I-87/ US 9 Integrated Corridor Management Plan

Final Report

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CDTC
CAPITAL DISTRICT TRANSPORTATION COMMITTEE

New York State Department of Transportation

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DISCLAIMER

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16. Abstract: This study evaluates the potentiality of developing an integrated freeway / arterial corridor plan to improve overall operations of I-87 and US 9 (parallel arterial) by improving the methodology of addressing recurring and non-recurring delays (including incident management) within the corridor between Exits 2 and 15. The output includes the following: a data mining tool that can easily extract incident information from NYSDOT's MIST system; a Traffic Performance Profile for I-87 and US 9; an Incident Profile for I-87, with recommendations for improving the region's incident management program; traffic operations recommendations; discussion of a Access Management Plan on US 9 and land use recommendations; a calibrated VISSIM model to test and evaluate differing traffic diversion strategies, specifically looking at the impact on local transportation facilities; and strategic capital actions (with start-up and operating costs) required to improve operations on I-87 and make US 9 and other surface arterials effective diversion routes.

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Preface

The Capital District Transportation Committee (CDTC) and the New York State Department of Transportation (NYSDOT) co-sponsored the development of this Integrated Corridor Management Plan (ICMP) for the I-87/US 9 Corridor within the Capital District region.

This study was funded utilizing Federal Highway Administration (FHWA) State Planning and Research (SPR) funds, with the desired project output being:

> *The development of an integrated freeway / arterial corridor plan to improve overall operations of I-87 and US 9 (parallel arterial) by better handling recurring and non-recurring delays (including incident management) within the corridor between Exits 2 and 15.*

To that end, the output was expected to include the following:

- A data mining tool that can be used to easily extract incident information from NYSDOT's MIST system (see Appendix A).
- An integrated I-87 and US 9 Corridor Plan, that includes:
- Traffic performance profile for I-87 and US 9;
    - I-87 Incident Profile and recommendations for improving the region's incident management program;
    - Traffic operations recommendations;
    - US 9 Access Management Plan (with more detail in identified sections) and land use recommendations;
    - A conceptual transit infrastructure plan;
    - A calibrated VISSIM model (or other software model that can easily be converted to VISSIM) that can be used to test and evaluate different traffic diversion strategies, specifically to measure the impact on local transportation facilities; and,
    - Strategic capital actions (with start-up and operating costs) required to make US 9 and other surface arterials effective diversion routes.

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Data Fusion Engine (DFE) Selected Priorities Applied to Evaluated Links (SPATEL)
NYSDOT recently had TRANSCOM (a coalition of 16 transportation and public safety agencies in the New York, New Jersey, and Connecticut metropolitan region created in 1986 to provide a cooperative, coordinated approach to regional transportation management) make their Data Fusion Engine (DFE) Selected Priorities Applied to Evaluated Links (SPATEL) web based data analysis tool available to NYSDOT. There is not an explicit cost incurred by NYSDOT for using SPATEL, access is obtained as NYSDOT is a paying member of the TRANSCOM Coalition.

DFE/SPATEL is a tool for both Operations and Planning that allows for the analysis of transportation system performance. It lets organizations examine current (real time) and historical regional conditions (travel time and volume), the impact of events on traffic, and view a breakdown of various indices (i.e. Planning Time, Buffer, Travel Time, etc.).

SPATEL uses NAVTEQ data which is a mix of probe data collected, approximately 60% passenger vehicles and 40% commercial vehicles, but can still vary month to month. SPATEL also pulls in detector data (at this point there are a few select Regions, including Region 1, feeding detector data to SPATEL).

The final MAP 21 rule making on Performance Measures is due Fall 2015. Until then, it is anticipated that SPATEL will help NYSDOT compile data for the final Performance Measures. To facilitate that, the Office of Traffic Safety & Mobility thought it would be good to select some corridors and begin to draft a proof of concept/prototype of the various indices, examine the impact of incidents, etc. This exercise would allow NYSDOT the opportunity to become comfortable with the tools available and permit NYSDOT to be prepared for implementation of MAP 21.

NYSDOT has allocated staff to develop the proof of concept. In addition to evaluating facilities downstate (on Long Island and in New York City), NYSDOT is planning to examine travel time on the parallel I-87 and US 9 corridors in the Capital District Area. Travel time trip analysis on I-87 includes:

Origin	**Destination**
US 20 (Western Ave)	Glens Falls
US 20 (Western Ave)	Exit 4
US 20 (Western Ave)	Exit 6
US 20 (Western Ave)	Exit 7
Exit 7	Exit 10
Exit 10	Exit 15
Exit 15	Exit 18

Travel time trip analysis on US 9 includes:

Origin	**Destination**
Route 155 (Latham)	Route 146 (Clifton Park)
Route 146 (Clifton Park)	Broadway (Saratoga)

While NYSDOT is interested in the SPATEL analysis and reporting functions, as it is thought to be a useful tool for ICMS development, it is unclear how this information would be strategically used in the development of an Integrated Corridor Management System. Further, it is thought that it may be best not to rely solely on SPATEL for US 9 traffic data and to continue considering the use of other types of readers along US 9 (once the US 9 trip is added to SPATEL, NYSDOT will be able to examine the 'richness' of the data and have an enhanced understanding of the coverage on US 9).

NOTE: While a considerable effort has been applied to this study, a considerable amount of work still remains before any of the concepts proposed within this study can be advanced to the construction phase. The recommendations set forth in this report are conceptual in nature and do not commit the NYSDOT and/or CDTC, or any of the municipalities within the study area to funding any of the improvements. The concepts need to be investigated in more detail before any financial commitment can be made.

Executive Summary

ES.1 Existing Conditions

The I-87/US 9 Integrated Corridor Management Plan (ICMP) addresses I-87 and US 9 between I-87 Exits 2 and 15, where the two roadways generally run parallel to each other. This is referenced as the study corridor. Integrated Corridor Management (ICM) traffic analyses and modeling focused on the most congested corridor between Exits 2 and 10. The study also includes the connecting roadways between I-87 and US 9.

I-87 is a vital interstate route supporting regional commerce and tourism while also serving as the primary commuter route between Saratoga and Albany Counties. I-87 also serves the Capital District Transportation Authority's (CDTA) successful Northway Xpress (NX) route. US 9, parallel to I-87, provides access to local land uses and also serves commuter traffic, though the trips are generally shorter than those on I-87. During the morning commuter peak, approximately 65% of traffic in the study corridor travels south into Albany County. This trend is reversed during the afternoon when workers are travelling home to/through Saratoga County.

Data indicates that I-87 is one of the most congested roadways in the Capital District. This congestion can be characterized as recurring congestion related to ambient roadway conditions such as delays at the Thaddeus Kosciuszko Bridge (also known as the Twin Bridges), and non-recurring congestion related to incidents. Non-recurring delay is often more significant to drivers because it affects the reliability of their travel. The worst periods of congestion typically occur on Friday evenings in the summer when peak commuter traffic on I-87 is mixed with summer vacation travel.

I-87's capacity (i.e., number of vehicles per hour that can be accommodated at an acceptable level of service) is generally limited by the number of lanes on the roadway. (Traffic capacity and level of service are also affected by vehicle mix, roadway design, pavement conditions, weather and other factors). During the typical commuter time periods, I-87 operates at capacity with significant levels of congestion and delay, southbound in the morning peak, and northbound in the evening peak. In general, the off peak direction operates well. I-87 delays regularly spill over to connecting and parallel roadways, particularly US 9.

Forecasts show that, unless corrective actions are taken, congestion and delays will continue to worsen throughout the I-87/US 9 corridor as the Capital District's population and employment opportunities grow. Given current fiscal conditions, right-of-way constraints, and environmental concerns, there are currently no plans to increase the number of general purpose travel lanes on I-87.

ES.2 Integrated Corridor Management Plans

Implementation of ICM is proposed to improve the movement of people and goods in the I-87/US 9 corridor. ICM would enable the New York State Department of Transportation (NYSDOT) to optimize use of available transportation infrastructure by directing travelers to underutilized capacity in a corridor. Strategies could include motorists shifting their trip departure times, routes, or modes, and/or NYSDOT dynamically adjusting capacity on I-87 by adjusting traffic signal timings to accommodate demand fluctuations.

In addition, access management and smart growth strategies are proposed for the US 9 corridor. Access management is the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway. Good access management provides a safe operating system for all users while balancing the function of the roadway with the access needs of the adjacent land uses.

Access management strategies include limiting and consolidating access while promoting a supporting street system for development. This would be accomplished through changes in site design and roadway design. Smart development, or transit oriented development (TOD), would promote transit use through the development of compact, walkable, mixed use communities along US 9.

ES.3 Phased Implementation Plan

The proposed I-87/US 9 ICM Plan is intended to optimize traffic operations on I-87 and US 9 from Exit 2 to Exit 13. ICM strategies were selected for implementation based on a review of existing corridor operational problems, current installed Intelligent Transportation System (ITS) elements, and traffic operations center (TOC) capabilities. Proposed elements were selected based on their potential operational benefits without consideration of cost. No funding has been identified for these elements. A phased implementation program has been developed based on stakeholder input, logical bundling of the strategies, and constructability.

Short term deployment would consist of the provision of a Bluetooth network on I-87 and US 9 and connecting facilities for detection and travel time data collection. Detectors would be installed at 16 links (see Table ES-1) on I-87 between Exits 2 and 10 and on US 9 and connecting facilities in both directions, with travel time data fed to the traffic operations center for analysis and dissemination. Estimated short-term deployment costs are approximately $480,000 with annual operating/ maintenance costs of $96,000 (2015 dollars). The estimated capital cost includes 5 years of cellular monthly charge. Solar powered units with cellular communications links are assumed to contain costs. A more permanent installation with power and hard wire communications would increase installation costs significantly due to the construction costs associated with installing infrastructure along the entire length. There is an existing communications line along US 9 between NYS Route 236 and old NYS Route 146 that is currently used for traffic signal coordination. This line is connected to the internet at three points and could be used for Bluetooth readers if surplus bandwidth can be used. There may be some cost savings that could be realized from using this communication line, however, often times connection costs (i.e., conduit and cabinets) can be expensive. Using the hard line would eliminate the recurring cost aspect of the estimate.

Table ES-1. Proposed Links for Detector Installation

Road Segment
I-87 Main Lanes in both directions
NYS Route 5 (Central Avenue) to NYS Route 155 (Shaker Road), Exit 2 to Exit 4
NYS Route 155 (Shaker Road) to Watervliet Shaker Road, Exit 4 to Exit 5
Watervliet Shaker Road to NYS Route 2 (Troy Schenectady Road), Exit 5 to Exit 6
NYS Route 2 (Troy Schenectady Road) to NYS Route 7
NYS Route 7 to the Twin Bridges
Twin Bridges to County Road 92 (Crescent Road)
Road 92 (Crescent Road) to County Road 91 (Grooms Road)
County Road 91 (Grooms Road) to Route 146
NYS Route 146 to Ushers Road (Exit 10)
US 9 arterial and connecting facilities in both directions
I-87 to Watervliet Shaker Road, to US 9, to NYS Route 7, to I-87
I-87 to NYS Route 7, to Crescent Road, to I-87
I-87 to Crescent Road to US 9 to Grooms Road to I-87
I-87 to Grooms Road to US 9 to Route 146 to I-87
I-87 to NYS Route 146, to US 9, to NYS Route 67, to I-87
I-87 to NYS Route 67, to US 9, to I-87 (at Exit 13)

Medium term deployment would build upon existing I-87 corridor ITS assets including the Bluetooth network and 511 systems. Medium term improvements would include extension of the existing ITS program (to complement existing cameras at Exits 8, 9, and 13), including the communications backbone, closed circuit television (CCTV), and variable message signs (VMS) for approximately 14.5 miles on I-87 between Exits 8 and 13 to extend the current NYSDOT congestion and incident management practices on this section of roadway. In addition, it would include implementation of Incident Detection on US 9 between Exits 2 and 13, including a communications backbone and CCTV at 26 signalized intersections to support arterial incident verification and traffic flow assessments (see Table ES-2). These would supplement the existing 8 cameras on US 9 located at the intersections of NYS Route 146, Grooms Road, NYS Route 236, Vischer Ferry Road, Boght Road, Route 9R, and Sparrowbush Road. Medium term deployment costs are estimated at $6,455,000 with annual operating/ maintenance costs of $801,000 (2015 dollars).

Long term ICM Plan deployment would include adaptive traffic signal control on US 9 to promote real time signal timing adjustments in support of corridor optimization and alternative route operations during incidents on I-87; US 9 access management and smart growth to improve corridor safety and improve arterial throughput; and US 9 transit development. Implementation of adaptive signal control would require enhanced detection at signalized intersections including in-pavement detectors in each approach lane, updated traffic signal controllers, and new central software for the traffic operations center. Estimated long-term deployment costs are $3,120,000 with annual operating/ maintenance costs of $624,000 (2015 dollars).

Table ES-2. Recommended Closed Circuit Television (CCTV) Locations

Main Street	Cross Street	Comment
Wolf Road	Central Av - Route 5 - Eastside	Interchange area
Wolf Road	Central Av - Route 5 - Westside	Interchange area
Wolf Road	Albany Shaker Rd - Eastside	Interchange area
Wolf Road	Albany Shaker Rd - Westside	Interchange area
Route 9	Watervliet Shaker Rd	
Route 9	Troy Schenectady Rd	Roundabout area
Route 9	Sparrowbush Rd/Route 7	Interchange area
Route 9	Columbia St/Route 7	Interchange area
Route 9	Crescent Vischer Ferry Rd	Northside of bridge over river
Route 9	Grooms Rd/Guideboard Rd	
Route 9	Usher Rd	
Route 9	Round Lake Bypass	
Route 9	Route 67/Dunning St	
Route 9	I-87 Interchange - Southside	Exit 13
Route 9	I-87 Interchange - Northside	Exit 13
Route 9	Washington St	
Route 9	Lake Av	
Route 9	Route 9p - Eastside (Union Ave)	Exit 14
Route 9	Route 9p - Westside (union Ave)	Exit 14
Route 9	Route 50 - Eastside	Exit 15
Route 9	Route 50 - Westside	Exit 15
Route 9	Ballard Rd	
Ballard Rd	I-87 Interchange - Eastside	Exit 16
Ballard Rd	I-87 Interchange - Westside	Exit 16
Route 9	I-87 Interchange - Southside	Exit 17
Route 9	I-87 Interchange - Northside	Exit 17

It should be noted that the ability to shift traffic to/from I-87 and US 9 is limited by the capacity of the connecting roadways and intersections. This led to recommendations to expand the existing ITS program and incident detection to connecting roadways as well as I-87 and US 9.

ES.4 Strategies Considered but Not Recommended

It should be noted that two additional strategies were considered throughout the course of this study, but are not recommended for further study due to cost and/or constraints. The strategies are:

- Hard Shoulder Running on I-87, where inside and outside paved shoulders are used as temporary travel lanes, typically during peak periods. Given existing discontinuities in I-87's shoulder width, particularly at the Twin Bridges, heavy ramp volumes, and close interchange spacing, hard shoulder running for general traffic and bus only purposes is not recommended for further study. Implementation of hard shoulder running would require modifications to the Twin Bridges to add shoulder width and pavement reconstruction along I-87. Additionally, this strategy was not supported by emergency responders.

- Ramp Metering on I-87, where on-merging traffic volume is matched with the availability of main lane acceptance gaps. The management of ramp merge activities allows the main lanes to operate more consistently and reduces crashes by smoothing out the overall flow of vehicles. The ramp metering analysis undertaken indicates that the potential benefits of ramp metering in the I-87 corridor appear to be nominal and likely not cost effective. Further, ramp metering has the potential to impact traffic operations of the local street network. The costs of implementing ramp metering do not account for the additional costs that would be incurred to mitigate impacts to local roads.

ES.5 Next Steps

Given the magnitude of the investment required to implement the full I-87/US 9 ICM Plan and current fiscal constraints, it is recommended that the program be progressed for consideration as a Big Ticket Initiative in the Capital District Transportation Committee's (CDTC) New Visions 2040 Plan. This will allow the concepts of the ICM Plan to be considered for implementation in stages as funds become available.

1 Introduction

1.1 Background

I-87 is a vital interstate route supporting regional commerce and tourism while also serving as the primary commuter route between Saratoga and Albany Counties. I-87 also serves CDTA's successful Northway Express (NX) route. The capacity of I-87 is generally limited by the number of lanes on the roadway, and is further constrained by the width and alignment of the Thaddeus Kosciuszko Bridge (also known as the Twin Bridges). During the typical commuter time periods, I-87 operates at capacity. Due to current fiscal conditions, right-of-way constraints, and environmental concerns, there are currently no plans to increase the number of general purpose travel lanes on I-87. Forecasts show that congestion will worsen in the future, if no further actions are taken, and that the duration of the congestion will spread to other times of the day.

The capacity of US 9 is a function of the capacity of the intersections along the roadway. There are more than 400 commercial and residential driveways that provide access to adjacent land and constrain the mobility function of the roadway. Although several intersections operate at capacity during the afternoon peak hour, many of the roadway segments and intersections operate well. Access management measures will be needed to preserve the function of this important regional arterial.

In addition to the general growth anticipated in the region over the next ten to twenty years, specific land use developments will impact roadway demand and operations. The Global Foundries project in the Luther Forest Technology Park in Malta, is likely to act as a catalyst to spur growth and development in the region. This specific development and additional projects will further increase congestion.

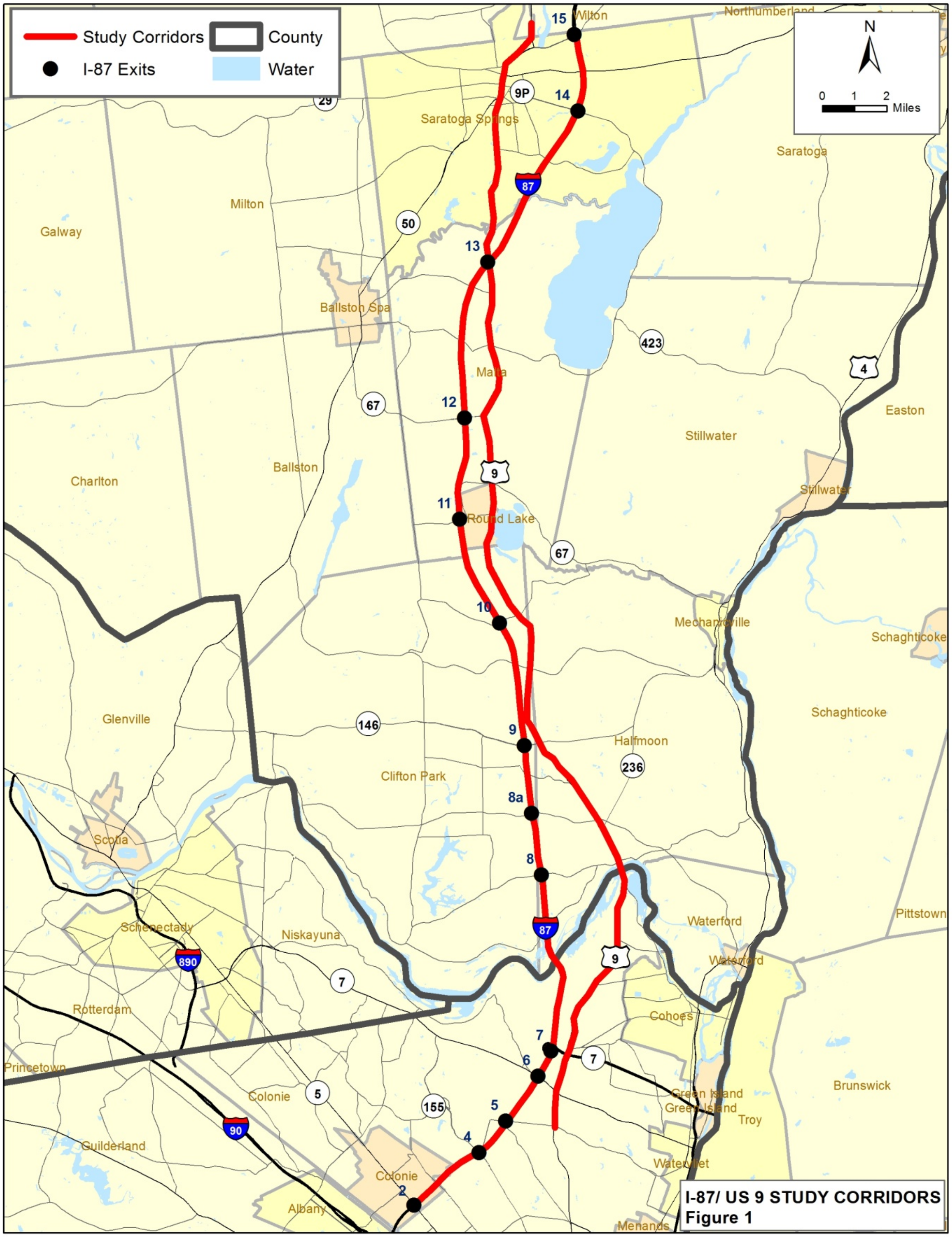
1.2 Study Area

The I-87/ US 9 ICM Plan will address I-87 and US 9 between I-87 Exits 2 and 15 where the two roadways generally run parallel to each other (see Figure 1). ICM traffic analyses and modeling will focus on the most congested corridor between Exits 2 and 10. The study also includes the connecting roadways between I-87 and US 9. Within this corridor, I-87 serves as the primary commuter route between Saratoga and Albany Counties, while also carrying interstate traffic. US 9 provides access to local land uses and also serves commuter traffic, though the trips are generally shorter. During the morning commuter peak, the majority of traffic travels south into Albany County. This trend is reversed during the afternoon when workers are travelling home to/through Saratoga County.

Land uses vary between I-87 Exits 2 and 15, ranging from urban core or central business districts to more suburban residential and undeveloped areas. In the southern end of the study area, I-87 travels through suburban corridor and suburban center areas characterized by commercial strip developments while US 9 is characterized by suburban neighborhood development. As these roadways extend north and run more parallel to each other near Exits

6 and 7, their land uses also merge with both roadways travelling through suburban corridor and suburban center areas.

The change between suburban residential and suburban corridor/center areas occurs consistently from the Town of Colonie in Albany County and north through the Town of Malta in Saratoga County. Transitioning from the Town of Malta to the City of Saratoga Springs, the land uses evolve from open space and parkland areas through suburban corridor, suburban center, and into an urban core type of land use characterized by closely spaced buildings ranging from 3 to 6 stories.


Study Corridors
County
I-87 Exits
Water
N
0 1 2 Miles
Milton
Northumberland
Saratoga Springs
Saratoga
Galway
Ballston Spa
Malta
Stillwater
Easton
Charlton
Ballston
Round Lake
Mechanicville
Schaghticoke
Glenville
Halfmoon
Clifton Park
Scotia
Schenectady
Niskayuna
Waterford
Pittstown
Rotterdam
Cohoes
Princetown
Colonie
Green Island
Troy
Brunswick
Guilderland
Watervliet
Albany
Menands
I-87/ US 9 STUDY CORRIDORS
Figure 1

2 Existing Transportation Conditions

2.1 Roadway Geometry and Intelligent Transportation Systems

2.1.1 I-87 (Northway)

I-87 between Exits 2 and 15 generally provides three northbound travel lanes and three southbound travel lanes, with 10-foot paved shoulders on the outside and shoulders of varying widths on the inside. All travel lanes are general purpose lanes accommodating a mix of trucks, buses, and passenger vehicles. The most significant bridges on I-87 between Exits 2 and 15 are the Twin Bridges (Thaddeus Kosciuszko Bridge) which span the Mohawk River dividing Albany and Saratoga Counties. There are no shoulders provided on the bridges.

Interchange on and off-ramps are typically single lane with merge, diverge, and some weaving operations. A limiting factor at some of the interchanges is the capacity of the intersection at the ramp termini which result in queues on exit ramps and increased delays. Intersection congestion can also result in delays accessing entrance ramps.

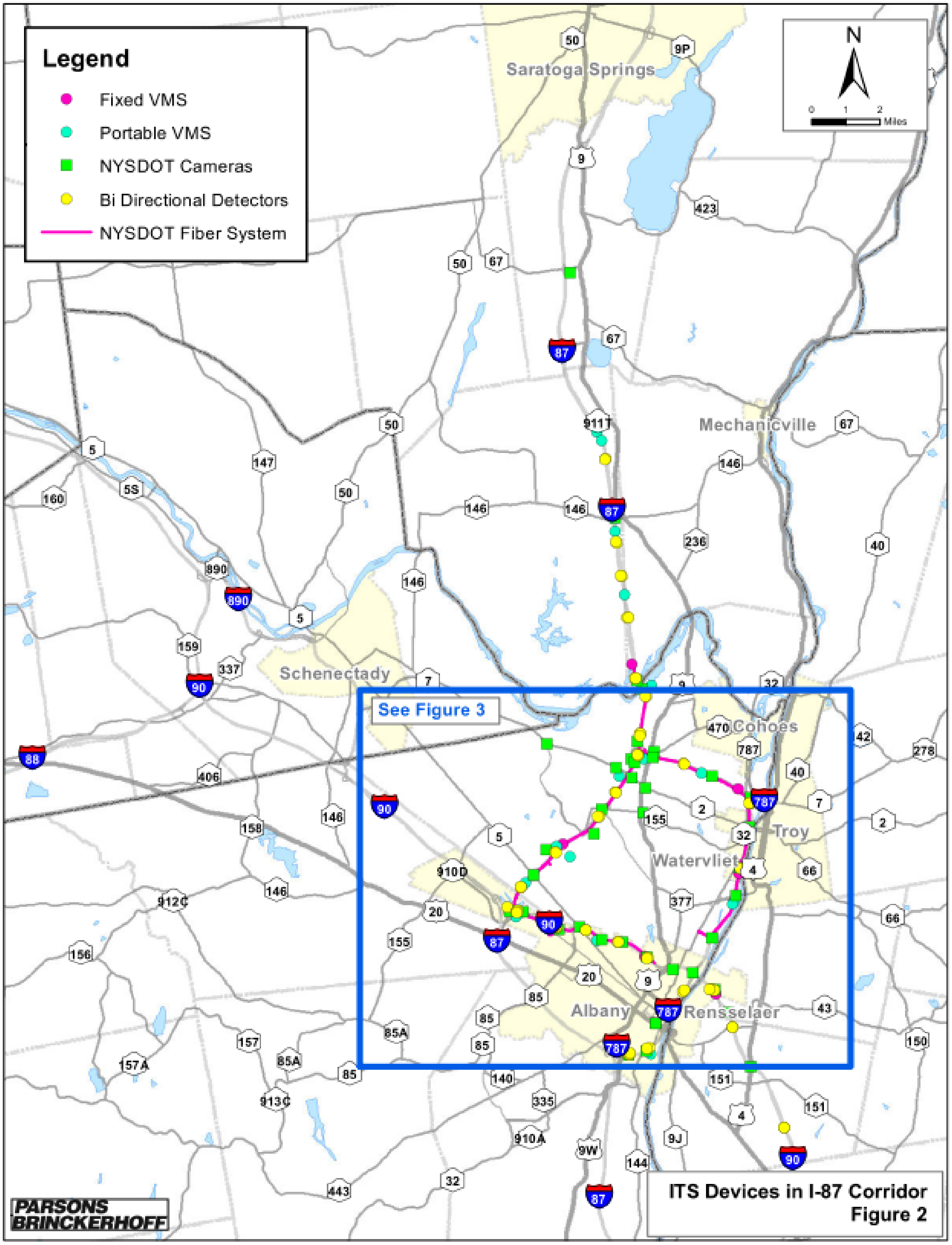
An I-87/US 9 VISSIM traffic model was developed as a tool that can be used to simulate and assess the effectiveness of recommended ICM strategies (see Appendix B) such as alternative route guidance, adaptive signal control, ramp metering, and speed harmonization. The model in this study consists of the 15-mile long segment of I-87 between Exits 2 and 10 and includes a total of nine interchanges:

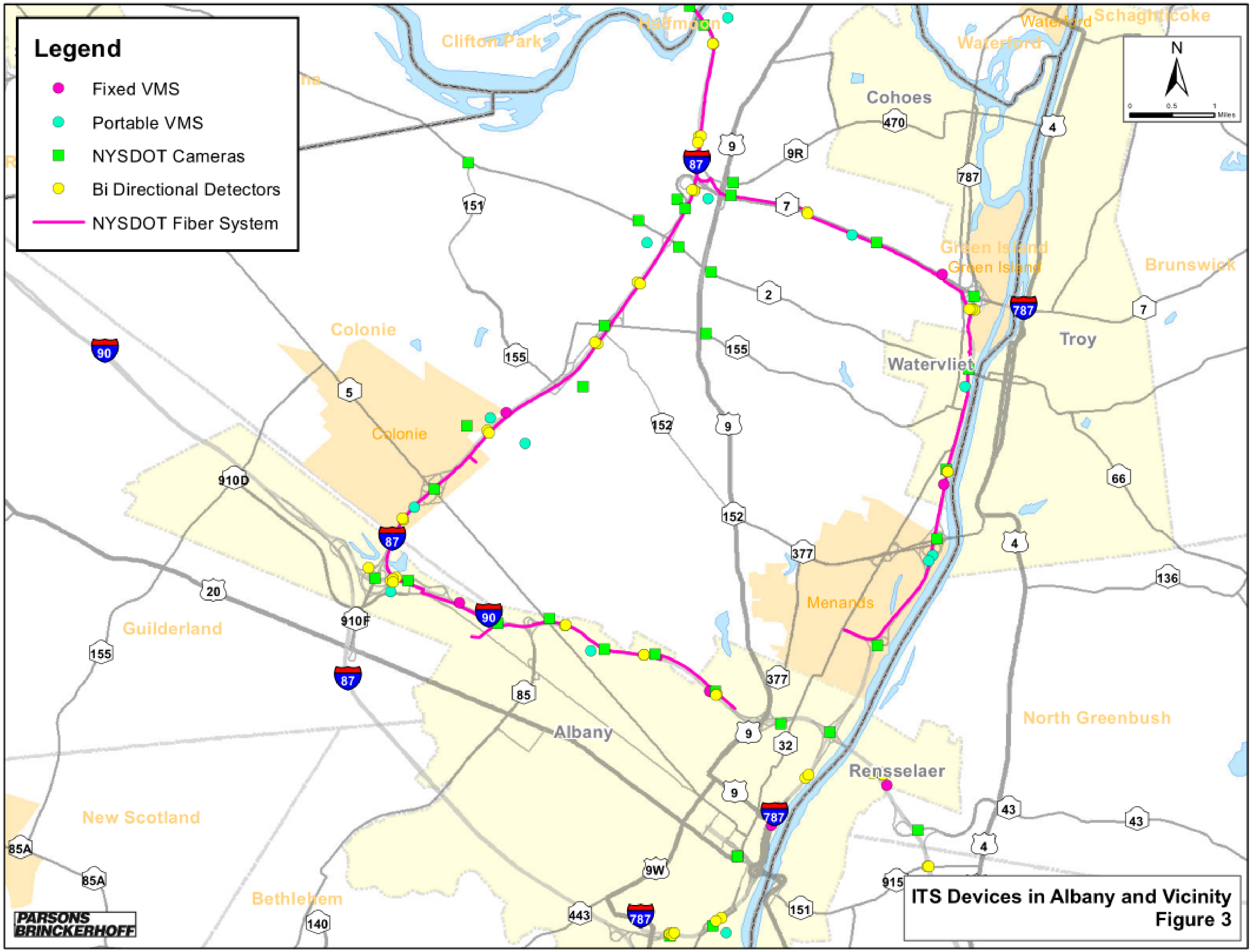
- Exit 2 (NYS Route 5)
- Exit 4 (Albany Shaker Road)
- Exit 5 (NYS Route 155)
- Exit 6 (NYS Routes 2/7)
- Exit 7 (Alternate NYS Route 7)
- Exit 8 (Crescent Vischer Ferry Road)
- Exit 8A (Grooms Road)
- Exit 9 (NYS Route 146)
- Exit 10 (Ushers Road)

Figures 2 and 3 present the locations of fixed VMS, portable VMS, NYSDOT cameras, vehicle detectors, and the NYSDOT fiber system. In general, I-87 has good camera coverage throughout the study area, and good detector coverage in the southern part of the corridor. There are two fixed VMS located north of NYS Route 5 and the Twin Bridges (one northbound and one southbound), with several locations in the southern part of the study area capable of supporting portable VMS. Traffic data is relayed to the NYSDOT Region 1 Traffic Operations Center for use in identifying and responding to incidents.

2.1.2 US 9 and Connecting Roadways

US 9 generally provides two travel lanes in each direction with a center two-way continuous left-turn lane. As US 9 travels through municipalities in areas of higher development density, the number and frequency of intersections and driveways increases. Between municipalities where development is less dense, intersections and driveways are spaced farther apart.


Legend
Fixed VMS
Portable VMS
NYSDOT Cameras
Bi Directional Detectors
NYSDOT Fiber System
N
Miles
Saratoga Springs
Mechanicville
Schenectady
See Figure 3
Cohoes
Troy
Watervliet
Albany
Rensselaer
PARSONS BRINCKERHOFF
ITS Devices in I-87 Corridor
Figure 2



ITS Devices in Albany and Vicinity
Figure 3

Arterials and collector roads provide access between I-87 and US 9. These roadways are generally a single lane in each direction with the exception of the following roadways which provide two travel lanes in each direction:

- NYS Route 7/ NYS Route 2 at Exit 6 in Colonie
- NYS Route 146 at Exit 9 in Clifton Park and Halfmoon
- NYS Route 67 at Exit 12 in Malta
- NYS Route 9P at Exit 14 in Saratoga Springs

The VISSIM model includes the 15-mile segment of US 9 between Osborne Road in Loudonville to Ushers Road in Clifton Park along with roadways that provide connections between the I-87 and US 9 corridors (see Table 1).

The intersection control along the roadways connecting the I-87 interchanges with US 9 includes stop sign, traffic signal, and roundabout control. As noted previously, these intersections are often the constraints that result in queues and delays on exit ramps and accessing entrance ramps. CCTV cameras are located at the NYS Route 155/US 9 and NYS Route 9R/US 9 intersections.

Table 1. Study Corridor Roadway Links, Functional Classification, and Ownership

Roadway	Functional Classification	Ownership
I-87	11 – Urban Interstate	State
US 9	14 – Urban Principal Arterial (Other Street)	State
NYS Route 5	14 – Urban Principal Arterial (Other Street)	State
Wolf Road	14 – Urban Principal Arterial (Other Street)	State
Albany Shaker Road (east of Wolf Road)	14 – Urban Principal Arterial (Other Street)	County
Maxwell Road	17 – Urban Collector	Local
Osborne Road	16 – Urban Minor Arterial	County
NYS Route 155 (west of Wolf Road)	14 – Urban Principal Arterial (Other Street)	State
NYS Route 155 (north of Wolf Road)	16 – Urban Minor Arterial	State
NYS Route 2	14 – Urban Principal Arterial (Other Street)	State
Sparrowbush Road/ Wade Road Extension	17 – Urban Collector	Local
NYS Route 7 (west of I-87 overlap)	14 – Urban Principal Arterial (Other Street)	State
NYS Route 7 (east of I-87 overlap)	12 – Urban Principal Arterial (Expressway)	State
NYS Route 9R (Columbia Street)	16 – Urban Minor Arterial	State
NYS Route 9R (Bought Street)	17 – Urban Collector	State
Crescent Vischer Ferry Road	16 – Urban Minor Arterial	County
NYS Route 236	16 – Urban Minor Arterial	State
Grooms Road	16 – Urban Minor Arterial	County
NYS Route 146	14 – Urban Principal Arterial (Other Street)	State
Ushers Road	16 – Urban Minor Arterial	Local

2.2 Pedestrian and Bicycle Accommodations

US 9 is designated as County Bike US 9 from Old Loudon Road/ Autopark Drive in the Town of Colonie, to the City of Saratoga Springs southern municipal line. There are also a number of on-road bike routes in the City of Saratoga Springs. These routes share the road on US 9, NYS Route 9P, NYS Route 29, and other city streets. The bike accommodation along these routes is typically shared use travel lane or on the roadway shoulder.

The Bicycle and Pedestrian Priority Network published by CDTC and currently being updated, identifies desirable bicycle and pedestrian corridors, provides a “model” to estimate the magnitude of resources required on a regional level, serves as an official plan for bicycle and pedestrian travel, and serves as a starting point for local planning. It lists several facilities and major travel routes that have the potential for use as bike routes, but contain various barriers and impediments to cycling or walking. A number of roadways in the ICM Plan area are identified on the Priority Network. They are:

- US 9
- NYS Route 2
- Albany-Shaker Road
- Osborne Road
- NYS Route 9P

Sidewalks are relatively limited along US 9 and the connector roadways. Generally, sidewalks are only provided within the urban core in Saratoga Springs on US 9 and the connector roadways. There are some sidewalks in the downtown center in Malta and Clifton Park. There are also some land development projects completed by private developers that include sidewalks along their site frontage in the Town of Colonie. However, these sidewalk segments are very short and do not connect to a larger pedestrian network. There is a need for new sidewalks and an expanded pedestrian network to connect land uses and transit stops, and provide safe street crossings.

2.3 Transit Service and Routes

2.3.1 The Northway Xpress (NX)

NX service is a weekday-only, express bus service provided by CDTA to deliver reliable, comfortable transportation, and primarily serves a commuter market. The NX connects origins in northern Albany and Saratoga Counties, including park & ride lots along I-87, with destinations in Downtown Albany. The service operates primarily on I-87, also known as the Northway. Since 2004, the service has been managed by CDTA and operated by a private contractor.

The NX service consists of a total of 29 one-way trips; there are 14 southbound trips and 15 northbound trips. Most of the trips on the existing Northway Service originate in the Saratoga area, making multiple stops in Saratoga before continuing south to Albany along I-87. The buses also make multiple stops in Downtown Albany. The services are timed to coincide with common work arrival and departure times in the downtown area. The NX schedule and fares are based on a zone system, with a total of three originating zones.

2.3.2 Route 409 Demonstration Project

CDTA began operating a pilot bus service on US 9, Route 409, on May 24, 2010. Service was provided between the Exit 9 Park & Ride at the Crossings in Halfmoon/ Clifton Park and Congress Park in Saratoga Springs. A $1 million federal grant was received specifically for corridor service focused on employment. Service operated Monday – Friday from 6:30 AM to 8:00 PM, with a 45 minute frequency. The schedule was modified in September 2010 to include 16 new stops and later evening service to encourage ridership. Paratransit service was also provided within 3/4 mile of the route as required by the Americans with Disabilities Act (ADA). CDTA discontinued Route 409 service on September 2, 2011 due to insufficient demand.

CDTA concluded that, while sufficient demand does not exist in the corridor to support transit service at this time, projected employment and population growth would likely support a service in the future. This is particularly true if the corridor moves from low density dispersed development to smart development patterns with walkable, compact, mixed use communities. Recent complete streets legislation will result in a more transit supportive environment along US 9 over time. Potential alternative routes will be conceptualized, within the context of smart growth and CDTA's 100 miles of bus rapid transit (BRT) framework.

2.4 Park and Ride Lots

A recent study to improve the capacity and utility of CDTA's park-and-ride program identified 39 park-and-ride locations in CDTA's service area including six located in the study corridor:

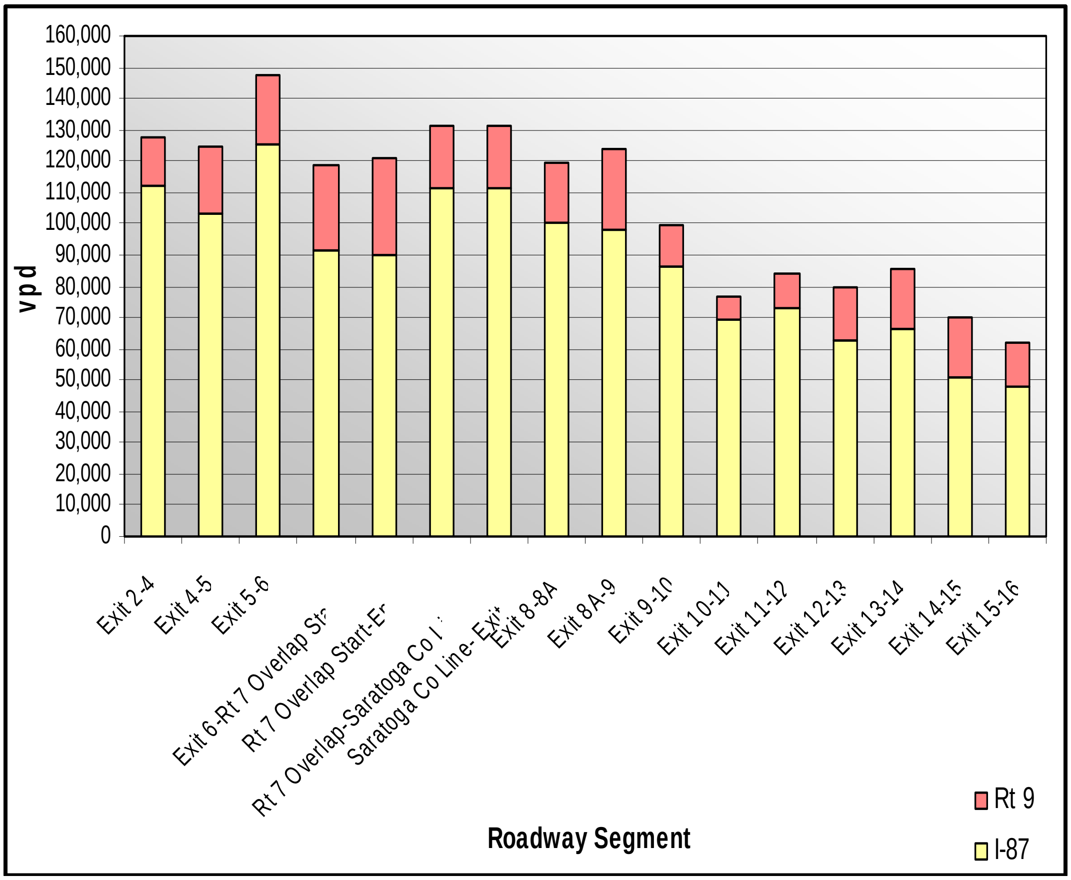
- Exit 8 in Clifton Park with 120 spaces
- Exit 9 in Clifton Park with a shared lot at the Crossings (Capacity/ utilization not estimated in study)
- Exit 9 in Clifton Park at Fire Road with 80 spaces
- Exit 11 in Malta at the Malta Mall with 50 spaces
- Exit 12 in Malta at Malta Commons with 50 spaces
- Exit 15 in Saratoga Springs at the Wilton Mall with 160 spaces

Capacities and utilization were estimated based on field surveys. These facilities operate at between 24% and 70% capacity, with an average for the corridor of 38% occupied. Work trips predominate with the majority of park and riders boarding a CDTA NX bus.

2.5 Traffic Volumes

Figure 4 presents the Average Annual Daily Traffic (AADT) on I-87 and US 9 between I-87 Exits 2 and 15. The data shows that traffic volumes peak at about 150,000 vehicles per day (vpd) between Exits 5 and 6 in the Town of Colonie, Albany County. In general, traffic volumes range from 120,000 vpd to 130,000 vpd on the two roadways from Exit 2 in the Village of Colonie at the southern end of the study area to Exit 9 in the Clifton Park/ Halfmoon area, roughly the middle of the study area. At Exit 9, traffic volumes drop to about 100,000 vpd. This overall trend makes sense as the Clifton Park/ Halfmoon area houses a relatively large percentage of the population in the Capital District and is within easy commuting distance of employment opportunities in Albany County.

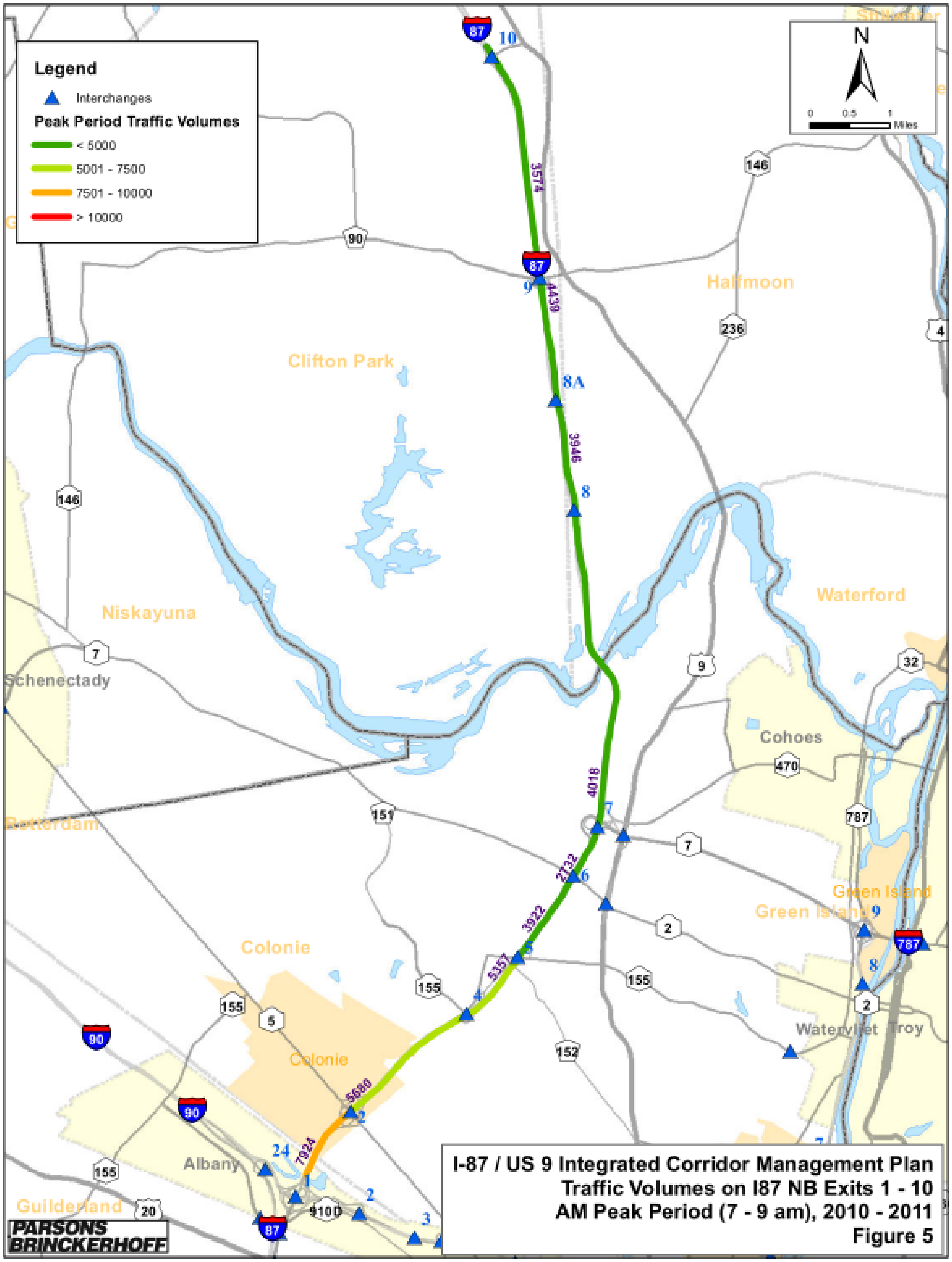
Figure 4. Average Annual Daily Traffic for I-87 and US 9

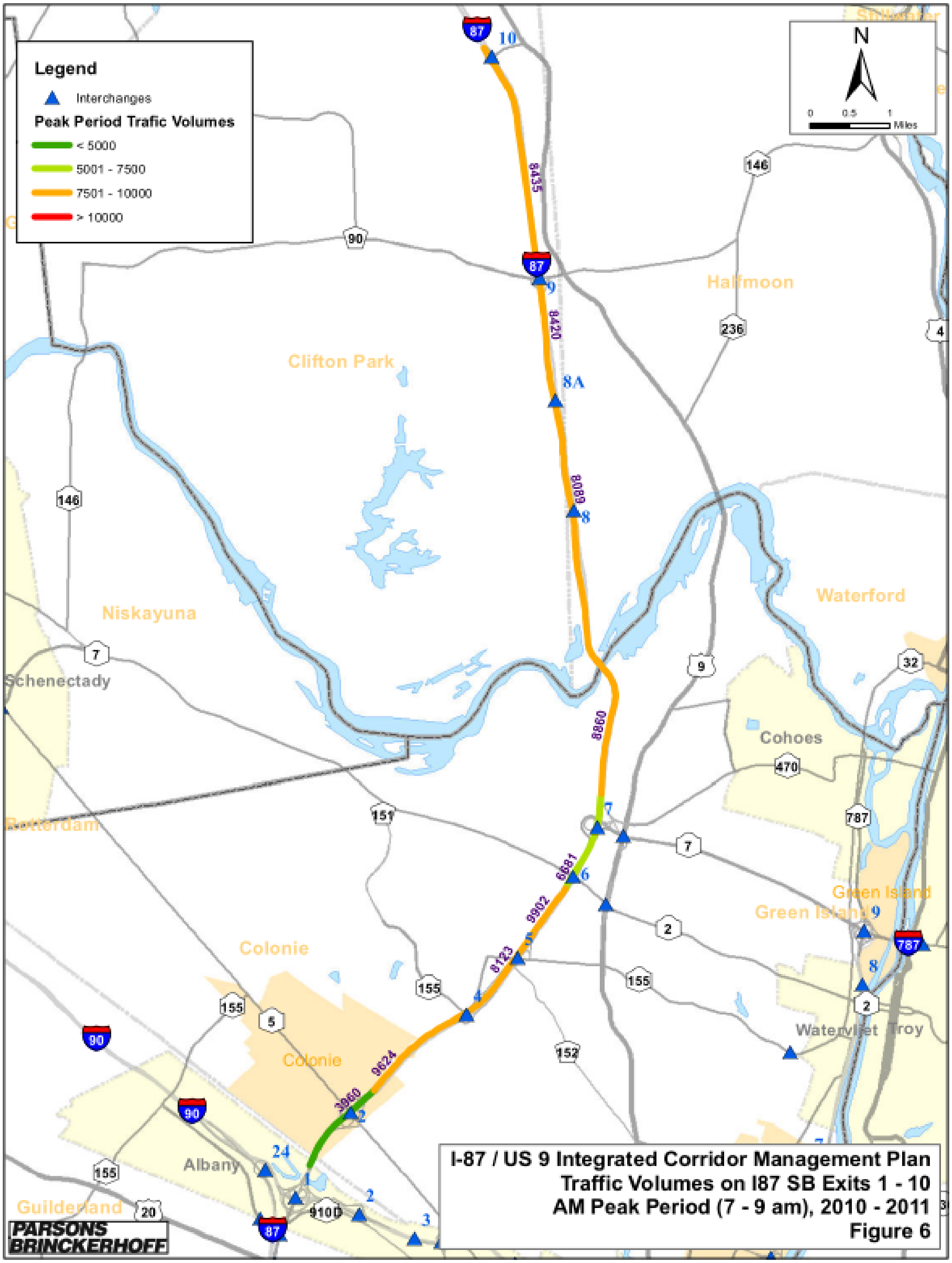


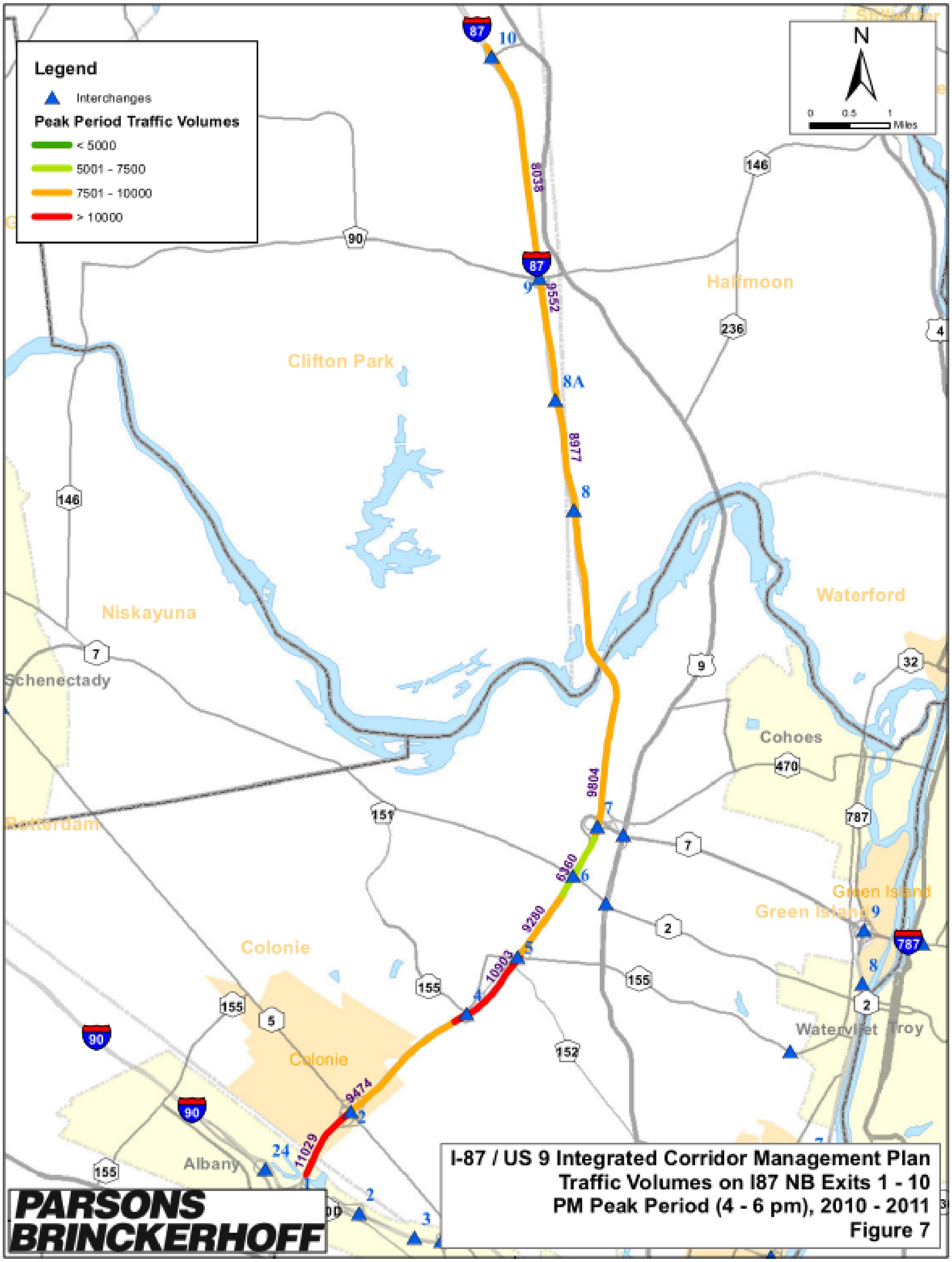
Source: 2009 NYSDOT Traffic Volume Report

I-87 serves as the primary commuter route between Saratoga and Albany Counties, while also carrying interstate traffic. US 9 provides access to local land uses and also serves commuter traffic, though the trips are generally shorter. During the morning commuter peak, almost 65% of traffic travels south into Albany County. This trend is reversed during the afternoon when workers are travelling home to/through Saratoga County.

Figures 5 and 6 present AM peak period (7AM – 9AM) traffic volumes on I-87 northbound and southbound, respectively. During the AM peak period traffic volumes are highest in the southbound direction with the highest volumes recorded between Exits 7 and 8 in the vicinity of the Twin Bridges. Figures 7 and 8 present PM peak period (4PM – 6PM) traffic volumes on I-87 northbound and southbound, respectively. During the PM peak period (4PM – 6PM) traffic volumes are highest in the northbound direction with the highest volumes recorded in the area south of NYS Route 5, in the vicinity of NYS Route 155, and south of the Twin Bridges.


Legend
Interchanges
Peak Period Traffic Volumes
< 5000
5001 - 7500
7501 - 10000
> 10000
N
Miles
Clifton Park
Halfmoon
Niskayuna
Schenectady
Waterford
Cohoes
Rotterdam
Colonie
Green Island
Watervliet
Troy
Albany
Guilderland
3574
4439
3946
4018
2732
3922
5357
5680
7924
PARSONS BRINCKERHOFF
I-87 / US 9 Integrated Corridor Management Plan
Traffic Volumes on I87 NB Exits 1 - 10
AM Peak Period (7 - 9 am), 2010 - 2011
Figure 5


Legend
Interchanges
Peak Period Trafic Volumes
< 5000
5001 - 7500
7501 - 10000
> 10000
I-87 / US 9 Integrated Corridor Management Plan
Traffic Volumes on I87 SB Exits 1 - 10
AM Peak Period (7 - 9 am), 2010 - 2011
Figure 6
Clifton Park
Halfmoon
Niskayuna
Schenectady
Waterford
Cohoes
Colonie
Green Island
Watervliet
Troy
Albany
Guilderland
Rotterdam
8435
8420
8089
8860
6681
9902
8123
9624
3960
PARSONS BRINCKERHOFF


Legend
Interchanges
Peak Period Traffic Volumes
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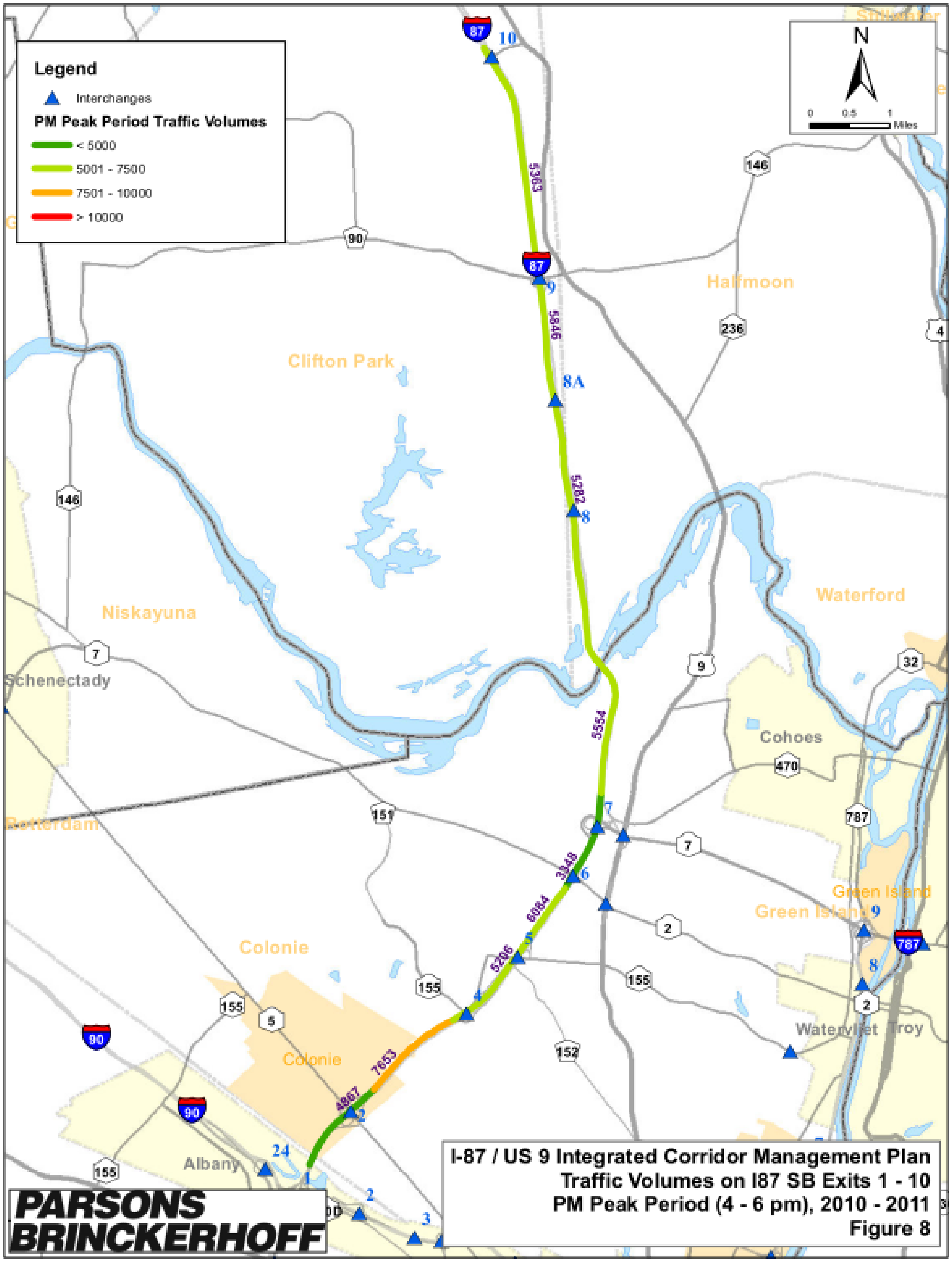
N
0 0.5 1 Miles
Clifton Park
Halfmoon
Niskayuna
Schenectady
Waterford
Cohoes
Rotterdam
Colonie
Green Island
Watervliet
Troy
Albany
8038
9552
8977
9804
6360
9280
10903
9474
11029
PARSONS BRINCKERHOFF
I-87 / US 9 Integrated Corridor Management Plan
Traffic Volumes on I87 NB Exits 1 - 10
PM Peak Period (4 - 6 pm), 2010 - 2011
Figure 7



I-87 / US 9 Integrated Corridor Management Plan
Traffic Volumes on I87 SB Exits 1 - 10
PM Peak Period (4 - 6 pm), 2010 - 2011
Figure 8

Figure 9. Directional PM Peak Hour Traffic Volumes and Reserve Capacities (Connector Roads)

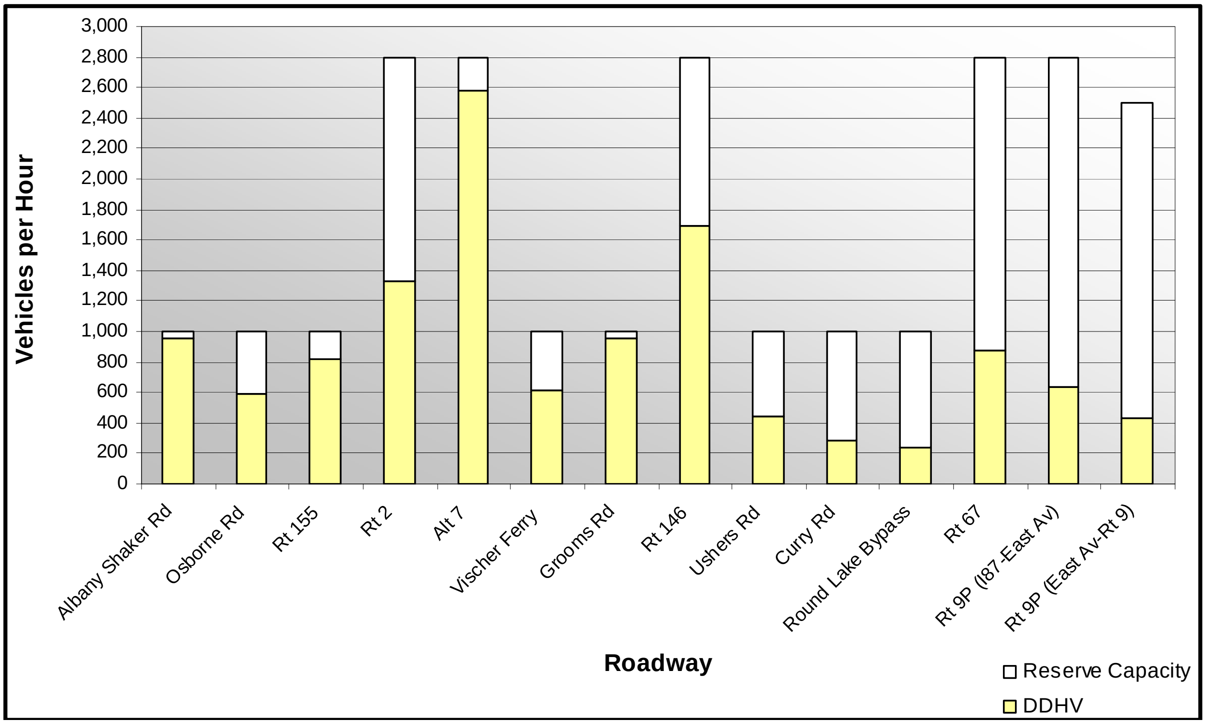
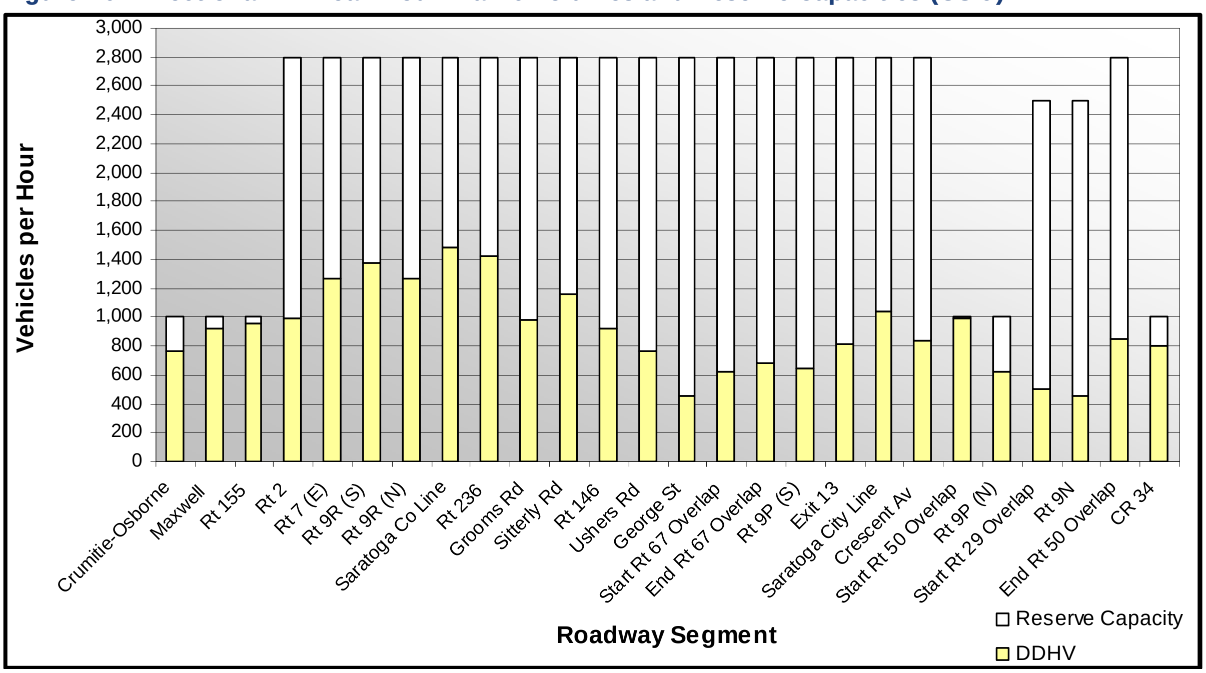


Figure 10. Directional PM Peak Hour Traffic Volumes and Reserve Capacities (US 9)



On the following pages Tables 2 and 3 summarize AADTs and growth rates for I-87 and US 9, respectively, for the period from 2004 through 2009. Traffic volumes on different sections of I-87 grew, and in some cases declined, at different rates between 2004 and 2009. Individual volumes may also reflect temporary conditions, such as travel impacts associated with the reconstruction of Exit 6 in 2006. Swings in the price of gasoline, economic conditions, and road construction each affect traffic volumes over time. Overall, I-87 traffic volumes were higher in 2009 than 2004 with the exceptions of sections north of Exit 9. The same was not true for US 9, which exhibits generally lower AADTs in 2009 when compared to 2004.

2.6 Capacity and Demand

Based on level of service (LOS) thresholds established by CDTC for various roadway types, the LOS D capacity for a four-lane highway is 2,500 vehicles per hour (vph) in both directions. This is somewhat higher than the capacity of 2,200 passenger car equivalents estimated in the I-87 Multimodal Corridor Plan using the Highway Capacity Manual. If the US 9 four-lane roadway has a flush median (two-way left-turn lane) then the capacity is 2,800 vph.

Two-lane roadways (i.e., connector roads between I-87 and US 9) have an approximate capacity of 1,000 vph in each direction. It is noted that these are approximate capacities and that the percentage of turning traffic, driveway and intersection spacing, on-street parking, and other roadway features will affect roadway capacity. Figures 9 and 10 on the previous page illustrate the existing PM peak hour directional volumes on US 9 and the collector roadways in the study area compared to the directional volumes to the appropriate CDTC LOS D capacity threshold. Much of US 9 has significant reserve capacity in the PM peak hour. However, localized capacity constraints and incidents result in peak period congestion.

2.7 Travel Speeds and Delays

Figures 11 and 12 present AM peak period (7AM – 9AM) travel speeds on I-87 northbound and southbound, respectively on an average weekday. During the AM peak period, travel speeds are lowest in the southbound direction with the lowest speeds approaching the Twin Bridges. Northbound speeds are lowest approaching NYS Route 5. Figures 13 and 14, present PM peak period (4PM – 6PM) travel speeds on I-87 northbound and southbound, respectively. During the PM peak period, travel speeds are lowest in the northbound direction with the lowest speeds approaching the Twin Bridges.

Table 4 presents US 9 peak period travel speeds northbound and southbound, respectively. Northbound speeds are less than 20 mph at three locations during the morning peak period (i.e. in the vicinity of Grooms Road, NYS Route 9R, and Sparrowbush Road). During the evening peak period, six northbound sections operate at speeds less than 20 mph (i.e., in the vicinity of Grooms Road, NYS Route 9R, Sparrowbush Road, Fonda Road, Crossing Boulevard, and NYS Route 146).

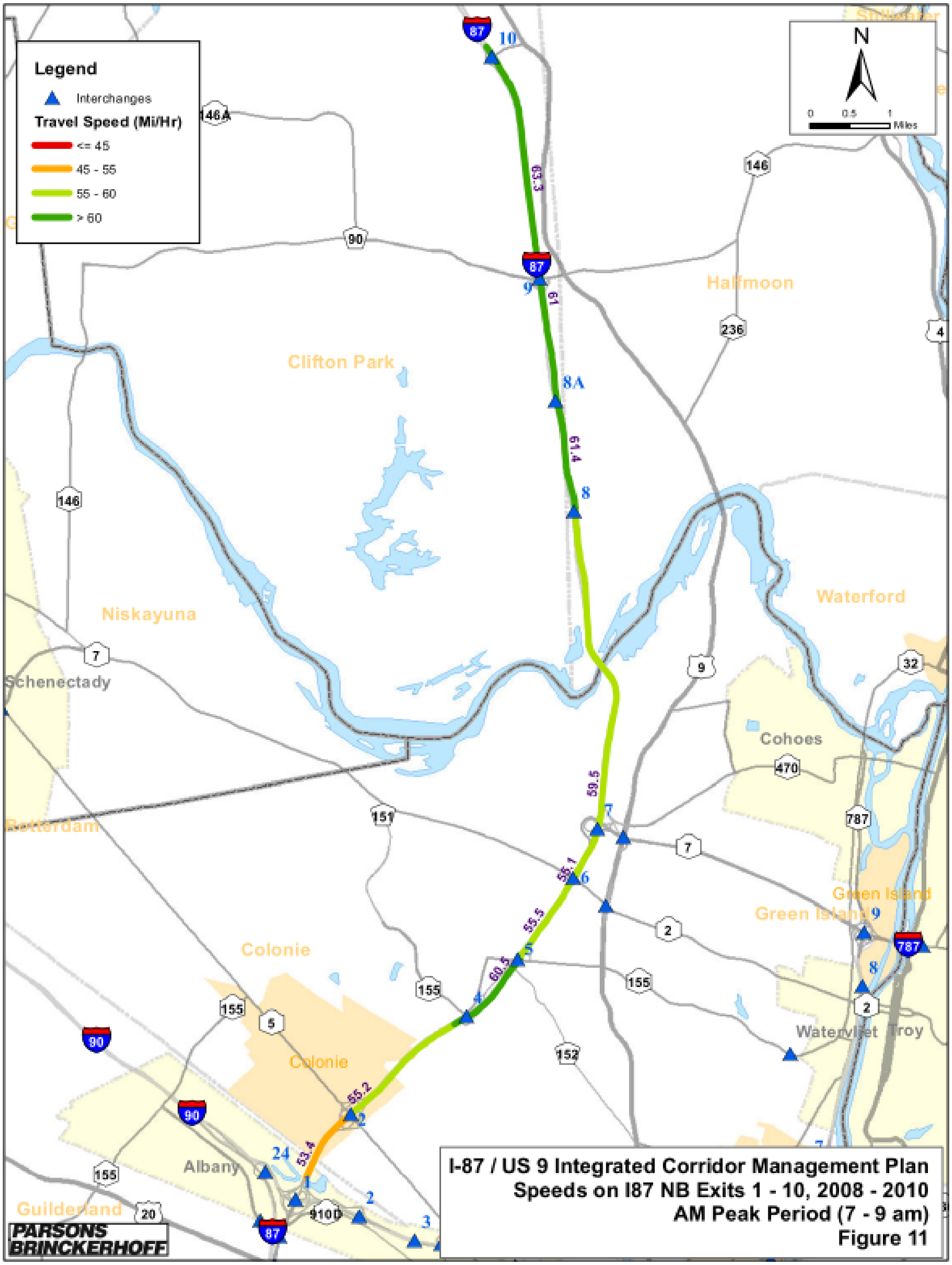
Southbound speeds are less than 20 mph at seven locations during the morning peak period (i.e., in the vicinity of Plant Road, Grooms Road, Vischer Ferry Road, Old Loudon Road, Boght Road, Lawrence Street, and Erin Street). During the evening peak period, eight southbound sections operate at speeds less than 20 mph (i.e., in the vicinity of Plant Road, Grooms Road, Vischer Ferry Road, Old Loudon Road, Boght Road, Lawrence Street, Sparrowbush Road, and Erin Street).

Table 2. I-87 AADTs and Annual Growth Rates (2004 – 2009)

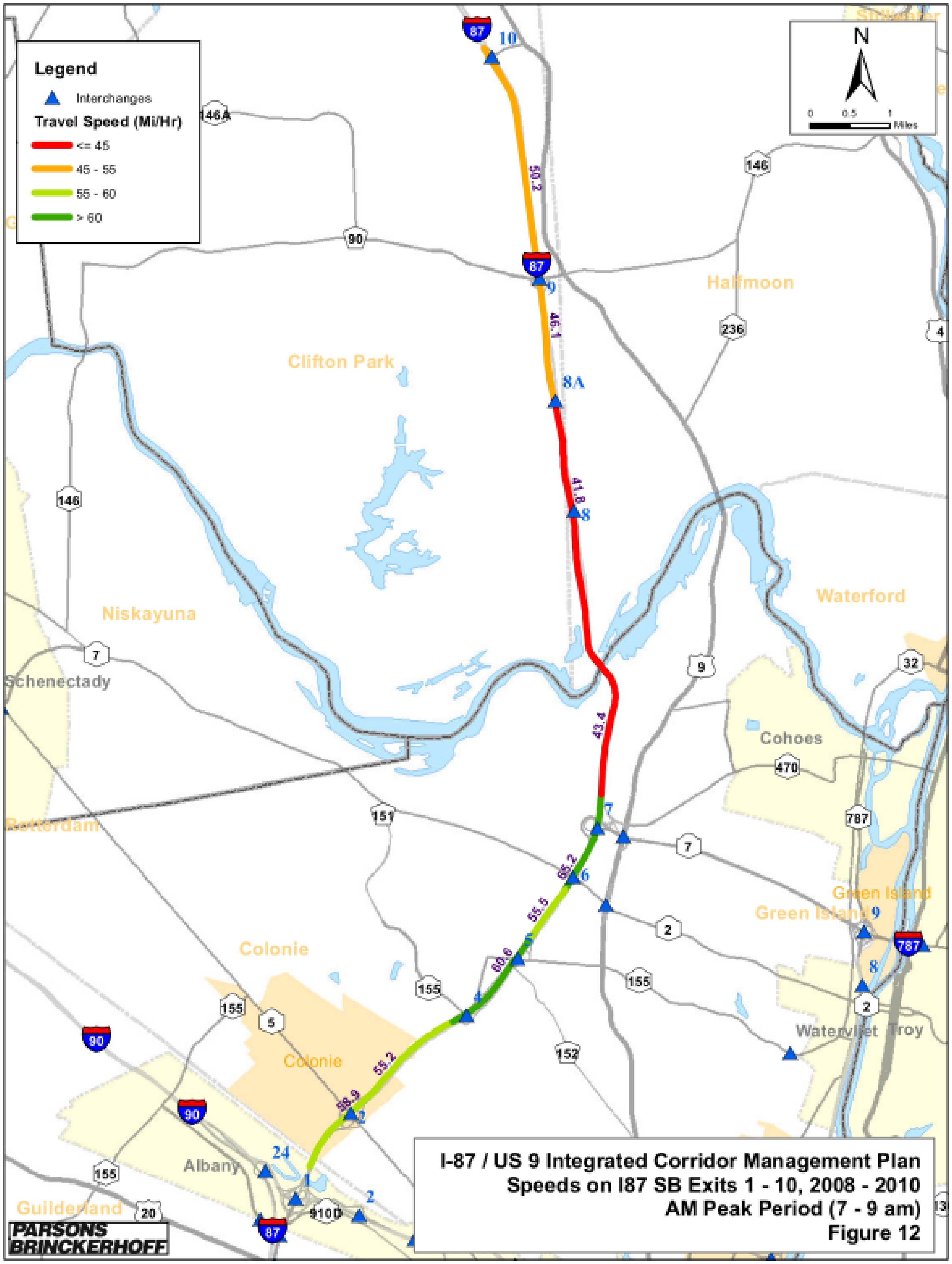
Section End Description	AADT					
	2004	2005	2006	2007	2008	2009
EXIT 2 RT 5	127,600	126,200	119,490	134,200	136,330	137,510
EXIT 4 ALBANY SHAKER ROAD UNDER	109,200	111,660	105,090	108,420	110,710	112,160
EXIT 5 RT 155	101,300	102,620	96,680	99,740	101,850	103,180
EXIT 6 RT 7	119,900	125,980	117,280	120,990	123,550	125,160
RT 7 OVERLAP BEGINS	83,000	84,780	-----	87,460	89,800	91,380
RT 7 OVERLAP ENDS	86,800	90,020	84,460	87,140	88,980	90,140
SARATOGA CO LINE	109,100	110,790	104,670	107,980	110,260	111,700
EXIT 8 RT 911P OVER	109,100	101,880	121,010	107,980	110,260	111,700
EXIT 8A	99,900	92,040	94,630	97,860	99,420	100,280
EXIT 9 RT 146 UNDER	90,500	92,850	95,060	99,350	98,720	97,720
EXIT 10 USHERS RD RT 911T OVER	92,900	87,080	80,840	83,390	85,160	86,270
EXIT 11 RT 911U UNDER	75,300	67,270	78,910	82,760	81,620	68,950
Section End Description	**Annual Growth Rate**					
	2005	**2006**	**2007**	**2008**	**2009**	**2004-2009**
EXIT 2 RT 5	-1.10%	-5.32%	12.31%	1.59%	0.87%	7.77%
EXIT 4 ALBANY SHAKER ROAD UNDER	2.25%	-5.88%	3.17%	2.11%	1.31%	2.71%
EXIT 5 RT 155	1.30%	-5.79%	3.17%	2.12%	1.31%	1.86%
EXIT 6 RT 7	5.07%	-6.91%	3.16%	2.12%	1.30%	4.39%
RT 7 OVERLAP BEGINS	2.14%	-----	-----	2.68%	1.76%	10.10%
RT 7 OVERLAP ENDS	3.71%	-6.18%	3.17%	2.11%	1.30%	3.85%
SARATOGA CO LINE	1.55%	-5.52%	3.16%	2.11%	1.31%	2.38%
EXIT 8 RT 911P OVER	-6.62%	18.78%	-10.77%	2.11%	1.31%	2.38%
EXIT 8A	-7.87%	2.81%	3.41%	1.59%	0.87%	0.38%
EXIT 9 RT 146 UNDER	2.60%	2.38%	4.51%	-0.63%	-1.01%	7.98%
EXIT 10 USHERS RD RT 911T OVER	-6.26%	-7.17%	3.15%	2.12%	1.30%	-7.14%
EXIT 11 RT 911U UNDER	-10.66%	17.30%	4.88%	-1.38%	-15.52%	-8.43%

Table 3. US 9 AADTs and Annual Growth Rates (2004 - 2009)

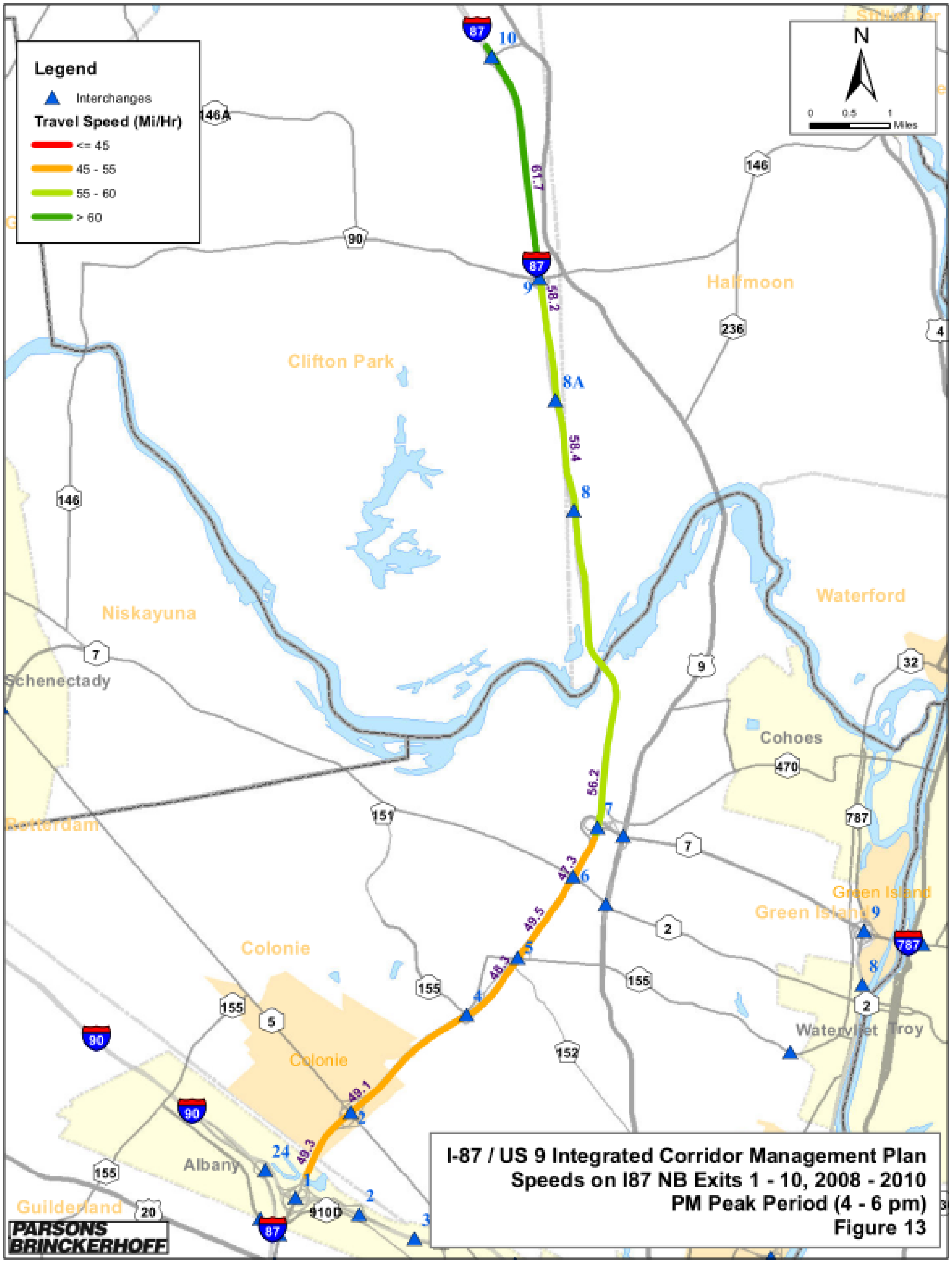
Section End Description	AADT					
	2004	2005	2006	2007	2008	2009
RT 378	16,700	16,840	17,040	17,200	15,140	15,240
MAXWELL RD	20,200	20,920	20,710	18,810	18,940	19,050
RT 155	22,100	22,490	21,430	20,830	20,730	21,080
RT 2 OVER LATHAM	28,700	25,400	21,950	22,180	22,250	22,380
ACC RT 7 EAST BOUND	26,500	26,240	28,360	27,400	27,080	27,200
JCT RT 9R ACC 7W & 87I	32,400	37,210	37,640	30,160	30,360	30,540
JCT RT 9R NORTH	19,000	20,050	20,280	19,600	19,370	19,460
SARATOGA CO LN	20,200	18,590	18,800	18,980	14,690	14,780
RT 236 JCT	16,800	19,190	19,410	19,600	19,170	19,290
GROOMS RD-GUIDEBOARD RD	15,200	15,410	15,590	15,060	15,160	15,250
SITTERLY RD	25,200	24,060	25,830	26,050	25,930	26,060
RT 146 JCT CLIFTON PK	17,800	18,750	18,970	18,310	18,040	18,110
RT 911T JCT USHERS RD	15,000	14,010	16,030	12,870	12,960	13,030
RT 911U JCT GEORGE ST	8,200	8,150	8,240	7,210	7,590	7,640
Section End Description	**Annual Growth Rate**					
	2005	**2006**	**2007**	**2008**	**2009**	**2004-2009**
RT 378	0.84%	1.19%	0.94%	-11.98%	0.66%	-8.74%
MAXWELL RD	3.56%	-1.00%	-9.17%	0.69%	0.58%	-5.69%
RT 155	1.76%	-4.71%	-2.80%	-0.48%	1.69%	-4.62%
RT 2 OVER LATHAM	-----	-13.58%	1.05%	0.32%	0.58%	-22.02%
ACC RT 7 EAST BOUND	-0.98%	8.08%	-3.39%	-1.17%	0.44%	2.64%
JCT RT 9R ACC 7W & 87I	14.85%	1.16%	-19.87%	0.66%	0.59%	-5.74%
JCT RT 9R NORTH	5.53%	1.15%	-3.35%	-1.17%	0.46%	2.42%
SARATOGA CO LN	-7.97%	1.13%	0.96%	-22.60%	0.61%	-26.83%
RT 236 JCT	14.23%	1.15%	0.98%	-2.19%	0.63%	14.82%
GROOMS RD-GUIDEBOARD RD	1.38%	1.17%	-3.40%	0.66%	0.59%	0.33%
SITTERLY RD	-4.52%	7.36%	0.85%	-0.46%	0.50%	3.41%
RT 146 JCT CLIFTON PK	5.34%	1.17%	-3.48%	-1.47%	0.39%	1.74%
RT 911T JCT USHERS RD	-6.60%	14.42%	-19.71%	0.70%	0.54%	-13.13%
RT 911U JCT GEORGE ST	-0.61%	1.10%	-12.50%	5.27%	0.66%	-6.83%



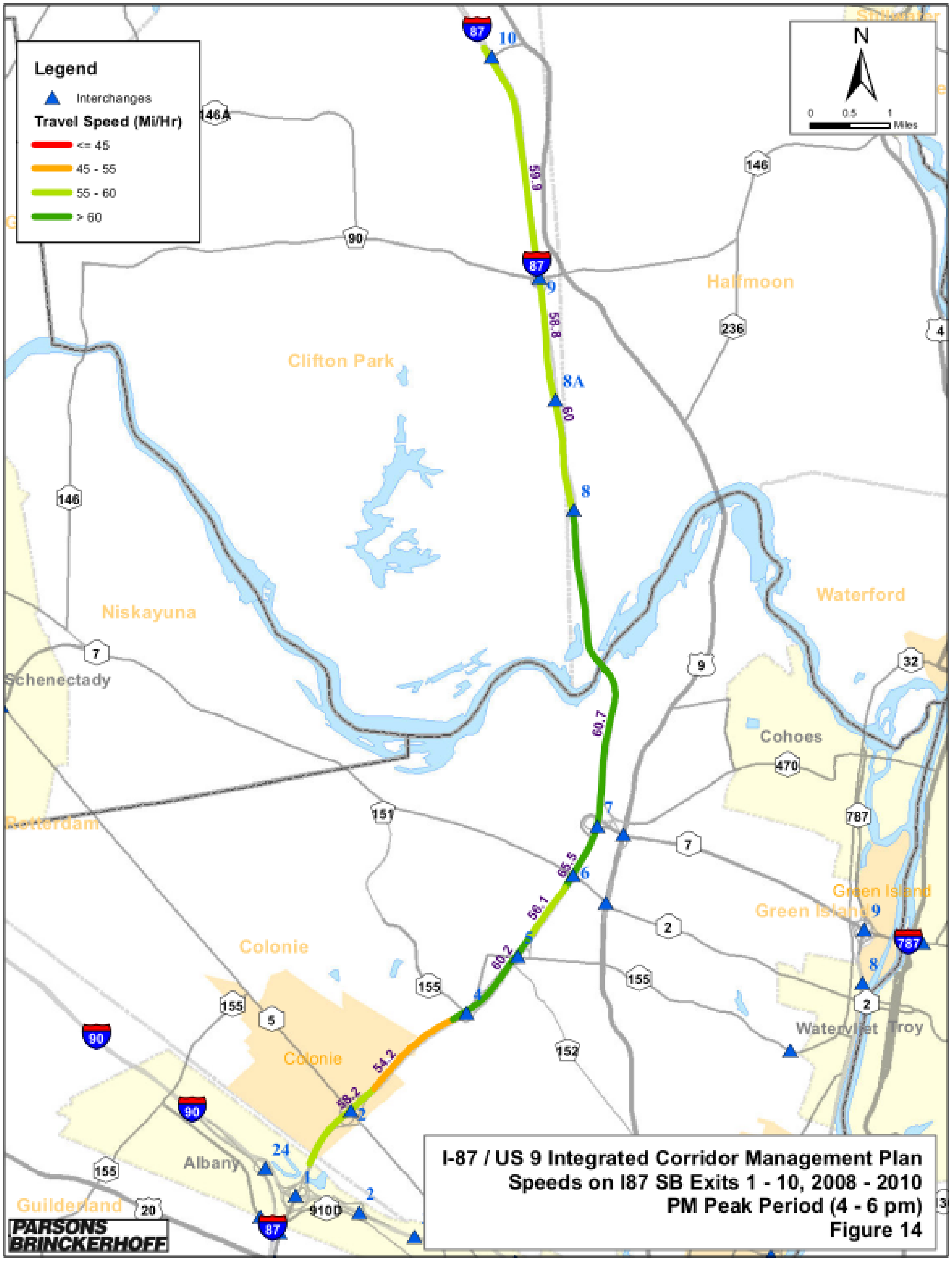
Legend
Interchanges
Travel Speed (Mi/Hr)
<= 45
45 - 55
55 - 60
> 60
N
0 0.5 1 Miles
Halfmoon
Clifton Park
Niskayuna
Schenectady
Waterford
Cohoes
Rotterdam
Colonie
Green Island
Watervliet
Troy
Albany
Guilderland
63.3
61
61.4
59.5
55.1
55.5
60.5
55.2
53.4
PARSONS BRINCKERHOFF
I-87 / US 9 Integrated Corridor Management Plan
Speeds on I87 NB Exits 1 - 10, 2008 - 2010
AM Peak Period (7 - 9 am)
Figure 11



I-87 / US 9 Integrated Corridor Management Plan
Speeds on I87 SB Exits 1 - 10, 2008 - 2010
AM Peak Period (7 - 9 am)
Figure 12



I-87 / US 9 Integrated Corridor Management Plan
Speeds on I87 NB Exits 1 - 10, 2008 - 2010
PM Peak Period (4 - 6 pm)
Figure 13



I-87 / US 9 Integrated Corridor Management Plan
Speeds on I87 SB Exits 1 - 10, 2008 - 2010
PM Peak Period (4 - 6 pm)
Figure 14

Table 4. US 9 Peak Period Travel Speeds (mph) – Northbound/ Southbound

From	To	AM	PM
NORTHBOUND			
Route 155	Kunker Avenue	22	28
Kunker Avenue	Latham Circle (entering)	38	23
Latham Circle (entering)	Erin Street	40	38
Erin Street	Sparrowbush Road	19	12
Sparrowbush Road	Route 9R	13	7
Route 9R	Century Hill Drive	36	30
Century Hill Drive	Lawrence Street	43	41
Lawrence Street	Boght Rd	45	29
Boght Rd	Old Loudon Rd	64	39
Old Loudon Rd	Fonda Road	21	14
Fonda Road	Vischer Ferry Road	51	40
Vischer Ferry Road	Church Hill Rd	36	31
Church Hill Rd	Rt 236	46	37
Rt 236	Grooms Road	6	4
Grooms Road	Plant Road	36	25
Plant Road	Halfmoon Walmart	37	25
Halfmoon Walmart	Sitterly Road	21	16
Sitterly Road	Halfmoon Crossing	35	30
Halfmoon Crossing	Crossing Boulevard	30	9
Crossing Boulevard	Route 146	31	11
SOUTHBOUND			
Route 146	Crossing Boulevard	24	20
Crossing Boulevard	Halfmoon Crossing	25	23
Halfmoon Crossing	Sitterly Road	34	34
Sitterly Road	Halfmoon Walmart	36	33
Halfmoon Walmart	Plant Road	16	14
Plant Road	Grooms Road	19	10
Grooms Road	Rt 236	28	27
Rt 236	Church Hill Rd	34	47
Church Hill Rd	Vischer Ferry Road	1	1
Vischer Ferry Road	Fonda Road	27	28
Fonda Road	Old Loudon Rd	13	12
Old Loudon Rd	Boght Rd	8	7
Boght Rd	Lawrence Street	14	13
Lawrence Street	Century Hill Drive	41	42
Century Hill Drive	Route 9R	20	22
Route 9R	Sparrowbush Road	29	14
Sparrowbush Road	Erin Street	16	8
Erin Street	Latham Circle (entering)	41	39
Latham Circle (entering)	Kunker Avenue	29	37
Kunker Avenue	Route 155	30	19

CDTC uses a measure developed by the Texas Transportation Institute (TTI) called "planning time index" or PTI, a ratio of driving time on a typical traffic day to driving at the speed limit to assess congestion. For example, a planning time index of 1.5 means that a trip which takes one hour in free flow traffic would take one and a half hours on an average day during the peak period. So, if a traveler wanted a 95% chance of arriving on time, he or she would have to plan to leave one half hour earlier than if there were no congestion.

Tables 5 through 8 summarize PTI data for I-87 northbound and southbound for the AM and PM peak periods, respectively. PTI data shows that in the AM peak period, northbound I-87 operates with some minor congested segments, with a maximum PTI of 1.09 between Exits 1 and 2. Southbound I-87 is considerably more congested during the AM peak period, with a PTI of 1.96 between Exits 9 and 8A, 3.06 between Exits 8A and 8, and 2.37 from Exit 8 to the Twin Bridges.

During the PM peak period, northbound I-87 is congested between Exits 1 and 9, with PTIs reaching as high as 2.17 between Exits 2 and 4. Southbound I-87 is significantly less congested during the PM peak period with a maximum PTI of 1.27 between Exits 2 and 1.

Table 5. AM Peak Period Planning Time Index: I-87 Northbound, 2011, Weekdays

Link Name	95th Percentile Speed (mph)	Planning Time Index
I-87 Ex. 1-2 (NB)	51	1.09
I-87 Ex. 2-4 (NB)	53	1.05
I-87 Ex. 4-5 (NB)	58	0.95
I-87 Ex. 5-6 (NB)	53	1.04
I-87 Ex. 7 (NB)	53	1.04
I-87 Ex. 7 (north of) (NB)	55	1.01
I-87 Twin Br. (south of) (NB)	60	0.92
I-87 NB Riverview Rd.	57	0.97
I-87 Ex. 8 Twin Br. (NB)	58	0.95
I-87 Ex. 8-8A (NB)	60	0.92
I-87 Ex. 8A-9 (NB)	60	0.92
I-87 Ex. 10 Rest Area (NB)	62	0.89

Table 6. AM Peak Period Planning Time Index: I-87 Southbound, 2011, Weekdays

Link Name	95th Percentile Speed (mph)	Planning Time Index
I-87 Ex. 2-1 (SB)	40	1.39
I-87 Ex. 4-2 (SB)	48	1.14
I-87 Ex. 5-4 (SB)	53	1.03
I-87 Ex. 6-5 (SB)	48	1.16
I-87 Ex. 7 (SB)	60	0.92
I-87 Ex. 7 (north of) (SB)	48	1.14
I-87 Twin Br. (south of) (SB)	43	1.29
I-87 SB Riverview Rd.	38	1.43
I-87 Ex. 8-Twin Br. (SB)	23	2.37
I-87 Ex. 8A-8 (SB)	18	3.06
I-87 Ex. 9-8A (SB)	28	1.96
I-87 Ex. 10-9 (SB)	35	1.58

Table 7. PM Peak Period Planning Time Index: I-87 Northbound, 2011, Weekdays

Link Name	95th Percentile Speed (mph)	Planning Time Index
I-87 Ex. 1-2 (NB)	30	1.83
I-87 Ex. 2-4 (NB)	25	2.17
I-87 Ex. 4-5 (NB)	30	1.81
I-87 Ex. 5-6 (NB)	29	1.90
I-87 Ex. 7 (NB)	34	1.62
I-87 Ex. 7 (north of) (NB)	32	1.74
I-87 Twin Br. (south of) (NB)	49	1.12
I-87 NB Riverview Rd.	50	1.10
I-87 Ex. 8 Twin Br. (NB)	51	1.07
I-87 Ex. 8-8A (NB)	54	1.02
I-87 Ex. 8A-9 (NB)	55	1.00
I-87 Ex. 10 Rest Area (NB)	58	0.94

Table 8. PM Peak Period Planning Time Index: I-87 Southbound, 2011, Weekdays

Link Name	95th Percentile Speed (mph)	Planning Time Index
I-87 Ex. 2-1 (SB)	43	1.27
I-87 Ex. 4-2 (SB)	44	1.25
I-87 Ex. 5-4 (SB)	57	0.96
I-87 Ex. 6-5 (SB)	55	1.00
I-87 Ex. 7 (SB)	64	0.87
I-87 Ex. 7 (north of) (SB)	56	0.99
I-87 Twin Br. (south of) (SB)	59	0.93
I-87 SB Riverview Rd.	57	0.96
I-87 Ex. 8-Twin Br. (SB)	58	0.95
I-87 Ex. 8A-8 (SB)	49	1.12
I-87 Ex. 9-8A (SB)	56	0.98
I-87 Ex. 10-9 (SB)	57	0.96

2.8 Incidents

The ITE *Traffic Incident Management Handbook* defines an incident as “any non-recurring event that causes a reduction of roadway capacity or an abnormal increase in demand.” Under this definition, events such as traffic crashes, disabled vehicles, spilled cargo, highway maintenance and reconstruction projects, and special non-emergency events (e.g., ball games, concerts, or any other event that significantly affects roadway operations) are classified as an incident. The NYSDOT Region 1 Traffic Operations Center collects data on traffic incidents along I-87. The statistics below reflect the total number of incidents between 2008 and 2010.

Figures 15 and 16 present AM peak period (7AM – 9AM) incidents on I-87 northbound and southbound, respectively. During the AM peak period, the highest numbers of incidents occur in the southbound direction on I-87 in the sections between Exits 2 and 4, north of the Twin Bridges, and between Exits 9 and 10. Figures 17 and 18 present PM peak period (4PM – 6PM) traffic volumes on I-87 northbound and southbound, respectively. During the PM peak period, incidents are highest in the southbound direction between Exits 2 and 4 and between Exits 9 and 10. However, incidents are also high in the northbound direction north of the Twin Bridges.

Figures 19 and 20 present the number of incidents by type on I-87 northbound and southbound, respectively, between Exits 1 and 10 for the period covering 2008 through 2010. The largest number of incidents by far involved disabled vehicles. Accidents constituted the second largest number of recorded incidents. Tables 9 and 10 summarize average incident duration on I-87 northbound between Exits 1 and 10 between 2008 and 2010 during the AM and PM peak periods, respectively. Similarly, Tables 11 and 12 summarize average incident duration on I-87 southbound between Exits 1 and 10 between 2008 and 2010 during the AM and PM peak periods, respectively.

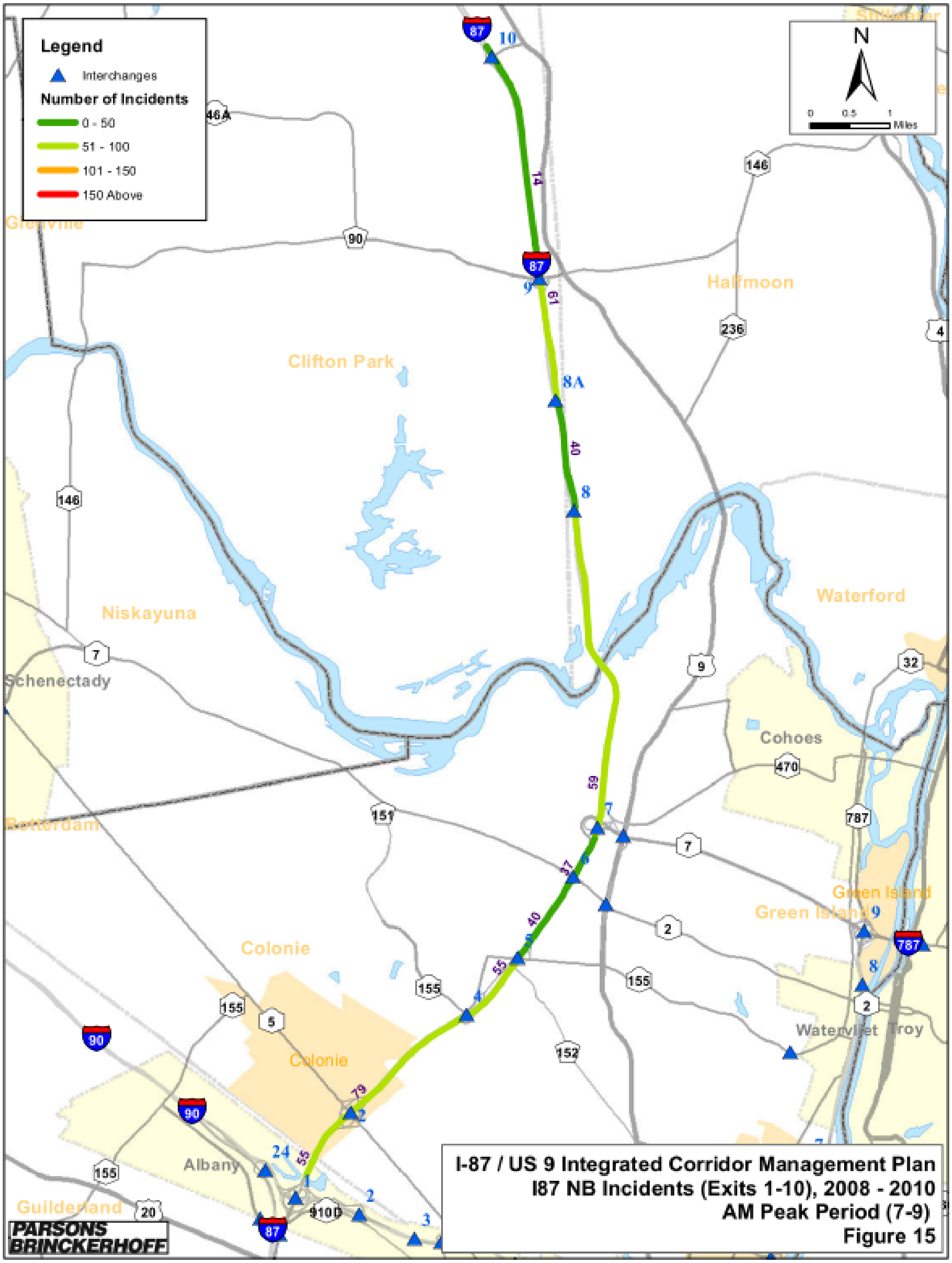
These tables address isolated incidents, not recurring delay associated with congestion or long-term construction projects. The longest delays are associated with unattended disabled vehicles, DOT maintenance activities, signal malfunctions at ramp termini, and water main breaks. In general, the incidents resulting in the longest delays occur infrequently.

CDTC’s *The Metropolitan Congestion Management Process* (May 29, 2007) uses the concept of “excess delay” as its primary measure of congestion.[1] Tables 13 through 16 summarize excess delay per vehicle and cumulatively for vehicles traveling northbound and southbound on I-87 during the AM and PM peak periods, respectively.

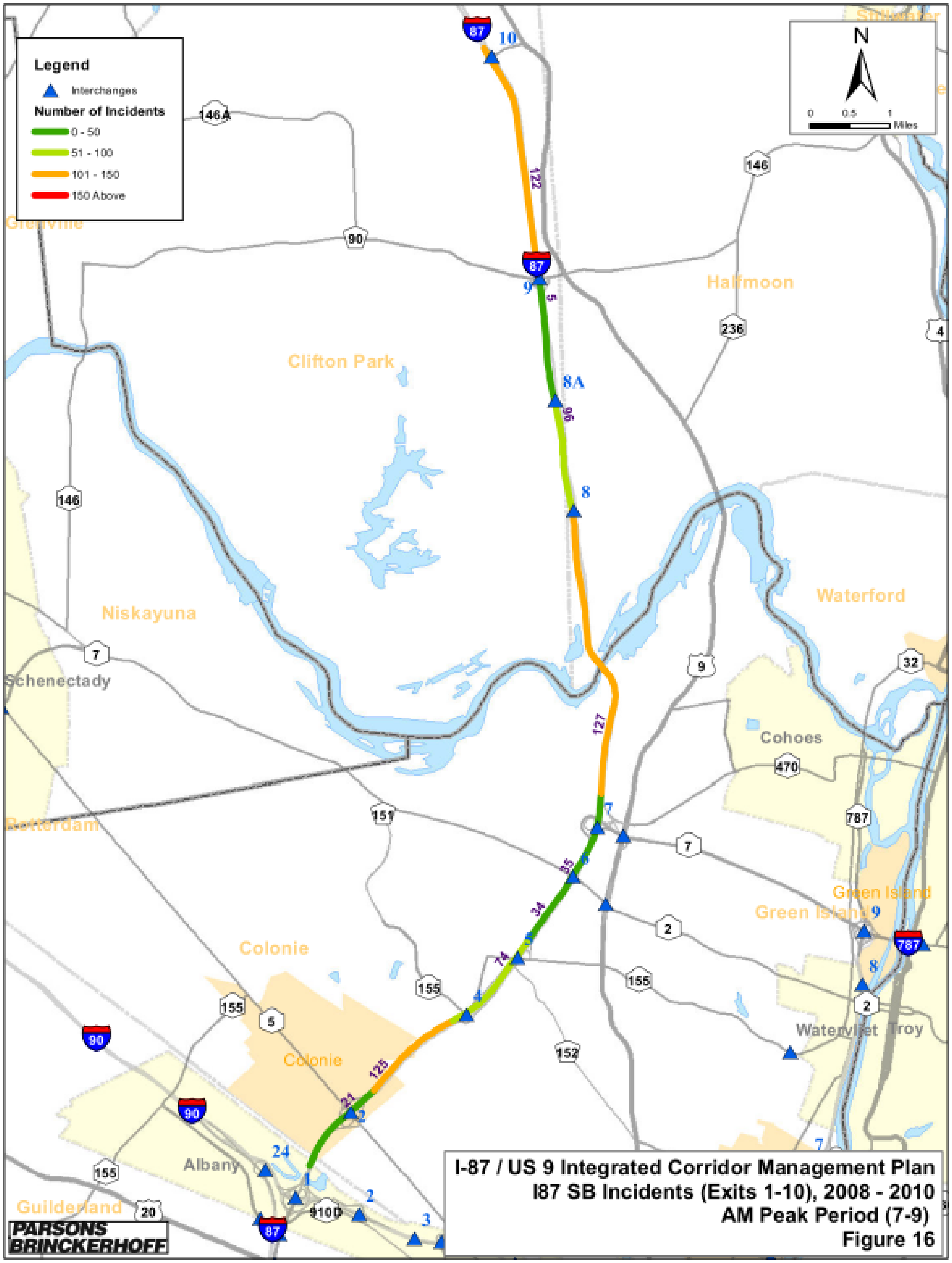
During the AM peak period, northbound I-87 experiences minor delays between Exits 2 and 6. Southbound, more delays are experienced throughout the corridor, with peak delays at the Twin Bridges. During the PM peak period, northbound I-87 drivers are delayed throughout

[1] CDTC in its Congestion Management Process defines “excess delay” as follows:
While all travel experiences some amount of delay (relative to free-flow speeds), excess delay is the amount of time spent at a given location that exceeds the maximum amount of time that is generally considered “acceptable.”
For auto travel excess delay is defined as the amount of time spend at an intersection or along a highway segment in Level-of-Service “E” or “F” conditions that exceeds the maximum LOS “D” time.

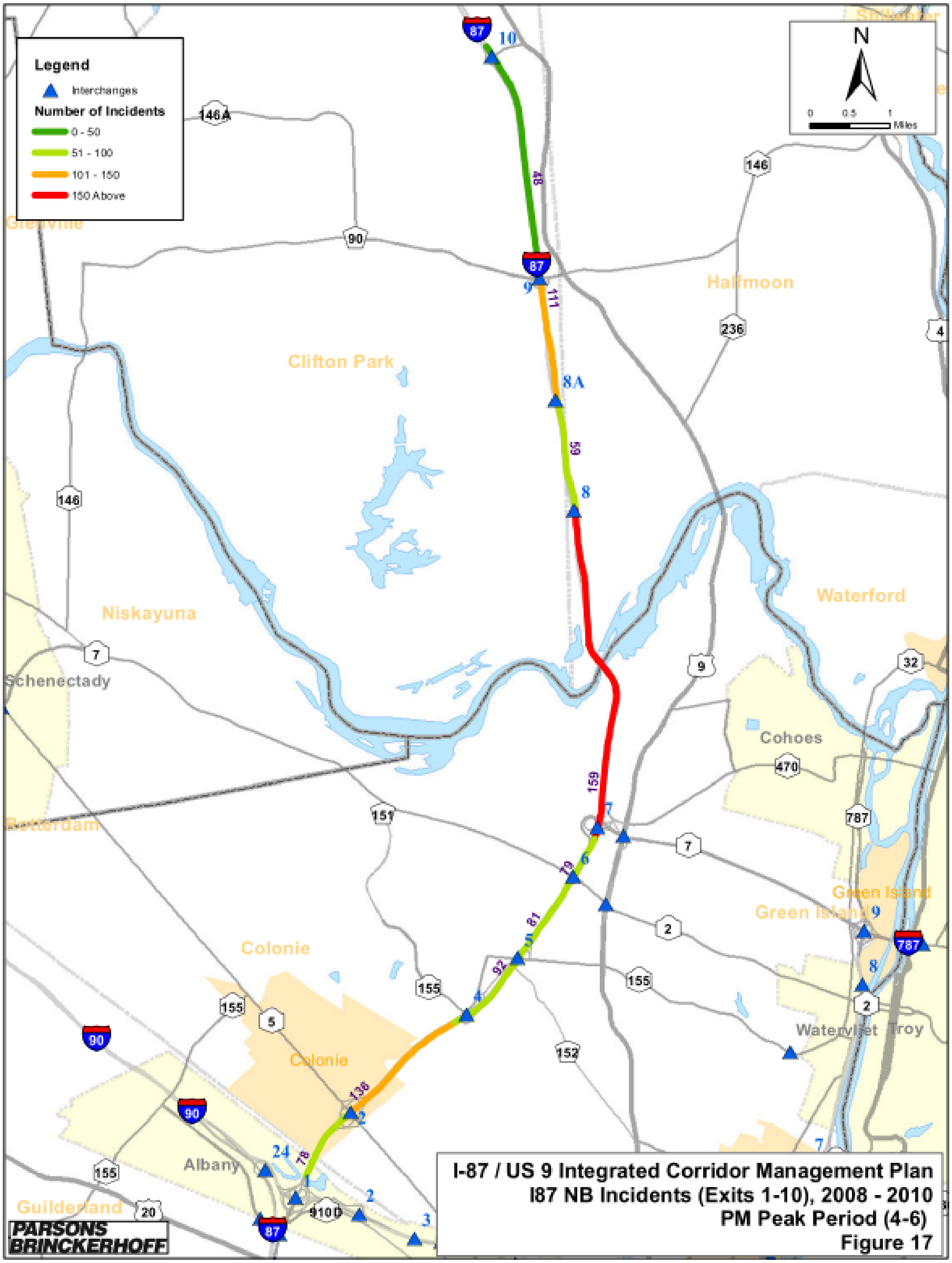
the corridor, with peak delays between Exits 2 and 4. Southbound travelers experience generally minor delay.

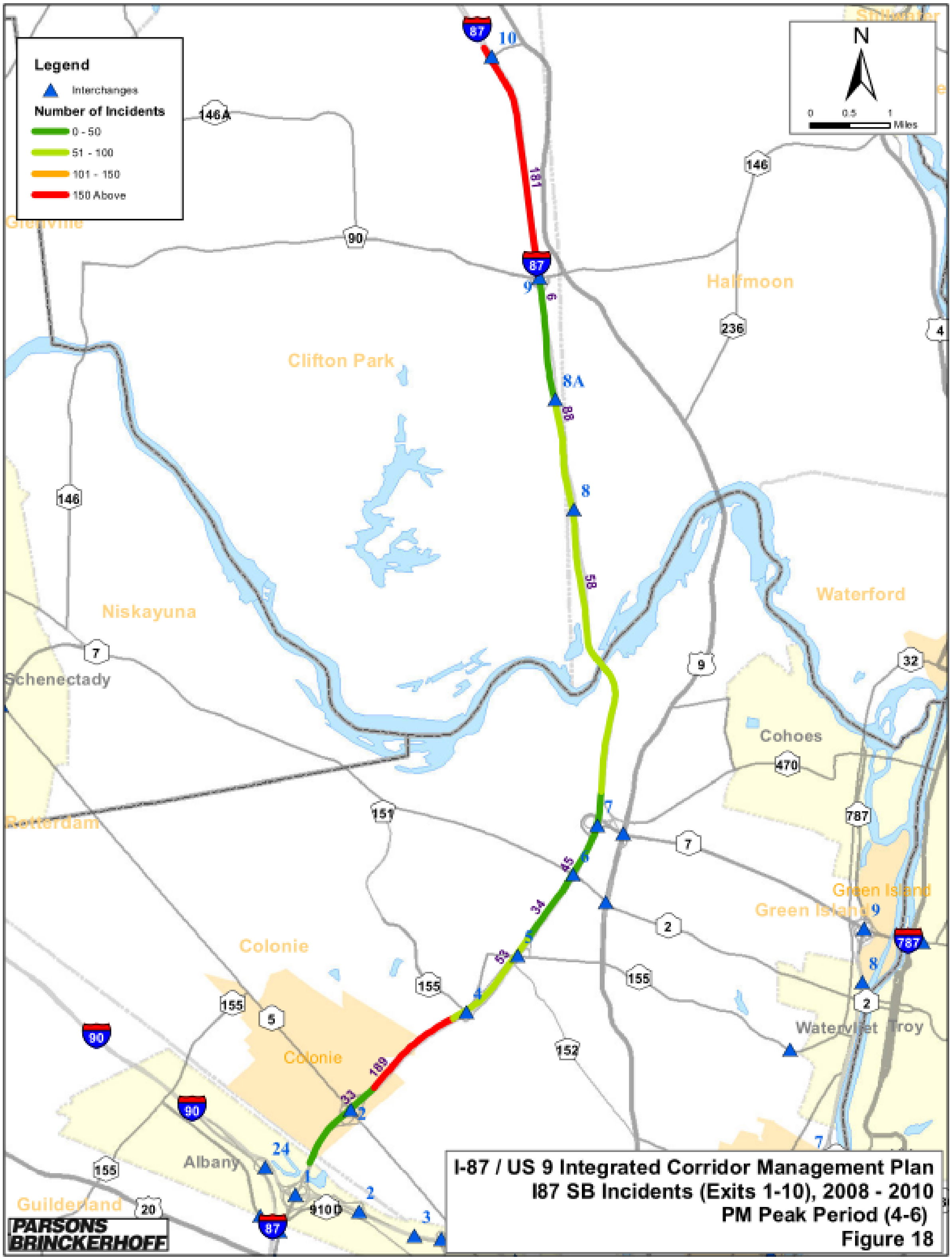


I-87 / US 9 Integrated Corridor Management Plan
I87 NB Incidents (Exits 1-10), 2008 - 2010
AM Peak Period (7-9)
Figure 15



I-87 / US 9 Integrated Corridor Management Plan
I87 SB Incidents (Exits 1-10), 2008 - 2010
AM Peak Period (7-9)
Figure 16


Legend
Interchanges
Number of Incidents
0 - 50
51 - 100
101 - 150
150 Above
N
Miles
Clifton Park
Halfmoon
Niskayuna
Waterford
Schenectady
Cohoes
Rotterdam
Colonie
Green Island
Watervliet
Troy
Albany
Guilderland
PARSONS BRINCKERHOFF
I-87 / US 9 Integrated Corridor Management Plan
I87 NB Incidents (Exits 1-10), 2008 - 2010
PM Peak Period (4-6)
Figure 17



I-87 / US 9 Integrated Corridor Management Plan
I87 SB Incidents (Exits 1-10), 2008 - 2010
PM Peak Period (4-6)
Figure 18

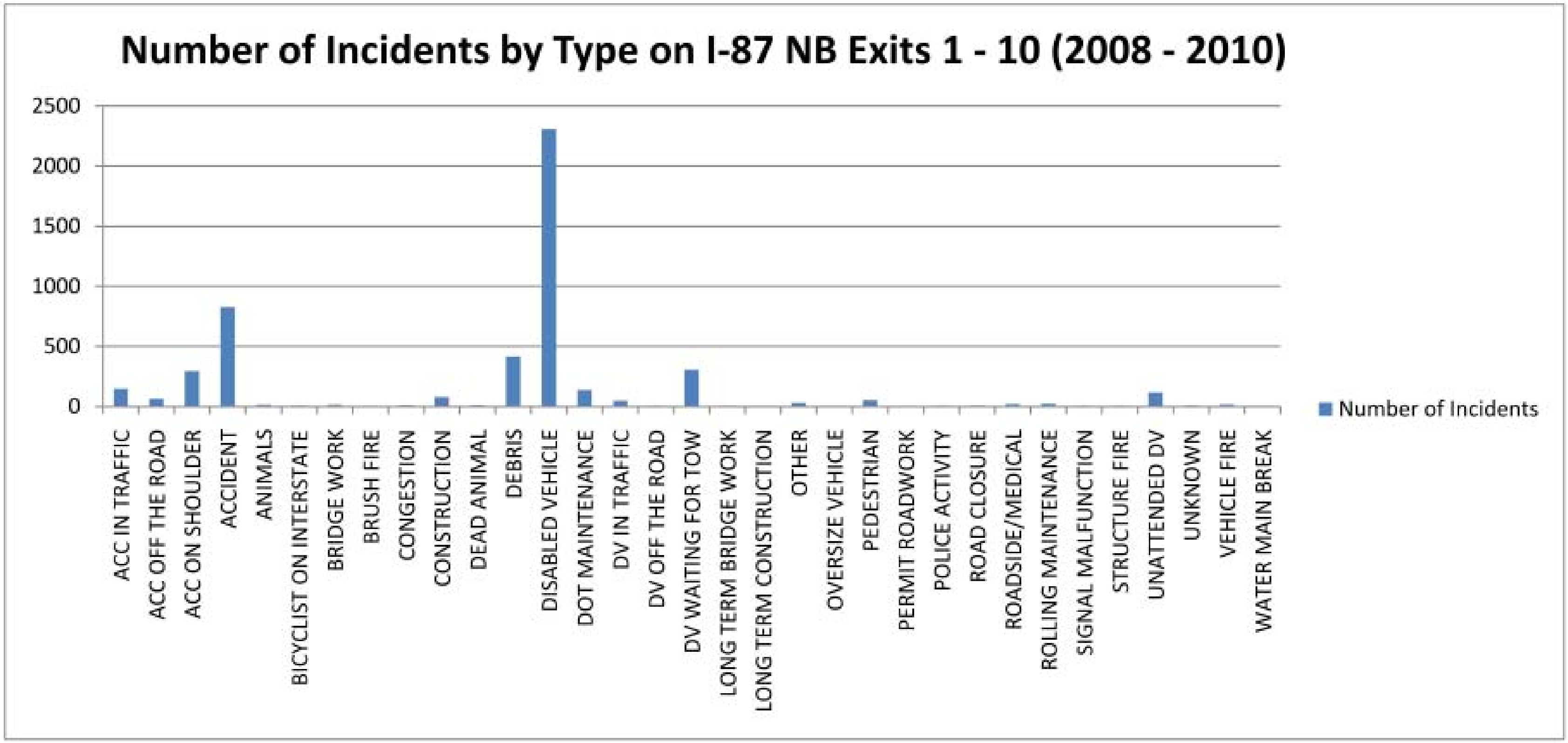

Number of Incidents by Type on I-87 NB Exits 1 - 10 (2008 - 2010)
2500
2000
1500
1000
500
0
ACC IN TRAFFIC
ACC OFF THE ROAD
ACC ON SHOULDER
ACCIDENT
ANIMALS
BICYCLIST ON INTERSTATE
BRIDGE WORK
BRUSH FIRE
CONGESTION
CONSTRUCTION
DEAD ANIMAL
DEBRIS
DISABLED VEHICLE
DOT MAINTENANCE
DV IN TRAFFIC
DV OFF THE ROAD
DV WAITING FOR TOW
LONG TERM BRIDGE WORK
LONG TERM CONSTRUCTION
OTHER
OVERSIZE VEHICLE
PEDESTRIAN
PERMIT ROADWORK
POLICE ACTIVITY
ROAD CLOSURE
ROADSIDE/MEDICAL
ROLLING MAINTENANCE
SIGNAL MALFUNCTION
STRUCTURE FIRE
UNATTENDED DV
UNKNOWN
VEHICLE FIRE
WATER MAIN BREAK
Number of Incidents

Figure 19

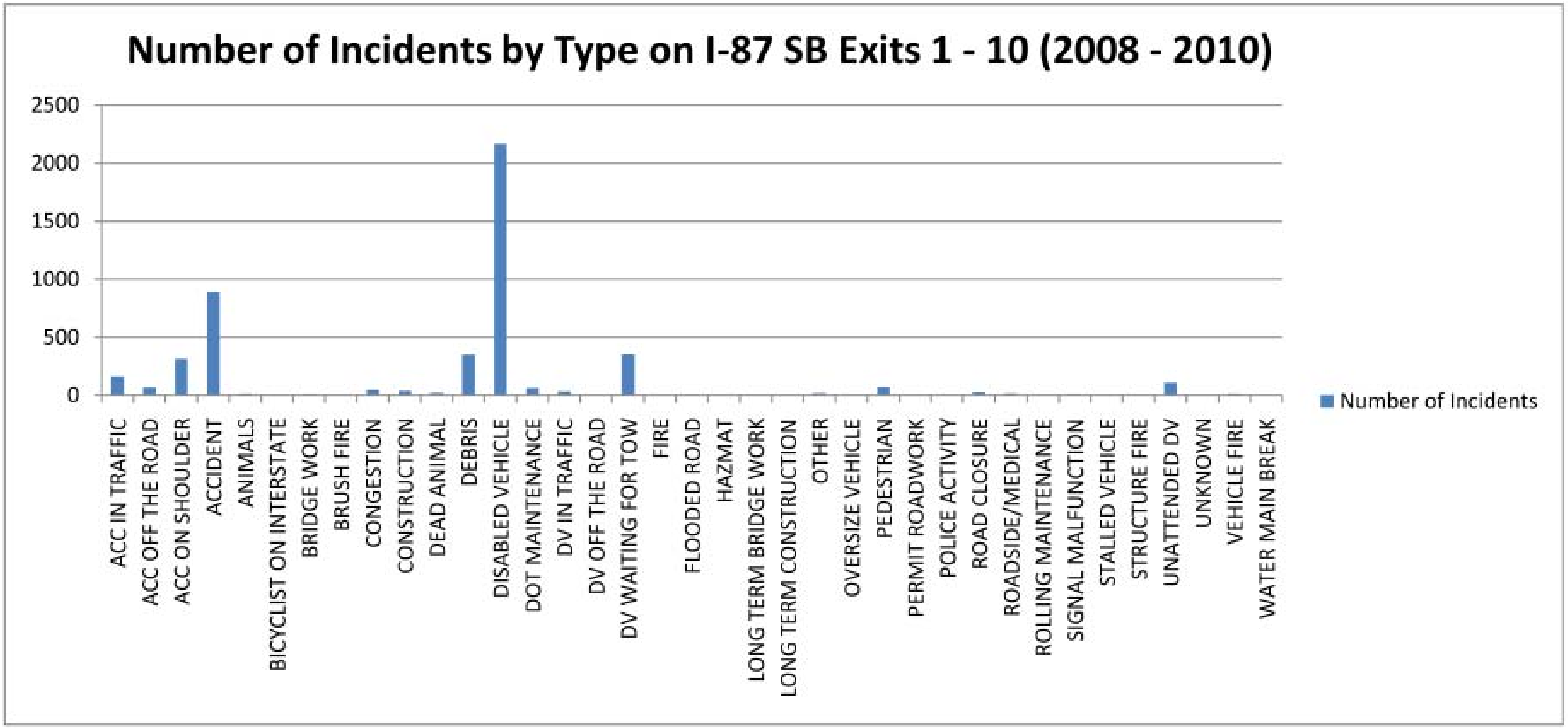

Number of Incidents by Type on I-87 SB Exits 1 - 10 (2008 - 2010)
2500
2000
1500
1000
500
0
ACC IN TRAFFIC
ACC OFF THE ROAD
ACC ON SHOULDER
ACCIDENT
ANIMALS
BICYCLIST ON INTERSTATE
BRIDGE WORK
BRUSH FIRE
CONGESTION
CONSTRUCTION
DEAD ANIMAL
DEBRIS
DISABLED VEHICLE
DOT MAINTENANCE
DV IN TRAFFIC
DV OFF THE ROAD
DV WAITING FOR TOW
FIRE
FLOODED ROAD
HAZMAT
LONG TERM BRIDGE WORK
LONG TERM CONSTRUCTION
OTHER
OVERSIZE VEHICLE
PEDESTRIAN
PERMIT ROADWORK
POLICE ACTIVITY
ROAD CLOSURE
ROADSIDE/MEDICAL
ROLLING MAINTENANCE
SIGNAL MALFUNCTION
STALLED VEHICLE
STRUCTURE FIRE
UNATTENDED DV
UNKNOWN
VEHICLE FIRE
WATER MAIN BREAK
Number of Incidents

Figure 20

Table 9: AM Peak Period (7 - 9 am) Incident Duration by Type (Minutes) on I-87 NB Exits 1 - 10 (2008 - 2010)

INCIDENT TYPE	AVGDuration_Minutes
ACC IN TRAFFIC	86
ACC OFF THE ROAD	167
ACC ON SHOULDER	104
ACCIDENT	232
ANIMALS	66
BICYCLIST ON INTERSTATE	9
CONGESTION	66
DEAD ANIMAL	324
DEBRIS	82
DISABLED VEHICLE	119
DOT MAINTENANCE	773
DV IN TRAFFIC	39
DV OFF THE ROAD	290
DV WAITING FOR TOW	103
OTHER	432
PEDESTRIAN	71
POLICE ACTIVITY	22
ROADSIDE/MEDICAL	41
UNATTENDED DV	990
UNKNOWN	20
VEHICLE FIRE	357

Table 10: PM Peak Period (4 - 6 pm) Incident Duration by Type (Minutes) on I-87 NB Exits 1 - 10 (2008 - 2010)

INCIDENT TYPE	AVGDuration_Minutes
ACC IN TRAFFIC	95
ACC OFF THE ROAD	103
ACC ON SHOULDER	108
ACCIDENT	148
ANIMALS	166
BICYCLIST ON INTERSTATE	85
BRUSH FIRE	97
CONGESTION	82
DEBRIS	123
DISABLED VEHICLE	103
DOT MAINTENANCE	939
DV IN TRAFFIC	75
DV WAITING FOR TOW	111
OTHER	108
PEDESTRIAN	66
POLICE ACTIVITY	165
ROAD CLOSURE	475
ROADSIDE/MEDICAL	65
SIGNAL MALFUNCTION	85
UNATTENDED DV	789
UNKNOWN	68
VEHICLE FIRE	38
WATER MAIN BREAK	767

Table 11 AM Peak Period (7 - 9 am) Incident Duration by Type (Minutes) on I-87 SB Exits 1 - 10 (2008 - 2010)

INCIDENT TYPE	AVGDuration_Minutes
ACC IN TRAFFIC	67
ACC OFF THE ROAD	240
ACC ON SHOULDER	66
ACCIDENT	176
ANIMALS	54
BICYCLIST ON INTERSTATE	94
CONGESTION	48
DEAD ANIMAL	266
DEBRIS	95
DISABLED VEHICLE	92
DOT MAINTENANCE	826
DV IN TRAFFIC	85
DV OFF THE ROAD	45
DV WAITING FOR TOW	84
OTHER	136
PEDESTRIAN	78
ROAD CLOSURE	240
ROADSIDE/MEDICAL	15
SIGNAL MALFUNCTION	198
STALLED VEHICLE	5
STRUCTURE FIRE	324
UNATTENDED DV	841
VEHICLE FIRE	116
WATER MAIN BREAK	1539

Table 12: PM Peak Period (4 - 6 pm) Incident Duration by Type (Minutes) on I-87 SB Exits 1 - 10 (2008 - 2010)

INCIDENT TYPE	AVGDuration_Minutes
ACC IN TRAFFIC	128
ACC OFF THE ROAD	85
ACC ON SHOULDER	117
ACCIDENT	133
ANIMALS	11
CONGESTION	44
DEAD ANIMAL	19
DEBRIS	118
DISABLED VEHICLE	113
DOT MAINTENANCE	316
DV IN TRAFFIC	62
DV WAITING FOR TOW	124
FLOODED ROAD	45
OTHER	611
PEDESTRIAN	58
ROAD CLOSURE	241
ROADSIDE/MEDICAL	119
SIGNAL MALFUNCTION	114
UNATTENDED DV	654
UNKNOWN	232
VEHICLE FIRE	120

Table 13

I87ICM: Excess Vehicle Hours of Delay (EVHD)

I87 North Exits 1-10, AM Peak (7-9), May, 2010

Link Name	EVHD (Minutes)	Delay (veh * hours)
Route Name **I-87 North Exits 1-10**		
I-87 Ex. 1-2 (NB)	0.00	39.0
I-87 Ex. 2-4 (NB)	0.20	13.3
I-87 Ex. 5-6 (NB)	0.10	31.9
I-87 Ex. 7 (NB)	0.00	52.9
I-87 Ex. 7 (north of) (NB)	0.00	1.7
I-87 Ex. 8-8A (NB)	0.00	345.9
I-87 Ex. 8A-9 (NB)	0.00	163.6
I-87 Ex. 10 Rest Area (NB)	0.00	202.5
Route Delay:	0.30	850.8

Table 14

I87ICM: Excess Vehicle Hours of Delay (EVHD)

I87 South Exits 10-1, AM Peak (7-9), May, 2010

Link Name	EVHD (Minutes)	Delay (veh * hours)
Route Name **I-87 South Exits 10-1**		
I-87 Ex. 4-2 (SB)	0.00	128.8
I-87 Ex. 6-5 (SB)	0.10	25.1
I-87 Ex. 7 (North of) (SB)	0.00	81.6
I-87 Ex. 8A-8 (SB)	0.40	11751.0
I-87 Ex. 8-Twin Br. (SB)	0.90	9293.4
I-87 Ex. 10-9 (SB)	0.10	1986.9
I-87 Ex. 2-1 (SB)	0.20	17.7
I-87 Ex. 9-8A (SB)	0.20	5134.8
I-87 SB Riverview Rd.	0.10	702.8
I-87 Twin Br. (south of) (SB)	0.30	1063.6
Route Delay:	2.30	30185.7

Table 15

I87ICM: Excess Vehicle Hours of Delay (EVHD)

I87 North Exits 1-10, PM Peak (4-6), May, 2010

Link Name	EVHD (Minutes)	Delay (veh * hours)
Route Name **I-87 North Exits 1-10**		
I-87 Ex. 1-2 (NB)	0.10	1153.3
I-87 Ex. 2-4 (NB)	0.80	3534.6
I-87 Ex. 5-6 (NB)	0.20	1616.0
I-87 Ex. 7 (NB)	0.20	1346.3
I-87 Ex. 7 (north of) (NB)	0.30	5532.3
I-87 Ex. 8 Twin Br. (NB)	0.10	42.5
I-87 Ex. 8-8A (NB)	0.10	1453.5
I-87 Ex. 8A-9 (NB)	0.10	876.4
I-87 Ex. 10 Rest Area (NB)	0.00	790.3
I-87 NB Riverview Rd.	0.20	146.4
I-87 Twin Br. (south of) (NB)	0.10	22.0
Route Delay:	2.20	16513.6

Table 16

I87ICM: Excess Vehicle Hours of Delay (EVHD)

I87 South Exits 10-1, PM Peak (4-6), May, 2010

Link Name	EVHD (Minutes)	Delay (veh * hours)
Route Name **I-87 South Exits 10-1**		
I-87 Ex. 4-2 (SB)	0.00	53.4
I-87 Ex. 8A-8 (SB)	0.10	879.1
I-87 Ex. 10-9 (SB)	0.10	1738.9
I-87 Ex. 2-1 (SB)	0.00	12.0
I-87 Ex. 9-8A (SB)	0.10	650.3
I-87 Twin Br. (south of) (SB)	0.10	11.8
Route Delay:	0.40	3345.5

2.9 I-87 Peak Period Conditions

2.9.1 AM Peak Period

In the southbound (peak) direction, traffic volumes are highest between Exits 2 and 10, while speeds are lowest between the Twin Bridges and Exit 10. Incidents are highest between Exits 2 and 4, the Twin Bridges and Exit 8, and between Exits 9 and 10. In the northbound (off-peak) direction, traffic volumes are highest and speeds are lowest between Exits 1 and 2. Incidents are relatively low throughout the corridor.

2.9.2 PM Peak Period

In the southbound (off-peak) direction, traffic volumes are highest and speeds are lowest between Exits 2 and 4. Incidents are highest between Exits 2 and 4, and between Exits 9 and 10. In the northbound (peak) direction, traffic volumes are highest between Exits 1 and 10, while speeds are lowest between Exit 1 and the Twin Bridges. Incidents are highest between Exits 2 and 4, the Twin Bridges and Exit 8, and between Exits 9 and 10.

2.10 US 9 Access Characteristics and Development Areas

A primary role of US 9 is to serve through traffic. Providing direct access to abutting land is secondary. Access to parcels is regulated through the local municipality's zoning code and site plan review process. Additional regulation is provided through the application for a NYSDOT Highway Work Permit on a site-by-site basis. There is no corridor-wide master plan, and NYSDOT's ability to control access is limited given control by the municipality.

An access density assessment was completed to identify the number of driveways per mile on US 9. In general, a higher number of unsignalized access points per mile correlates to higher crash rate. Fewer access points per mile generally results in a lower crash rate. Figure 21 on the following page shows a single section of US 9 (shown in red) with more than 50 unsignalized access points per mile at the southernmost end of the study area. There are also several areas of the corridor with between 40 and 50 unsignalized access points per mile. These are areas of the corridor with more development and consequently more driveways. The segments of the corridor shown in green are those with fewer than 40 unsignalized access points per mile. These sections of the corridor have generally experienced less development pressure and are characterized by large sections of undeveloped land.

CDTC completed a parcel access assessment which identifies the parcels on US 9 that have signalized access to US 9 or those that have access to a side street. This becomes important as access management strives to maximize the number of parcels that have access to mainline traffic through a signalized side street intersection. Identification of parcels with side street access helps to inform decisions identifying locations where providing inter parcel connections will have the most benefit.

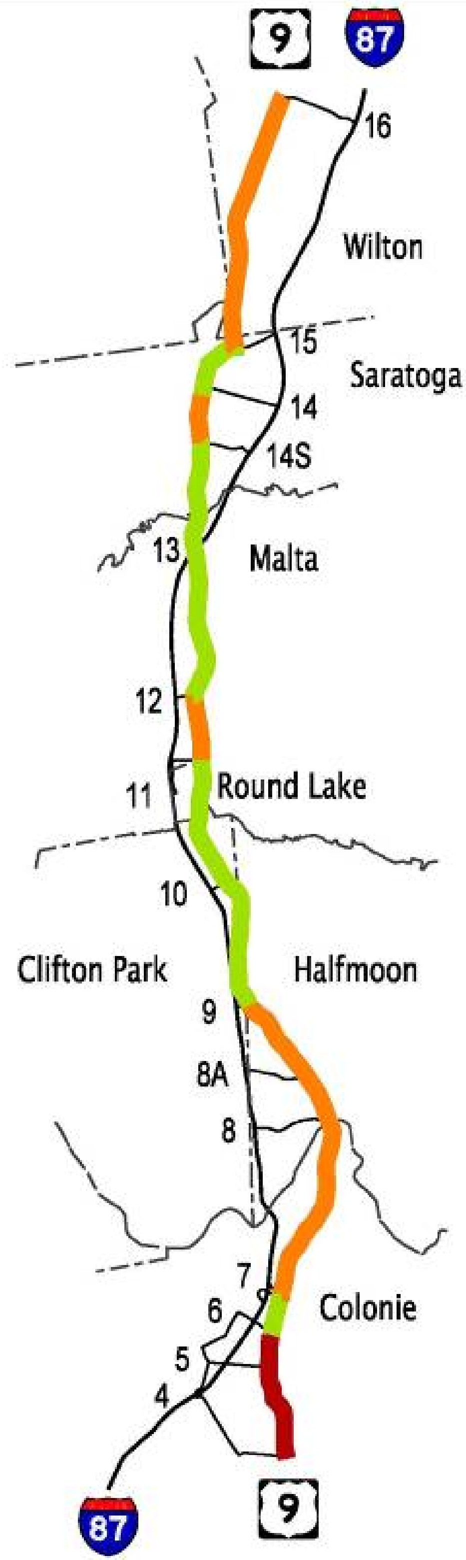
In addition to the parcel assessments, a field review of the US 9 corridor identified over 165 underutilized or vacant parcels. These were a combination of empty and abandoned buildings, plazas with empty storefronts, and undeveloped greenfields. The plethora of available land shows that there is significant growth potential along US 9. Build out of these developable parcels will increase the number of vehicles and driveways along US 9 and illustrate the importance of pursuing corridor management techniques throughout the corridor.

Plot size versions of the maps were used at stakeholder meetings to get municipal planners and NYSDOT to comment on access management and parcel development. An appendix on access management was never developed because consensus on access management recommendations was never reached.

2.11 Planned Improvements

The CDTC's *New Visions for a Quality Region (2030)* plan adopted in October 2007 established the Region's commitment to maintaining and managing the existing transportation system rather than funding capacity improvements for single-occupant passenger vehicles. This commitment is an effort to create a cost-effective, sustainable transportation system, combat sprawl, and reduce greenhouse gas emissions. New Visions 2030 identified managed lanes as a potential "Big Idea" future transportation initiative. Construction of additional lanes along I-87 to be operated as managed use lanes would significantly increase the person carrying capacity of I-87 and promote carpooling and transit use. In 2011, CDTC reassessed the 2030 plan in light of recent events, and reaffirmed the validity of plan content through the adoption of the *New Visions 2035 Plan Update*. However, there are no plans to provide additional general purpose travel lanes on I-87 within the study area within the foreseeable future.

Figure 21. US 9 Access Density



There are a number of short-term (less than three years) improvements expected to be completed along the study roadways and intersections. Table 17 identifies projects identified in the Transportation Improvement Program (TIP) expected to be completed in the short-term.

Table 17. Transportation Improvement Projects

Municipality	Project Name	Project Identification Number	Federal Fiscal Year Funding
Multiple	Crescent Road Bike and Pedestrian Improvements	1757.36	2012–2014
Saratoga Springs	NY50 Bridge over I-87 at Exit 15: Bridge Rehabilitation or Repair	1722.23	2013-2014
Multiple	I-87 from Exit 13-15: Resurfacing	1722.05	2014-2016
Multiple	NY50, North of Saratoga Springs: Reconstruction	1096.18	2017-2018
Multiple	NY67 from I-87 to NY50: Resurfacing	1188.31	2014-2015
Multiple	Round Lake Road Traffic & Mobility Improvements	1757.54	2012-2015
Colonie	NY7 from I-87 to I-787 Overlap: Minor Rehabilitation	1306.77	2017-2018
Colonie	I-87 over Shaker Rd.: Exit 4 Improvements Part 1	1721.51	2014-2018
Albany	NY85 from NYS Thruway Bridge to I-90	1125.18	2013-2015
Albany	Washington Avenue over NY85: Bridge Replacement or Repair	1806.45	2013-2014
Albany	ITS Transit Signal Priority on Washington Avenue	1756.63	2012-2014
Albany	ITS Transit Signal Priority on Western Avenue	1756.63	2013-2014
Guilderland	Western Avenue from Fuller Road to Albany City Line: Sidewalk Construction	1808.01	2013-2014

Source: Capital District Transportation Committee, Transportation Improvement Program (TIP) June 6, 2013.

3 ICM Plan Operational Concept

3.1 System Overview

The I-87/US 9 corridor in the Capital Region experiences significant recurring and non-recurring congestion. Currently, the corridor has a very active ITS program to manage traffic flow on the main lanes of I-87. Implementation of a more corridor-based management approach is being explored to determine the strategies that can be considered to improve the overall throughput in the corridor and better serve the transportation needs of all users. These strategies fall into the broad category of "ICM", which is defined as:

> "The operational coordination of multiple transportation networks and cross-network connections comprising a corridor, and the coordination of institutions responsible for corridor mobility. ICM implementation can involve policy, cooperation among entities, sharing of physical assets and resources, and use of communications. Integrated Corridor Management may result in the deployment of an actual transportation management system connecting the individual network-based transportation management systems; or integrated corridor management may just be a set of operational procedures – agreed to by the network owners – with appropriate linkages between their respective systems."

The ICM strategies that were explored through the stakeholder involvement process are summarized in Table 18. Most of these strategies are supported (and made operational) through the use of ITS, where ITS is defined as the "application of advanced electronics, computers, communications, and sensor technologies."

Table 18. ICM Strategies and Supporting Technologies

Incident and Special Event Management • Detection and Verification • Response	**Active Traffic Management** • Variable Speed Displays • Dynamic Lane Assignment • Queue Warning • Hard Shoulder Running	**ICM & Regional Coordination** • Information Sharing • Accommodate Diversions and Modal Shifts • Manage Capacity – Demand Relationship
Traveler Information • Web/ 511 • Dynamic Message Signs • In-vehicle • Marketing Campaign	**Managed Lanes** • High Occupancy Vehicles • High Occupancy/ Tolls • Express Toll • Bus Only	**Supporting Technologies** • Detection and Surveillance (traffic flow, CCTV, vehicle location, road conditions/ weather) • Transportation Management Centers • ATMS Software • Communications • System interfaces and standards
Ramp Management • Metering • Closures/ Gates • Junction Control • Bus Queue Jumping	**Arterial Management** • Traffic Signal Control • Transit Signal Priority • Bus Rapid Transit • Bottleneck Improvements	

ICM strategies were developed for two different temporal perspectives:

- **Long Term** – The ICM strategies recommended for on-going I-87 operations. While many of these recommendations are not expected to become operational for several years, certain roadway elements for these recommendations (e.g., foundations, shoulder and ramp re-configuration and widening, conduits) need to be designed, budgeted and constructed.
- **Short Term** – Those ICM strategies recommended for deployment that do not include major roadway construction elements for quick implementation. In general, these recommendations address operational improvements in the corridor that may be used to increase corridor throughput without major construction activities.

3.2 Operational Concept

Currently, the main lanes of I-87 are actively managed through the NYSDOT Region 1 Traffic Operations Center (TOC). The center is staffed 24 hours per day, 365 days per year. All incident response activities on I-87 are coordinated through the Region 1 TOC. They have access to detectors, CCTV, and DMS devices and implement response scenarios based on prevailing conditions. This review will explore the ability to expand the geographic scope of the TOC to include the parallel arterial, US 9, and explore additional traffic management strategies.

Through the stakeholder involvement process, an operational concept has emerged that provides opportunity to enhance traffic operations in the corridor. The concept includes a set of strategies which include:

- Active Traffic Management (ATM) on the main lanes
- Enhanced data collection on the alternate route – US 9
- Travel time data and dissemination in the corridor
- Alternative route guidance signing
- Targeted corridor traveler information

3.3 Active Traffic Management

ATM is defined as the ability to dynamically manage recurrent and non-recurrent congestion based on prevailing traffic conditions. ATM can encompass many strategies such as:

- Speed harmonization
- Variable speed limits
- Dynamic lane assignment
- Queue warning
- Hard shoulder running
- Ramp metering

3.3.1 I-87 Speed Harmonization

Speed harmonization focuses on stabilizing the speed distribution such that differences between the highest and lowest vehicle speeds are minimized. This results in more uniform traffic flow, thereby promoting safety. Speed harmonization can also help to reduce flow breakdown and the onset of stop-and-go driving behavior in support of improved mobility. Speed harmonization strategies include:

- **Variable Speed Displays** are set (and varied) according to prevalent roadway and operating conditions, including visibility, weather, lane constraints (e.g., work zones), crashes and other incidents, and real-time traffic flows/ congestion levels. Variable speed displays may be advisory or regulatory. If they are regulatory (i.e., variable speed limits, or VSL), they are legal speed limits for which a motorist can receive a citation if they exceed the posted limit. If they are advisory, a motorist cannot be cited for a speed limit violation unless, in the officer's judgment, they are driving too fast for the prevailing conditions. Regulatory speed displays would be the responsibility of NYSDOT's Main Office.

- **Dynamic Lane Assignment (DLA)** consist of lane control signals, typically installed in conjunction with variable speed displays, providing advance notice that a lane(s) is closed ahead and to start the merge process into the available lanes well in advance of the actual closure.

- **Queue Warning** involves the use of warning signs, and in some instances, flashing lights, to alert motorists of downstream queues. Queue warning can be used in conjunction with variable speed displays (to slow traffic), and with lane control signals (to direct traffic to alternate lanes if the queuing is caused by a blocked lane). In some applications, the cause of the queue (e.g., crash, maintenance activities, and other congestion) is also displayed.

ATM has been widely used in Europe (e.g., UK, Netherlands, and Germany) with significant benefits, as summarized in Table 19. ATM has recently been introduced in the United States – in Seattle and Minneapolis – as part of the FHWA Urban Partnership Agreement (UPA). Seattle's "Smarter Highway" signage (see Figure 22) includes signs over each lane which is blank when the traffic is flowing normally. When traffic begins to slow down, the signs display regulatory speed limits (less than the normal 60 mph). The signs can also be used to display directional arrows for dynamic lane control, although speed limits and lane control are not shown in an alternating sequence, as was originally planned. Traffic information Dynamic Message Signs (DMS) on the VSL gantries are used to provide warnings and other text-based information to the drivers.

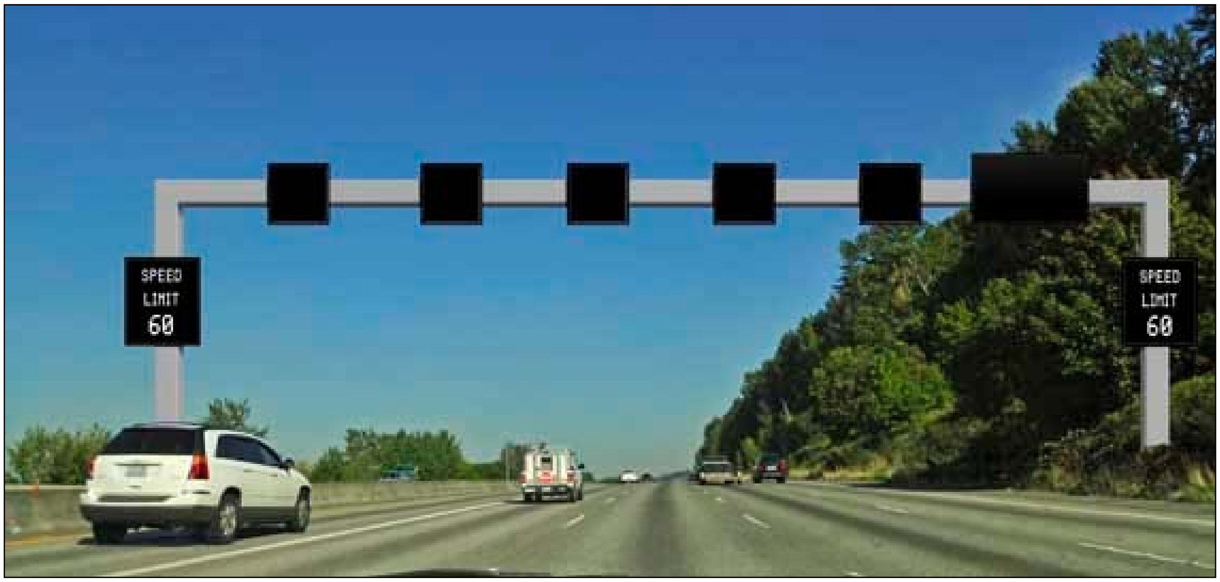
Table 19. Benefits from ATM Systems in Europe

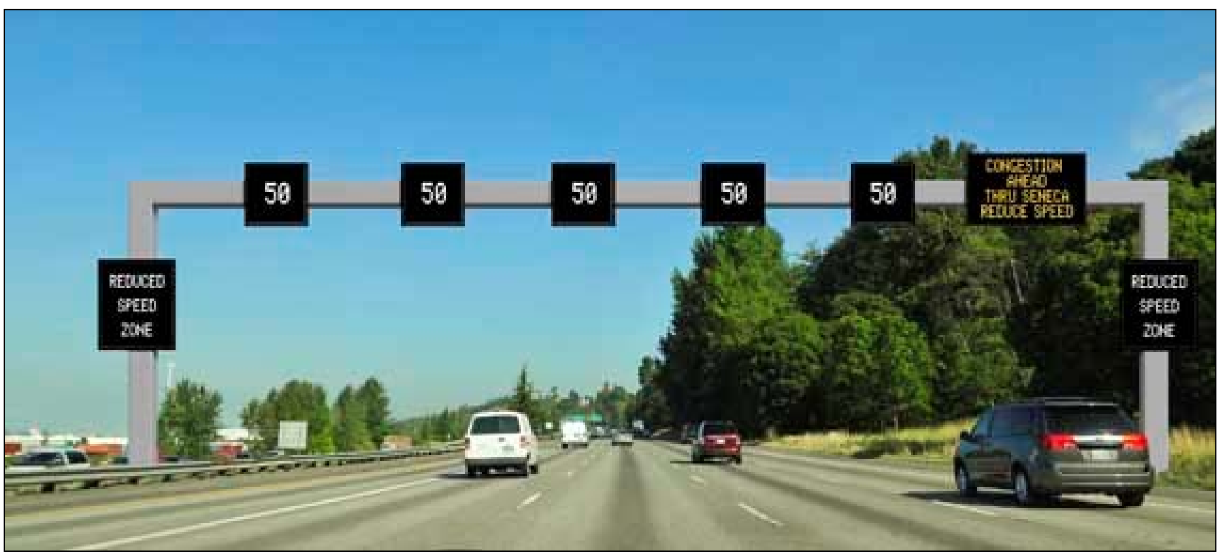
- The FHWA 2006 International Scan of ATM systems in Europe identified multiple benefits. Depending on the location and the combination of strategies deployed, specific ATM benefits as measured in Europe included:
  - increase in average throughput for congested periods of 3 to 7%
  - increase in overall capacity of 3 to 22%
  - decrease in primary incidents of 3 to 30%
  - decrease in secondary incidents of 40 to 50%
- An evaluation of the "Managed Motorway System" on the M25 (London Orbital) in the UK – consisting of variable speed limits and dynamic lane assignment – showed a decrease in the number of shockwaves, with a reduction from a typical seven shockwaves per morning rush hour, down to a typical five. Other benefits included:
  - injury accidents decreased by 10 percent
  - damage-only accidents decreased by 30 percent

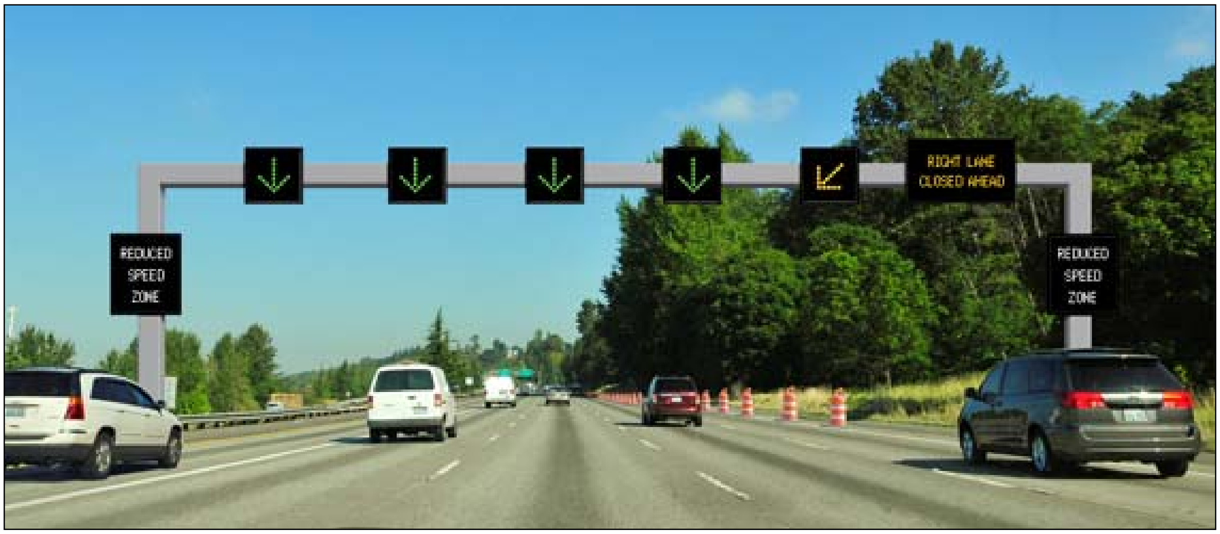
- emissions decreased overall by between 2 percent and 8 percent
- weekday traffic noise adjacent to the scheme was reduced by 0.7 dB.

- ATM on the A9 in Germany has resulted in major reductions in accidents (e.g., a 35% reduction in the number of accidents and a 31% reduction in the number of injuries), plus fewer bottlenecks and more throughput during peak hours.

Figure 22. Seattle Variable Speed Limits and DLA Signage





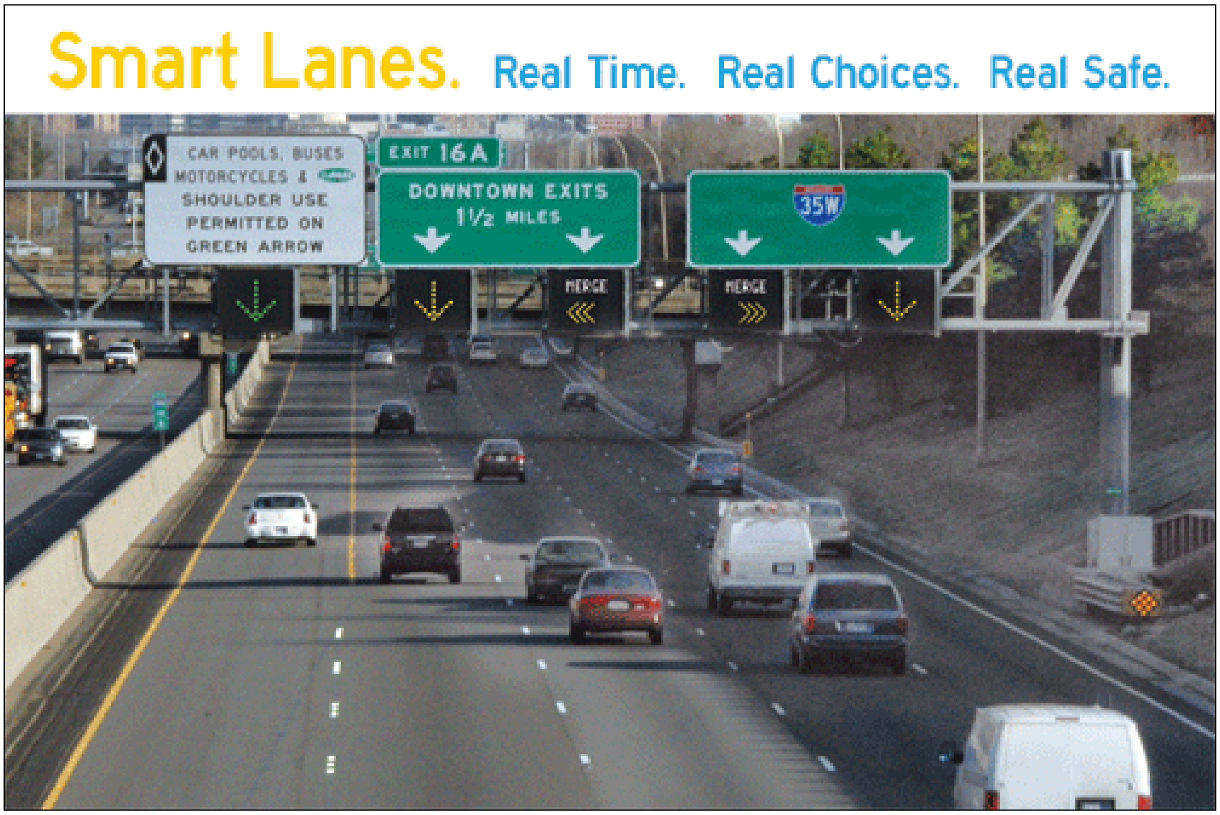


The Minneapolis “Smart Lanes” system and signage (see Figure 23) differs from Seattle in that the posted speeds are advisory. Like Seattle, the signs, one over each lane, can also display directional arrows for dynamic lane control. Lane control signs and in-pavement signals are also applied to the Express Lane (HOT) Operation.

Figure 23. Minneapolis Speed Advisory and DLA Signage

Express Lane Closed/ No Speed Advisories

Express Lane Open/ Speed Advisories



Express Lane Open/ Dynamic Lane Assignment

Other states are also in various stages of developing ATM systems. The Colorado Department of Transportation is developing a comprehensive ATM program to address safety and congestion problems on several critical interstate highway segments. The program is envisioned to include multiple projects, including "pilot" or demonstration projects to test out new technologies at key locations. The current operational concept is to utilize Color Dynamic Message Signs (CDMS) that can display MUTCD–compliant signs and other messages as appropriate. These overhead CDMS will be placed downstream of all entrance ramps. To reduce costs and still reinforce the reduced posted speed, ground-mounted roadside "tweener" signs are envisioned with frequent spacing between the CDMS.

3.3.2 I-87 Hard Shoulder Running

Hard Shoulder Running (HSR) is another ATM strategy, one that is focused more on congestion relief. HSR is the temporary use of the outside or inside paved shoulder as a travel lane. Often hard shoulder running use is limited to the AM and/or PM peak periods when recurrent congestion most often occurs, increasing available capacity and decreasing congestion during these periods. In other instances, hard shoulder running may be a means to improve traffic flow in the general purpose lanes during incidents and special events. In most cases, hard shoulder running is implemented in conjunction with variable speed displays and dynamic lane assignment and control systems; although it can operate alone as is done in the Boston area and in Northern Virginia (see Figure 24).

Figure 24. HSR Signage in Northern Virginia

Hard shoulder running would require resolution of a number of issues. For example, I-87 provides only 10-foot shoulders along most of its length in the study area, but no shoulders are provided on the Twin Bridges. Existing rumple strips on the current shoulders are generally located where a vehicle's wheels would be positioned while driving on the shoulder. Vehicle interactions at ramps and weaving areas require study as does the structural capacity of the ramps.

Other issues include the potential impact on driver safety vis-à-vis any drainage facilities in the shoulder, and the provision for emergency refuge areas for disabled vehicles when HSR is in operation.

A potential example of signing hard shoulder running is provided in Figure 25, showing the sign displays when the shoulder is closed and a lane closure and reduced speed "advisories" (rather than "limits") are in effect for a work zone. Other potential operational issues include:

- Procedures for commencing HSR operations (e.g., visual check via CCTV, communications with service patrols and police to ensure no disabled vehicles are currently in the shoulder)
- Procedures for an unscheduled ending of HSR operations (e.g., incident requiring rapid emergency response – response vehicles can use the shoulder to reach the incident site)

Figure 25. Sample Sign Displays for ATM and HSR

3.4 US 9 Enhanced Data Collection

In order to optimize traffic throughput in the I-87 corridor, the motorist will need to need convinced to divert from their normal route to an alternate route where they are less familiar. The most effective method to induce a route change involves providing the following:

- Travel time information on route choices
- Route guidance on the alternate route
- Real time traffic information and condition status

Travel times should be collected on the main lanes of I-87 and the desired alternate, US 9 arterial. The information should be displayed on the DMS, 511 website, shared with the media, and available to third party apps (on Smartphone, MY511, GPS route guidance systems, etc.). Data collection should be accurate and include travel times for the individual segments which can be aggregated to accurately reflect the bottlenecks that may exist in the corridor. Travel time segments should include the following segments:

- I-87 Main Lanes in both directions between:
  - I-90 to NYS Route 5 (Central Avenue), Exit 1 and Exit 2
  - NYS Route 5 (Central Avenue) to NYS Route 155 (Shaker Road), Exit 2 and Exit 4
  - NYS Route 155 (Shaker Road) to Watervliet Shaker Road, Exit 4 and Exit 5
  - Watervliet Shaker Road and NYS Route 2 (Troy Schenectady Road), Exit 5 and Exit 6
  - NYS Route 2 (Troy Schenectady Road) to NYS Route 7
  - NYS Route 7 to the Twin Bridges
  - Twin Bridges to County Road 92 (Crescent Road)
  - Road 92 (Crescent Road) to County Road 91 (Grooms Road)
  - County Road 91 (Grooms Road) to Route 146
  - NYS Route 146 to Ushers Road (Exit 10)
  - Ushers Road (Exit 10) to Round Lake-Curry Road (Exit 11)
  - Round Lake-Curry Road (Exit 11) to NYS Route 67 (Dunning Street, Exit 12)
  - NYS Route 67 (Dunning Street, Exit 12) to US 9 (Exit 13)
  - US 9 (Exit 13) to NYS Route 9P (Union Avenue, Exit 14)
- Wolf Road
  - I-87 to NYS Route 5 (Central Avenue), to Wolf Road, to NYS Route 155 (Shaker Road), to I-87
- US 9 arterial and connecting facilities in both directions for each leg of route:
  - I-87 to Watervliet Shaker Road, to US 9, to NYS Route 7, to I-87
  - I-87 to NYS Route 7, to Crescent Road, to I-87
  - I-87 to Crescent Road to US 9 to Grooms Road to I-87
  - I-87 to Grooms Road to US 9 to Route 146 to I-87
  - I-87 to NYS Route 146, to US 9, to NYS Route 67, to I-87
  - I-87 to NYS Route 67, to US 9, to I-87 (at Exit 13)
  - I-87 to US 9 (at Exit 13), to Union Avenue, to I-87

Travel times can be obtained using a variety of technologies and vendor products. The travel times on the I-87 main lanes can be obtained through subscription services (such as INRX and Mygistics), probe technology (TRANSMIT which is currently used on the Thruway), and spot speeds from radar detectors, micro wave detectors, or speed traps (using inductive loops). Probe based technologies tend to offer more accurate travel times in the freeway environment.

Travel times on the arterials can be gathered from in-pavement sensors (such as the Synsys detector array), speed traps (using inductive loops), and spot speeds (from radar detectors and micro wave detectors). With Bluetooth based systems, field processing units are installed at various locations on the road network. These capture the time Bluetooth enabled device passes through the network and transmit the data back to the TOC.

The New York State Department of Transportation recently had TRANSCOM (a coalition of 16 transportation and public safety agencies in the New York, New Jersey, and Connecticut metropolitan region created in 1986 to provide a cooperative, coordinated approach to regional transportation management) make their Data Fusion Engine (DFE) Selected Priorities Applied to Evaluated Links (SPATEL) web based data analysis tool available to NYSDOT.

DFE/SPATEL is a tool for both Operations and Planning that allows for the analysis of transportation system performance. It lets organizations examine current (real time) and historical regional conditions (travel time and volume), the impact of events on traffic, and view a breakdown of various indices (i.e. Planning Time, Buffer, Travel Time, etc.). There is not an explicit cost incurred by NYSDOT for using SPATEL, access is obtained as NYSDOT is a paying member of the TRANSCOM Coalition.

While NYSDOT is interested in the SPATEL analysis and reporting functions, as it is thought to be a useful tool for ICMS development, it is unclear how this information would be strategically used in the development of an Integrated Corridor Management System. Further, it is thought that it may be best not to rely solely on SPATEL for US 9 traffic data and to continue considering the use of other types of readers along US 9. (Once the US 9 trip is added to SPATEL, NYSDOT will be able to examine the ‘richness’ of the data and have an enhanced understanding of the coverage on US 9). The potential use of SPATEL is outlined further in the preface of this report (page vii).

3.5 Alternative Route Guidance

It is important for a motorist that diverts off the main lanes of I-87 to know where they should be traveling and where to get back on I-87 after the congested area or incident. Under alternative route guidance, a series of signs would be placed along US 9 that have a dynamic element allowing the signs to indicate the path that motorist should follow to divert around the observed congestion. Route selection should be based on actual travel times such that diverted motorist do not experience greater delays that motorists who choose not to divert.

The TMC central software would be enhanced to support a real time evaluation of the primary and alternative routes and prompt the TMC operator to activate the alternative route guidance notification systems. Notification should be through DMS, en-route guide signs, NYSDOT’s 511 web site, MY511 feature, and notifications to the media outlets.

3.6 Adaptive Signal Control

NYSDOT has a central signal control platform for managing signalized intersections along state management roadways. As part of the ICM program, signal operations on the parallel routes to I-87 should be coordinated and managed as a part of a comprehensive approach to optimizing corridor throughput.

Traffic capacity constraints on the main lanes of the I-87 facility may have an opportunity to encourage motorist to shift their traffic patterns to the parallel US 9 street network. Arterial capacity is generally governed by the controlled intersections. Signal timing adjustments can be made to maximize throughput on the arterial diversion routes by optimizing the signal phasing and splits to meet the demand associated with the new traffic patterns created by route diversion activities. Given unpredictable nature of congestion in the corridor, the parallel arterial network system would benefit from the implementation of adaptive signal control strategies.

Adaptive signal control is a control strategy whereby the signal controller makes adjustments to cycle length, off-sets, and phase timings in real time based on changes in the traffic characteristics on the arterial. There are numerous adaptive control algorithms on the market today that could be leveraged to improve traffic operations conditions. NYSDOT should consider the deployment of an adaptive control solution on the arterial alternate routes that would serve to maximize the traffic throughput in the I-87 corridor during construction, incidents, and special event type activities. The benefits[2] come in the form of:

- Automatically adapt to unexpected changes in traffic conditions.
- Maximizing green time on diversion routes.
- Improving travel time reliability.
- Reducing congestion and fuel consumption.
- Prolonging the effectiveness of traffic signal timing.
- Reducing the complaints that agencies receive in response to outdated signal timing.
- Making traffic signal operations proactive by monitoring and responding to gaps in performance.

3.7 Targeted Traveler Information

Currently, NYSDOT Region 1 leverages the statewide 511 system, which boasts a robust suite of traveler information capabilities for both pre-trip and en-route information. The primary vehicle for traveler information is NYSDOT's 511 system (www.511ny.org). 511NY provides users with real-time traffic information, transportation alternatives, and links to tourism hotspots across the state. Internet and phone service offering real-time traffic alerts, road conditions, and other alerts are part of the integrated 511 NY system. The system provides the following information:

- Traffic conditions
- Live traffic camera feeds
- Highway construction updates
- Winter road conditions
- Weather conditions and alerts
- Transit and airport information
- Carpool, vanpool and rideshare information

[2] FHWA Everyday Counts, Accelerating Technology web site

Another primary means of disseminating information to motorists is via the NYSDOT's Dynamic Message Signs (DMS). The Region 1 Traffic Control Center currently manages DMS along I-87. These DMS are used to display incident information and alerts to motorists.

3.8 Expanded Safety Service Patrols

Since 1994, the NYSDOT Highway Emergency Local Patrol (H.E.L.P.) has supported mobility by quickly responding to and clearing incidents, and calling for other response resources as appropriate. In addition, H.E.L.P. provides services to assist motorists (e.g., jump starts, gasoline, water for overheating radiators, tire changes, access to a telephone for tow services) and are also responsible for roadway debris removal. The times of coverage, length of duty route (i.e., "beat"), and scope of support services directly impact the effectiveness of NYSDOT's H.E.L.P. program. Assuming that traffic on I-87 at a minimum remains constant, or, as is more likely, continues to grow, NYSDOT should consider expanding the number of patrols in the corridor.

For the short term, NYSDOT should review H.E.L.P. coverage on I-87 to account for increased travel times associated with the congestion. It will likely be necessary to reduce the length of each beat and to add additional beats to provide the same level of service (in terms of average time to complete one pass through the service patrol beat) as is provided today. It should also consider expanding the coverage to the US 9 alternate route during diversion times.

3.9 Roadside Signs for Quick Clearance

It is important to actively publicize minor crash removal expectation thereby increasing the overall throughput in the corridor. By moving vehicles to the shoulder or to a near-by off ramp, the lane remains clear for traffic, reducing congestion and the possibility of secondary crashes. However, drivers are generally reluctant to move their vehicles when involved in minor crashes, even when there are no injuries and the vehicles can still be driven (e.g., a "fender-bender"). The implementation of signs (see Figure 26) in the right-of-way should help reinforce the concept of quick clearance.

NYSDOT has proposed "Move it" legislation that would require individuals involved in minor traffic accidents with no personal injuries to move their vehicles out of harm's way, as well as a "quick clearance" bill that would allow anyone directed by the "Commissioner of Transportation or his representative" to cause the removal of cargo or debris at an incident scene. The towing industry has also proposed "Move It" and "Quick Clearance" legislation. However, both the New York State Senate and Assembly failed to pass the proposed "Move it" legislation (S1242 and A587-2015) during the 2015 legislative session.

In addition, NYSDOT operates the HELP program on I-87 up to Exit 10 for the same purpose – to get motorist out of harm's way and to minimize the effect of "rubbernecking" their presence might cause. NYSDOT encourages the regions to coordinate with local emergency responders and utilize HELP as a means to assist in providing proper traffic control at incidents.

Figure 26. Sample Fender Bender Sign

3.10 Ramp Management

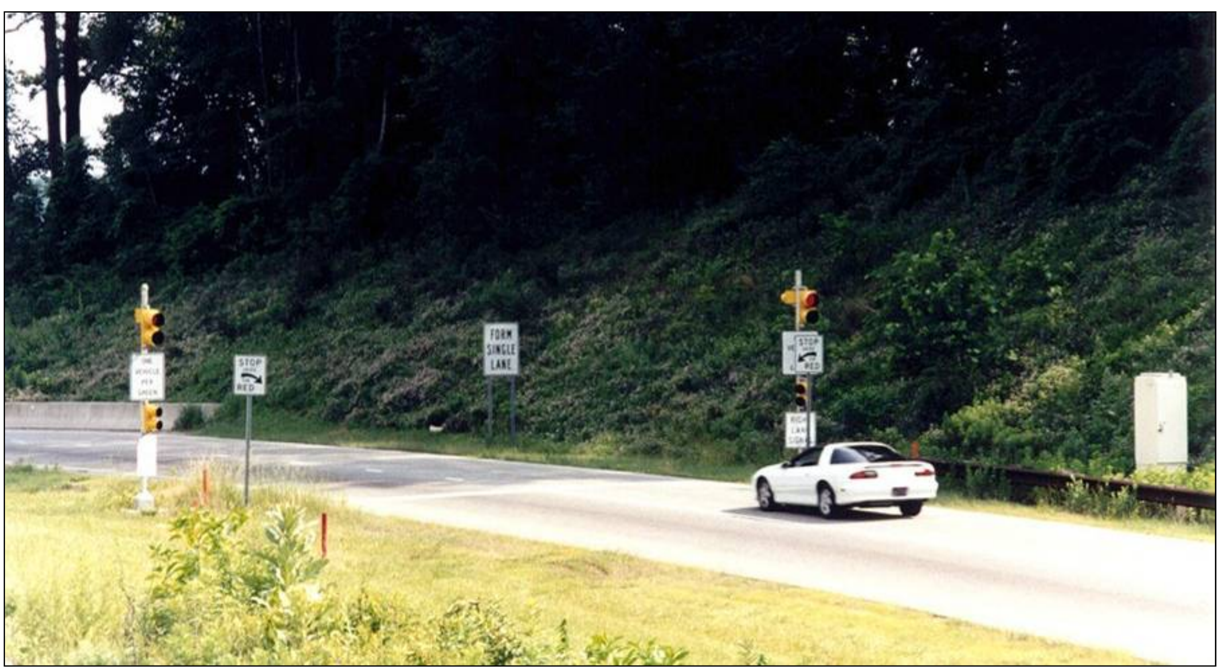
Ramp Management is a freeway-based strategy defined as the "application of control devices, such as traffic signals, signing, and gates to regulate the number of vehicles entering or leaving the freeway, or to smooth out the rate at which vehicles enter and exit the freeway."

Ramp metering is the use a traffic signal(s) deployed on a ramp to control the rate at which vehicles enter a freeway (see Figure 27). By controlling the rate at which vehicles are allowed to enter a freeway, the flow of traffic onto the freeway becomes more consistent, smoothing the flow of traffic on the mainline and allowing more efficient use of existing freeway capacity. Vehicles that enter the freeway in platoons introduce turbulence, which causes vehicles on both the mainline and ramp to slow down to safely merge, causing congestion around and upstream of ramp/ freeway merge points. Ramp metering also discourages short trips from using the freeway.

Benefits of Ramp Metering

- A study of a six-week shutdown of the ramp meters in Minneapolis-St. Paul found that metering was responsible for a 21 percent crash reduction.
- The Minneapolis-St. Paul study also found that freeway throughput was 10 percent higher with ramp meters than they were during the shutdown.
- In Salt Lake Valley, Utah, a ramp metering study showed that mainline peak period delay decreased by 36 percent or 54 seconds per vehicle

Figure 27. Ramp Metering Example



4 US 9 Access Management and Corridor Development

4.1 Access Management

Roadways provide different functions ranging from local streets providing direct access to property, to interstate facilities providing high speed long distance uninterrupted travel. US 9 is a principal arterial with a high mobility function, yet in many locations along the corridor it is characterized by numerous driveways to individual parcels.

> "Access management is the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway."
> ~*Access Management Manual*, Transportation Research Board, 2003

Good access management provides a safe operating system for all users while balancing the function of the roadway with the access needs of the adjacent land uses. It calls for limiting and consolidating access while promoting a supporting street system for development. This is accomplished through changes in site design and roadway design.

4.2 Roadway Design

Roadway techniques typically have a high impact on corridor safety and mobility. For example, the construction of a left-turn lane at an intersection can reduce conflicts by removing turning traffic from through lanes and increasing mobility for other motorists. Implementation of roadway access management techniques typically requires the cooperation of the NYSDOT, municipalities, other involved agencies, and when right-of-way is required – landowner cooperation is also needed. The safety and mobility benefits associated with implementation of the major roadway techniques, like raised medians and parallel service roads, are significant.

4.2.1 On-street Parking

On-street parallel parking on a public roadway narrows the street and clams traffic while creating a buffer between vehicles and pedestrians. Lower speed roadways in urban areas with sidewalks and pedestrian and transit activity associated with adjacent commercial land uses are ideal locations for on-street parking.

4.2.2 Dedicated Turn Lane

Separating turning traffic from through traffic at intersections and near busy driveways reduces the number of crashes while increasing capacity and mobility. This is accomplished by creating dedicated lanes for turning movements. Dedicated turning lanes allow through traffic to continue to flow, and reduce the potential from rear end and right-angle accidents by removing turning traffic from the through travel lanes.

4.2.3 Service Roads

A service road is a road that parallels a major road. Constructing a road parallel to the main street relieves main street vehicular traffic and minimizes access points by providing an opportunity to separate through traffic from traffic entering or exiting a site. Travel speeds on parallel roadways are also slower than those of the major roadway.

4.2.4 Raised Median

A raised median is a barrier separating opposing traffic that restricts turns across the barrier. The median can provide sufficient width for attractive landscaping or where space may be limited, can be as simple as a jersey barrier. Wider medians can also provide benefits for pedestrians by creating a refuge for pedestrians crossing many lanes of traffic at signalized intersections. Where wider refuge islands are incorporated, there may be the need for a pedestrian button to be installed within the median to ensure that pedestrians have an appropriate means to cross the remaining travel lanes.

Raised medians reduce the number of accidents by restricting left-turn movements at uncontrolled intersections and driveways and therefore decreasing conflict points.

4.3 Site Design

Some of the most important techniques in access management require a commitment from municipalities during planning and site plan review and approval. Each project should be evaluated with an eye toward minimizing main street access points and maximizing inter-parcel connections, or more formal side street connections. The following Site Design Tools should be considered at the project level:

4.3.1 Pedestrian Connections

Pedestrian connections between parcels and to the adjacent travel network can include sidewalks, crosswalks, and multi-use paths. The provision of these connections call attention to the presence of pedestrians and clearly delineates where pedestrians should be for both drivers and pedestrians. Good pedestrian connections also encourage transit use by providing the transit user a clear, easy path between the bus stops and adjacent land uses.

4.3.2 Shared Driveways

A shared driveway serves two or more adjacent lots or parcels with a single access point. Shared driveways reduce the number of roadway access points and therefore increase safety by reducing the number of conflict points. Mobility is increased because traffic flow is more consistent as there are fewer starts and stops caused by vehicles turning onto and off of the main roadway.

4.3.3 Cross Access Connections

Cross access connections have some of the same benefits as shared driveways. The development of formal connections between adjacent parcels creates the opportunity for fewer driveways for more parcels. Similar to shared driveways, cross access connections between parcels increase corridor safety by reducing the number of conflict points and reducing turning movements on the main street. The connections can also encourage pedestrian movement between parcels.

4.3.4 Access and Turn Restrictions

Access and turn restrictions limit the vehicular access to a parcel by not allowing access on a particular roadway or by limiting how a vehicle can enter a parcel or roadway. Access restrictions are most usually employed within the influence area of an intersection. For example, a right-in only driveway may be implemented on a parcel immediately upstream of a signalized intersection where normal queuing is present or where turn lanes exist. Restricting turning movements, closing driveways, or only allowing vehicular access to a lower volume side street are all types of access restrictions. Access restrictions lend themselves well to roadway design techniques like raised medians and roundabouts.

4.3.5 Align Driveways/ Roadways

Driveways located directly opposite each other or opposite an existing road are aligned properly to create a typical four-leg intersection. The appropriate driveway alignment reduces driver confusion and eliminates the potential for left-turning vehicle conflicts. Improperly aligned driveways cause driver confusion and create competition for storage or acceleration space for left-turning vehicles.

4.3.6 Rear or Side Parking

Placing parking lots in the rear of buildings allows for a more walkable, pedestrian and transit friendly, and visually appealing corridor. Pedestrians and transit users benefit by not having to travel through a sea of parking to enter a store and business owners benefit by creating a more visible storefront for passing motorists by removing parked cars from the front of the building. Rear parking also benefits drivers because it allows for easier development of cross-access connections to adjacent parcels providing easy access to adjacent parcels without having to enter the main street.

These site plan features can typically be controlled through the local zoning code and site plan approval process. Ensuring access to nearby side streets or traffic signals should be pursued on a site by site basis. Over time, the implementation of access management at the site level can result in major corridor benefits. Without the concerted effort of the local planning boards taking care to implement access management on each site, larger corridor benefits cannot be realized.

4.4 Transit and Smart Growth

US 9 and I-87 have different needs and different potential for transit and transit oriented development (TOD). While I-87 already has a successful commuter express bus system, US 9 does not have any transit service in place, and a recent pilot project produced low ridership. The two roadways differ greatly in character, such that strategies for adjacent land use and design would differ as well. Therefore, while there is an underlying assumption that improvement on either roadway would benefit the integrated corridor as a whole by promoting a modal shift to transit or walking, the two roadways warrant different treatments.

4.4.1 I-87 Corridor

The I-87 corridor would benefit from upgrades that would improve the efficiency and effectiveness of the existing NX commuter bus service. Recommendations would likely include both operational and infrastructural strategies. The use of bus-on-shoulder for transit service will be examined, along with wayfinding to park-and-rides and integrating commuter express bus support facilities within the communities they serve (such as through better park-and-ride design, layout, and/or shared parking practices).

CDTA's 2009 North-South Corridor's Study recommended the following improvements to NX service:

- Short Term:
  - Provide NX reverse commute service
  - Increase service on the commute hour shoulders (e.g., 6AM to 7AM and 9AM to 10AM when 7AM to 9AM represents the AM peak travel period)
  - Increase service frequency
  - Simplify NX zone structure
  - Rationalize NX fares/ equity in discounts
  - Study potential for priority treatments such as queue jumps and signal priority
  - Identify potential location and implement second park-and-ride lot at Exit 9

- Long Term:
  - Construct queue jumps at ramps and major intersections and implement signal priority treatment
  - Increase NX service frequency
  - Develop Saratoga local shuttles to emerging employment centers including a Luther Forest shuttle connection with financial support from Luther Forest

4.4.2 US 9 Corridor

The analysis of US 9 will focus on creating a more walkable corridor that would better support transit services and TOD in the future. This will be achieved by addressing issues at both the corridor level and at two specific opportunity areas within the corridor located in Clifton Park and in Halfmoon. Solutions in the corridor are anticipated to be a combination of general education in promoting walkability in the corridor (i.e., defining walkable development and how it promotes transit use; describing effective strategies to implementation), and targeted advice to planners at the municipal level in implementing walkable communities and making their community attractive to developers who incorporate walkable design.

4.5 Access Management Benefits

When implemented appropriately, access management strategies can have a significant and positive impact on safety and traffic efficiency. The benefits of good access management and complete streets policies are numerous and affect all roadway users. The TRB *Access Management Manual* describes many of these benefits some of which are described below:

- <u>Motorists</u> face fewer decision points and traffic conflicts which simplifies driving and increases safety.

- <u>Cyclists</u> can choose alternative travel routes as supporting roadway systems are developed and face fewer conflicts with motorists, which increases safety.

- <u>Pedestrians</u> face fewer and less frequent access points where motorists enter and exit the roadway making it safer to walk along major roadways.

- <u>Transit riders</u> experience reduced delay and travel times and more convenient access to transit stops as connectivity is improved.

- Business persons experience a more predictable development environment served by a more efficient roadway system that captures a broader market area.
- Communities have a safer transportation system with less need for road widening, thereby avoiding displacement of existing businesses and residences.

In addition, well managed corridors provide safe routes to walk or bike, they remove barriers and improve mobility for older Americans and those with disabilities, they promote good health, they make transit safe and convenient by including the needs of transit users in the design process, and they fight climate change and ease congestion by increasing the number of pedestrian, bicycle, or transit trips.

5 Conclusions and Recommendations

Interstate 87

I-87 is a vital Interstate route supporting regional commerce and tourism while also serving as the primary commuter route between Saratoga and Albany Counties. I-87 also serves CDTA's successful NX commuter bus route. US 9, parallel to I-87, provides access to local land uses and also serves commuter traffic, though the trips are generally shorter than those on I-87. Data indicates that I-87 is one of the most congested roadways in the Capital District. Congestion is a function of recurring traffic volumes and incident related delay commonly referred to as non-recurring congestion. Incident related congestion represents approximately 2/3's of the delay on I-87.

I-87's capacity (i.e., number of vehicles per hour that can be accommodated at an acceptable level of service) is generally limited by the number of lanes on the roadway (traffic capacity and level of service are also affected by vehicle mix, roadway design, pavement conditions, weather, and other factors). During the typical commuter time periods, I-87 operates at capacity with significant levels of congestion and delay. During the AM peak period, average travel speeds are lowest in the southbound direction, with the lowest speeds approaching the Twin Bridges. Average travel speeds for southbound traffic in the AM peak period slow to less than 45mph between Exits 8A and 7. Northbound average travel speeds are lowest during the PM peak period with average speeds of less than 50mph approaching the Twin Bridges, between Exits 1 and 7.

CDTC uses a measure developed by the Texas Transportation Institute (TTI) called "Planning Time Index" or PTI, a ratio of driving time on a typical traffic day to driving at the speed limit to assess congestion. For example, a PTI of 1.5 means that a trip which takes one hour in free flow traffic would take one and a half hours on an average day during the peak period. PTI data for I-87 shows that in the AM peak period, northbound I-87 operates with some minor congested segments, with a maximum PTI of 1.09. Southbound I-87 traffic is considerably more congested during the AM peak period, with a PTI of 1.96 between Exits 9 and 8A, 3.06 between Exits 8A and 8, and 2.37 from Exit 8 to the Twin Bridges. During the PM peak period, northbound I-87 is congested between Exits 1 and 9, with PTI's reaching as high as 2.17 between Exits 2 and 4. Southbound I-87 traffic during the PM peak period is less congested, with a maximum PTI of 1.27 between Exits 2 and 1.

Corridor operations and traffic flow are also measured in terms of travel time and delay. The approach to examining the I-87/ US 9 corridor has focused on the improvement of travel time in terms of consistency and reduction in delay caused by incidents. Safety is a focus in the corridor and the strategies explored include an examination of crash reduction and incident response associated with crashes.

Congestion along I-87 can be characterized as recurring congestion related to ambient roadway conditions such as delays at the Twin Bridges, and non-recurring congestion related to incidents. Table 20 summarizes 2011 weekday vehicle hours of delay on I-87 based upon the VISSIM traffic modeling developed for the corridor.

Table 20. 2011 Weekday Vehicle Hours of Delay on I-87

	Hours of Delay			Percent Delay	
	Recurrent Delay	Incident Delay	Total Delay	Recurrent Delay	Incident Delay
AM Peak Southbound	32,312	55,213	91,186	35%	61%
AM Peak Northbound	150	3,471	3,637	4%	95%
Total AM Peak	32,461	58,684	94,823	34%	62%
PM Peak Southbound	19,766	63,473	90,402	22%	70%
PM Peak Northbound	1,479	2,503	4,335	34%	58%
Total PM Peak	21,245	65,976	94,737	22%	70%
Total AM and PM Peaks	**53,706**	**124,660**	**189,559**	**28%**	**66%**

Non-recurring or incident delay is often more significant to drivers because it affects the reliability of their travel. The longest delays are associated with unattended disabled vehicles, DOT maintenance activities, signal malfunctions at ramp termini, and water main breaks. The worst periods of congestion typically occur on Friday evenings in the summer when peak commuter traffic on I-87 is mixed with summer vacation travel.

In general, the off peak direction operates well, indicating that there is a peak directional focus to the ICM concepts. I-87 delays regularly create a “spill over” traffic condition onto the connecting roadways and parallel US 9. Spill over traffic onto the connecting roadways and US 9 indicates that US 9 is serving traffic volumes that generally would prefer to be on I-87.

US 9 and Parallel Roadways

US 9 generally provides two travel lanes in each direction with a center two-way continuous left-turn lane. As US 9 travels through municipalities that consist of higher development density, the number and frequency of intersections and driveways increases.

Several roads provide access between I-87 and US 9. These roadways are generally a single lane in each direction with the exception of the following roadways, which provide two travel lanes in each direction:

- NYS Route 7/ NYS Route 2 at Exit 6 in Colonie
- NYS Route 146 at Exit 9 in Clifton Park and Halfmoon
- NYS Route 67 at Exit 12 in Malta
- NYS Route 9P at Exit 14 in Saratoga Springs

The primary role of US 9 is to serve through traffic; providing access to abutting land uses is secondary. Access to adjacent land uses is regulated through each municipality’s zoning code and site plan review process. Additional regulation is provided through the application for a NYSDOT Highway Work Permit on a site by site basis. A section of US 9 south of Colonie consists of more than 50 unsignalized access points per mile. There are also several segments that consist of 40-50 unsignalized access points per mile, primarily focused along segments between Wilton and Saratoga Springs and between Halfmoon and Colonie. Additionally, there are over 150 underutilized or vacant parcels along US 9. Development or redevelopment of these parcels has the potential to add unsignalized access points along the roadway and add additional local traffic.

Congestion is evident along US 9 for both northbound and southbound traffic during both the AM and PM peak periods. Average travel speeds during the AM peak period are less than 20mph at three locations (vicinity of Grooms Road, NYS Route 9R, and Sparrowbush Road) for northbound US 9 traffic and less than 20mph at seven locations (vicinity of Plant Road, Grooms Road, Vischer Ferry Road, Old Loudon Road, Boght Road, Lawrence Street, and Erin Street) for southbound US 9 traffic. Average travel speeds during the PM peak period are less than 20 mph at six locations (vicinity of Grooms Road, NYS Route 9R, Sparrowbush Road, Fonda Road, Crossing Boulevard, and NYS Route 146) for northbound US 9 traffic and less than 20mph at eight locations (vicinity of Plant Road, Grooms Road, Vischer Ferry Road, Old Loudon Road, Boght Road, Lawrence Street, Sparrowbush Road, and Erin Street) for southbound US 9 traffic. Congestion along US 9 during the AM and PM peak periods is highly resultant from local capacity constraints and incidents. For example, several sections of US 9 consist of more than 40 unsignalized intersections per mile due to adjacent development.

I-87/ US 9 Corridor

Forecasts show that, unless corrective actions are taken, congestion and delays will continue to worsen throughout the I-87/ US 9 corridor as the Capital District's population and employment opportunities grow. Given current fiscal conditions, right-of-way constraints, and environmental concerns, there are currently no plans to increase the number of general purpose travel lanes on I-87 which leads the focus toward optimizing the throughput of the corridor throughout the peak periods.

Implementation of ICM concepts balance the flow and travel time characteristics of the corridor by achieving a balanced operating state between I-87 and parallel US 9, improving the overall movement of people and goods in the I-87/ US 9 corridor. ICM would enable NYSDOT to expand their current traffic operational strategies by providing additional tools to optimize the use of the available transportation infrastructure not only within, but also outside of the I-87 right-of-way, such as along connecting roadways and along US 9, by directing travelers to underutilized capacity in a corridor. Strategies could include motorists shifting their trip departure times, routes, or modes and/or NYSDOT dynamically adjusting capacity on I-87 through active transportation management or by having additional opportunities to adjust traffic signal timings (within the interchanges and along US 9) to accommodate demand fluctuations. In addition, access management and strategies that emphasize smart growth are proposed for the US 9 corridor.

This chapter describes the Integrated Corridor Management Plan strategies proposed for implementation in the I-87/ US 9 corridor along with their anticipated benefits and costs. A phased implementation program has been developed based on stakeholder input, logical bundling of the strategies and constructability.

5.1 Strategies Recommended for Implementation

A Concept of Operations is a description of how the ICM system will be used. It is generally non-technical and represents the viewpoints of the various stakeholders in the corridor. This project conducted a series of stakeholder meetings with local agencies in the corridor including police, fire, EMS, and NYSDOT staff. The resulting outcome of the stakeholder meetings lead to the operational concept described as the I-87 ICM program in this document. The operational concept provides a bridge between the often vague needs that motivated the project to begin with and the specific technical requirements associated with implementation and operations. Implementation of an I-87 ICM program should include the review of the maintenance and operations. A review of the maintenance and operations workloads should be performed to determine if additional staff will be need or if the system expansion can be handled within the allocated budgets.

The proposed ICM program is intended to optimize traffic operations on I-87 and US 9. The ICM strategies were selected for implementation based on a review of existing corridor operations, current installed intelligent transportation system (ITS) elements, and traffic management center (TMC) capabilities. Proposed elements were selected based on their potential operational benefits in terms of travel time consistency, safety improvement, and delay reduction without consideration of cost. No funding has been identified for these elements.

- Extension of Existing ITS Program on I-87
- Incident Detection on US 9
- Adaptive Traffic Signals on US 9
- US 9 Access Management
- US 9 Smart Growth
- US 9 Transit Development

Each of these strategies is described in the following sections.

5.1.1 Extension of Existing ITS Program on I-87

Extension of the existing I-87 ITS program from Exit 8 to Exit 13 would bring a heavily used, and often congested, section of I-87 into the proactively managed part of NYSDOT's system. The following ITS support elements for the operations staff would be implemented and integrated into NYSDOT’s Advance Transportation Management System (ATMS):

- Bluetooth Based Travel Time and Incident Detection
- Enhanced Communications Backbone
- Expanded Closed Circuit Television (CCTV) Coverage
- Additional Variable Message Signs (VMS)

System extension would benefit daily traffic operations and incident management through enhanced detection, response, and communications with motorists and the Traffic

Operations Center (TOC). Field sensors and displays provide NYSDOT operators with real time information allowing them to identify and verify incidents quickly, dispatch the appropriate response assets, and alert the motoring public of incidents and trip modification options through the VMS and 511 system. Similar ITS programs have documented ability to increase traffic carrying capacity 10% to 15% from the same roadway cross-section, thereby reducing recurring delays and the need to consider widening the roadways. This approach will serve to reduce delays associated with non-recurring incident activities, which makes up the large portion of the unexpected delay measured in the corridor.

5.1.2 Incident Detection on US 9

Extension of the existing ITS system from I-87 onto US 9 and connecting facilities would allow the NYSDOT to improve traffic operations on US 9 through improved incident detection and response, and would facilitate the coordinated operation of I-87, US 9 and connecting facilities during incidents. Incident detection on US 9 can help reduce delays by expediting the identification of traffic problems, providing information to motorists as to incidents and potential alternative routes, and reducing response times.

Incident detection related US 9 ITS equipment would be integrated into the existing NYSDOT ATMS supporting a corridor wide management approach. Through the development of cooperate agreements with the local jurisdictions, NYSDOT would assign dedicated staff to the comprehensive management of the I-87/US 9 corridor. Incident response operational procedures and resources would be developed that identified response assets based on geographic location of the incident detected and verified such as the appropriate fire/ police/ EMS contacts and towing services to maximize quick response and clearance activities. Information as to the operational state of US 9 and connecting facilities would be integrated into the NYSDOT 511 system and standard messaging developed to convey the operational state of US 9 on the field VMS's in the corridor. US 9 and connecting facility traffic signal operations may be adjusted to address route diversions during incidents on I-87 in a planned, pro-active approach with preplanned signal timing plans or the implementation of adaptive signal control strategies. Adjusting arterial signal operations would be included in the development of the cooperative agreements with the local jurisdictions where appropriate.

Arterial incident detection on US 9 would serve to improve travel time reliability, reduce delays associated with incidents, and allow NYSDOT to maximize corridor throughput. The US 9 ITS system would include the following components:

- Bluetooth Based Travel Time and Incident Detection
- Expansion of the Communications Backbone
- Addition of CCTV at US 9 and connecting facility signalized Intersections

Implementation of arterial infrastructure along US 9 would improve daily operations and support pro-active route diversions guidance to and from I-87. Similar ITS programs on arterials have the documented ability to increase traffic capacity 10% to 15% and improve the overall travel time reliability in the corridor.

It should be noted that the ability to shift traffic to/from I-87 and US 9 is limited by the capacity of the connecting roadways and intersections. This led to recommendations to expand the existing ITS program and incident detection to connecting roadways as well as I-87 and US 9.

The New York State Department of Transportation recently had TRANSCOM (a coalition of 16 transportation and public safety agencies in the New York, New Jersey, and Connecticut metropolitan region created in 1986 to provide a cooperative, coordinated approach to regional transportation management) make their Data Fusion Engine (DFE) Selected Priorities Applied to Evaluated Links (SPATEL) web based data analysis tool available to NYSDOT.

DFE/SPATEL is a tool for both Operations and Planning that allows for the analysis of transportation system performance. It lets organizations examine current (real time) and historical regional conditions (travel time and volume), the impact of events on traffic, and view a breakdown of various indices (i.e. Planning Time, Buffer, Travel Time, etc.). There is not an explicit cost incurred by NYSDOT for using SPATEL, access is obtained as NYSDOT is a paying member of the TRANSCOM Coalition.

While NYSDOT is interested in the SPATEL analysis and reporting functions, as it is thought to be a useful tool for ICMS development, it is unclear how this information would be strategically used in the development of an Integrated Corridor Management System. Further, it is thought that it may be best not to rely solely on SPATEL for US 9 traffic data and to continue considering the use of other types of readers along US 9. (Once the US 9 trip is added to SPATEL, NYSDOT will be able to examine the 'richness' of the data and have an enhanced understanding of the coverage on US 9). The potential use of SPATEL is outlined further in the preface of this report (page vii).

5.1.3 Adaptive Traffic Signals on US 9

NYSDOT has a central signal control platform for managing signalized intersections along state management roadways. Adaptive signal control is a control strategy whereby the signal controller makes adjustments to cycle length, off-sets, and phase timings in real time based on changes in traffic conditions.

NYSDOT is preparing to install an Adaptive Traffic Signal System along Wolf Road in Albany. The project covers 9 intersections from Central Avenue to the entrance to I-87 N, approximately 2 miles. The following Wolf Road intersections are included in the project:

- Colonie Center Mall
- NYSDOT/ Colonie Center Mall
- San Creek Road
- Computer Drive
- Metro Park Road
- Marcus Boulevard

- At I-87 Exit 4 off-ramp
- Albany Shaker Road and I-87 ramp
- Albany Shaker Road

The traffic signal controllers will communicate via an Ethernet communications link to a master computer. The local controllers will receive detection inputs from both approaches, then transmit information to the master computer as to system splits and offsets for each intersection based upon demand.

Signal timing adjustments have the biggest impact on reducing delay and increasing traffic throughput on US 9 under both normal operating conditions, and during incidents on I-87 when traffic diverts to US 9 or is advised to divert to alternative routes. Installation of adaptive traffic signals on US 9 and connecting facilities would optimize signal operations and aid in supporting route diversion during incidents from I-87 by:

- Automatically adapting to unexpected changes in traffic conditions
- Maximizing green time on diversion routes
- Improving travel time reliability
- Reducing congestion and fuel consumption
- Prolonging the effectiveness of traffic signal timing
- Reducing the complaints that agencies receive in response to outdated signal timing
- Making traffic signal operations proactive by monitoring and responding to gaps in performance

The system would automatically adjust timing operations to provide optimized green time at all intersection approaches, even under diversionary and emergency conditions. This strategy requires a memorandum of understanding (MOU) between NYSDOT and local jurisdictions with traffic signals to define the parameters under which detected traffic levels would initiate timing changes and the acceptable limits of operation. Adaptive signals would be implemented using available traffic signal infrastructure with the installation of updated central software updated algorithm/controllers and with wireless detectors installed at the intersections.

The implementation of adaptive traffic signal control strategies will be governed by the terms of the MOU's developed. There are several different types of adaptive signal control architectures ranging from solutions that have a distributive architecture and can run based solely on field detector inputs to centralized solutions that require the field signal controllers to be connected to a central computer to operate. In order to facilitate a corridor wide comprehensive management approach, the field signal controller operational state needs to be known by the NYSDOT traffic operations staff and the local jurisdictions who own the traffic signals. A common or connected communication infrastructure should be implemented to convey the operational state of the signal to operators and allow real time signal timing adjustments when appropriate. See Appendix C – Adaptive Traffic Signals for an overview of adaptive signal controls.

Signal timing optimization is the single most common tool used to reduce air quality impacts associated with arterial operations. The area, as of July 2013, is now considered an attainment area, thus using Congestion Mitigation and Air Quality Improvement Program (CMAQ) funds for upgrading the US 9 roadway and I-87 connecting facilities is no longer an option.

5.1.4 US 9 Access Management/Smart Growth

Access management is the systematic control of the location, spacing, design, and operation of driveways, median openings, and street connections to a roadway. Good access management provides a safer and more efficient operating system for all users while balancing the function of the roadway with the access needs of the adjacent land uses. The benefits of access management can be realized by motorists, cyclists, pedestrians, transit riders, business and development interests, and communities. Additionally, well managed corridors remove barriers and improve mobility for older and younger people and those with disabilities.

Access management strategies include limiting and consolidating access while promoting a supporting street system for development through changes in site and roadway design. Smart growth and transit oriented development would promote transit use through the development of compact, walkable, mixed use communities along US 9.

It is recommended that a long-term plan be developed to limit and consolidate access on US 9 while promoting a supporting street system for development. This would be accomplished through changes in local land use laws, site design, and roadway design on a parcel by parcel basis through continuous coordination with local municipalities. Recommended access management/ smart growth strategies can include:

- Pedestrian Connections
- Cross-Access Connections
- Access and Turn Restrictions
- Align Driveways/Roadways
- Rear or Side Parking

These site plan features can typically be controlled through the local zoning code and site plan approval process. Ensuring access to nearby side streets or traffic signals should be pursued on a site by site basis. Over time, the implementation of access management at the site level can result in major corridor benefits. However, this strategy requires the concerted effort of local planning departments/boards to implement access management (on each development site) under a comprehensive plan.

5.1.5 I-87 and US 9 Transit Development

In 2010, CDTA operated a pilot bus service, Route 409, on US 9 between the Exit 9 Park & Ride at the Crossings in Halfmoon/ Clifton Park and Congress Park in Saratoga Springs. The service operated Monday through Friday from 6:30AM to 8PM, with a 45 minute frequency. CDTA also provided paratransit service within 3/4 mile of the route as required by the

Americans with Disabilities Act (ADA). Unfortunately, the corridor lacked the transit supportive infrastructure, land use, population density, and site design, for the service to be successful, resulting is low transit ridership, and it was discontinued.

At present, the best fixed route service in the corridor is the NX commuter service on I-87, providing service between Albany and Saratoga Counties. CDTA's 2009 North-South Corridor Study recommended numerous short term and long term operational and infrastructure improvements to the NX service that would improve operations and efficiency of the I-87/ US 9 corridor by offering alternatives to vehicle travel. Transit alternatives would be made more attractive through the use of increased frequency, reverse commute options, additional park & ride lots, implementing transit vehicle queue jumps, and using signal prioritization for transit.

The implementation of carpools and vanpools, human service transportation coordination, and public transit connections, while improving transportation service for certain individuals, may not have an observed impact on the operations of the I-87/ US 9 corridor. It likely will require a much larger investment in enhanced transit (i.e., priority or dedicated transitways or BRT) along with the implementation of other carpools and vanpools, human service transportation coordination, public transit connections, and park & ride lots in order to demonstrate a noticeable improvement in operations along the I-87/ US 9 Corridor.

In the long term, as population and employment grow in the corridor, the corridor will become more capable of supporting transit service which can lead to fewer local trips and the implementation of enhanced transit to serve local land uses. Good access management and smart growth practices on US 9 would further support a successful transit service.

5.2 Strategies Requiring Further Study

Based on the initial reviews conducted under this study, it was determined that the following strategies require further study before they can be recommended for implementation.

5.2.1 Active Traffic Management on I-87

Active Traffic Management (ATM) is the ability to dynamically manage recurrent and non-recurrent congestion based on prevailing traffic conditions. Active traffic management has been shown to improve travel time reliability, increase roadway throughput, reduce crashes, save fuel, and squeeze more traffic capacity from the existing roadway cross section.

Using ATM to serve traffic on I-87 approaching the Twin Bridges would require the installation of a series of overhead gantries at a spacing of approximately every 1/2 mile northbound on I-87 from Exit 4 to the Twin Bridges (5 miles) and southbound on I-87 from Exit 9 to the Twin Bridges (5 miles). As described earlier, this is a location of recurring traffic congestion due to the geometry of I-87 approaching the Twin Bridges.

Implementation of the ATM approach would allow the NYSDOT traffic operations center to manage traffic approaching the recurring congestion associated with the Twin Bridges on a per lane basis in real time. Traffic speeds can be posted to slow down traffic in a stepwise fashion approaching the Twin Bridges encouraging the roadway users to slow down before reaching the back of queues (reducing rear-end crashes and delays due to incidents), guide traffic out of blocked lanes in advance of the closure point, or provide clear lanes for emergency and clearance response vehicles. Speed limit adjustments can be advisory or regulatory. Regulatory variable speeds require legislative and enforcement support. Both regulatory and advisory variable speeds have proven effective in improving traffic flow as motorist become accustomed to and knowledgeable on the operational information being presented. If speeds are regulatory (i.e., variable speed limits, or VSL), they become legal speed limits for which a motorist can receive a citation if they exceed the posted limit. If they are advisory, a motorist cannot be cited for a speed limit violation unless in the officer's judgment they are driving too fast for the prevailing conditions. Getting the traveling public to understand variable speeds limits requires public education campaigns similar to those of other on-site, television, radio, print, and web based transportation and safety campaigns. The NYSDOT ATMS software platform would require upgrading and dedicated operational staff would need to be assigned in order to maximize the benefit of the ATM solution.

5.3 Strategies Considered but not Recommended

The following strategies were considered throughout the course of the study but are not recommended for further study due to costs and/or constraints.

5.3.1 Hard Shoulder Running on I-87

Hard Shoulder Running is an ATM strategy focused on congestion relief that involves temporary use of the outside or inside paved shoulder as a travel lane, typically during peak periods.

Given existing discontinuities in I-87's shoulder width, particularly at the Twin Bridges, heavy ramp volumes, and close interchange spacing, hard shoulder running for general traffic and bus only purposes is not recommended for further study. Implementation of hard shoulder running would require modifications to the Twin Bridges to add shoulder width and pavement reconstruction along I-87. Additionally, this strategy was not supported by emergency responders.

5.3.2 Ramp Metering on I-87

Ramp metering is designed to match on-merging traffic volume with the availability of main lane acceptance gaps. The management of ramp merge activities allows the main lanes to operate more consistently and reduces crashes by smoothing out the overall flow of vehicles.

The VISSIM traffic simulation model was used to assess the effect of ramp meters on AM peak period recurrent congestion on I-87 southbound, between Exits 7 and 8, approaching the Twin Bridges. Using VISSIM traffic modeling software, two options for ramp metering were undertaken.

Under Option 1, ramp meters are placed at the southbound entrance ramps at Exits 8 and 8A. The average speed would improve to 48.2 mph (from the baseline of 45.6 mph), a net increase of 2.6 mph. However, the simulation also showed that the ramp meter at Exit 8 would result in significant queuing onto Crescent Road. The maximum ramp queue would extend for approximately 1,675 feet, well beyond the end of the entrance ramp onto Crescent Road. Based on these results, it is likely that a ramp meter on Exit 8 would have significant impacts on the operations of the local street network.

Under Option 2, ramp meters are placed at the southbound entrance ramps at Exit 8A only. The average speed of southbound vehicles would increase to 46.3 mph (from the baseline of 45.6 mph), a net increase of 0.7 mph. The maximum queue would extend for approximately 375 feet. As the ramp meter is located more than 500 feet away from the end of the entrance ramp at Grooms Road, the queuing from a ramp meter at this location would not be expected to result in impacts to the local street network. This option provides a nominal improvement to traffic conditions on I-87. See Appendix D – VISSIM Ramp Meters Assessment for more detailed information.

The cost for implementing ramp metering for Option 1 (Exits 8 and 8A) is approximately $250,000 plus $25,000 per year in operational costs. The ramp metering analysis undertaken indicates that the potential benefits of ramp metering in the I-87 corridor appear to be nominal and likely not cost effective. Further, ramp metering has the potential to impact traffic operations of the local street network. The costs of implementing ramp metering do not account for the additional costs that would be incurred to mitigate impacts to local roads. Should crash rates at the ramp/ main line merge areas increase in the future, ramp metering could be considered to address the possible safety concern. Consequently, ramp metering is not recommended as a part of the initial ICM program.

5.4 Implementation Strategy and Cost Estimates

The cost estimates included in this section represent project planning and budgetary numbers, and are based on a number of sources including the FHWA ITS cost database, prior project costs, and vendor information. They are subject to refinement based on final location and design considerations.

5.4.1 Operational Cost Impacts

Implementation of technology based corridor wide solutions, such as those recommended in this ICM plan, are intended to improve safety, provide reliable travel times, and optimize traffic throughput without reconstructing I-87. Technology based solutions are powerful tools when managed properly. Proper management requires a commitment to the maintenance of the devices in the field, support for ATM software enhancements, and the assignment of traffic operations staff in the traffic management center to oversee, manage, and implement the operational strategies. In addition to the operational costs of specific recommended strategies outlined in the short-term, medium-term, and long-term deployment cost tables (see Table 22, Table 23, and Table 24), there are Software enhancements that will be necessary to support the implementation of such strategies. Software enhancements will be in the range of $260,000 for the ATM solution but the expansion of the existing ITS system up I-87 will require little or no software enhancements. Implementation of Incident Detection on US 9 would bring about an annual operation/ maintenance cost of approximately $422,000 and would require central software for the Traffic Operations Center, pavement detectors on approach lanes with wireless connection, and algorithm/ controllers, which come with an annual maintenance cost of $624,000 per year. At the traffic operations center, operation staffing support will be approximate $130,000 per year (assuming 2 FTEs). Field maintenance costs have been included in the individual element cost estimates provided in the following sections.

The New York State Department of Transportation recently had TRANSCOM (a coalition of 16 transportation and public safety agencies in the New York, New Jersey, and Connecticut metropolitan region created in 1986 to provide a cooperative, coordinated approach to regional transportation management) make their Data Fusion Engine (DFE) Selected Priorities Applied to Evaluated Links (SPATEL) web based data analysis tool available to NYSDOT.

DFE/SPATEL is a tool for both Operations and Planning that allows for the analysis of transportation system performance. It lets organizations examine current (real time) and historical regional conditions (travel time and volume), the impact of events on traffic, and view a breakdown of various indices (i.e. Planning Time, Buffer, Travel Time, etc.). There is not an explicit cost incurred by NYSDOT for using SPATEL, access is obtained as NYSDOT is a paying member of the TRANSCOM Coalition.

While NYSDOT is interested in the SPATEL analysis and reporting functions, as it is thought to be a useful tool for ICMS development, it is unclear how this information would be strategically used in the development of an Integrated Corridor Management System. Further, it is thought that it may be best not to rely solely on SPATEL for US 9 traffic data and to continue considering the use of other types of readers along US 9. (Once the US 9 trip is added to SPATEL, NYSDOT will be able to examine the 'richness' of the data and have an enhanced understanding of the coverage on US 9). The potential use of SPATEL is outlined further in the preface of this report (page vii).

5.4.2 Short-Term Deployment

Short-term deployment would consist of the provision of a Bluetooth network on I-87 and US 9 for detection and travel time data collection. Detectors would be installed at 16 links (see Table 21) on I-87 between Exits 2 and 10 and on US 9 in both directions, with travel time data fed to the traffic operations center for analysis and dissemination.

Estimated short-term deployment costs are summarized in Table 22. The estimated capital cost includes 5 years of cellular monthly charge. Solar powered units with cellular communications links are assumed in order to contain costs. A more permanent installation with power and hard wire communications would increase installation costs significantly due to the construction costs associated with installing infrastructure along the entire length.

There is an existing communication line along US 9 between NYS Route 236 and old NYS Route 146 that is currently used for traffic signal coordination. This line is connected to the internet at three points and could be used for Bluetooth readers if surplus bandwidth can be used. There may be some cost savings that could be realized from using this communication line, however, often times connection costs (i.e., conduit and cabinets) can be expensive. Using the hard line would eliminate the recurring cost aspect of the estimate.

Table 21. Proposed Links for Detector Installation

Road Segment
I-87 Main Lanes in both directions
NYS Route 5 (Central Avenue) to NYS Route 155 (Shaker Road), Exit 2 to Exit 4
NYS Route 155 (Shaker Road) to Watervliet Shaker Road, Exit 4 to Exit 5
Watervliet Shaker Road to NYS Route 2 (Troy Schenectady Road), Exit 5 to Exit 6
NYS Route 2 (Troy Schenectady Road) to NYS Route 7
NYS Route 7 to the Twin Bridges
Twin Bridges to County Road 92 (Crescent Road)
Road 92 (Crescent Road) to County Road 91 (Grooms Road)
County Road 91 (Grooms Road) to Route 146
NYS Route 146 to Ushers Road (Exit 10)
US 9 arterial and connecting facilities in both directions
I-87 to Watervliet Shaker Road, to US 9, to NYS Route 7, to I-87
I-87 to NYS Route 7, to Crescent Road, to I-87
I-87 to Crescent Road to US 9 to Grooms Road to I-87
I-87 to Grooms Road to US 9 to Route 146 to I-87
I-87 to NYS Route 146, to US 9, to NYS Route 67, to I-87
I-87 to NYS Route 67, to US 9, to I-87 (at Exit 13)

Table 22. Estimated Short Term Deployment Costs

Strategy/ Elements	Description	Qty	Unit Price	Capital Cost	Operation/ Maintenance Cost (per year)
Bluetooth Based Detection for Travel Time I-87 & US 9					
Bluetooth Based Detection on I-87	Solar powered, cellular communications links, Bluetooth installed at ramps	16	$7,812	$125,000	$25,000
Bluetooth Based Detection on US 9	Solar powered, cellular communications links, Bluetooth installed at Selected intersections	34	$10,441	$355,000	$71,000
Totals				**$480,000**	**$96,000**

5.4.3 Medium-Term Deployment

Medium-term deployment would build upon existing I-87 corridor ITS assets including the Bluetooth network and 511 systems. Medium-term improvements would include the following elements:

- Extension of existing ITS Program (to complement existing cameras at Exits 8, 9, and 13), including the communications backbone, closed circuit television (CCTV), and variable message signs (VMS) for approximately 14.5 miles on I-87 between Exits 8 and 13 to extend the current NYSDOT congestion and incident management practices on this section of roadway.
- Implementation of Incident Detection on US 9 between Exits 2 and 13, including a communications backbone and CCTV at 26 signalized intersections (see Table 23) to support arterial incident verification and traffic flow assessments. These would supplement the existing 8 cameras on US 9 located at the intersections of NYS Route 146, Grooms Road, NYS Route 236, Vischer Ferry Road, Boght Road, NYS Route 9R, and Sparrowbush Road.

Table 23. Proposed Locations for CCTV

Main Street	Cross Street	Comment
Wolf Road	Central Av - Route 5 - Eastside	Interchange area
Wolf Road	Central Av - Route 5 - Westside	Interchange area
Wolf Road	Albany Shaker Rd - Eastside	Interchange area
Wolf Road	Albany Shaker Rd - Westside	Interchange area
Route 9	Watervliet Shaker Rd	
Route 9	Troy Schenectady Rd	Roundabout area
Route 9	Sparrowbush Rd/Route 7	Interchange area
Route 9	Columbia St/Route 7	Interchange area
Route 9	Crescent Vischer Ferry Rd	Northside of bridge over river
Route 9	Grooms Rd/Guideboard Rd	
Route 9	Usher Rd	
Route 9	Round Lake Bypass	
Route 9	Route 67/Dunning St	
Route 9	I-87 Interchange - Southside	Exit 13
Route 9	I-87 Interchange - Northside	Exit 13
Route 9	Washington St	
Route 9	Lake Av	
Route 9	Route 9p - Eastside (Union Ave)	Exit 14
Route 9	Route 9p - Westside (union Ave)	Exit 14
Route 9	Route 50 - Eastside	Exit 15
Route 9	Route 50 - Westside	Exit 15
Route 9	Ballard Rd	

Ballard Rd	I-87 Interchange - Eastside	Exit 16
Ballard Rd	I-87 Interchange - Westside	Exit 16
Route 9	I-87 Interchange - Southside	Exit 17
Route 9	I-87 Interchange - Northside	Exit 17

Figure 28 shows a typical variable message sign. These systems would be tied to the traffic operations center. Estimated medium term deployment costs are summarized in Table 24.

Figure 28. Variable Message Sign

Table 24. Estimated Medium Term Deployment Costs

Strategy/Elements	Description	Qty	Unit Price	Capital Cost	Operation/ Maintenance Cost (per year)
Extension of Existing ITS Program on I-87					
Communications Backbone (per mile)	Extension of the existing fiber optic backbone from the Twin Bridges north to Saratoga Springs (Exit 8 to Exit 13)	14.5	$124,759	$1,809,000	$181,000
CCTV	Color video with pan, tilt, and zoom, cabinet, tower, foundation and conduit (Fill in between Exit 8 and 13)	10	$46,800	$468,000	$94,000
Variable Message Signs	Full matrix NTCIP, with foundations and gantry	4	$260,000	$1,040,000	$104,000
Incident Detection on US 9					
Communications Backbone (per mile)	Extension of the existing fiber optic backbone on I-87 to US 9, on US 9 from Exit 2 to 13	16.5	$124,727	$2,058,000	$206,000
CCTV	Color video with pan, tilt, and zoom, cabinet, tower, foundation and conduit at intersections along US 9	26	$41,538	$1,080,000	$216,000
Totals				**$6,455,000**	**$801,000**

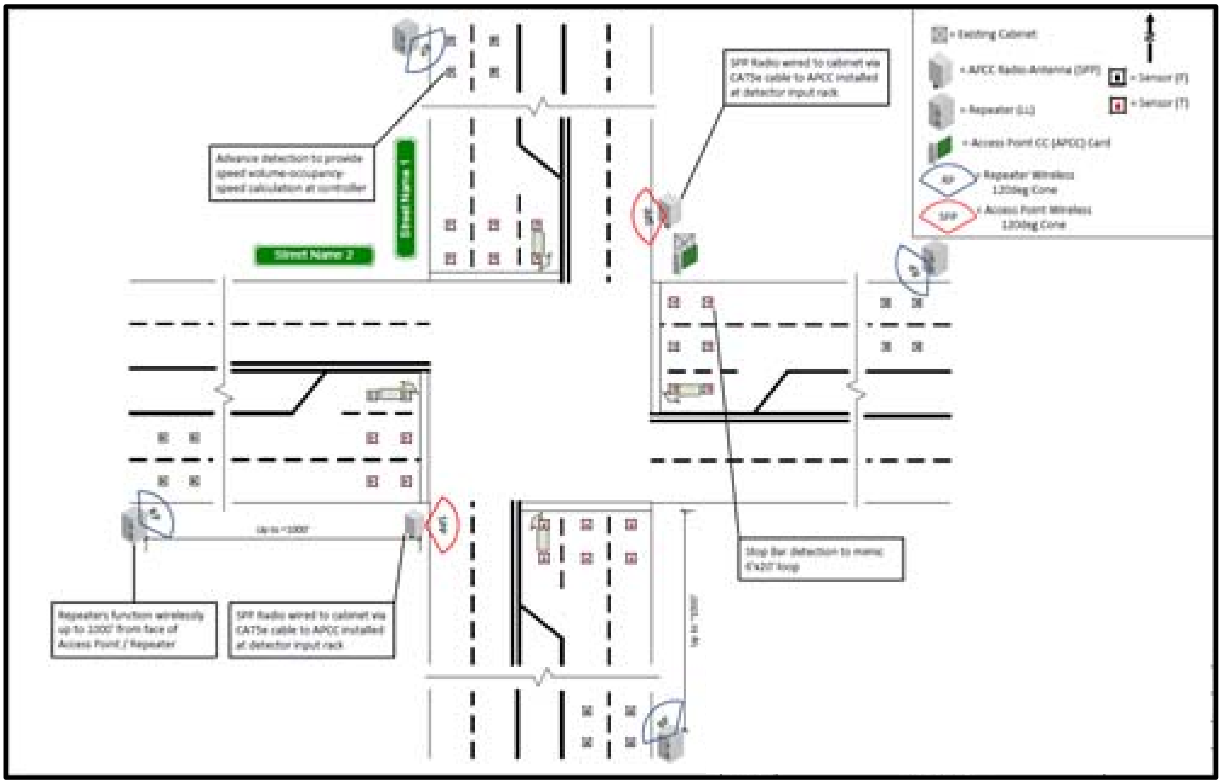
5.4.4 Long-Term Deployment

Long-term ICM program deployment would include the following elements:

- Adaptive Traffic Signal Control on US 9 to promote real time signal timing adjustments in support of corridor optimization and alternative route operations during incidents on I-87.
- US 9 Access Management and Smart Growth to improve corridor safety and improve arterial throughput.
- US 9 Transit Development.

Implementation of adaptive signal control would require enhanced detection at signalized intersections including in-pavement detectors in each approach lane, updated traffic signal controllers, and new central software for the traffic operations center. Figure 29 presents a typical adaptive traffic signal installation. Estimated long-term deployment costs are summarized in Table 25.

Figure 29. Typical Adaptive Traffic Signal Installation



Access management strategies along US 9 would include limiting and consolidating access through changes in site and roadway design. This would be accomplished through changes in local land use laws, site design, and roadway design on a parcel by parcel basis through continuous coordination with local municipalities.

Long term transit development along US 9 would consist of creating a more transit oriented corridor through the development of compact, walkable, mixed use centers that builds the population and employment density and characteristics that can sustain long term transit use.

Table 25. Estimated Long Term Deployment Costs

Strategy/Elements	Description	Qty	Unit Price	Capital Cost	Operation/ Maintenance Cost (per year)
Adaptive Signal Control on US 9					
Central Software	Central software for Traffic Operations Center	LS	$260,000	$260,000	$52,000
Detection	In pavement detectors (speed, volume, occupancy) on approach lanes with wireless connection	50	$41,600	$2,080,000	$416,000
Algorithm/ Controllers	Algorithm/ Controllers	50	$15,00	$780,000	$156,000
Totals				**$3,120,000**	**$624,000**

5.4.5 Strategies Requiring Further Study

As discussed earlier, active traffic management was determined to require additional study. Figure 30 presents a typical speed harmonization lane control signage and gantry. Costs for these strategies are presented in Table 26.

Figure 30. Speed Harmonization Signing

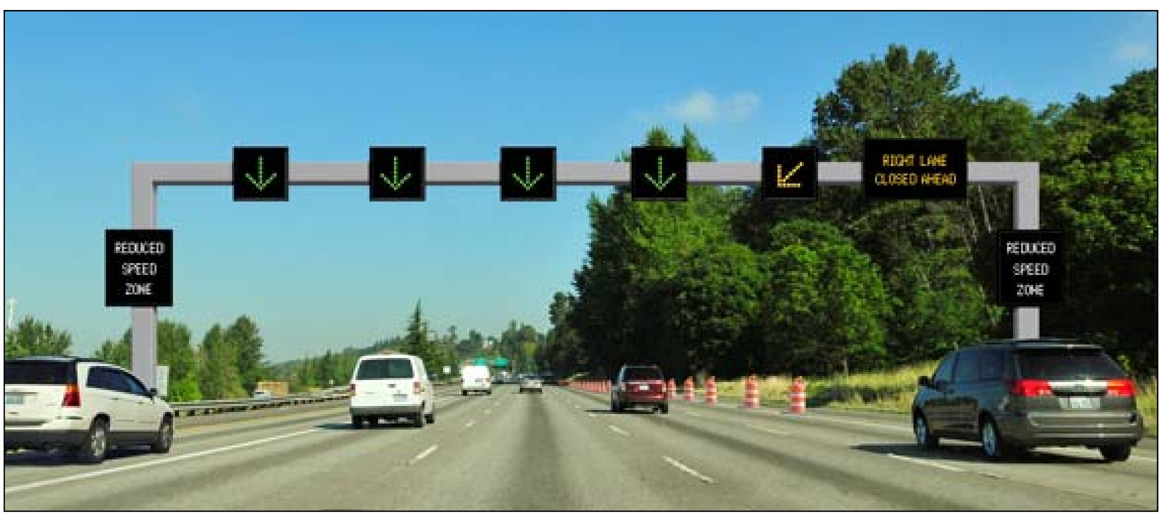


Table 26. Estimated Deployment Costs for Strategies Requiring Further Study

Strategy/Elements	Description	Qty	Unit Price	Capital Cost	Operation/ Maintenance Cost (per year)
Active Traffic Management on I-87					
Speed Harmonization Variable Speed Limits Dynamic Lane Assignment Queue Warning	Gantries every 1/2 mile Northbound on I-87 from Exit 4 to the Twin Bridges (5 miles) and Southbound from Exit 9 to the Twin Bridges (5 Miles)	20	$233,900	$4,678,000	$468,000

5.5 Next Steps

Given the magnitude of the investment required to implement the full I-87/US 9 ICM Plan and current fiscal constraints, it is recommended that the program be progressed for consideration as a Big Ticket Initiative in the CDTC's New Visions 2040 Plan. This will allow the concepts of the ICM Plan to be considered for implementation in stages as funds become available.

APPENDIX

Appendix A – MIST Data Mining Tool

The Management and Information System for Transportation (MIST) deployed in the Capital Region's Traffic Operation Center is an Advanced Traffic Management System (ATMS) that has device level command and control capabilities and a back end database that stores a variety of operator and device level information and operator actions. The system has been developed and installed by a third party vendor and is currently in daily use for the management of the freeway system in the Albany metropolitan area. Data mining is a term of art used to describe the process for extracting data from a database in a format that identifies patterns or reports. A MIST data mining tool was developed using JAVA/ Jasper Report API to automate the mining of incident data from MIST to support NYSDOT operations.

Typical User

A typical user of the data mining tool will be a transportation planner or engineer, ATMS operator, or ATMS system administrator. Users are expected to have a general understanding of traffic principles and computer applications.

Support Environment

CDTC/NYSDOT will have unencumbered rights to the tool with the exception of licensing associated with the use of commercial-off-the-shelf (COTS) software. The tool is designed to run in a Microsoft Windows operating system environment, Microsoft XP, Vista, or Windows 7 (there can be no guarantee made as to compatibility with future Windows operating systems).

Description of Tool

The MIST data mining tool is built based on the following agreed upon elements:

- The data mining tool is a standalone application that runs in an "off-line" environment from the existing MIST system.
- Data is extracted from the MIST system by authorized NYSDOT personnel, saved into Microsoft Access Database format, and transferred to the data mining tool user.
- A report generation tool was developed that contains a set of pre-stored data queries and report output formats. The user can select a report type from a pull down list and the tool will generate the report for the data imported into the tool.
- Reports are available on-screen, print and capable of being saved to disk in pdf and Microsoft Excel formats.

System/ User Guide

MIST Database

The data mining tool relies on data in MS Access format from a NYSDOT supplied MIST database snapshot.

Report Outputs

The data mining tool provides the ability to print the reports generated and to save the reports generated to a local hard drive in the following formats:

- PDF

- EXCEL
- Other formats (i.e. HTML, CSV, Word RTF)

Installation

The data mining tool has the following requirements:

- Operation System Requirement: Windows XP.
- JAVA SDK requirement: Java 1.6.25 SDK.

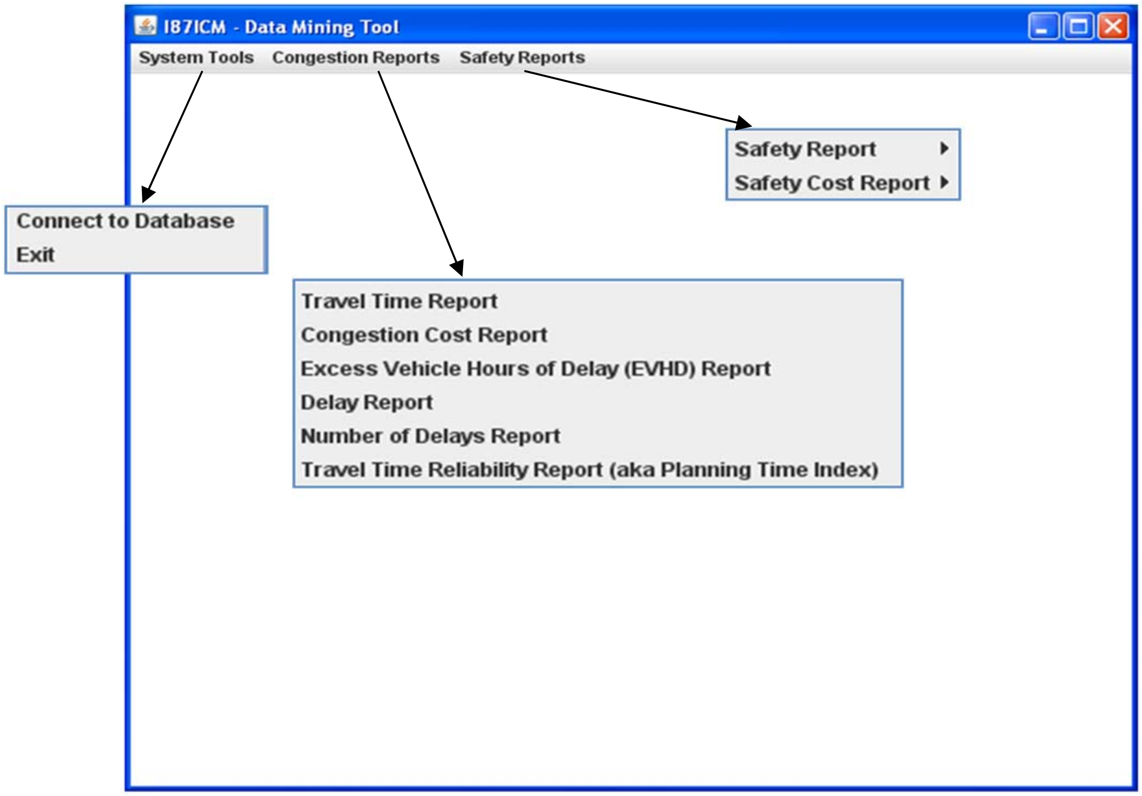
In order to install the tool:

- Copy the whole I87ICM_DataMiningTool folder to a local drive or folder.
- Double click I87ICM_DataMiningTool.jar to run. The user may also double click the start.bat file to run the tool.

Graphic User Interface

The mining tool runs as an executable file (I87ICM_DataMiningTool.jar). When the user double clicks the executable file, the system will automatically open a window on the user's desktop (see Figure A.1). The graphic user interface includes a menu, a toolbar and a series of dialog forms (windows). Every dialog form is designed to handle predefined queries such as travel time, congestion, and hot spots etc. when the user clicks on a menu item under the menu or a tool/ button on the toolbar, the system will display a query dialog form. The user can then enter necessary parameters and run the query. The query result will be shown in a separate window form (based on a designed report template) from there the user can print or export to other report formats.

Figure A.1. Data Mining Tool Graphic User Interface



Report Types

The reports include the following types.

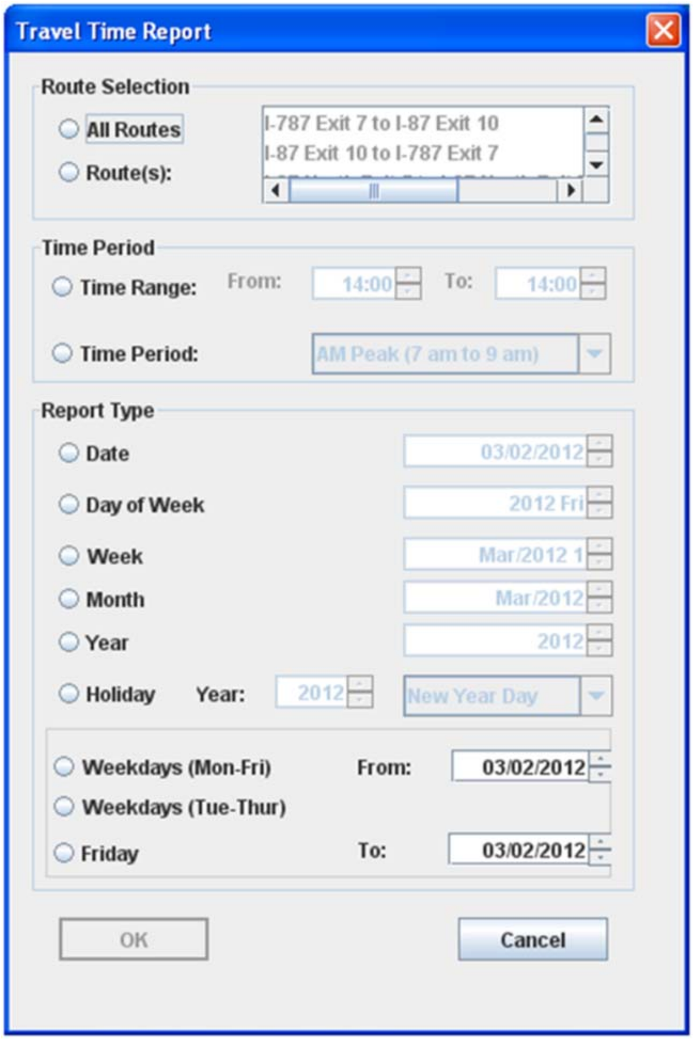
Congestions Reports

<u>Corridor Travel Time Report</u>

The ability to extract travel times for the I-87 corridor for specific dates and times, average for a specific week, month and year. Ability to generate the same report for a specific day of week (i.e. Mondays, Tuesdays, etc.) or day of the year (Memorial Day, Labor Day, etc.) will be pulled from the MIST historical database (see Figure A.2). Travel time will be based on using the spot speed sensor data and applying the spot speed to the link as defined in the MIST system. Intervals for summary are:

- AM Peak Period (7AM to 9AM)
- Mid-Day (9AM to 4PM)
- PM Peak (4PM to 6PM)

Figure A.2. Travel Time Report GUI



<u>Congestion Cost Report</u>

The user inputs a dollar value associated with minutes of delay and the travel time report data will be used to generate a total cost estimate for the delay relative to a free flow speed condition using the corridor's speed limit as free flow conditions.

<u>Delay Report</u>

The report is developed based on a comparison with free flow travel time (as per speed limit) and actual travel time; and reports how many days in a week/ month/ year, there was a delay. Speed of 50 mph is used as the cut-off limit threshold for the delay report for determining when delay occurs. If the speed of traffic during a 15-minute interval is less than 50 mph, it will be considered a delay condition. If the delay was not linked to any incident or lasted less than 90 minutes, it was considered a recurring delay. If the delay was linked to an incident or lasted 90 minutes or more, it was considered an incident delay.

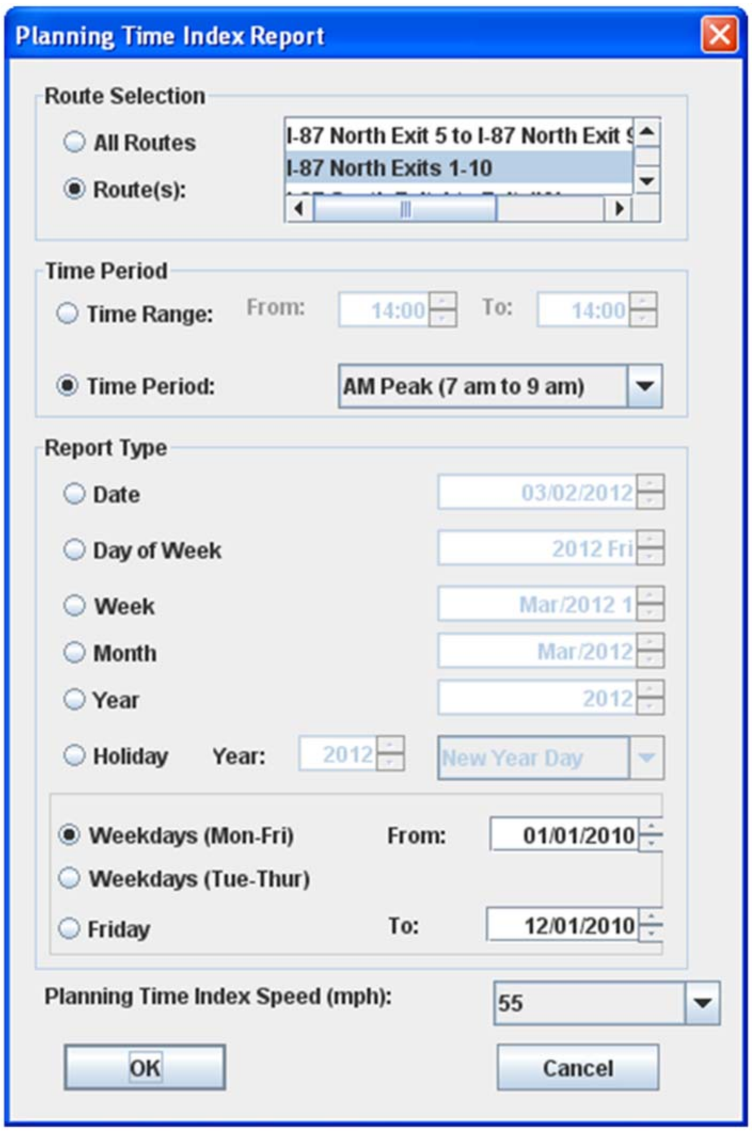
Excess Vehicle Hours of Delay (EVHD) Report

The report is developed using the actual travel time minus free flow travel time summed over all vehicles during the peak period. The delay figures will be calculated for the AM peak period (7AM - 9AM), PM peak period (4PM - 6PM), and off-peak period (6AM - 9PM excluding both AM and PM peak periods).

Travel Time Reliability Report (aka Planning Time Index)

The report is developed using the measured speed of traffic on a day that is slower than the 95 percent of traffic days during the previous 12 months. The travel time that corresponds to this speed is divided by the travel time that corresponds to 55 miles per hour driving speed for the I-87 corridor providing a reliability index. The index will be calculated for link on I-87 between exit points within the study corridor (see Figure A.3).

Figure A.3. Planning Time Index Report GUI



Safety Reports

Safety Reports

The reports are generated by reporting the number and type of incidents in the I-87 corridor for specific dates and times, number for a specific week, month and year. Ability to generate the same report for a specific day of week (Mondays, Tuesdays, etc.) or day of the year (Memorial Day, Labor Day, etc.) will be available.

Safety Cost Reports

The reports are developed with user input. The user inputs a dollar value associated with each incident type and the safety report data will be used to generate a total cost estimate for the incidents reported in the MIST database.

Appendix B – VISSIM Simulation Model

An existing conditions VISSIM model of the I-87/US 9 corridor was developed to serve as a tool that can be used to simulate and assess the effectiveness of recommended Integrated Corridor Management (ICM) strategies. VISSIM is a microscopic traffic simulation program and can be used to model ICM strategies such as alternative route guidance, adaptive signal control, ramp metering and speed harmonization.

Study Area and Analysis Periods

On I-87, most of the recurring congestion occurs between Exits 4 and 9. The boundaries of the VISSIM network were selected to include this section of limited access highway as well as the adjacent upstream and downstream interchanges to ensure all potential bottleneck locations were incorporated into the model. The VISSIM network consists of:

- The 15-mile long segment of I-87 between Exits 2 and 10;
- The parallel 15-mile segment of US 9 between Osborne Road in Loudonville and Ushers Road in Clifton Park; and
- A total of nine roadways that provide connections between the I-87 and US 9 corridors (Albany Shaker Road, Osborne Road, NYS Route 155, NYS Routes 2/7, Alternate NYS Route 7, Crescent Vischer Ferry Road, Grooms Road, NYS Route 146 and Ushers Road).

VISSIM models were developed for the AM peak period (7AM – 9AM) and PM peak period (4PM – 6PM) to reflect the peak travel demand in the southbound and northbound directions, respectively. An initialization period of 30 minutes was included at the start of each simulation run to allow for traffic to be fully loaded throughout the network before the start of each analysis period. Each model also had a 30 minute unloading period at the end of each analysis period to allow for queue dissipation.

Model Coding

The VISSIM model was developed from the Capital District Transportation Committee (CDTC) Systematic Transportation Evaluation and Planning (STEP) Model, a VISUM travel demand forecasting model that covers Albany, Rensselaer, Saratoga, and Schenectady Counties. A subnetwork representing the boundaries of the VISSIM model was created in VISUM so that the roadway network and origin-destination (O-D) trip tables could be brought into VISSIM using the abstract network model (ANM) import feature.

The roadway network in the VISSIM model—including mainline segments, ramps, acceleration/ deceleration lanes, lane additions/ drops and weaving sections—was then further coded in detail by tracing over scaled aerial photos provided by NYSDOT. Other details such as lane configurations, turn restrictions, posted speed limits and advisory speeds were obtained from panoramic photos in Google Street View. In addition, the Single Point Urban Interchange (SPUI) at Exit 6, which was completed in September 2010 and not shown on the aerial photos, was coded into the VISSIM model using the plans in Appendix A of the *Route 7 Bridge Over I-87 Design Report* (May 2007).

The VISSIM model includes 33 signalized intersections, all of which are actuated. The traffic signals were modeled using Ring Barrier Control (RBC) based on signal timing and phasing plans provided by NYSDOT.

Traffic Data

Traffic data used in the development of the VISSIM models included a combination of automatic traffic recorder (ATR) counts, turning movement counts and Management Information System for Transportation (MIST) data provided by NYSDOT. MIST data were available at 30 locations along I-87 and included volume and speed data on a lane-by-lane basis. Where necessary, growth factors were applied to the traffic counts to consistently reflect 2010 volumes, as this was the base year selected for the VISSIM model.

Calibration

Before each VISSIM model could be calibrated, approximately 10 simulation runs were made using the dynamic assignment procedure to allow for the travel times in the model to reach convergence. The VISSIM models were then calibrated against the baseline traffic data to meet the following acceptability targets with regards to observed traffic volumes and bottlenecks:

- Modeled traffic volumes must be within 15% of observed volumes in 85% of all cases.
- Bottlenecks should represent visually acceptable queuing.

Traffic volumes were calibrated by adjusting the O-D trip tables and placing surcharges on certain links and connectors to alter vehicle routing decisions through the network. The VISSIM models were then modified so that the bottlenecks that occurred in the models reflected recurrent congestion based on MIST data and other field observations. Queuing conditions were calibrated through the adjustment of driving behavior parameters, speed decision points and reduced speed areas.

For example, on the southbound I-87 service road between Exits 6 and 7, significant traffic backups were occurring in the model in this section, even though in real life no significant queuing occurs at this location. For this reason, the driving behavior at this location was changed from the default freeway parameters by adding the keyword “COOPERATIVE” after the keyword “FREE_LANESEL” to allow vehicles to make more cooperative lane changes in this weaving section.

As another example, on southbound I-87 between Exits 8 and 7, a reduced speed area was added to the AM peak period model at the approach to the Twin Bridges to reflect the slowdown that occurs as vehicles approach this bottleneck location. The parameters for the reduced speed area were set to vary in time in order to accurately reflect travel speeds in the existing conditions based on the MIST speed data:

Time Period	Speed Distribution Parameters		
	Average	Minimum	Maximum
7:15 am – 7:30 am	40 mph	35 mph	45 mph
7:30 am – 8:00 am	32.5 mph	27.5 mph	37.5 mph
8:00 am – 8:15 am	40 mph	35 mph	45 mph
8:15 am – 8:30 am	45 mph	40 mph	50 mph
8:30 am – 8:45 am	50 mph	45 mph	55 mph

Appendix C – Adaptive Traffic Signals

Adaptive Control Overview

FHWA defines adaptive signal control as:

> "Adaptive traffic signal control is a concept where vehicular traffic in a network is detected at an upstream and/or downstream point and an algorithm is used to predict when and where the traffic will be and to make signal adjustments at the downstream intersections based on those predictions. The signal controller utilizes these algorithms to compute optimal signal timings based on detected traffic volume and simultaneously implement the timings in real-time. This real-time optimization allows a signal network to react to volume variations, which results in reduced vehicle delay, shorter queues, and decreased travel times".[3]

As the traffic signal control market evolved, vendors have developed a wide variety of "adaptive" signal control solutions. Each system has its unique algorithm and success of the system's implementation can vary greatly. The solutions general deploy strategies that are meant to address signal operations in one of four basic strategies:

- Balance phase utilization - fair distribution of green
- Minimize arrivals on red - improve progressed flow
- Minimize queue-time density - serve the most cars waiting the longest
- Minimize combination of stops and delay - delay-offset optimization

Architecture is a term used to describe the logical and physical means by which the adaptive system is put together. System architectures can vary significantly as well, falling in the general range of solution such as:

- Built into the central system
- Works in parallel to central system
- Built into local controller
- Separate local-cabinet processor
- Replaces a field master
- Built into a field master
- Uses a system-to-controller interface, separate processor board talking to the controller

For the purposes of this report, the discussion will be centered around describing architectures as:

- Centralized – meaning the algorithm resides with the central software and timing plan adjustments are managed, controlled and changed by the central software residing in one location.
- Distributed – meaning the algorithm resides at the intersection in the controller or a supplemental "CPU" installed at the local intersection.

[3] FHWA's website, http://ops.fhwa.dot.gov/publications/fhwahop08024/chapter9.htm

Adaptive Control Algorithms

There are a significant number of adaptive control strategies that have been developed and deployed to various degrees around the globe. Below is a list of a significant number of the adaptive control strategies with a brief description.

- **ACS Lite** - Adaptive Control Software Lite (ACS Lite) is designed to operate as a closed-loop type system using local ACS Lite master controllers. Several signal control manufactures have integrated ACS Lite into their central control platforms. ACS Lite adapts splits and offsets of signal control patterns and plans with optimization steps occurring every 5 to 10 minutes. Using the currently running traffic plan, ACS Lite creates and analyzes a statistical profile of intersection efficiencies along an arterial. In the event communication interruptions occur between the ACS Lite application and the local controllers, the local controller still maintains full coordinated operation of the intersection using the preexisting plans stored in the controller.[4] There are several controller manufacturers that have a version of ACS Lite such as Econolite and Siemens.
- **InSync** – An adaptive control strategy developed by Rhythm Engineering [5]builds on a distributed architecture that balances MOEs for phase splits and green band optimization. Green bands (or ‘tunnels” as Rhythm Engineer refers to them as) are guaranteed by successively turning each light green at the expected arrival time of vehicles from upstream intersections. The solution is generally deployed with video detection and has a install base of approximately 400 intersections.
- **LA ATCS** – Los Angeles County has developed its own version of adaptive control. The algorithm optimizes cycle length, phase split, and offset on a cycle-by-cycle basis. The algorithm requires specific detection at each intersection running on a 2070 controller platform. The algorithm and decision making functions reside with the central software. The software is available to agencies for purchase.
- **OPAC** – OPAC is an acronym for Optimization Policies for Adaptive Control. OPAC is a predictive, distributed control strategy featuring an optimization algorithm that calculates signal timing to minimize the performance function of total intersection delay and stops[6]. It evaluates specific optimization parameters every cycle. OPAC was originally developed as part of an FHWA research effort in the 1990’s. OPAC is commercially available from Telvent.
- **RHODES** – An adaptive control strategy developed by the University of Arizona in conjunction with FHWA. The algorithm is predictive and does not follow a traditional “signal timing plan” approach instead provides green time to traffic approaches as demanded. The software algorithm continues to evolve through the efforts of the University of Arizona. The solution is commercially available.

[4] Econolite’s Website, http://www.econolite.com/products/systems/acs-lite.asp, January 23, 2012, selected based on Demo Econolite made to the St/ Charles County Stakeholders.
[5] InSync Adaptive Traffic Signal Technology white paper, Real-Time Artificial Intelligence Delivery Real-World Results, Reggie Chandra and Chris Gregory, July 2011
[6] Telvent’s Website, http://www.telventblogs.com/transportation/post.cfm/telvent-smartmobility-adaptive-traffic-signal-control-opac, January 23, 2012

- **SCATS** – An adaptive control strategy developed in Australia. SCATS is an acronym for Sydney Coordinated Adaptive Traffic System (SCATS). The algorithm manages "groups" of intersections from the central system using one intersection in the group as the master or critical intersection that drives the algorithm for that group by managing platoons of traffic.
- **SCOOT** – An adaptive control strategy developed in the UK. SCOOT is an algorithm run from a central computer that polls detectors every second and makes small adjustments to timing parameters to avoid disturbances in traffic flow.

Table C.1 has been developed to summarize the main features of the most popular adaptive control strategies deployed across the county.

Table C.1. Adaptive Control Implementation Architecture Summary[7]

Adaptive System	Controller Type	Detection required	Field/Central Based Algorithm	Field Processor Required
ACS Lite	Various legacy controllers/cabinets	Existing stop-bar detection (by phase). Prefer 1 or more advance detectors per coordinated phase	Field or Central	Yes
InSync	Various - can work with most controller firmwares	Video Stop bar only	Field	Yes
LAACTS	ATCS firmware, 170/2070 platform	Unknown at time of report	Unknown	UNK
OPAC	Econolite ASC2, ASC3; Other NTCIP controllers on way	Stop bar and upstream detection	Field & Central	Yes
RHODES	Siemens NextPhase 1.7.6c - 2070	Stop bar and upstream detection	Field	Yes
SCATS	SCATS firmware on 2070-1B CPU	Stop Bar only (by lane)	Central	No
SCOOT	SEPAC firmware on EPAC M50 and 2070	Stop bar and upstream detection	Central	No

Implementation Cost Estimate

The cost of implementing an adaptive control strategy includes three basic elements:

- Central control/ monitoring software
- Detection
- Adaptive control algorithm installation

Central control software for traffic signal systems with and adaptive control function generally runs in the $250,000 to $300,000 range. It serves as the base from which the adaptive

[7] ITS Transpo Presentation, Adam Moser, Pinellas County FL, February 2011, http://www.itstranspo.org/PRESNTATION%20-%20Adam%20Moser.pdf

control platform is managed, monitored and controller. Once the central software is in place the field installation elements need to be installed. The specific elements required will vary based on the specific strategy selected but the general planning should be based on the following:

- Detection should be budgeted at $20,000 to $30,000 per intersection (based on a point detection solution such as Sensys). This is for advance detection and stop line detection on all approaches. Video based detection solutions would increase the detection cost to approximately $50,000 per intersection.
- Field Hardware should be budgeted at $5,000 per intersection
- Field Algorithm licensing should be budgeted at $3,000 per intersection

Appendix D – VISSIM Ramp Meters Assessment

Introduction

Ramp metering is an Active Traffic Management (ATM) strategy in which traffic signals are placed on entrance ramps to control the rate in which vehicles enter a freeway, smoothing the flow of traffic on the mainline. The existing conditions VISSIM model developed for this study (see Appendix B) was used to test ramp metering as a potential means for reducing congestion and improving travel times on I-87. During the AM peak period, recurrent congestion occurs on I-87 southbound approaching the Twin Bridges, which are located between Exits 7 and 8. Ramp meters were tested on the southbound entrance ramps at Exit 8 (Crescent Road) and Exit 8A (Grooms Road) to assess the effectiveness of ramp metering in reducing congestion on the mainline and determine if adequate ramp queue storage capacity is available.

Model Development

Ramp meters were coded into the simulation model using VISSIM's Vehicle-Actuated Programming (VAP) signal control module, which includes signal heads on the entrance ramps, detectors on the mainline lanes right before the merge with the entrance ramp and a VAP controller logic file. At both Exits 8 and 8A, two-lane ramp meters were coded into the model, with the green time alternating between each lane on the entrance ramp. One full cycle length involves a separate two-second green phase for each lane (during which only one vehicle can proceed), followed by an all-red interval until the next cycle is triggered. The cycle lengths vary from 7 to 11 seconds, depending on the density of the traffic on the mainline.

Ramp metering allows traffic to enter the freeway at a more even rate. Using the physical space of the entrance ramp to store queues, the mainline can be protected from turbulence to the traffic flow that can result from vehicles entering the freeway in platoons. While travel times on the mainline are generally expected to improve with the use of ramp meters, the tradeoff is that queues on ramps with meters can become substantial.

To provide an assessment of ramp metering, travel time and queue length data were collected from both the existing conditions VISSIM model and the models with ramp metering. Travel times were measured along the I-87 southbound mainline from a point just south of Exit 9 to a point just north of Exit 7, a total distance of approximately 5.5 miles. This segment includes both of the entrance ramps where the ramp meters were tested. Queue counters were also placed on the entrance ramps in the VISSIM model to measure the lengths of the queues that formed behind the ramp meters.

Results of Analysis

Two different ramp metering scenarios were simulated in VISSIM:

- Option 1 included ramp meters at the southbound entrance ramps at Exits 8 and 8A; and,
- Option 2 included a ramp meter at the southbound entrance ramp at Exit 8A.

Option 2 was developed in response to observations made while running the VISSIM model for Option 1, as this resulted in substantial queues on the entrance ramp at Exit 8.

Table D.1 summarizes the results of the mainline travel time measurements between Exits 7 and 9 for the VISSIM models of existing (baseline) conditions, Option 1 and Option 2. The table also includes the average speed of vehicles through this mainline segment during the 7AM – 9AM peak period.

Table D.1. Mainline Travel Times and Speeds During AM Peak Period

		Baseline Model		Option 1		Option 2	
	Time Period	Travel Time (min:sec)	Speed (mph)	Travel Time (min:sec)	Speed (mph)	Travel Time (min:sec)	Speed (mph)
	6:30 – 6:45	5:45	57.2	5:43	57.5	5:45	57.2
	6:45 – 7:00	6:15	52.6	5:54	55.8	6:17	52.3
Peak Period	7:00 – 7:15	6:17	52.4	6:18	52.3	6:22	51.7
Peak Period	7:15 – 7:30	7:29	43.9	7:21	44.8	7:47	42.3
Peak Period	7:30 – 7:45	8:25	39.1	7:39	43.0	7:58	41.3
Peak Period	7:45 – 8:00	8:10	40.3	7:06	46.3	7:36	43.3
Peak Period	8:00 – 8:15	7:22	44.7	6:42	49.1	7:18	45.1
Peak Period	8:15 – 8:30	6:32	50.3	6:23	51.5	6:38	49.6
Peak Period	8:30 – 8:45	6:25	51.2	6:32	50.3	6:41	49.2
Peak Period	8:45 – 9:00	6:57	47.3	6:27	51.0	6:29	50.8
	9:00 – 9:15	6:41	49.2	6:16	52.4	6:55	47.6
	9:15 – 9:30	6:20	52.0	6:20	52.0	6:57	47.4
	Peak Period Average		**45.6**		**48.2**		**46.3**

Note: Travel time and speed data collected on I-87 southbound between Exits 7 and 9.

As shown in Table D.1, the average speed of southbound vehicles between Exits 7 and 9 is 45.6 mph in the baseline model. Under Option 1, with ramp meters at Exits 8 and 8A, the average speed would improve to 48.2 mph, a net increase of 2.6 mph compared to the baseline model. However, the simulation also showed that the ramp meter at Exit 8 would result in significant queuing onto Crescent Road. Figure D.1 is a screenshot of the VISSIM model showing the queue along eastbound Crescent Road resulting from the ramp meter. Under Option 2, with a ramp meter at Exit 8A, the average speed of southbound vehicles would increase to 46.3 mph, a net increase of 0.7 mph compared to the baseline model.

Figure D.1. Queuing on Crescent Road in Option 1

Table D.2 summarizes the results of the queue length measurements on the entrance ramps in Option 1 and Option 2. Under Option 1, with ramp meters at Exits 8 and 8A, the maximum queue would occur at Exit 8 and would extend for approximately 1,675 feet, well beyond the end of the entrance ramp onto Crescent Road. Based on the results shown in Table D.2 and Figure D.1, it is likely that a ramp meter on Exit 8 would have significant impacts on the local street network. Under Option 2, with a ramp meter at Exit 8A, the maximum queue would extend for approximately 375 feet. As the ramp meter is located more than 500 feet away from the end of the entrance ramp at Grooms Road, the queuing from a ramp meter at this location would not be expected to result in impacts to the local street network.

Table D.2. Queue Lengths on Entrance Ramps During AM Peak Period

		Option 1				Option 2	
		Exit 8A		Exit 8		Exit 8A	
	Time Period	Average (ft)	Maximum (ft)	Average (ft)	Maximum (ft)	Average (ft)	Maximum (ft)
	6:30 - 6:45	3	67	6	78	2	53
	6:45 - 7:00	11	106	63	225	5	63
Peak Period	7:00 - 7:15	54	219	781	1,671	39	199
	7:15 - 7:30	99	280	1,645	1,674	92	246
	7:30 - 7:45	62	196	1,640	1,677	163	358
	7:45 - 8:00	87	238	1,636	1,678	174	372
	8:00 - 8:15	97	337	1,642	1,676	168	328
	8:15 - 8:30	39	187	1,642	1,678	96	297
	8:30 - 8:45	47	182	1,640	1,678	141	365
	8:45 - 9:00	145	314	1,641	1,678	39	193
	9:00 - 9:15	115	356	1,642	1,678	43	167
	9:15 - 9:30	41	190	1,644	1,677	27	128

Conclusion

The results of the VISSIM ramp metering assessment showed that the addition of ramp meters at Exits 8 and 8A would improve speeds and reduce travel times along the I-87 southbound mainline. However, the queues from the ramp meter at Exit 8 would spill back onto Crescent Road and would likely result in significant impacts to the local street network. If ramp metering were only implemented at Exit 8A, no impacts to the local street network would be expected, but there would only be slight improvements to speeds and travel times along the I-87 southbound mainline.