - Route 24 SB - 2030 No Build - Basic Freeway Segment - PM		

**Geometric Data**

Number of Lanes (N), ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.67
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.7
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	5565	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.997
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1861
Total Trucks, %	0.30	Capacity (c), pc/h/ln	2327
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2327
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.80
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	60.6
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	30.7
Total Ramp Density Adjustment	2.3	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.7		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 4 - Route 24 SB - Alternative 1 - Basic Freeway Segment - PM		

**Geometric Data**

Number of Lanes (N), ln	4	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.67
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	61.5
Right-Side Lateral Clearance, ft	0		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	5565	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.997
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1396
Total Trucks, %	0.30	Capacity (c), pc/h/ln	2315
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2315
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.60
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	61.5
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	1.2	Density (D), pc/mi/ln	22.7
Total Ramp Density Adjustment	2.3	Level of Service (LOS)	C
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	61.5		

## HCS7 Basic Freeway Report

**Project Information**

Analyst		Date	9/6/2017
Agency		Analysis Year	2017
Jurisdiction		Time Period Analyzed	
Project Description	Location 4 - Route 24 SB - Existing Conditions - Basic Freeway Segment - PM		

**Geometric Data**

Number of Lanes (N), ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	65.0	Total Ramp Density (TRD), ramps/mi	0.67
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	62.7
Right-Side Lateral Clearance, ft	10		

**Adjustment Factors**

Driver Population	All Familiar	Final Speed Adjustment Factor (SAF)	1.000
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	1.000
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

**Demand and Capacity**

Volume (V), veh/h	5300	Heavy Vehicle Adjustment Factor (f <sub>HV</sub> )	0.997
Peak Hour Factor (PHF)	1.00	Flow Rate (v <sub>p</sub> ), pc/h/ln	1772
Total Trucks, %	0.30	Capacity (c), pc/h/ln	2327
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c <sub>adj</sub> ), pc/h/ln	2327
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.76
Passenger Car Equivalent (E <sub>T</sub> )	2.000		

**Speed and Density**

Lane Width Adjustment (f <sub>LW</sub> )	0.0	Average Speed (S), mi/h	61.5
Right-Side Lateral Clearance Adj. (f <sub>RLC</sub> )	0.0	Density (D), pc/mi/ln	28.8
Total Ramp Density Adjustment	2.3	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS <sub>adj</sub> ), mi/h	62.7		