ROUTE 110 & 113 METHUEN ROTARY INTERCHANGE STUDY

Methuen, Massachusetts

The Executive Office of
Transportation & Public Works
April 2008

EOT
MASSACHUSETTS EXECUTIVE OFFICE OF TRANSPORTATION

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Methuen Rotary Study
Route 110 - Route 113

Chapter 1: Study Framework

1.0 Introduction

The following chapter describes and documents how the study was conducted or structured, including project purpose, goals and objectives, evaluation criteria, study area, and the public involvement plan. Subsequent chapters document the evaluation of existing conditions, problem identification, alternatives development, alternatives analysis, and recommendations.

1.1 Project Purpose

The Executive Office of Transportation & Public Works initiated this study in order to evaluate and address transportation issues at the Route 110 & 113 rotary interchange at I-93 in the City of Methuen. The Route I-93 Corridor Study conducted in 2003 for the Merrimack Valley Planning Commission, developed and briefly analyzed seven (7) transportation alternatives for the Exit 46: Route 110 & 113 rotary interchange. However, due to the size of the study area and lack of local public involvement, the recommendation of the prior study was to examine the rotary and interchange in more detail and with additional public involvement, thus initiating the current study.

This study reviewed those prior alternatives, created new alternatives, and also considered transportation issues related to industrial development along Route 113 in Dracut. Specifically, this study's intent was to assess the existing infrastructure, traffic, safety, environmental, socio-economic, land use, and planned development data against a forecast year of 2025 for comparative analysis. Based on the alternatives analysis and extensive public involvement, a plan of recommendations for transportation improvements (immediate, short-term, and long-term) is a major product of the study.

1.2 Study Goals and Objectives

The intent of the Goals and Objectives task was to define a meaningful mission statement for the overall study in cooperation with a Study Advisory Committee (SAC). The primary goals were defined as the following:

- ***To increase mobility, reduce congestion, and improve safety at the Exit 46: Route 110 & 113 Rotary on I-93 and surrounding arterials***

Specific objectives were also developed in order to achieve the goals of the study. These objectives included the reduction of traffic congestion and delay at the interchange and on Routes 110 and 113; reduction of traffic queuing on the off-ramps back onto the mainline of I-

93; improvement of air quality through better traffic flow and idle reduction; reduction of the potential for vehicle crash occurrence; minimize right-of-way (ROW) impacts during the development of alternatives; development of cost-effective alternatives; development of alternatives that are supported by the SAC and the general public; and the development of alternatives that can readily proceed into the project development phase.

1.3 Evaluation Criteria

Evaluation criteria are specific considerations, or measures of effectiveness, used to assess the benefits and impacts of the alternatives. More specifically, the evaluation criteria were determined based on the defined goals and objectives; they were applied during the alternatives development and alternatives analysis tasks of the study; and they were ultimately used to recommend the best solutions based on the defined goals and objectives. They were developed in cooperation with the SAC and were modified on an as-needed basis. Table 1-1 below contains the evaluation criteria developed for the study:

Table 1-1 Evaluation Criteria

Criteria	Measure
Mobility	Vehicle Delays; Level of Service; Vehicle Miles Traveled; Vehicle Hours Traveled; Demand Shifts
Safety	Crash Rates/High Crash Locations; Public Safety; Pedestrian and Bicycle Access; School Bus Safety
Environmental Effects	Air Quality; Wetlands; Hazardous Material Sites; Archaeological and Historic Sites; Parks and Open Space; Farmland
Land Use and Economic Development	Access to Existing Parcels and Those Planned for Development; Right-of-Way; Parking
Community Cohesion	Neighborhood Identification; Pedestrian and Bicycle Access
Cost and Schedule	Construction Costs; Short-range feasibility; Permitting and Construction Timeframe

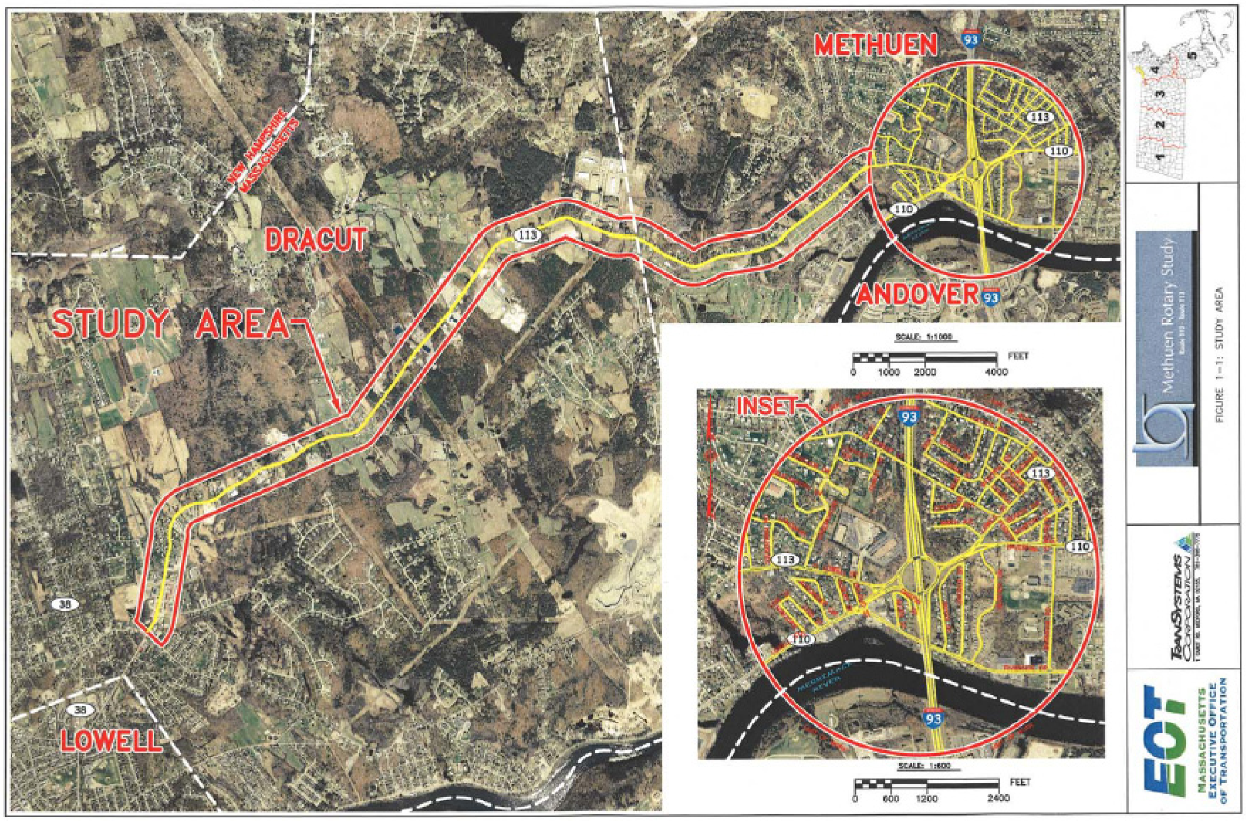
1.4 Study Area

The overall study area, shown in Figure 1-1, included the Exit 46 rotary interchange on I-93 in Methuen at the convergence of Routes 110 and 113, and extended one-half mile in each direction east and west of the rotary. Route 113 was also included as part of the study area, west of the rotary to the intersection of Route 38 in the Town of Dracut. The study area was defined in this way in an effort to understand and consider existing and future growth pressures and traffic needs for the Exit 46 interchange, Routes 110 and 113 at the rotary, and the Route 113 corridor in Dracut. However, the Route 113 corridor in Dracut was not examined at the same level of detail as the immediate vicinity of the rotary interchange. Instead, Route 113 was considered in terms of the economic potential of industrial development, and how traffic levels at the rotary and intersections in the immediate vicinity would be impacted.

1.5 Public Involvement Plan

While the deficiencies of the study area may be widely recognized by the traveling public, nearby residents and local businesses, a plan to address the deficiencies that would gain public understanding and acceptance required a comprehensive public participation process. Many approaches were used to keep the public involved and informed throughout the study process, including numerous opportunities for discussion and comment. All public comments were documented and submitted for consideration in the development of recommendations for improvements to the study area.

Figure 1-1: Study Area and Limits of Work



1.5.0 Public Participation

The public involvement plan was developed to support civic engagement in the study by emphasizing the following principles:

- <u>Access to information:</u> A record of all public informational meetings will be documented. Technical documents will be placed in locations readily available to the community.
- <u>Responsiveness:</u> All questions by the public will be answered in a timely manner.
- <u>Multi-level communication:</u> A variety of methods will be used to reach out to the public including community meetings, a study website, articles in the local newspapers and community newsletters, and the formation of a Study Advisory Committee (SAC).

- Timeliness: The public will receive adequate notice of meetings. Meetings will be scheduled at a time and place that is convenient and comfortable. Adequate time to review materials will be provided.

1.5.1 Elements of the Plan

The public involvement plan had many elements to involve and inform the public in a meaningful way. The study team was accessible to the public, shared information in a complete and understandable manner, and recorded and responded to public comments and concerns. Specific elements of the plan included:

- **Study Advisory Committee**
  Municipal officials, state legislators, regional entities, state agencies, and affected residents were invited to serve on the Study Advisory Committee (SAC). Some members of the SAC were involved in the previous study of the interchange, either as members of the SAC or as individuals who had shown interest in the study area. A full listing of the SAC is included in the Appendix.

  A collaborative approach was taken with the SAC in terms of openly sharing study documents as they were developed. Materials were sent to the committee in advance of the meetings to allow time for review. SAC members were asked to bring concerns and insights to the meetings for discussion by the committee and consultant team. Alternatives and impacts were examined as the study progressed. SAC members were asked to assist the consultant in conducting community outreach by identifying issues, inviting key individuals, and attending public meetings. Ultimately, the SAC assisted in the recommendation of improvements for the study area.

  The SAC was convened for a total of six (6) meetings that were scheduled at key project milestones. Meeting summaries for all of these meetings are included in the Appendix.

- **Public Meetings**
  Two (2) public informational meetings (PIM) were held during the course of the study. The first PIM was held after the study area, goals, objectives, and evaluation criteria for the project were finalized by the SAC, and the existing and future conditions had been evaluated and documented. A second meeting was held after a range of alternatives had been narrowed and refined, and a substantial evaluation of the impacts had been completed.

  The format of the PIM's allowed for public review of documents; opportunities for one-on-one discussion with members of the study team and EOTPW officials; a formal presentation of the study's purpose, findings, and proposed improvements; followed by a question and answer period. The consultant prepared display materials that were graphically rich, written in clear language, and easy for the public to understand.

- **Project Website**
  Project websites are a very effective way to support public participation efforts for transportation projects and studies of this type. The following project website was developed and maintained throughout the study process: www.methuenrotarystudy.org. This site documented the progress of the study, advertised public meetings, provided access to meeting summaries and documents, and allowed the general public and local

citizens to submit comments and ask questions. The website was linked to a database of area residents and organizations that received notices of the open public meeting announcements.

- **Media Coordination**
  Media outlets were contacted in advance of public meetings to publicize notice of the upcoming meetings. Whenever feasible, briefing materials were provided to create a better understanding of the study's progress. Figure 1-2 shows the various communication contacts that were employed as part of the public participation plan.

- **Document Repositories**
  The Final Report was delivered to and can be reviewed at the Dracut Town Hall and Library, Methuen City Hall and Library, the Northern Middlesex Council of Governments, the Merrimack Valley Planning Commission, and at the study website: www.methuenrotarystudy.org.

Figure 1-2: Communication Contacts

PRINT - Newspapers
Lowell Sun
Lawrence Eagle Tribune
The Valley Dispatch
Andover Townsman
Salem (NH) Observer
CABLE - Public Access Television
Methuen – MCTV Channel 22
Lowell - (LTC Channels 8 & 10 – local community and municipal access)
MediaOne Dracut Public Access
RADIO
WUML (formerly WJUL - University of Massachusetts Radio station in Lowell)
WCAP Lowell
WEBSITES
Municipalities
http://www.ci.methuen.ma.us
http://www.dracut-ma.us
http://www.ci.lawrence.ma.us
http://www.lowellma.gov
http://www.townofsalemnh.org
Regional business organizations
http://www.merrimackvalleychamber.com
http://www.merrimackvalley.info
info@methuenboardoftrade.org(Methuen Board of Trade)
http://www.glcc.biz/ (Greater Lowell Chamber of Commerce)
Regional Planning Agencies
http://www.mvpc.org/ (Merrimack Valley Planning Commission)
http://www.nmcog.org/ (Northern Middlesex Council of Governments)

Chapter 2: Existing Conditions, Future No-Build Conditions, and Issues Identification

2.0 Introduction

The following chapter documents data collection, evaluation of the existing traffic conditions, existing transit services, an inventory of socioeconomic data and economic development plans, an inventory of existing land use and environmental conditions, future year no-build traffic conditions, and identification of issues and inventory of project constraints. These tasks were all necessary prior to the beginning of the development of alternatives.

2.1 Data Collection and Analysis of Existing Traffic Conditions

The following section documents the collection of data such as roadway descriptions, traffic counts, vehicle crash information, and vehicle speed counts. This data was then used to conduct traffic operation and safety analyses.

2.1.0 Roadway Descriptions

The study area contains a complex network of roadways that function together as part of an existing interchange system with I-93. In order to understand how this system functions, it is vital to know the configuration of these roadways and the associated intersections. The following section provides brief physical descriptions of the major roadways and intersections in the study area.

Figure 2-1: Interstate 93 Mainline

Roadway Jurisdiction: MassHighway

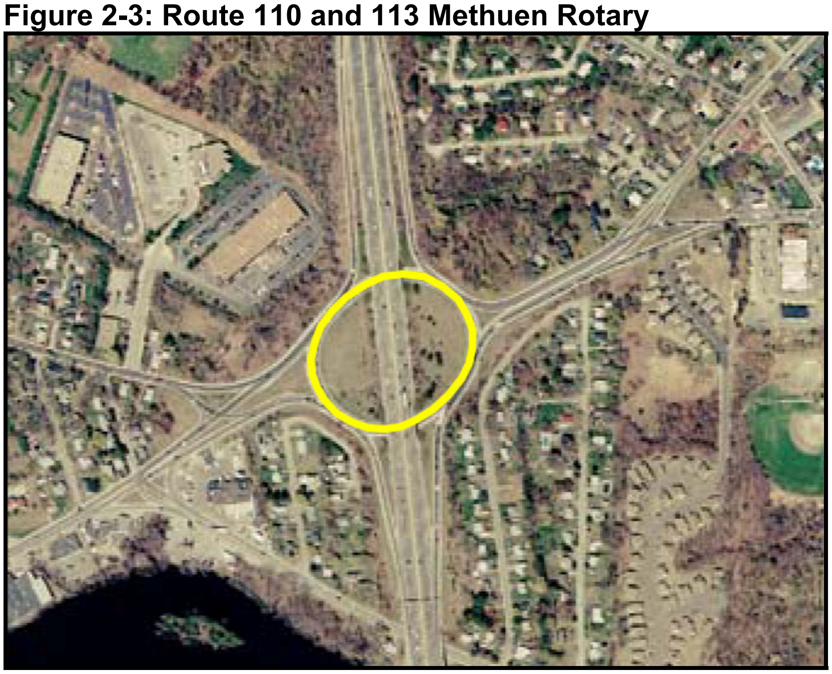
The portion of I-93 included in the study area generally consists of three northbound and three southbound lanes for a total of six travel lanes. The shoulder widths through the study area vary between 10 to 12 feet. There is an approximately 15-foot wide median with a guardrail generally following the roadway centerline. The horizontal alignment is on a tangent through the majority of the study area with a slight curve to the east near the terminal of the northbound on-ramp. The existing I-93 bridge over the Merrimack River contains an extra wide shoulder of approximately 18 feet in both the northbound and southbound directions.

Figure 2-2: Interstate 93 On and Off-Ramps

Roadway Jurisdiction: MassHighway

Exit 46 is configured as a diamond interchange with the ramps terminating at a rotary. All four on and off-ramps are single lane ramps with an approximately 18-foot wide travel lane. The northbound off-ramp has a tapered configuration with a deflection angle of 4 degrees. The taper begins approximately 170 feet north of the Merrimack River. The ramp continues for 700 feet before terminating at the rotary. The northbound on-ramp begins at the rotary and extends approximately 1000 feet before merging into the I-93 mainline with a 500 foot parallel acceleration lane. The southbound off-ramp diverges from the mainline with a 6 degree taper rate and extends for approximately 1000 feet before terminating at the rotary. The southbound on-ramp extends 600 feet from the rotary before merging with I-93 prior to the bridge over Riverside Drive. The parallel acceleration lane extends for an additional 2000 feet before dropping.

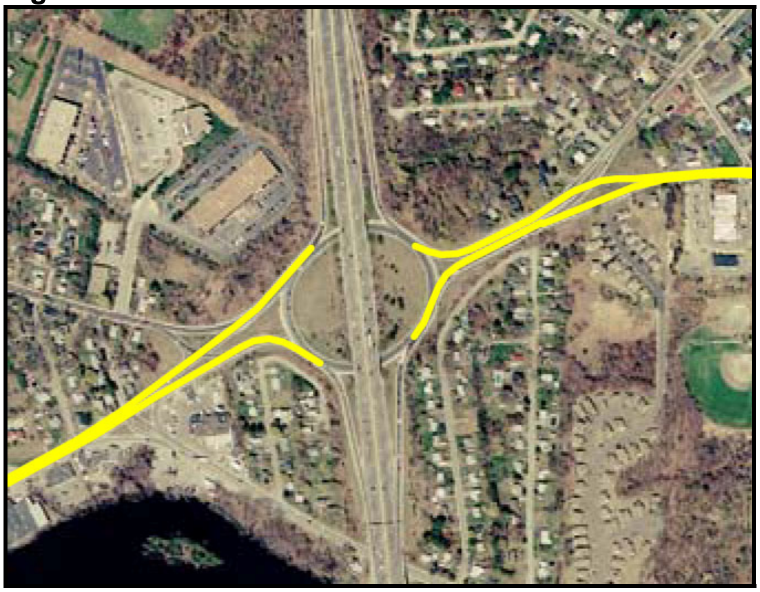
Figure 2-3: Route 110 and 113 Methuen Rotary



Roadway Jurisdiction: MassHighway

The Route 110 and 113 Methuen Rotary has a slightly elongated shape. There are four entering legs and four exiting legs. The rotary provides approximately 26 feet of travel lane width with additional width provided between each entrance into the rotary and the following exit. By visual inspection, the sight lines appear to be insufficient for prevailing speeds with the bridge piers providing a horizontal obstruction for vehicles traveling in the rotary. Striping has been added to the rotary to define two lanes. Intermittent solid white and dashed white lane lines delineate the two lanes.

Figure 2-4: Route 110

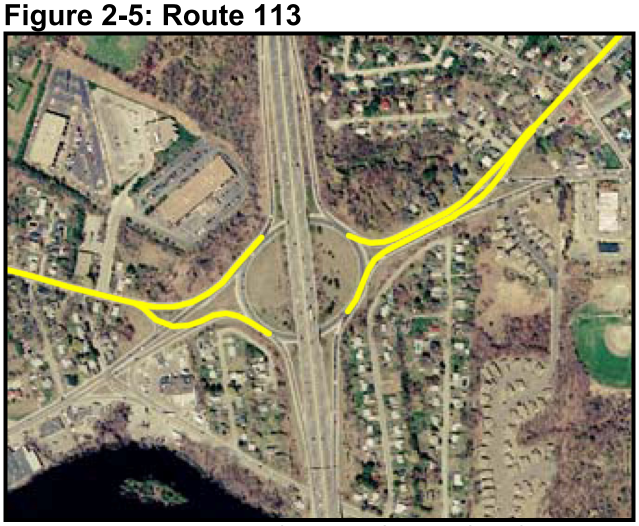


Roadway Jurisdiction: MassHighway

Approaching the study area from the west, Route 110 (Lowell Street) is a two lane roadway with 12-foot lanes and approximately 8-foot shoulders. Approaching the intersection of Route 110 with Route 113, the shoulders begin to narrow as the travel lane width begins to widen. Striping has been added in the vicinity of the intersection to define two travel lanes. Vehicles traveling eastbound on Route 110 must yield to eastbound Route 113 traffic. Similar to eastbound Route 110 in this vicinity, striping has been added to westbound Route 110 to define two travel lanes approaching the intersection.

East of the rotary, the combined Route 110 and 113 (Lowell Street) roadway provides approximately 30 feet of pavement width in each direction. The eastbound and westbound lanes are separated with a 6-foot wide raised median. Approximately 500 feet east of the rotary, the roadway splits with Route 110 traffic continuing straight in an extra wide single lane while Route 113 traffic splits to left. Proceeding east on Route 110 (Haverhill Street), the eastbound and westbound lanes merge back to a standard two lane configuration with two 12-foot wide travel lanes and variable width shoulders. The road continues in this configuration with irregular sidewalks on both the north and south sides of the roadway until approaching its intersection with Burnham Street. At this point, an eastbound right-turn lane is added for vehicles turning south on Burnham Street.

Figure 2-5: Route 113



Roadway Jurisdiction: East of Haverhill Street is City of Methuen
West of Haverhill Street is MassHighway

Route 113 (North Lowell St) west of the rotary consists of two 12-foot wide travel lanes with narrow, variable width shoulders and a 5-foot wide sidewalk along the north side of the roadway. There are numerous residential curb cuts along the length of the roadway. Approaching the intersection with Route 110 from the west, the eastbound and westbound lanes of Route 113 divide. The eastbound lane widens as it approaches the intersection and is able to provide two lanes through the intersection. Similarly, the westbound Route 113 exiting the rotary begins to narrow as it splits from Route 110 until it reaches the standard two lane configuration.

Proceeding east of the rotary, Route 113 separates from Route 110 similar to the configuration on the west side of the rotary. While not striped, the lanes are wide enough to allow drivers to drive this portion of the roadway as two lanes. The lanes then merge back to the standard two lane configuration with minimal shoulders but sidewalks on both sides of the roadway.

Figure 2-6: Burnham Road

Roadway Jurisdiction: City of Methuen

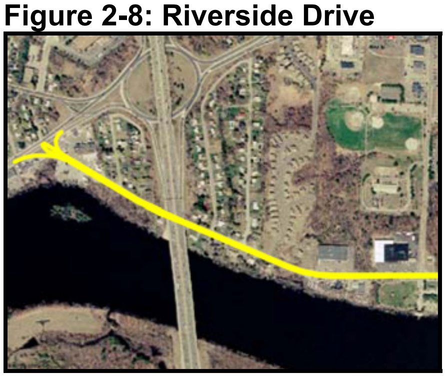
Burnham Road is a striped two lane road running north and south between Route 110 and Riverside Drive, and serves as a continuation of Green Street. It consists of two 12-foot lanes with variable width shoulders and a 5’-6” sidewalk along the east side of the roadway. The horizontal alignment is on a tangent with no horizontal curvature evident for the length of the roadway. The vertical profile can generally be described as two relatively level plateaus with a rapid incline approximately at the midpoint of the road. There are several curb cuts serving larger residential and commercial drives.

Figure 2-7: Green Street

Roadway Jurisdiction: City of Methuen

Green Street is located near the eastern edge of the project limits. It is approximately 1200 feet long and serves as a cross street between Route 110 and Route 113. It is an unstriped, two direction roadway. The roadway cross-section consists of two 12’-6” travel lanes, and a 5’-6” sidewalk on the east side of the roadway. There are numerous residential curb cuts along the length of the roadway. There is an undesirable combination of horizontal and vertical curves resulting in poor sight distance just north of Green Street’s intersection with Newport Street.

Figure 2-8: Riverside Drive



Roadway Jurisdiction: MassHighway

Riverside Drive is a variable width two lane road that extends through the study area. It begins at an intersection with Route 110 west of the rotary and continues easterly, passing under I-93 and intersecting with Burnham Street before continuing east. Although only 3-foot wide shoulders are present, the pavement cross-section as striped offers 16 to 17-foot wide travel lanes, with no sidewalks present. There are intermittent residential and commercial driveways throughout this portion of the roadway.

Figure 2-9: Bolduc Street

Roadway Jurisdiction: City of Methuen

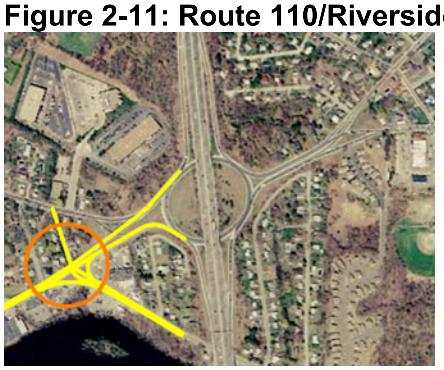
Bolduc Street is a local 400-foot long roadway runnning between Route 110 and Route 113 west of the rotary. It is a one-way road servicing northbound vehicles only with no striping or sidewalks. The roadway cross section consists of 23 feet of pavement width. There are six residential drives along this short stretch of roadway.

Figure 2-10: Branch Street

Roadway Jurisdiction: City of Methuen

Branch Street is a 400-foot long roadway extending north from Route 113 approximately 200 feet west of the Route 110 and Route 113 intersection west of the rotary. It terminates in a 50 foot radius cul-de-sac. The roadway is approximately 44 feet wide and serves two-way traffic. There are sidewalks on both sides of the roadway. There is one residential drive on the east side of the roadway, one office/commercial parking lot access on the west side of the roadway, and three office/commercial parking lot access points from the cul-de-sac. The parking lots are not interconnected and each has one access point via the Branch Street cul-de-sac.

Figure 2-11: Route 110/Riverside Drive/Bolduc Street Intersection



Roadway Jurisdiction: MassHighway

This intersection is a large unsignalized intersection west of the rotary. As mentioned previously, this intersection serves as the terminus of Riverside Drive. There are very pronounced right-turn lanes from eastbound Route 110 to southbound Riverside and from northbound Riverside to eastbound Route 110. As also mentioned above, Bolduc Street is a one way out of the intersection heading north.

Figure 2-12: Route 110/Route 113 (West of the Rotary) Intersection

Roadway Jurisdiction: MassHighway

This intersection serves as the merge point for Route 110 and Route 113 west of the rotary. The westbound Route 113 to Route 110 and eastbound Route 113 intersection is signal controlled while eastbound Route 110 and westbound Route 113 have yield controlled and free flow movements, respectively. Striping has been added to delineate two through lanes for eastbound Route 113 traffic.

Figure 2-13: Route 110/Route 113 (East of Rotary) Intersection

Roadway Jurisdiction: MassHighway

This intersection functions in a similar manner to the Route 110 and Route 113 intersection west of the rotary. It serves as the merge/diverge point for Routes 110 and 113 east of the rotary. Approaching the intersection from the west, the Route 110 traffic has an uncontrolled through movement as it continues straight. The eastbound Route 113 traffic splits to the left and passes through a signalized intersection with westbound Route 110. The westbound Route 110 traffic widens to two lanes as it approaches this intersection before continuing westerly where it merges with Route 113 westbound traffic.

2.1.1 2006 Traffic Volumes, Levels of Service (LOS), and Speed Analysis

24-hour traffic volume counts were collected in January 2006 throughout the study area as part of the effort to understand and assess traffic operations on the roadways and at key intersections. Peak hour turning movement count (TMC) data was also collected at six (6) intersections during a typical weekday morning (7AM – 9AM) and afternoon (4PM – 6PM) peak period, which is when most roadways typically receive the highest volume of traffic. The following section summarizes the results of the analysis of the data, and the raw traffic counts can be found in the Appendix at the end of this report.

Three of the intersections are controlled by a traffic signal and the other three intersections (unsignalized) are controlled by a stop sign, as shown in Figure 2-14 and also listed below.

<u>**Signalized Intersections**</u>

- Route 110/Route 113 (west of rotary)
- Route 110/Route 113 (east of rotary)
- Route 110/Green Street/Burnham Road

<u>**Unsignalized Intersections**</u>

- Route 110/Riverside Drive
- Riverside Drive/Burnham Road
- Route 113/Branch Street

Figure 2-14: Study Area Intersections

The existing peak hour TMC volumes were determined for each study area intersection and are shown in Figure 2-15. These peak hour volumes, 7:30 to 8:30 for the AM and 4:30 to 5:30 for the PM, represent the maximum traffic volume that occurs during a single hour of the peak period. The highest traffic volumes during the AM and PM peak hours were recorded on Route 110/113 west of the rotary, between the merge point for Route 110 and 113 and the rotary interchange. At this location, there were 2,660 vehicles (1,520 eastbound and 1,140 westbound) recorded during the AM peak hour, and 3,200 vehicles (1,502 eastbound and 1,698 westbound) during the PM peak hour. The lowest traffic volumes were recorded east of the Riverside Drive intersection with Burnham Road, with 628 vehicles (309 eastbound and 319 westbound) recorded during the AM peak hour and 878 vehicles (400 eastbound and 476 westbound) during the PM peak hour.

Volumes for the entry and exit points specific to the rotary were also determined and are also presented in Figure 2-15. Volumes at the off-ramps from I-93 northbound and southbound also represent entry volumes into the rotary. For example, the exit volume for the I-93 northbound off-ramp recorded during the AM peak hour was 783, which is also the entry volume for the Route 110 and 113 Rotary at that entry point. Likewise, the exit volume for the I-93 southbound off-ramp was 737, which represents the entry volume at the rotary during the AM peak period. However, entry volumes east and west of I-93, as indicated in the figure below, do not represent the number of vehicles utilizing the northbound or southbound on-ramps.

Percentages of heavy vehicles traveling on the roadways were also obtained from the turning movement count data collected. Data showed the following ranges of heavy vehicles during the peak periods.

- **Route 110 (west of the rotary):** 7% during the AM peak hour, 3% to 4% during the PM peak hour
- **Route 113 (west of the rotary):** 2% - 4% during the AM peak hour, 2% during the PM peak hour
- **Route 110 (east of the rotary):** 4% during the AM peak hour and 2% during the PM peak hour
- **Route 113 (east of the rotary):** 2% during the AM and PM peak hours
- **Riverside Drive**: 5% during the AM peak hour, 3% during the PM peak hour
- **Burnham Road**: 3% during the AM peak hour, 1% during the PM peak hour

2.1.2 Capacity Analysis

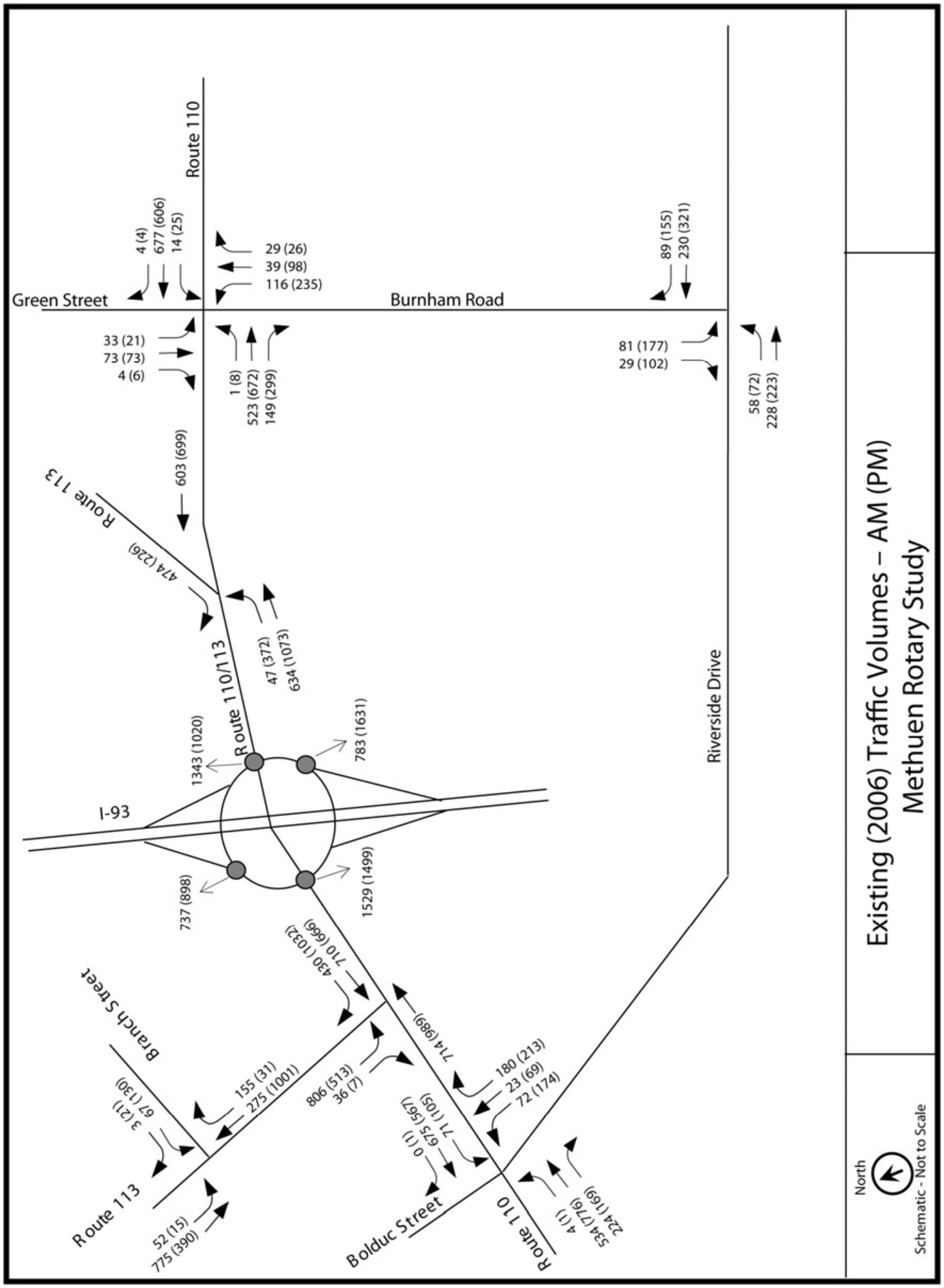
Capacity analyses were performed to determine how the intersections and the rotary currently operate in the study area in terms of processing the existing traffic volumes. The analyses were conducted using the Synchro and SIDRA software packages, which implement procedures presented in the Highway Capacity Manual 2000 (HCM). A capacity analysis provides the following important pieces of information that measure the operational effectiveness of an intersection, rotary, or roadway segment: a volume to capacity (v/c) ratio and/or a level-of-service (LOS). Volume represents the travel demand and capacity represents the amount of traffic the roadway or facility can accommodate under prevailing conditions. Thus, the v/c ratio for a roadway segment is a reflection of how the facility is accommodating the demand. Volume to capacity ratios that approach or exceed 1.0 indicate traffic congestion or poor operating conditions.

Level-of-service (LOS) is a term used to denote different operating conditions that occur at a given intersection or roadway segment under various traffic volume loads. It is a qualitative measure of the effect of a number of factors including intersection geometrics, speed, travel delay, freedom to maneuver, and safety. The LOS at an intersection is divided into a range of six letter grades, ranging from A to F, with A being the best and F the worst.

LOS designation is reported differently for signalized and unsignalized intersections. For signalized intersections, it is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. Specifically, LOS criteria are quantified in terms of average control delay per vehicle for the peak hour, which is reported for the entire intersection and by lane or lane group approach.

For unsignalized intersections, the analysis assumes that the traffic on the mainline is not affected by traffic on the side street. The LOS for each movement is calculated by determining the length of gaps that are available in the conflicting traffic stream. Based on the length of the gaps between vehicles, the capacity of the movement can be calculated. The demand of the movement is then compared to the capacity and utilized to determine the average control delay-

Figure 2-15: Existing (2006) Traffic Volumes – AM (PM) Peak Hours



for the movement. For unsignalized intersections, an overall intersection LOS is not determined. It is generally reported in terms of delay for left-turns on the mainline, as well as all side street movements. The delay ranges differ slightly between unsignalized and signalized intersections due to driver expectations and behavior for each LOS. Table 2-1 below summarizes the LOS criteria.

Table 2-1: Level-of-Service Criteria

Level-of-Service (LOS)	Signalized Intersection Control Delay (sec/veh)	Unsignalized Intersection Control Delay (sec/veh)
A	0-10	0-10
B	>10-20	>10-15
C	>20-35	>15-25
D	>35-55	>25-35
E	>55-80	>35-50
F	>80	>50

Source: 2000 Highway Capacity Manual (Special Report 209)

Similar to unsignalized intersections, the rotary operations analysis is based primarily on the delay for vehicles entering the rotary. As traffic in the rotary has the right-of-way and traffic entering the rotary is required to yield, delay is based on the driver's ability to find acceptable gaps and safely merge into the rotary traffic.

The operation analyses were performed for the two peak hours (weekday AM and PM) for the six intersections and for the rotary. Overall results from the operations analysis are shown in Table 2-2 and Figure 2-16. More importantly, four of the six intersections analyzed within the study area, operate at an overall failing LOS (E or F) and are shown in the bulleted list below:

- *Route 110/Route 113 (east of rotary)* operates at LOS E during the PM peak hour
- *Route 110/Riverside Drive* operates at LOS F during the AM and PM peak hour
- *Route 113/Branch Street* operates at LOS F during the AM and PM peak hour
- *Riverside Drive/Burnham Road* operates at a LOS F during the PM peak hour

Table 2-2: LOS Summary for Existing Conditions (2006)

	AM Peak Hour		PM Peak Hour	
Intersection	LOS	Average Delay (sec/veh)	LOS	Average Delay (sec/veh)
Signalized Intersections				
Route 110/Route 113 (west of rotary)	C	22	C	22
Route 110/Route 113 (east of rotary)	B	13	E	67
Route 110 (Haverhill Street)/Burnham Road	B	13	C	25
Unsignalized Intersections				
Route 110/Riverside Drive (Riverside lefts)	F	72	F	>80
Riverside Drive/Burnham Road (Burnham lefts)	C	17	F	52
Route 113/Branch Street (Branch lefts)	F	>80	F	>80
Rotary				
Northbound Approach	A	6	F	>80
Southbound Approach	F	>80	F	>80
Eastbound Approach	F	>80	A	4
Westbound Approach	C	32	F	>80
(#) = Delay expressed in seconds per vehicle				

Although four intersections experience failing operations as a whole, five of the six intersections were identified as locations with critical movements currently operating at a failing LOS. The critical movements are listed below:

Route 110/Route 113 (west of the rotary)

- The southbound (Route 113) left-turn movement operates at LOS E during the AM peak hour.

Route 110/Route 113 (east of the rotary)

- The eastbound (Route 110/Route 113) through movement operates at LOS F during the PM peak hour.

Route 110/Riverside Drive

- The northbound (Riverside Drive) left and right-turn movements operate at LOS F during the AM and PM peak hours.

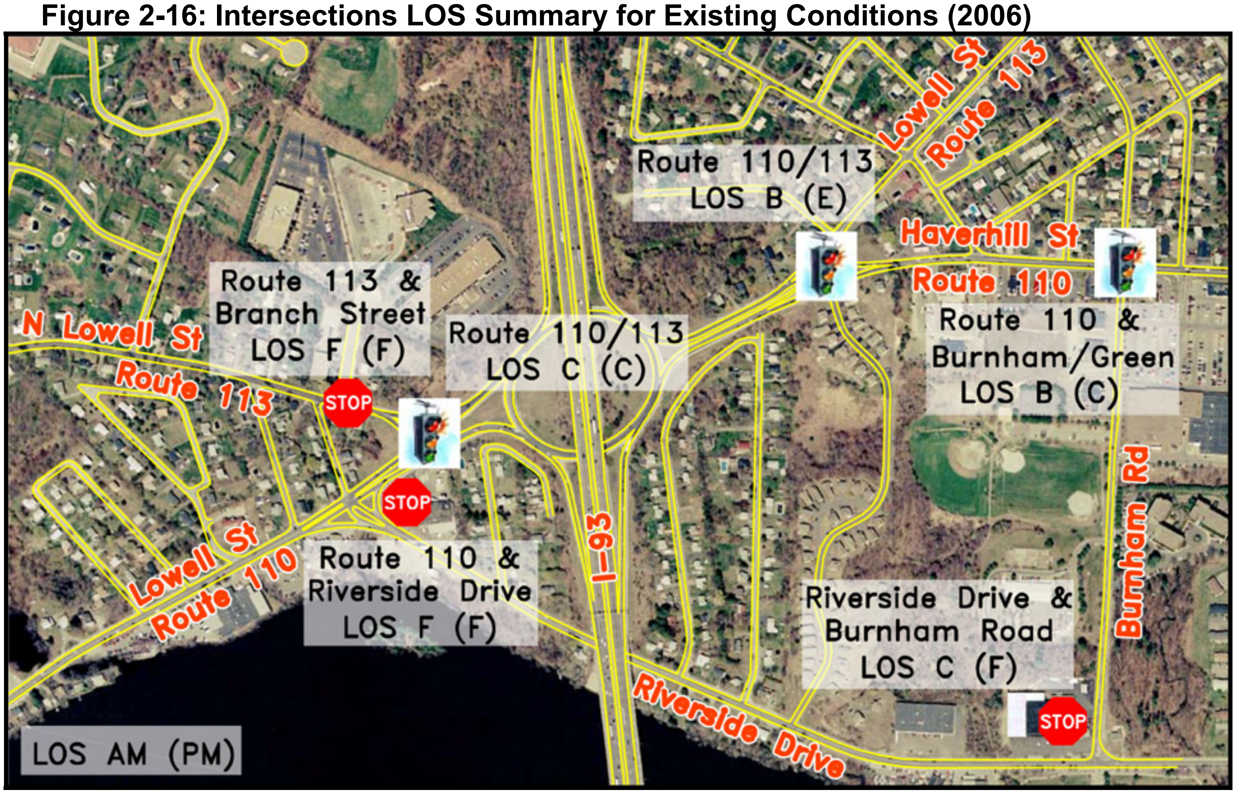
Riverside Drive/Burnham Road

- The southbound (Burnham Road) left and right turns operate at LOS F during the PM peak hour

Route 113/Branch Street

- The southbound (Branch Street) left and right-turn movements operate at LOS F during the AM and PM peak hours.

Figure 2-16: Intersections LOS Summary for Existing Conditions (2006)



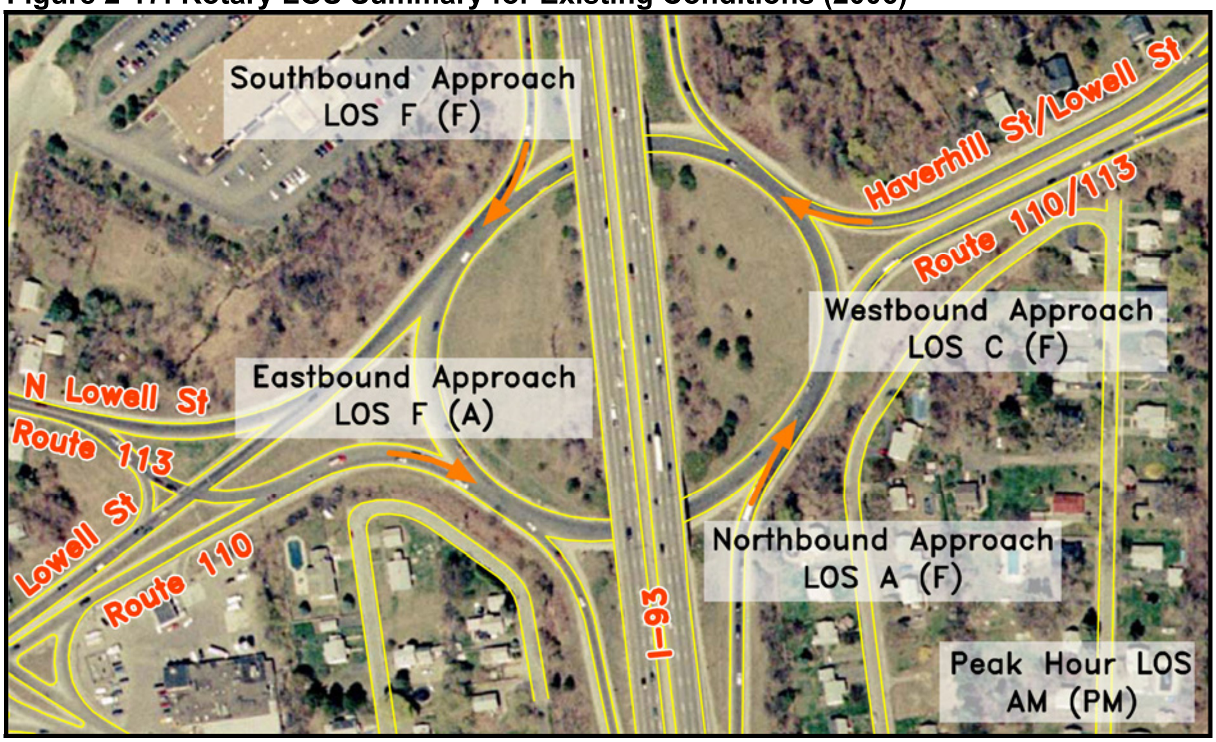
Further, all approaches to the Route 110 and 113 rotary operate at a failing LOS during the either the AM or PM peak hour or during both, as in the case of the southbound approach. The critical movements are listed below:

- Eastbound approach operates at a LOS F during the AM peak hour.
- Westbound approach operates at a LOS F during the PM peak hour.
- Northbound approach operates at a LOS F during the PM peak hour.
- Southbound approach operates at a LOS F during the AM and PM peak hour.

In summary, the areas immediately east and west of the rotary are experience high traffic volumes and consequently are the most congested locations in the study area. All approaches entering the rotary experience congestion and unacceptable delays during one or both of the peak hours. Delays are encountered for vehicles entering the rotary as a result of high volumes on an approach to the rotary and / or as a result of high volumes in the rotary. In addition, at unsignalized intersections, vehicles turning left from the minor streets experience high delay during peak travel periods.

Rotary Levels of Service are depicted below in Figure 2-17 for the Existing Conditions.

Figure 2-17: Rotary LOS Summary for Existing Conditions (2006)



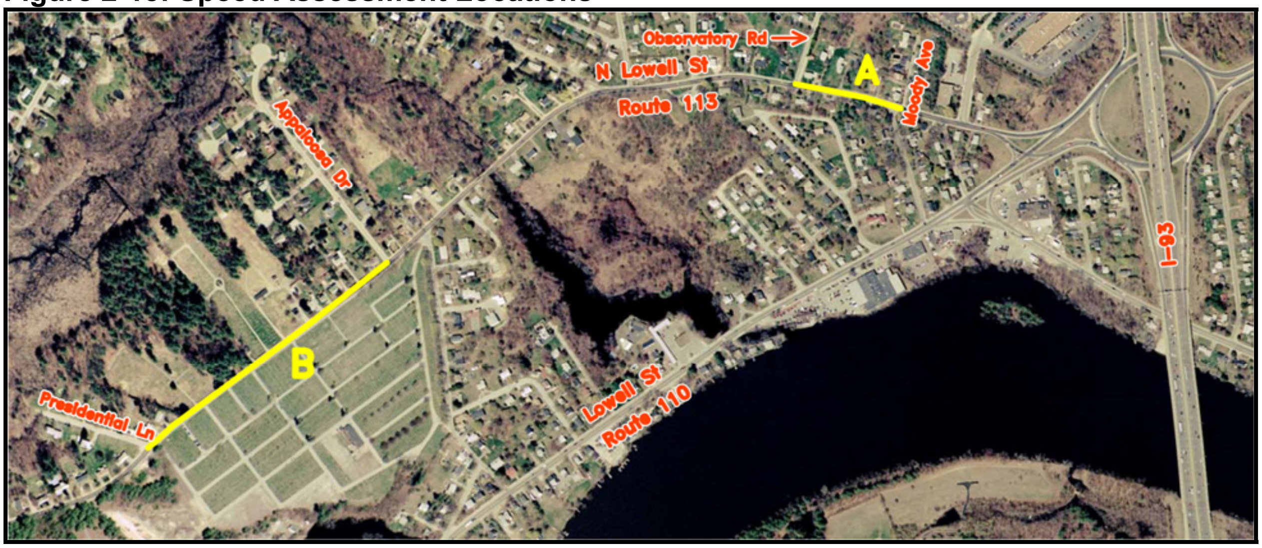
2.1.3 Speed Assessment

In response to the Study Advisory Committee regarding vehicles traveling at unsafe speeds on Route 113 west of the rotary, data was collected to determine vehicle speeds on the roadway. Automatic traffic recorder (ATR) data was collected in May 2006 and was used to determine the 85th percentile speed. This percentile is used in evaluating posted speed limits with the assumption that 85 percent of the drivers are traveling at a speed they perceive to be safe. The driver's perception of safety is influenced by lane and shoulder widths, horizontal and vertical alignments, stopping sight distances, and bordering vegetation.

Also shown in Figure 2-18, the following two locations were chosen for analysis:

A - Route 113 between Moody Avenue and Observatory Road
B - Route 113 between Appaloosa Drive and Presidential Lane

Figure 2-18: Speed Assessment Locations



The speed data indicates that the 85th percentile speed is between 30 and 32 miles per hour (mph) east of Moody Avenue, and between 35 and 54 mph east of Appaloosa Drive. Table 2-3 identifies the 85th percentile speed for both locations by direction.

Table 2-3: Summary of Speed Analysis on Route 113

Location	85th Percentile Speed	
	Eastbound	Westbound
A - Route 113 between Moody Avenue and Observatory Road	30 mph	32 mph
B - Route 113 between Appaloosa Drive and Presidential Lane	35 mph	54 mph

The posted speed limits in both count area locations ranges from 30 to 40 MPH depending on the terrain, roadway geometry, and land use. As you can see, the westbound direction of location B at 54 MPH is significantly higher than the posted limits. Based on field observations, it was concluded that the flat terrain and lack of a horizontal curvature contributes to the higher than posted speeds recorded.

2.1.4 Crash Data Analysis

Crash analysis was conducted for the study area, by identifying intersections, ramp merges and diverges, or roadway segment locations that experience a statistically significant number of crashes or an unacceptable level of severity. The crash data was obtained from the Massachusetts Highway Department for the three latest years available: 2002, 2003, and 2004.

As the crash data was provided for the entire Town of Methuen, a detailed search was first performed to extract all crashes on I-93 in the vicinity of Exit 46, as well as on Route 110 and Route 113. Next, the location of each crash was reviewed to confirm if it occurred at or close to the Route 110 and 113 rotary.

In order to better understand the crash patterns, the area of focus was divided into 8 crash zones. Figure 2-19 graphically shows the location of each of the zones. Zone 1 covers the I-93 mainline, which includes the merge and diverge points at the on and off-ramps. Zone 2 encompasses the rotary, including the on and off-ramps. Zones 3 and 4 cover the signalized intersections on either side of the rotary. The remaining 4 zones cover the approaches to the two signalized intersections. Table 2-4 summarizes the 8 crash zones by total number of crashes for each year.

Figure 2-19: Crash Zones

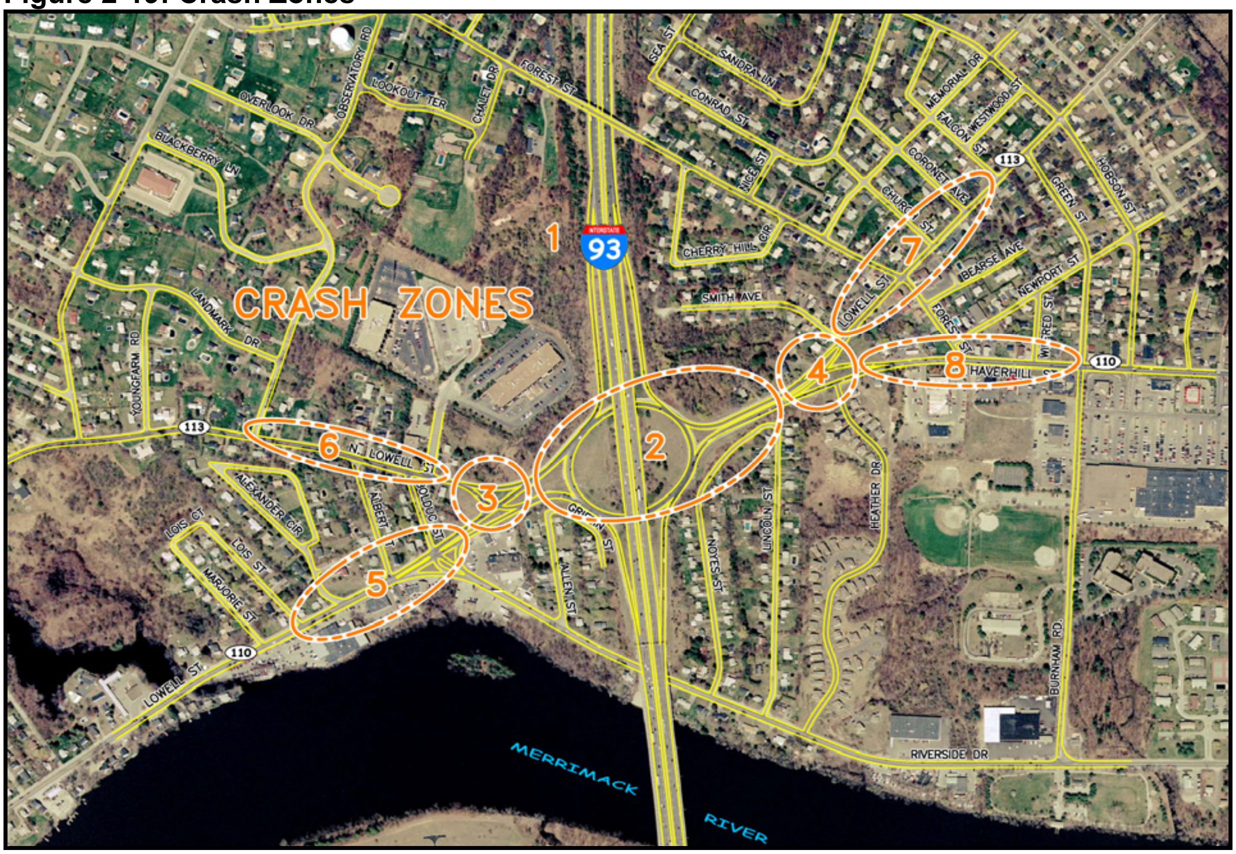
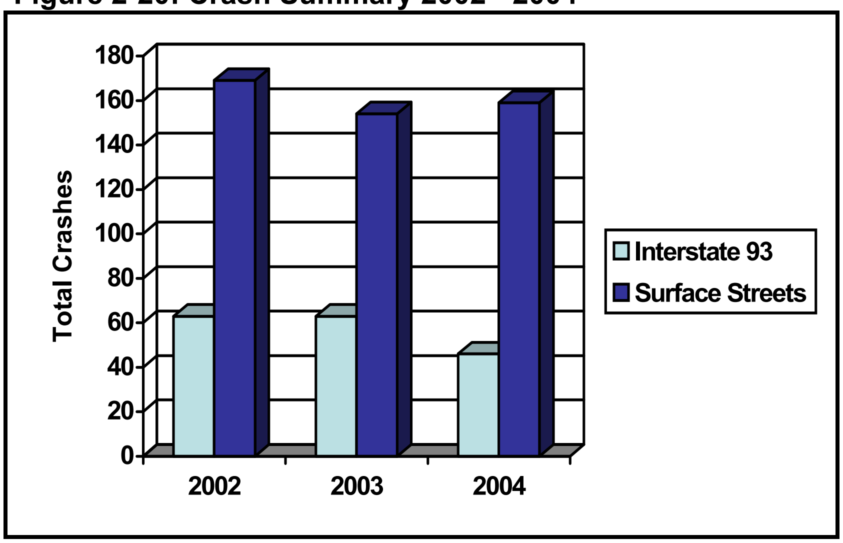


Table 2-4: Summary of Crashes

Crash Zone	2002	2003	2004	Total
1. Interstate 93	63	63	46	172
2. Route 110/113 Rotary	63	70	73	206
3. Lowell Street/North Lowell Street	16	4	7	27
4. Lowell Street/Haverhill Street	18	5	15	38
5. Lowell St. between Lois St. & N. Lowell St.	11	23	17	51
6. N. Lowell St. between Hill St. & Lowell St.	12	11	8	31
7. Lowell St. between Haverhill St. & Hobson St.	2	10	7	19
8. Haverhill St between Lowell St. & Hobson St.	47	31	32	110
TOTAL	**232**	**217**	**205**	**654**

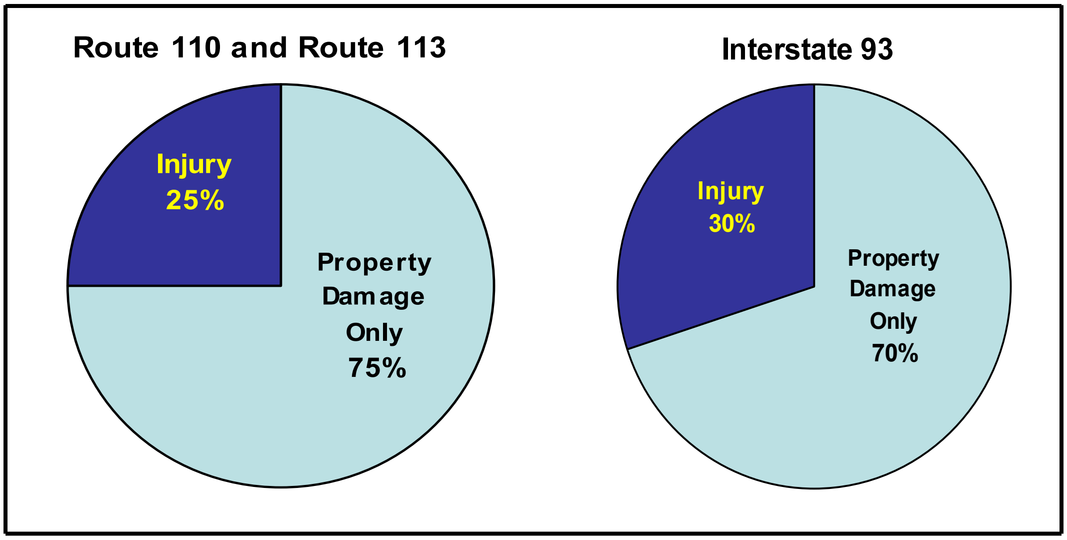
A total of 654 crashes occurred within study area, which is an average of 218 crashes per year. I-93 in the vicinity of Exit 46 had a total of 172 crashes during the three year period, but the rotary experienced a higher total number of crashes with 206. Haverhill Street (Route 110) south of Lowell Street (Route 113) also had a significant number of crashes, most likely due to the number of driveways and curb-cuts to existing businesses. Figure 2-20 compares the crash levels on the surface streets (including the rotary) to I-93.

Figure 2-20: Crash Summary 2002 - 2004



The charts in Figure 2-21 show the crash severity on I-93 and on Route 110 and Route 113 (including the rotary). There were no fatalities during the three year period. In comparing the severity of crashes on I-93 with crashes on Route 110 and Route 113, I-93 had a higher percentage of non-fatal injury crashes at 30%, while the non-fatal injury crashes on Route 110 and Route 113 was 25%. This could be explained by the higher speeds on the interstate facility resulting in a greater likelihood of injury in a crash.

Figure 2-21: Summary of Crashes by Severity 2002 - 2004



The number of crashes by month of the year did not show a marked variation among the different months. In general, the summer months tended to have higher number of crashes. The only other pattern was a higher number of crashes on I-93 during December, reflecting the increased volumes during the Christmas season. In terms of time of day, I-93 had more crashes during the PM peak period between 3:00 PM and 6:00 PM while Route 110 and Route 113 had more crashes during the midday period between 9:00 AM and 3:00 PM.

To identify the existing safety deficiencies, further research was conducted into the types of collisions that occurred on I-93 as well as on Route 110 and Route 113. Collisions are categorized into several types, the most severe being rear-end (when a vehicle is collided by another vehicle from the rear), and angular (when two vehicles collide at an angle).

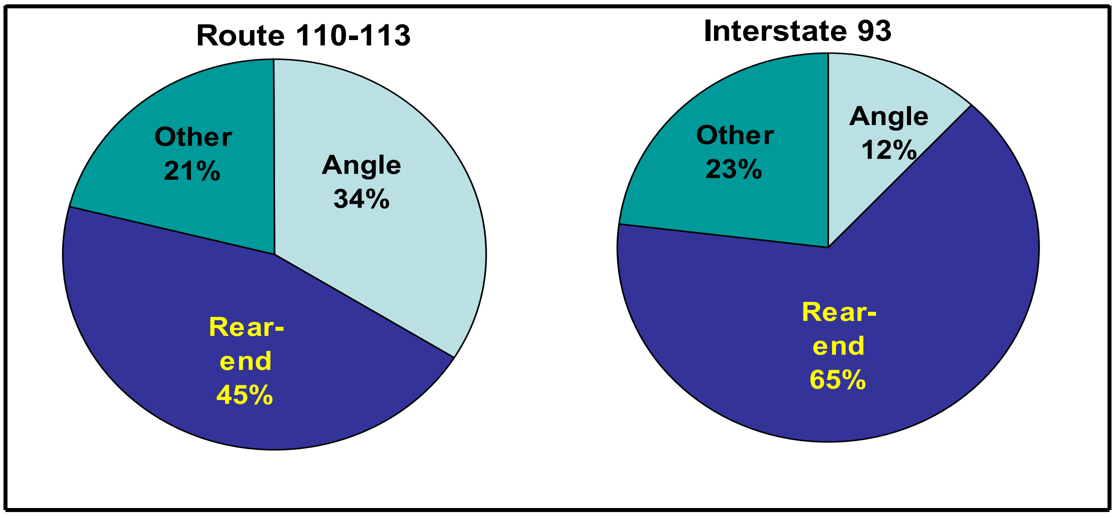
A large number of rear-end collisions typically occur on congested roadways and intersections. Traffic is usually in a stop-and-go condition under congestion resulting in vehicles continuously having to accelerate and decelerate. This causes differential speeds among vehicles resulting in rear-end collisions.

Angular collisions occur either at merge points or at intersections. This collision occurs when a vehicle attempting to join a travel lane does not yield to a vehicle already in that lane either due to sight distance restriction or due to the lack of precaution by the driver of the vehicle attempting to join the lane.

The charts in Figure 2-22 show the collision types for I-93 and for Route 110 and Route 113. A majority of all crashes (65%) were rear-end collisions on I-93, reflective of the congested nature of traffic during the peak periods on the interstate. The manner of collisions on the Route 110 and Route 113 local street system consisted of both angle crashes (34%) and rear-ends (45%). In general, more of the rear-end crashes occurred at the two signalized intersections. The first being Route 110 (Lowell Street)/Route 113 (North Lowell Street), and the other is Route 113 (Lowell Street)/Route 110 (Haverhill Street). The angular crashes mostly occurred on Route 110 (Lowell Street) west of Route 113 (North Lowell Street), and on Route 110 (Haverhill Street) south of Route 113 (Lowell Street).

Most of the crashes occurred when the weather was clear. However, I-93 had a slightly higher percent of crashes in cloudy weather than the Route 110 and Route 113 local street system. Most of the crashes occurred during the daylight. The Route 110 and 113 local street system had a higher percent of crashes during dark ambient light conditions than did I-93. This may indicate the need to review the existing lighting conditions at the Route 110/113 rotary. Finally, most crashes occurred during dry road conditions, but I-93 had a slightly higher percent of crashes occurring during snow/slush/icy road conditions than did the Route 110 and Route 113 local street system.

Figure 2-22: Summary of Collision Types 2002 - 2004



Roads and intersections with high volumes of traffic typically have a higher number of crashes, but having a high number of crashes does not necessarily indicate a safety problem. In order to assess the magnitude of the safety problems in the study area, crash rates were calculated for the rotary and the two signalized intersections adjacent to either side of the rotary.

Crash rate relates the number of crashes to the volume of traffic (also referred to as exposure), which allows for a consistent comparison of different intersections. To account for the traffic volumes within the crash rate calculation, the number of crashes at an intersection in a three year period is divided by the total number of vehicles entering that intersection during the same three year period. This total number of vehicles entering the intersection is expressed in terms of million entering vehicles or MEV.

So if the rate of crashes at a specific location is higher than the average crash rate at similar locations throughout the state, then it is indicative of a potential safety problem.

Table 2-5 presents the crash rates for the rotary and the two signalized intersections immediately east and west of the rotary. The rotary had a crash rate of 2.95 per million entering vehicles (MEV). In comparison to a statewide average crash rate of 0.63 for unsignalized intersections, the rotary had a crash rate 4.5 times greater than the statewide average. This type of safety analysis shows clear evidence that the Route 110 and 113 rotary interchange has a safety problem. Further, the two adjacent signalized intersections also have crash rates that are slightly higher than the statewide average, which indicates that there could be a safety concern.

Table 2-5: Crash Rates 2002-2004

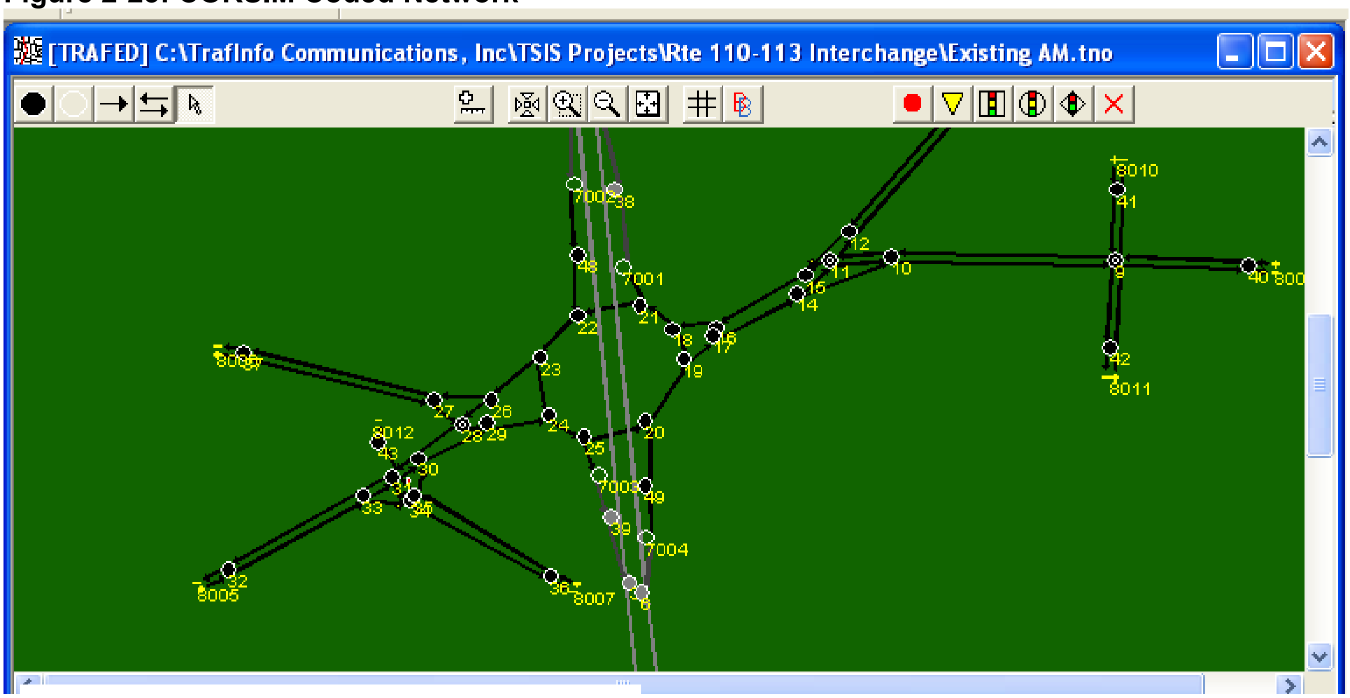
Location	Crash Rate (Per MEV)	Statewide Average
Route 110 and 113 Rotary	2.95	0.63
Route 110 (Lowell Street) at Route 113 (North Lowell Street)	1.01	0.88
Route 110 (Haverhill Street) at Route 113 (Lowell Street)	1.12	0.88

MEV: Million Entering Vehicles

2.1.5 Micro-simulation

Various highway alternatives were examined that would reconfigure the interchange, some of the roadway alignments, and intersections in the study area. In order to have the ability to perform a system-wide analysis, which would include freeway ramps as well as the surface street system and intersections, a micro-simulation model of the existing conditions was developed. The micro-simulation model for the study was built using CORSIM software developed by the Federal Highway Administration (FHWA). It is important to note that in addition to the micro-simulation model, two other software computer models were also used in this study. As previously mentioned, a Synchro model used to perform level of service analysis at the intersections and on roadway segments, and a regional travel demand model called TransCAD, which was used to forecast future traffic volumes and will be discussed later in this chapter.

Figure 2-23: CORSIM Coded Network



EOT Massachusetts Executive Office of Transportation

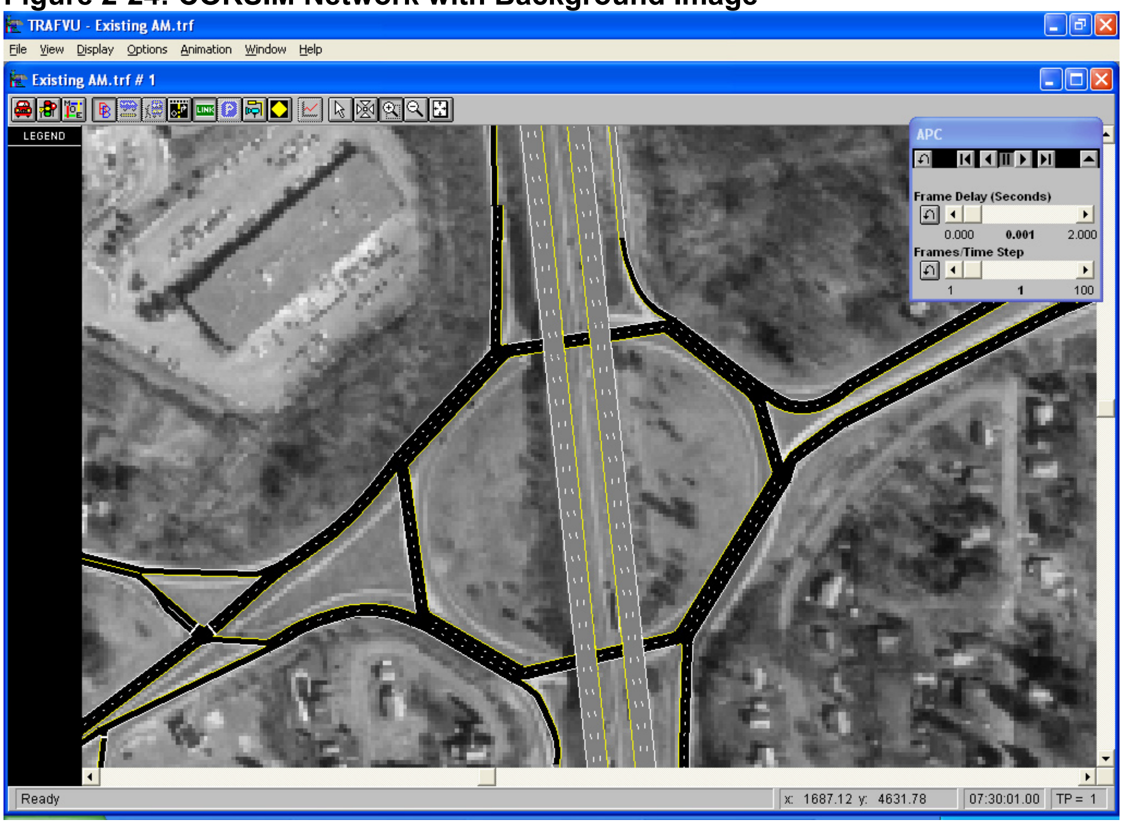
TranSystems

The first step in the micro-simulation model network development was to "code" the computer representation of the roadway system within the study area. Each roadway segment was represented by a link, and each intersection or transition point was represented as a node. This included I-93 on either side of the interchange for about 1500 feet to the north and about 2800 feet to the south (down to the Exit 45 interchange to the south). The network also included Routes 110 and 113 as well as the rotary and other local roads in the vicinity. All of the intersections included in the study were coded into the micro-simulation model. Figure 2-23 provides an example of what the coded network looks like in the CORSIM software program.

Each link and node within the model was then populated with input information such as number of lanes, lane channelization, sign control, and traffic signal timing information. This information was obtained from existing MassHighway engineering plans and field observations.

In order to get the proper graphic visual representation, orientation, and alignments for the various links (roads) and nodes (intersections) in the simulated network, the next step was to import a background aerial photograph image. An example of this is shown below in Figure 2-24. The network was then manually adjusted to visually match the existing conditions to the best extent possible.

Figure 2-24: CORSIM Network with Background Image



The network was then input with traffic volumes and other pertinent information for two time periods: the AM peak hour (7:30 AM - 8:30 AM) and PM peak hour (4:30 PM - 5:30 PM). The peak hour volumes used in the micro-simulation model were the same as those used for the traffic operations and capacity analyses.

Model Calibration

Upon completion of the network development, the next step was the model calibration effort. It is very important that the micro-simulation model should, to the best extent possible, accurately represent the existing traffic patterns and operations. If the model can accurately represent the existing conditions, then it is reasonable to conclude that it would be capable of accurately representing the future conditions and any alternatives that would makes changes to the roadway network.

To verify if the micro-simulation model accurately represents existing conditions, the simulated volumes at the rotary (the approaches and the exits) were compared against volumes based upon actual counts. Furthermore, the simulation within CORSIM was used to verify if the queues at the ramps reflected observed field conditions. Initial model runs indicated that there was a need to change certain default parameters within CORSIM to calibrate the model. Listed below are the various parameters that had to be adjusted to calibrate the model.

- *Pitt car following constant:* This reflects the physical distance between two cars following each other on a lane. The default value of 10 was reduced to 9 to reflect the local driving habits.
- *Minimum separation for generation of vehicles:* This is the frequency with which vehicles are generated at the source nodes (entry points for vehicles into the network). To accommodate the count volumes, the default value of 1.6 was changed to 1.5.
- *Near side cross traffic gap distribution:* This provides the gap distance used by various drivers to enter the traffic stream. This parameter was needed to reflect the gaps used by drivers at the rotary approaches to enter into the rotary. The default values had to be reduced by 60 percent to reflect that drivers were using smaller gaps to enter the rotary due to the congested conditions.
- *Car following sensitivity multiplier:* The default value of 100 has to be adjusted on just one freeway link (the I-93 NB freeway section south of the Route 110/113 off-ramp) to 90 to signify the close headway traffic uses on that section given the relatively high congestion.
- *Mean startup delay and mean discharge headway:* The default values had to be reduced to 0.5 and 1.4 respectively on just link (the I-93 NB off-ramp approach to the rotary) to reflect the aggressive nature of traffic on that approach. This was also necessary to make the simulated queues on that approach be similar to actual field conditions.

With the above model calibration, the micro-simulation model reflected a reasonable representation of the existing conditions based on two measures:

- The simulated volumes on the approaches and exits to/from the rotary were within 1-2 percent of the ground count volumes; and
- The queues observed in the simulation of the model were similar to the queues observed in the field.

Existing Traffic Operations

The micro-simulation model depicts the traffic conditions and congestion that occurs on a frequent basis under existing conditions. Two major congestion points at the rotary are: 1) during the AM peak hour at the entrance to the I-93 southbound on-ramp; and 2) during the PM at the I-93 northbound off-ramp approach to the rotary. Figure 2-25 shows the queuing at the entrance to the I-93 southbound on-ramp in the AM peak hour

Figure 2-25: AM Peak Hour Congestion on Southbound On-Ramp

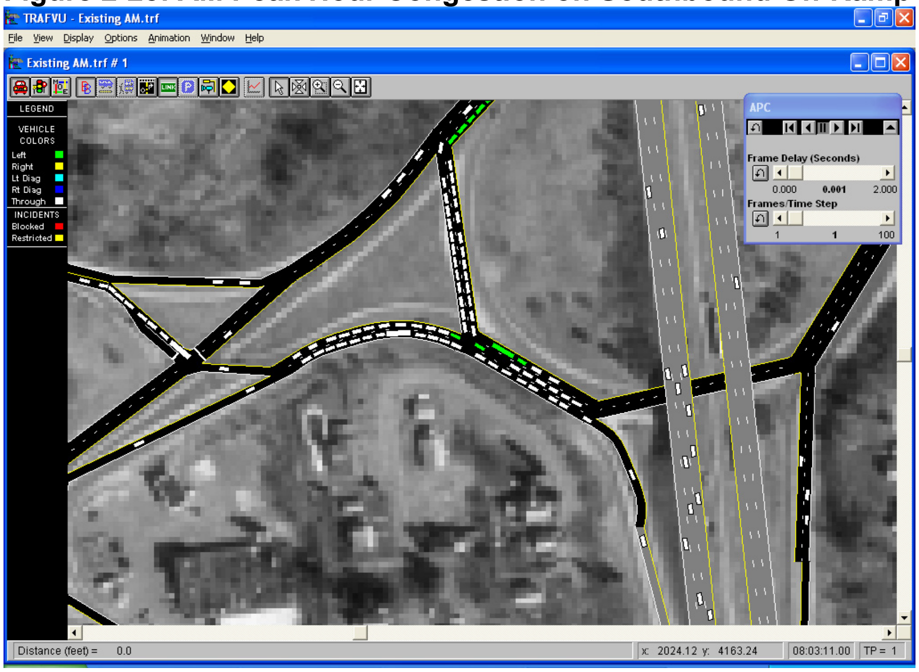
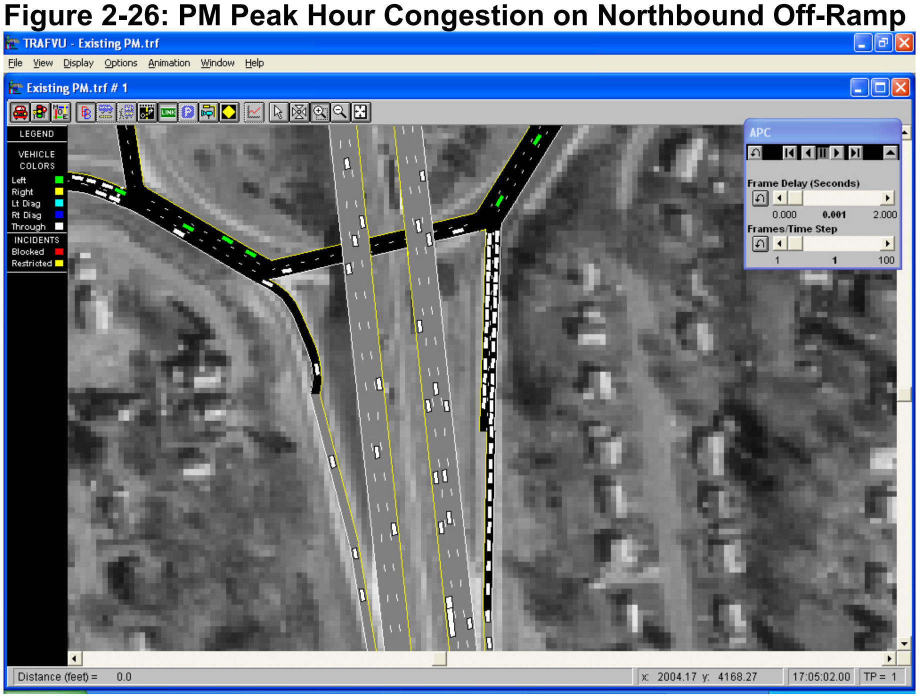


Figure 2-26 below shows a micro-simulation of the queues on the I-93 northbound off-ramp in the PM peak hour.

Figure 2-26: PM Peak Hour Congestion on Northbound Off-Ramp



2.2 Existing Transit Services

The following section documents the current transit services for the study area that were inventoried as part of the data collection efforts. This was done so that any gaps or deficiencies were identified, and then addressed in the alternatives development and analysis tasks.

2.2.0 Available Service Routes

Transit services within or near the project study area are provided by the Merrimack Valley Regional Transit Authority (MVRTA), Lowell Regional Transit Authority (LRTA), and the Massachusetts Bay Transportation Authority (MBTA). The MVRTA provides local bus service operating through the rotary and provides commuter bus service to Boston on I-93. The LRTA also provides local bus service between Dracut to Lowell. The MBTA provides commuter rail service to Boston from Stations in Haverhill, Bedford, Lawrence, and Lowell.

The MVRTA operates several local bus routes in the Lawrence and Methuen area that can be used for local travel, as well as access to commuter bus and rail services to Boston. The MVRTA increased service on most routes in April 2006 so that most local routes operate every 25 minutes in peak periods and every 45 minutes in off-peak times. The most relevant MVRTA services to this study are shown in Table 2-6. MVRTA Route 41 operates between Lawrence and Lowell directly through the Route 110 and 113 rotary. Route 35 also operates through the rotary, beginning in Lawrence and ending about ½ mile west of the rotary.

The MVRTA also operates the Boston Commuter Bus which increased its service from two to three round trips daily from Methuen, Lawrence, and Andover to Boston. The route begins at the Pelham Street park-and-ride lot along I-93 in Methuen, which is one exit north of the Route 110 and 113 rotary interchange. The route follows local roads and Route 28 through Methuen, Lawrence and Andover before entering I-93 at the Route 125 exit in Wilmington. While this route serves Boston-bound travelers who might otherwise drive through the Route 110 and 113 interchange, the route itself does not pass through the interchange.

Table 2-6: Existing MVRTA Services

Route	2005 Service	April 2006 Service	Average Weekday Ridership	Riders Per 1-way Trip
Route 41: Lawrence to Lowell	Every 45-50 minutes	25 min peak 45 min off-peak	800	22
Route 35: Water Street	Every 45-50 minutes	25 min peak 45 min off-peak	267	8
Boston commuter bus	2 round trips	3 round trips (Began 10/05)	121	30 *

* 20 assuming 10/05 service increase

The LRTA operates bus service in the Lowell area which can be used both for local travel and to access MBTA commuter rail service in Lowell. LRTA Route 1 operates between Lowell and Village Square in Dracut, serving the western 0.6 mile of the Route 113 portion of the study area. Together with Route 10, which operates in the western part of Dracut furthest from I-93, these two routes provide a connection to the Lowell commuter rail station for Dracut residents who might otherwise use Route 113 to access I-93.

The MBTA operates the Haverhill/Reading Line commuter rail line which has stations in Haverhill, Bedford, Lawrence, and Andover and terminates in Boston. The MBTA operates 13 weekday trains in each direction through these stations. The MBTA also operates the Lowell commuter rail line which provides 21 weekday trains in each direction from Lowell to Boston. Most MBTA commuter rail stations have park and ride lots, but many tend to fill to capacity. A significant exception in the study area is the new McGovern Transportation Center in downtown Lawrence, which has 540 parking spaces and typically is only about 40% full on a daily basis.

2.2.1 Route Ridership

MVRTA ridership on the most relevant routes is included in Table 2-6. The Lawrence-Lowell route (Route 41) carries about 800 riders per day, which is about 22 per one-way trip, or about 50% of the capacity. Route 35 carries only about 267 riders per day, or only eight per trip. The Boston Commuter Bus carried about 120 daily riders in 2005, or about 30 per one-way trip. The change in service to three daily round trips increased capacity to handle about another 85 riders in each direction.

The MBTA Haverhill-Reading commuter rail line serves about 4,700 daily inbound riders. About 1,350 of these are from the Haverhill, Bedford and Lawrence Stations. Another 600 are from the Andover Station. The MBTA Lowell Line also serves about 4,700 daily inbound riders, of which approximately 1,220 of these are from the Lowell Station. The peak hour trains typically operate very close to capacity, and the MBTA has been able to add capacity to peak trains as demand has grown.

2.2.2 ITS Utilization in Transit

ITS, in terms of real-time passenger information, has not been used in the study area. MBTA commuter rail stations are equipped with variable message signs but these typically display general information regarding delays, not real-time train arrival information.

2.2.3 Park & Ride Facilities

The Massachusetts Highway Department provides two park & ride lots along I-93 near the study area. The Pelham Street lot at exit 47, one exit north of the Route 110 and 113 Rotary, can accommodate 189 cars. It is used by carpools and vanpools and is served by the MVRTA's Boston Commuter Bus. Recent counts show there are between 89 and 120 cars using this lot on a daily basis, and approximately half are from New Hampshire. The majority of Massachusetts users are from Lawrence, Methuen and Haverhill.

The Andover lot on Dascomb Road off I-93 at exit 42 can accommodate 73 cars. It is used only for carpooling since no transit service is provided at this lot, and the lot tends to fill to capacity early in the morning. Recent counts show between 72 and 82 cars using the lot. Recent analyses also indicate that 66% of the cars are from Massachusetts communities along I-93 and I-495 and approximately 33% of the cars are from New Hampshire.

The McGovern Transportation Center at the Lawrence commuter rail station has parking spaces for 540 commuters using either the commuter rail or the Boston Commuter Bus. As of April 2006, typically about 230 were being used daily, leaving 310 available for additional commuters.

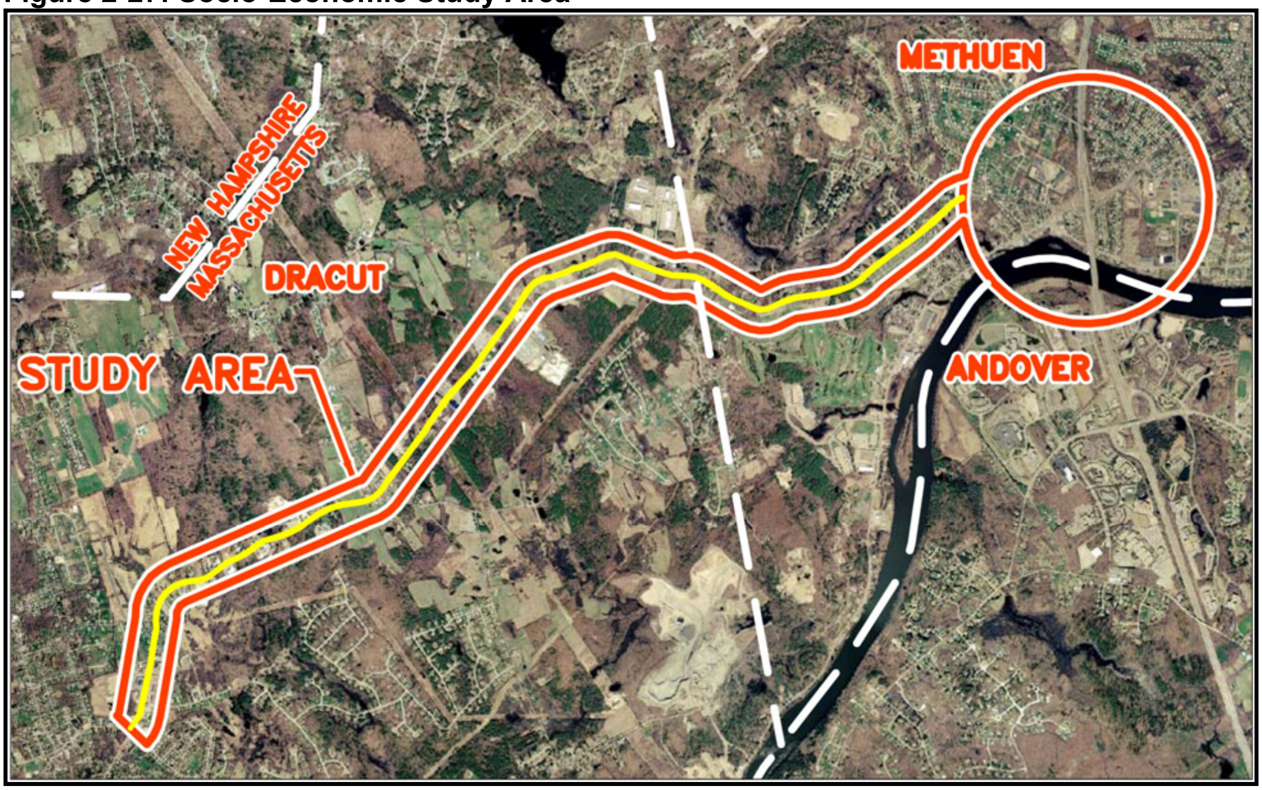
Additional municipal parking is also provided for commuters at the Boston Commuter Bus stops in Andover.

2.3 Socioeconomic Data and Economic Development Plans

Population, households, employment and zoning all play an important role in current traffic patterns and volumes, and also how traffic will be affected in the future. One of the main uses for this information is as input to travel demand model, which will be discussed in more detail later in this chapter.

Figure 2-27 shows the study area for socioeconomic analysis, which is the same as the overall defined study area developed in Chapter 1. As mentioned previously, this is slightly different than that of the study area for traffic operations analyses. This is due to the need to look at input from a larger area of population, households, and employment that might affect the developed alternatives.

Figure 2-27: Socio-Economic Study Area



2.3.0 Zoning

The Route 113 corridor is characterized by commercial and industrial uses, many of them major truck generators. There are also pockets of residential development and some relatively large tracts of open land, particularly in Dracut. Table 2-7 lists the uses compiled during a windshield

Table 2-7: Windshield Survey of the Route 110 and 113 Corridors

Route 110 – Lowell Street/ Haverhill Street
Haverhill Street from the rotary heading east towards Lawrence: • strip commercial; • automotive; • older residential **Lowell Street rotary heading west towards Lowell:** • strip commercial along river, near rotary; • single-family residential; • strip commercial; • truck dealer; • industrial park; • National Guard Armory; • Assembly of God Church; • Jimmy's Restaurant on river; • office park
Route 113 – North Lowell Street/ Lowell Street
North Lowell Street from rotary heading west towards Dracut: • single-family, detached residential (close to road); • National Catholic Cemetery; • golf course; • woods, open space, residential; • high tension lines near Dracut town line (mile 2.1); • bus station and strip commercial; • green houses; • Dow Co. (small contractor); • Broadway Road Industrial Center; • Toupin Warehousing; • industrial land with construction; • open space and wetlands; • residential; • Dracut Fire Department; • horse farm (mile 4.4); • sand and gravel; • New England Block and Pipe; • self-storage; • residential – 2 new developments of single-family detached homes and condos; • small commercial strips; • Dracut Village Square – large strip shopping center and commercial area; • townhouse development; • Town Hall (on school bus route) **Lowell Street from rotary heading east towards Methuen and Haverhill:** • single family residential; • multi-family residential; • Forest Street Union Church

survey of the rotary and corridor. Zoning along both sides of the Methuen segment of the corridor is General Residential from the rotary to approximately Appaloosa Drive, where it becomes Conservation land on the southern side of the roadway, then Agricultural/Conservation on both sides. In Dracut, from the Methuen town line to approximately Silva Lane, the corridor is zoned Single Family Residential. Next, it enters one of Dracut's three concentrations of predominantly Industrial zoned land until Route 113 (Broadway) intersects with Wheeler Road, after which a second Industrial zone is found to the south of Route 113.

2.3.1 Socioeconomic Characteristics

As mentioned previously, the socioeconomic study area defined for the analyses included an area roughly one-half mile around the rotary and west on Route 113 to Route 38 in Dracut.

The population in this area was estimated at 23,820 for the year 2005. This represents a growth rate of 3% over 2000 and 9% since 1990, which is a rate of growth similar to that of the Commonwealth of Massachusetts. An estimated 38% of the study population is Hispanic, compared to 8% statewide. About ½ the population has at least a high school diploma.

The study area is made up of more than 8,000 households, with a rate of growth similar to that of the entire Commonwealth. In contrast, the statewide pattern has shown an increased rate of household formation, particularly over the decade between 1990 and 2000. In accordance with this difference, household size in the study area, 2.9 persons, is somewhat larger than that of the state as a whole, at 2.5 persons. Additional data are presented below in Table 2-8, and more detailed demographic data can be found in the Appendix.

Table 2-8: Demographic Characteristics for 2005

	Study Area	State
Population		
1990 U.S. Census	21,916	6,016,425
2000 U.S. Census	23,207	6,349,097
2005 Estimate	23,820	6,461,435
2010 Projection	24,407	6,561,725
percent Δ 1990-2000	6 %	6 %
percent Δ 2000-2005	3 %	2 %
percent Δ 2005-2010	2 %	2 %
Households		
1990 U.S. Census	7,583	2,247,110
2000 U.S. Census	8,053	2,443,580
2005 Estimate	8,252	2,508,081
2010 Projection	8,421	2,560,225
percent Δ 1990-2000	6%	9%
percent Δ 2000-2005	2%	3%
percent Δ 2005-20010	2%	2%
Average Household Size	2.9	2.5
Average Number of Vehicles per Household	1.6	1.6

Source: Claritas, Inc., *Site Reports*, 2005 data, and FXM Associates

The employment and occupation profile of the study area is very similar to that of the state, with the following examples of some differences: 28% of study area residents work in sales and office jobs, compared to 26% at the state level; 19% are employed in professional occupations compared to 25% statewide. The estimated unemployment rate for 2005 was the same for both at 3%. Workers from the study area spend about 27 minutes getting to work, compared to 29 minutes statewide.

Housing characteristics closely mirror the state with 61% of units being owner-occupied, and an average length of residence of 12 years. The median value of owner-occupied units is $213,825, which is much lower than the statewide median of $284,191 (2005 values).

There are 520 business establishments in the study area that employ over 5,000 people and generate over $590 million in annual sales. The major sectors are:

- Services, which account for 188 firms, 1,680 employees, and $139 million in sales;
- Retail with 94 firms, over 1,000 employees, and $130 million in sales; and
- Construction with 85 firms, 600 employees, and $117 million in sales.

Manufacturing firms employ 700 workers, but have lower annual sales and fewer firms Also of note is the Transportation and Communication sector, which accounts for 32 firms and over 400 employees in the study area. Twenty of these firms are considered part of the Motor Freight and Warehousing sector, which generates some amount of truck traffic on Route 113 west of the rotary.

In 2000, the U.S. Census reported 10,451 households in the town of Dracut at a density of 1,366 persons per square mile. Over 80% of Dracut residents have a high school diploma, while 20% hold a bachelor's degree. 71.8% of the population age 16 and older are members of the labor force, traveling a mean of 28.1 minutes to work every day.

In the year 2000, only 2.7% of Dracut families were below the federal poverty line. Between 1990 and 2000, the median household income in the town of Dracut grew from $45,165 to $57,676, an increase of 27.7%. Although median income growth in Dracut was slower than that of the overall region, it is important to note that within Dracut all categories of households reporting less that $74,999 per year decreased in number, while all categories of households reporting median incomes greater than $75,000 per year, increased.

The vast majority of housing units in Dracut are owner-occupied. Between 1990 and 2000, the median home value in Dracut increased from $146,000 to $163,900, an increase of 12.3%. The supply of homes valued between $300,000 and $499,999 increased over 182%, from 78 to 220. Within that time, each category of percentage of homes with a median value under $149,999 also saw a drop in market share. According to The Warren Group and as reported in the Affordable Housing Productivity Plan published by the town of Dracut, as of October 2002, Dracut ranked 156 out of the 351 cities or towns in the Commonwealth in terms of median home price.

What the preceding data analysis indicates is that the Town of Dracut is becoming more of an emerging community for residential development and industrial growth. The population and employment statistics indicate a transition from a rural community to a suburban center.

Journey-to-work travel time will increase as more workers make longer trips to employment centers throughout Metrowest and Boston.

Within Dracut, there are approximately 227 lane miles of local roads, 40 lane miles of arterials, and 36 miles of collectors. However, there is no major highway access within the town of Dracut, which requires residents, commuters, and commerce to travel through other towns to access I-93, I-495 and Route 3. This means added growth in traffic on the arterials, specifically Route 113 in Dracut, and increased demand for access to I-93 and I-495. This more than likely necessitates change at the Route 110 and 113 Rotary Interchange, where antiquated highway geometry combined with increased traffic will exacerbate the existing problems.

2.3.2 Economic Development Plans

Dracut

The Town of Dracut has a considerable amount of developable land, particularly in the eastern half of the study area. The Dracut Town Planner provided the following information on planned developments:

- 296 units in a Chapter 40B development at 341 Broadway Road (Route 113);
- Four single family lots at Bartlett Court, off Broadway Road near the Methuen line;
- 34 homes on Wheeler Road, which connects to Route113;
- 144 rental units (half Chapter 40B) at Civic Village, at Route 113 and Loon Hill Road;
- 73 single family lots at Wheeler Road Estates, off Route 113 (under review by the Planning Board);
- Additional 54 single family lots planned for Wheeler Road Estates;
- 178 homes (approx. 45 already built) and a golf course, at Meadow Creek/Route 113;
- Six units planned for Sophia Drive off Pelham Road/Route113 intersection;
- Five single family homes, off Salem Road/Peter Pond Estates;
- Six single family homes at Jones Ave, off Route 113;
- Five single family homes nearly completed at Harley Drive extension.

In addition to planned residential developments, the following commercial developments are planned:

- 1187 Broadway – 19,000 square foot building for rent;
- 983 Broadway – warehouse space available;
- 1112 Broadway – 5,000 square feet of rental space available for offices;
- 1330 Broadway – planned addition to existing high tech firm;
- 1330 Broadway – leather business planning to double their production line and add about 100 employees;
- Silver Road – new business is locating there with 20 truck bays and manufacturing.

In general, the western half of Route 113 in Dracut is more heavily developed, while the eastern half has the potential for more development. Dracut is planning to extend municipal water to this area, through an agreement with the city of Methuen. The city of Methuen is one of three water providers that operate along the Route 113 corridor. The town of Dracut is hoping that provision of additional water and sewage services will attract more industrial jobs to the area.

Methuen
Planning officials for the City of Methuen have provided the following inventory of current or planned developments in the study area, all residential:

- 240 condominium units for residents over age 55 is planned for the former Zambino gravel pit on Wheeler Street, near the Dracut town line;
- 28 market-rate condominiums at Park View and Burnham Road/Riverside Drive;
- 20 market-rate condominium units at Park Place/Burnham Road, near Riverside Drive;
- 89 single family homes for residents over age 55 in a 40(B) development at Stone Castle, off Tyler Street;
- 78 units in 36 duplex structures (25% affordable) in a 40(B) project off Tyler Street;
- In the same development, another 377 units are expected to be approved shortly.

In addition, approximately 50 market-rate condominium units or an indoor sports complex, including a rink, pool, and soccer field are under consideration in the study area. Although this is the only commercial development currently identified, there are over 260 acres bounded by Routes 110, Route 113, and Wheeler Street that could potentially be developed.

2.4 Existing Land Use and Environmental Conditions

The following section documents an inventory of the existing land use and environmental conditions, which was used during the alternatives development and analysis tasks. More specifically, the product of this inventory was a list of constraints used during the development and analysis of the improvements and alternatives to determine the extent of impacts.

To assess existing environmental conditions for the study area, data from the MassGIS database were acquired and superimposed onto aerial photographs of the project study area. This GIS data was supplemented by resource information reported in the I-93 Corridor Study, and in the Merrimack Valley Metropolitan Planning Organization's (MVMPO) 2003 Regional Transportation Plan.

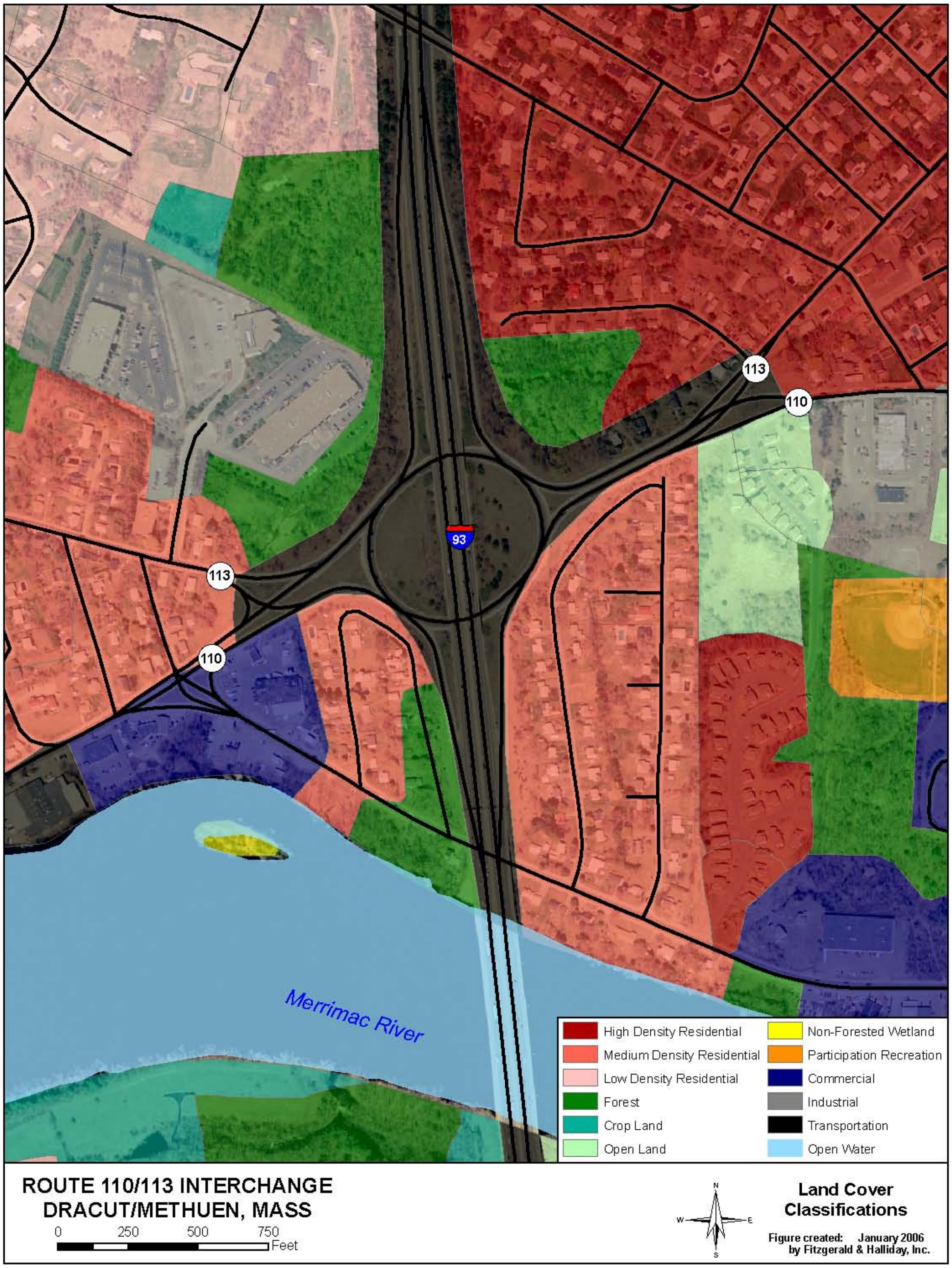
In addition to this mapping, information gleaned from reviewing a variety of natural resource web sites was also used to document existing conditions in the study area. Limited coordination with resource agencies was undertaken, for this preliminary planning study, to ascertain the presence and/or absence of federally threatened and endangered species. Coordination with natural resource agencies, such as the United States Fish and Wildlife Service (USFWS), will become more important as any alternatives move forward into the environmental documentation phase that will be required by both the National Environmental Policy Act (NEPA) and Massachusetts Environmental Policy Act (MEPA).

2.4.0 Existing Land Use

The Route 110 and 113 Rotary is located in a suburban area within the Town of Methuen, directly west of the City of Lawrence. MassGIS land use/land cover GIS data depicted in Figure 2-28 shows that the land use directly northeast of the existing rotary is predominantly high-density residential with a small patch of forested land directly adjacent to the rotary.

To the southeast, the land use and land cover is slightly more variable. Immediately adjacent to the rotary is broad area of medium-density residential development along Noyes Street and

Figure 2-28: Land Use Classifications



Lincoln Street accessed via Riverside Drive. This medium-density residential neighborhood is flanked to the southeast by a smaller area of higher-density residential development and to the east by an area classified as open land, although it appears that newer high-density residential development has encroached into this open space region. This high-density residential neighborhood is accessed via Heather Drive. Further to the east and south of Route 110 is an industrial area, and south of this industrial area is a recreational baseball diamond. A forested region and a commercial zone located along the shores of the Merrimack River define the remaining land area southeast of the rotary.

To the southwest of the rotary and directly west of I-93 is a small area of forested land that is bordered on the west by a medium-density residential neighborhood accessed via Allen Street from Riverside Drive. Further to the west and south of Route 110, is a commercial zone that is bisected by Riverside Drive. Continuing west is the Merrimack Valley Sea Plane Base, which is designated as a transportation land use.

Northwest of the rotary, there is a narrow band of forested land that flares out into a broader forested region further to the north. A large industrial zone accessed from Branch Street, and a medium-density residential zone is located to the west of this forested region and north of Route 110. The residential neighborhoods are accessed via Branch Street, Moody Court, Bolduc Street, Albert Street, and Alexander Circle. To the north of the industrial property is a large area identified by MassGIS as low-density residential. A small area designated as cropland is also found to the north of the industrial zone.

2.4.1 Surface Water Resources

The Merrimack River is the only surface water resource within the project study area. It is located approximately 850 feet due south of the Route 110 and 113 Rotary, where it is crossed by the I-93 bridge. The Merrimack River forms at the confluence of the Pemigewasset River, originating from Profile Lake in Franconia Notch, New Hampshire, and the Winnipesauke River originating from Lake Winnipesauke. The Merrimack flows in a southerly direction through central and southern New Hampshire for approximately 78 miles and then for another 50 miles through northeastern Massachusetts before discharging into the Atlantic Ocean at Newburyport.

Within Massachusetts, its watershed encompasses approximately 1,200 square miles covering all or a portion of 24 communities. Its watershed is predominantly forested and undeveloped north of Manchester, New Hampshire. South of Manchester, the land use in its watershed can be described as a mix of residential, commercial, and industrial, transportation, agriculture, and open space.

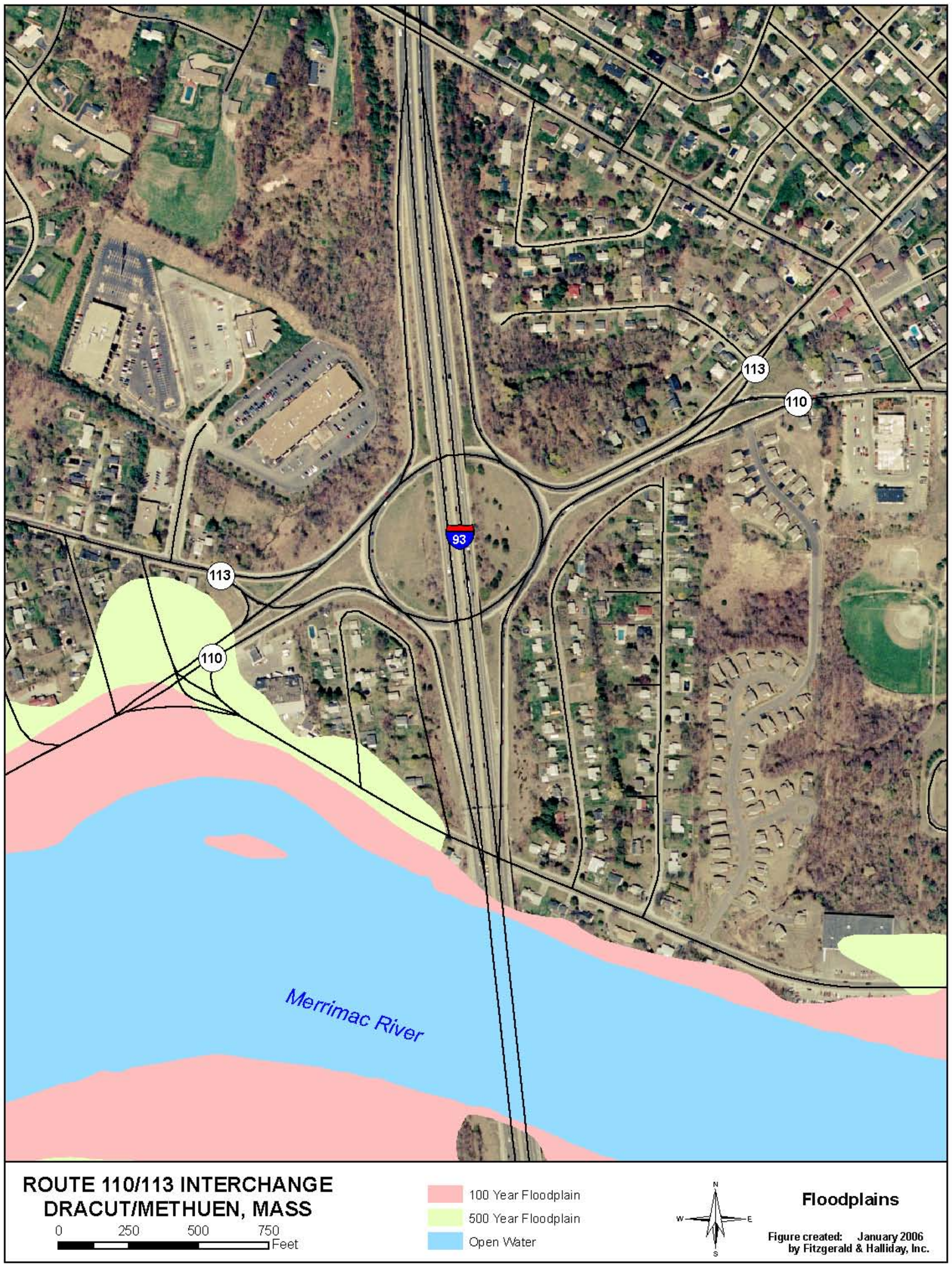
Water quality south of Manchester was once a concern, but has improved significantly since the early 1970's with the development of numerous wastewater treatment plants. Water quality in the river has improved so much that it is now the sole source of public drinking water (with treatment) for the communities of Methuen, Lowell and Lawrence Massachusetts.

Like most major rivers, the Merrimack is a vital natural resource that sustains a wide variety of plants, fish, and wildlife, while offering scenic beauty to the landscape and offering a wide range of recreational opportunities to tourists and the local population.

2.4.2 Floodplains

Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps and GIS data obtained from MassGIS were reviewed to identify floodways and 100-year and 500-year floodplains within the project study area. The only floodplain resources located within the study area are associated with the Merrimack River and are depicted in Figure 2-29. The Merrimack River floodway is located south of the existing rotary and is completely confined within the

Figure 2-29: 100 and 500-Year Floodplains



banks of the river. The floodway ranges from about 500 to 600 feet wide and is spanned by the I-93 Bridge. The 100-year floodplain associated with the Merrimack River covers much of the land area to the south of Riverside Drive, and encroaches slightly into the Route 110 corridor just west of the Route 110 at Riverside Drive intersection near the southernmost end of Bolduc Street, Albert Street, and Alexander Circle. The 500-year floodplain extends further inland than the 100-year floodplain in the area of Riverside Drive southeast of the rotary, and extends almost to Route 113 in the vicinity of Bolduc Street, Albert Street, and Alexander Circle.

2.4.3 Groundwater Resources

Aquifer and groundwater information was obtained from the United States Geological Survey (USGS) Hydrologic Atlas produced by the USGS Water Resource Discipline (WRD) via MassGIS (1960s to the present). Groundwater resources in the Commonwealth of Massachusetts are not assigned a water quality classification but instead are designated as either “high” or “medium” output water supply aquifers.

In the Merrimack River watershed, principal aquifers are composed of unconsolidated sand and gravel that were deposited by meltwater streams during the glacial period. Based on available data, there are no known principal or “sole source” aquifers or significant groundwater resources in the project study area. It is likely that igneous and metamorphic bedrock underlying the study area is a source of a sufficient quantity of groundwater for domestic wells, although the study area is predominantly served by a public drinking water system whose source is the Merrimack River.

2.4.4 Aquifers and Public Water Supplies

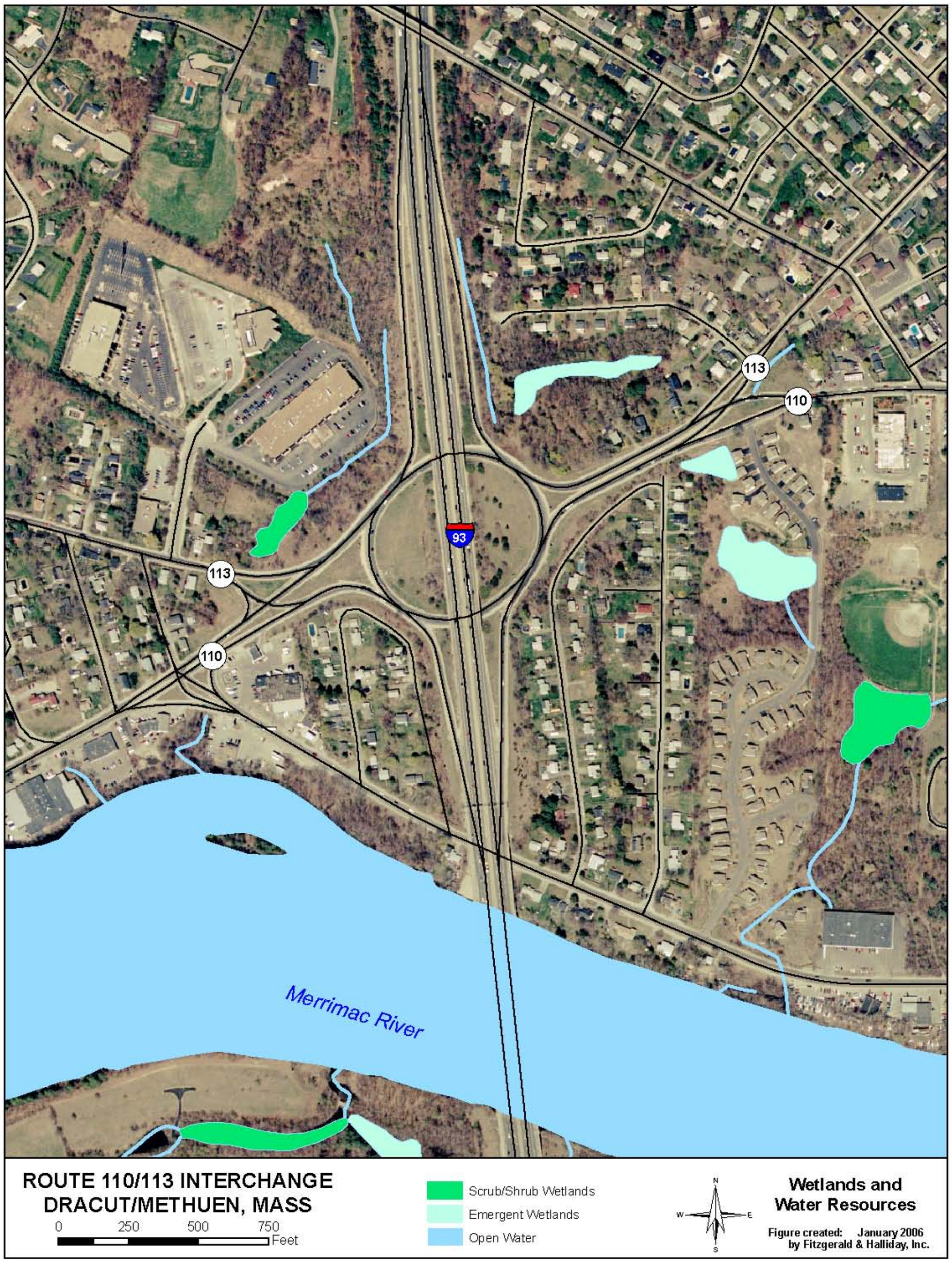
The Merrimack River serves as the public drinking water supply for approximately 300,000 residents in the communities of Methuen, Lowell, and Lawrence, Massachusetts. In Methuen, source water undergoes several treatment processes at the Burnham Road Water Treatment Plant before it is distributed to the consumer. Residents and businesses within the study area receive public drinking water from this distribution system, which is maintained by the Methuen Water Department. The exact location of the drinking water distribution system within the project study area will need to be ascertained by project engineers during project design development and through coordination with the City of Methuen Water Department.

2.4.5 Wetlands

The MassGIS database entitled DEP Wetlands (1:12,000) was used to identify wetland resources in the vicinity of the Route 110 and 113 Rotary. Figure 2-30 depicts study area wetlands. To the northeast, within a forested area located between the rotary and a large high-density residential development zone, is a narrow linear emergent wetland associated with an unnamed stream. The stream appears to convey drainage and/or runoff from the adjacent residential development towards the west, where it eventually ties into a drainage swale located along the eastern side of the I-93 northbound on-ramp. The emergent wetland is approximately 250 feet from the rotary.

East of the rotary, there are two emergent wetlands that appear to be hydraulically connected to a stream that enters the study area from the northeast near where Route 110 and Route 113 diverge. Both emergent wetlands reside within an area identified in Figure 2-28 as open land, located just northwest of the baseball field. The northernmost and smaller of the two emergent wetlands is located approximately 50 feet south of Route 110 and 113. Drainage from these emergent wetlands appears to flow to the southeast, passing under Heather Drive, and eventually connecting to a third wetland, a scrub shrub swamp, located directly south of the baseball field. A second hydraulic connection (stream) appears to flow into this scrub shrub swamp from the northeast. According to the data, this wetland drains to the southwest via one stream that eventually discharges into the Merrimack River.

Figure 2-30: Study Area Wetlands



There are no wetlands located southeast of the rotary. However, where Route 110 and Riverside Drive intersect, the mapping indicates that a stream emerges from beneath the roadway and discharges into the Merrimack River. It is likely that this stream is fed by runoff from impervious surfaces located northwest and northeast of the rotary as well as from I-93 and the roadways that make up the rotary itself.

One last wetland is located in a forested area just north of where Route 113 and 110 diverge west of the rotary, and just south of a large industrial development. According to the MassGIS database, this wetland is a scrub shrub swamp hydraulically connected to a stream that partially parallels the I-93 southbound off-ramp leading into the rotary. The scrub shrub swamp is located approximately 50 to 75 feet from Route 113.

As this conceptual study recommends improvements and transitions into the formal environmental documentation phase required by both the National Environmental Policy Act (NEPA) and Massachusetts Environmental Policy Act (MEPA), a more detailed assessment of wetland functions and values, vegetative species composition, and overall quality will need to be undertaken.

2.4.6 Fish and Wildlife Habitat

The passage of the New England Fishery Resources Restoration Act of 1990 (16 U.S.C 777e-1) enabled the United States Fish and Wildlife Service (USFWS) to focus on restoring the Atlantic Salmon and other anadramous fish species back to self sustaining levels in the Merrimack River and other rivers in New England. The construction of fish ladders on some of the dams along the lower Merrimack River coupled with a comprehensive nursery and stocking program has resulted in a slow and steady increase in the number of returning anadramous fish, with American Shad showing the greatest rate of return to date. In addition to the Atlantic Salmon and American Shad, other anadramous fish species that may be found in the Merrimack River in the vicinity of the project include Blueback Herring, Alewife, Striped Bass, Sea Lamprey and American Eel.

The Merrimack River in the vicinity of the study area is an important recreational fishery. Anglers can often be seen along the banks of the river landing a variety of fish including White Catfish, Bullheads, Largemouth Bass, Yellow Perch, White Perch, Walleye, Smallmouth Bass, Carp, and Fallfish among others.

2.4.7 Wildlife Habitat

The study area is predominantly a developed suburban environment, with natural vegetated habitat essentially limited to relatively small, fragmented forest areas and wetland and drainage corridors located adjacent to I-93 and the existing rotary. Additional natural habitat is offered by the emergent and scrub shrub wetlands located within the open land area west of Heather Drive and south of the baseball field. Wildlife expected to use these patches of natural vegetated habitat include rabbits, chipmunks, squirrels, shrews, moles, raccoons, skunks, fox, coyote and deer as well as various common songbirds, amphibians, and reptiles. Neither the high density residential areas, nor the commercial and industrial zones within the study area are likely to provide significant habitat for wildlife, but still may provide cover and some food sources for more urban-tolerant species.

2.4.8 Threatened and Endangered Species

The Massachusetts Natural Heritage and Endangered Species Program (NHESP) digital data contained on the MassGIS web site were reviewed to identify the potential for threatened and endangered species, as well as critical habitats within the study area. NHESP GIS coverages that were examined included the Priority Resource (21E) Map, the Priority and Estimated Habitats Map, and the NHESP Biomap.

The mapping depicts a contiguous linear zone along the entire length of the Merrimack River to the south of the study area that is identified as a rare species priority habitat. There are no other such designations within the study area. The mapped data also indicates general areas where threatened and endangered species and significant habitats could occur, but does not accurately reflect the size and shape of potential or confirmed habitats or populations. Since this information is of a sensitive nature, any NHESP sites identified in close proximity to the study area would require coordination with the Massachusetts Department of Environmental Management (DEM) for further assessment of possible project effects during the NEPA and MEPA environmental documentation phase. Coordination with the U. S. Fish and Wildlife Service (FWS) would also be required, and was initiated as part of this conceptual planning study. An endangered species data request letter was forwarded to the USFWS Regional Field Office.

2.4.9 Areas of Critical Environmental Concern

A review of the Massachusetts Department of Conservation and Recreation's (DCR) digital Areas of Critical Environmental Concern (ACEC) map contained on the MassGIS web site revealed that there are no ACECs within the project study area.

2.4.10 Hazardous Waste Sites

A review of hazardous materials GIS data for the project area revealed the locations of eight Underground Storage Tank (UST) sites and one Tier II Oil/Hazardous Material Disposal site. No field verification or visual inspection of these locations has been conducted at this planning stage. None of the hazardous materials sites are located within or directly adjacent to the existing rotary. UST locations include three sites along Route 110 west of the rotary; Merrimack Valley Wood Products, Inc., Merrimack Valley Sea Plane Base, and Magor Gas. There is also a UST location along Riverside Drive to the southwest of the Rotary associated with Cyr Oil Corporation. Adjacent to this Cyr Oil is the Tier II Oil/Hazardous Material Disposal site, which is associated with Riverside Gulf. The other four UST locations are east of the existing rotary along Route 110. They are associated with Allied Electric Corporation, Getty Property #30603, Mobil Gas Station 01287, and the Methuen Water Treatment Plant.

2.4.11 Cultural, Historical and Archaeological Resources

Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f) states that any federally funded project must "take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register."

The first step in evaluating potential impacts to historic resources is to establish an Area of Potential Effect (APE) for a project. For this conceptual planning study, the APE was preliminarily defined as the area within ½ mile east and west of the existing Route 110 and 113 Rotary. The size of the APE was selected because it was determined that alternatives for the Route 110 and 113 interchange would more than likely not incur any potential impacts, including visual impacts, beyond this range. This proposed APE has not been reviewed by the Massachusetts State Historic Preservation Office (SHPO). It is simply used as a planning tool to identify potential historic resources that might be affected by future interchange improvements. The size of the APE would be determined during the analyses of cultural resources, which would take place during the NEPA and MEPA environmental documentation phase and formal coordination with the SHPO.

With the APE preliminarily defined, the National Park Service's National Register of Historic Places database was consulted to determine the presence of any recognized historic sites or districts within the APE. The query revealed that no recognized historic sites or districts exist in the vicinity of the proposed project. It should be noted that there may be several resources within the APE that are not "listed on the National Register," but could potentially be eligible. Further field reconnaissance, research, and coordination with the Massachusetts SHPO would be necessary to determine their eligibility as any alternative progresses into the environmental documentation phase required by both NEPA and MEPA. This is particularly true for archaeological resources, which have yet to be defined at this planning stage.

2.4.12 Air Quality

The Clean Air Act of 1970 and subsequent amendments (1990) established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants including carbon monoxide (CO), nitrogen dioxide (NO2), sulfur dioxide (SO2), lead (Pb), ozone, and particulate matter (PM). The Clean Air Act required states to monitor regional air quality to determine if regions meet the NAAQS. If a region shows exceedances of any of the NAAQS, that part of the state is classified as nonattainment for that pollutant, and the state must develop an air quality plan, called a State Implementation Plan (SIP), that will bring that region into compliance. According to the United States Environmental Protection Agency's (EPA) Air Quality Report (2004) for Massachusetts, eastern Massachusetts, which includes Essex County (the study location), has been designated as serious nonattainment for ozone. Eastern Massachusetts is in attainment for the other five criteria pollutants.

Exhaust products of fuel combustion from motor vehicles can contribute to a region's air quality pollutant burden. Emissions vary greatly depending on vehicle type, distance traveled, operating speed, and ambient conditions. For this study, no quantitative air quality analyses were conducted. However, congestion and delays increase idling and decrease combustion efficiency, leading to higher emissions. Therefore, the excessive congestion and delays within the study area can be assumed to be a major contributor of poor air quality levels in the immediate vicinity of the rotary.

State Implementation Plan (SIP)/Transportation Improvement Program (TIP) Conformity

Conformity with State Implementation Plan (SIP) and the Transportation Improvement Program (TIP) requires that implementation of projects in TIPs and Long Range Plans (LRP) must not cause or contribute to further violations of the NAAQS and must conform to the SIP's purpose of meeting air quality attainment. This demonstration requires an extensive modeling effort to estimate vehicle miles of travel on a regional transportation system and the resulting motor vehicle emissions. The Methuen Rotary Interchange Improvement Project has been formally included in the TIP for the Merrimack Valley region. The Massachusetts Executive Office of Transportation and Public Works has found the emission levels from all areas and all MPOs in the Eastern Massachusetts region – including from the 2003 Merrimack Valley Regional Transportation Plan – to be in conformance with the SIP according to conformity criteria.

2.4.13 Noise

Noise sensitive land uses include a) residences, hotels, and other buildings where people sleep, b) institutional resources such as churches, schools, hospitals, and libraries, and c) various tracts of land where quiet is an essential element of the land's intended purpose, such as a National Historic Landmark where outdoor recreation routinely takes place.

Aerial photographs of the project study area were reviewed to identify noise sensitive land uses and to obtain a better understanding of the existing noise environment. The project site is in suburban Methuen amidst primarily medium and high-density residential neighborhoods that are bisected by Interstate 93, Route 110, and Route 113. Residences located to the southeast of the existing rotary within the Noyes Street neighborhood and residences to the southeast of the rotary along Allen Street are the closest to the rotary, and are considered to be the most sensitive to potential project noise. Residences to the west of the rotary along Bolduc Street, Branch Street, Moody Avenue, Albert Street, and Alexander Circle; and residences to the east along the extreme northern end of Lincoln Street and Heather Road and the southern end of Smith Street; may also be somewhat affected depending on which interchange improvement alternative is ultimately recommended.

MassHighway has developed a noise barrier program based on FHWA noise abatement criteria and policies and on MassHighway's noise abatement guidelines. There are essentially two programs; Type I and Type II. The Type I program covers noise barrier construction coincidental with construction of major highways on new locations, or physical alteration of an existing highway, including widening or realignment. Such major projects usually require an Environmental Impact Statement (EIS) or Environmental Assessment (EA) and/or an Environmental Impact Report (EIR) to comply with the National Environmental Policy Act (NEPA) and the Massachusetts Environmental Policy Act (MEPA). As part of this analysis, the need for a noise barrier is evaluated and if determined to be reasonable and feasible is constructed as part of the project.

The Type II Program is a voluntary effort undertaken by MassHighway to construct noise barriers along existing Interstate roadways where reasonable and feasible and as funding priorities allow. Under this program, MassHighway has identified 53 locations that meet the criteria for consideration of a noise barrier. To-date MassHighway has constructed four of those, has determined that two are not feasible, three are currently being designed, and one other location is being reviewed. The remaining 43 locations will continue to be reviewed to determine if they are feasible and reasonable for construction. Of the 53 locations, there are two located along I-93 in Methuen within the project area, and they are currently ranked numbers 42 and 47 based on MassHighway's priority ranking system. Priority Location 42 is focused on the residential areas east of I-93 and south of the rotary including Noyes Street and sections of Riverside Drive and Lincoln Street. Priority Location 47 is on the west side of I-93 south of the rotary including Allen Street, Griffin Street, and sections of Riverside Drive.

2.4.14 Protected and Recreational Open Space

Section 4(f) of the Department of Transportation Act of 1966 (49 USC 303) protects historic resources eligible for listing or listed on the National Register of Historic Places, as well as significant publicly owned parks, recreation areas, and wildlife/waterfowl preserves. Section 4(f) properties may only be impacted if there is no feasible and prudent alternative to their use and if the project includes all possible planning to minimize harm resulting from such use.

There are no historic Section 4(f) resources in the immediate project study area. However, there is a baseball diamond located approximately 1,000 feet to the southeast of the existing rotary. Whether or not this field is open to public use has not been determined for this planning study. Further environmental research and analysis conducted during the NEPA and MEPA environmental documentation phase will determine ownership and use of this recreational facility, as well as the potential for project impacts on the resource. In addition, at the intersection of Riverside Drive and Burnham Drive, there is a park used by the public for recreational activities, including walking trails and a boat ramp to the Merrimack River.

2.4.15 Bedrock and Surface Geology

Bedrock Geology: The study area resides within the New Hampshire-Maine geologic province. This geologic province is comprised principally of Silurodevonian metasedimentary rocks and Silurodevonian and younger igneous rocks. Calcgranofels are the primary rock type found within the study area. They include slate and greywacke; slightly calcareous, clastic sedimentary rocks at or above biotite-grade of regional metamorphism.

Surficial Geology: MassGIS has produced a statewide surficial geology datalayer showing the location of sand and gravel deposits. The datalayer is very generalized and is used only to produce volume or area measurements over a larger region such as a drainage basin. It is not considered accurate for site specific analysis. However, the datalayer can be used to generally describe the type of surficial deposits likely to be encountered at a site. The project study area is underlain almost entirely by till or bedrock with the exception of a small region to the southwest that is adjacent to the Merrimack River. This area is characterized by sand and gravel deposits.

2.5 Future Year 2025 No-Build Conditions

Once the existing conditions were established, traffic volumes were projected to the year 2025. This is also referred to as the future year no-build conditions, or how traffic volumes would be approximately 20 into the future with annual background growth, but with no roadway improvements implemented.

2.5.0 Socio-Economic Projections

Population, households, and employment are the basis for traffic growth. The projections for this area were developed based on a review of the statewide projections, as well as community projections prepared by the regional planning agencies. Table 2-9 shows the base year and forecasted socioeconomic data for Dracut and Methuen. This data was used as input to the travel demand model, which was used primarily to predict traffic growth and trip distribution in the study area, and is discussed in more detail in the following sections.

Table 2-9: Forecasted Population and Employment

Community	Population in Households	Total Employment	Total Households
2006			
Dracut	31,980	5,250	11,940
Methuen	43,924	16,434	17,100
2025			
Dracut	38,049	5,810	14,783
Methuen	46,883	18,385	18,905

2.5.1 Traffic Forecasting Methodology

In order to predict long-term traffic growth in the study area, use of a travel demand forecasting model was employed. Travel demand forecasting is the term used to define a standard suite of models, which use changes in demographic data such as population, households and employment to predict future traffic volume and travel patterns. The Massachusetts Highway Department (MHD) funded the development of regional travel demand forecasting models in nearly all of the Commonwealth's 13 regional planning agencies. MHD also funded the development of a statewide model. Since the study area is adjacent to I-93 and because the statewide model captures regional travel on the interstate highway system and interstate ramps, the statewide model was a better choice for forecasting traffic growth within the study area.

The MHD statewide travel demand forecasting model covers all of Massachusetts, as well as southern New Hampshire, Maine, and Vermont; New York border communities adjacent to Berkshire County; northern Connecticut; and all of Rhode Island.

The statewide model highway network representation includes all roads in the state which are functionally classified as "collectors" or higher (using the Federal Highway Administrations roadway functional classification criteria).

The statewide model is known as an aggregate planning model, which is typical for state and regional modeling systems. Aggregate models are the most common type of forecasting model. In an aggregate planning model, communities are sub-divided into traffic analysis zones. A zone is an area of similar land use. Consequently, zones are typically residential or commercial in nature. Although in densely developed areas such as in eastern Massachusetts, many zones are somewhat mixed use.

Disaggregate models work from individual household or employment data. While more accurate, disaggregate models are an order of magnitude more costly to build, and maintain. In MHD's statewide model there are 3,753 traffic zones, 3,069 of which are in Massachusetts. The network covers 19,493 miles of road, of which 15,893 are in Massachusetts. The model has been designed to predict traffic conditions for a base year of 2000 and forecast years of 2007, 2015, and 2025.

Generally speaking, the modeling process has four distinct steps: *Trip Generation, Trip Distribution, Mode Split and Trip Assignment*.

In MHD's statewide model, ***Trip Generation*** is performed using a combination of regression and cross-classification procedures. These methods estimate the likely number of trips produced by residential areas as well as the number of trips attracted to commercial areas. Trip generation is based on demographic variables such as population and number of households. Employment type sectors such as retail, government, education, health, entertainment, service, construction, and transportation are also included. Employment and population levels reflect average conditions for the year of analysis. The model does not produce forecasts for specific events or for a specific season. All output for the model is average conditions for that year. The trip generation equations represent weekday conditions. Consequently, all subsequent model steps reflect average weekday travel conditions.

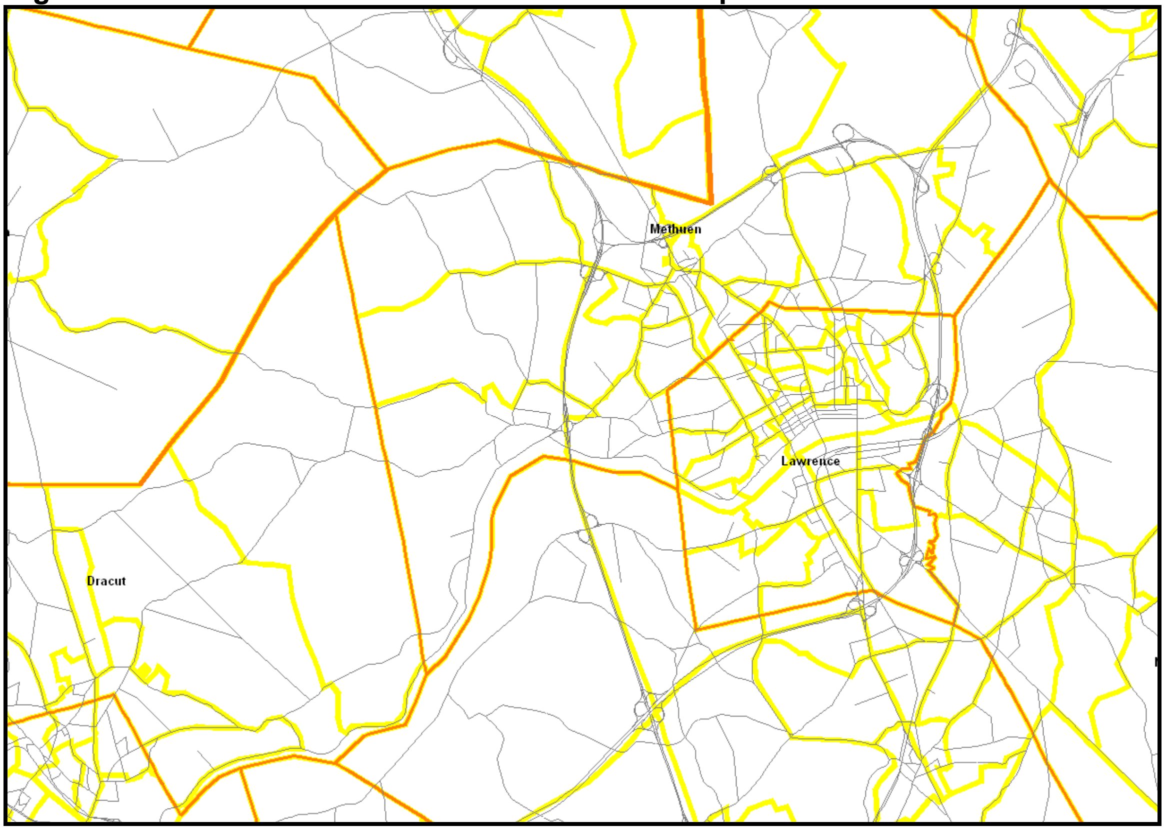
The ***Trip Distribution*** step computes likely origin and destination patterns. The statewide model uses a gravity distribution model; the most common distribution simulation model. These travel pattern computations are based on travel behavior studies that show how different trip purposes (work, shopping, school, etc) have different behavior patterns.

Mode Split is the step associated with determining whether the trip will be made by walking, driving, as an auto passenger, by transit, or by a combination of modes. Mode split computations are based on mode share tables from the Boston Metropolitan Planning Organization (MPO), as well as national statistics for vehicle occupancy.

The ***Trip Assignment*** step actually calculates the travel route for each trip exchange. The assignment models calculate traffic volumes on each roadway segment and the turning movements at key study intersections. The traffic assignment process is a system equilibrium methodology. Traffic assignment is performed independently for 4 time periods: AM peak period, midday, PM peak period, and off-peak. These four time periods total to 24 hours, or essentially a daily model. The assignment process is sensitive to congestion, and considers alternate paths when roads approach capacity or become congested. Consequently, the model has trip diversion analysis capabilities, which is an important feature in eastern Massachusetts.

Figure 2-31 shows a view from the statewide model in the study area and gives a sense of the granularity of the network and zone system. The orange lines represent community boundaries; the yellow lines represent zone boundaries. Please note that zones do not cross community boundaries, so some of the orange lines also represent zone boundaries. Roads are shown as gray lines.

Figure 2-31: Statewide Model Network and Zone Representation



2.5.2 Model Calibration

Whenever the statewide model is used for a particular project application, it must be refined to accurately represent the subject area. This refinement is needed because the model was developed using aggregate databases. For example, the employment in the model was derived from national employment databases. These databases contain listings of employers, number of employees, and address. The addresses were then used to electronically locate the employers in traffic zones, within the community. Because national databases sometimes contain incorrect or inaccurate data, the employment for Methuen and Dracut was examined to determine if the employment was actually loaded into the proper zones. This “verification” was performed using aerial photography and field reconnaissance. Similarly, the network attributes (such as speed and number of travel lanes) is based on MHD’s road inventory database. These data items were also checked using aerial photography and field reconnaissance.

After the data verification phase, the model was then run to produce a base assignment. In this study, the base year selected was 2006. The model assignment was then compared against observed traffic counts. Based on this comparison, additional model refinements were made to the highway network. These refinements included adding roads to the highway network and changing travel times on roadway segments to more accurately reflect real travel conditions and intersection delay. Table 2-10 shows a comparison of the model produced traffic assignment and the observed traffic volumes, which is consistent with accepted practices for model calibration results.

Table 2-10: Comparison of Ground Counts and Base Year Model Assignment

Town	Location	Ground Count	Model Assignment
Methuen	EB Route 110 west of Rotary	10,381	9,459
Methuen	Forest Street west of Lowell Street	3,771	3,406
Methuen	I-93 exit 45 NB off ramp	8,698	5,439
Methuen	I-93 exit 45 NB on ramp	11,820	8,598
Methuen	I-93 exit 45 SB off ramp	11,658	7,234
Methuen	I-93 exit 45 SB on ramp	8,529	7,514
Andover	I-93 exit 46 NB off ramp	16,005	16,422
Andover	I-93 exit 46 NB on ramp	10,389	8,933
Andover	I-93 exit 46 SB off ramp	10,591	8,947
Andover	I-93 exit 46 SB on ramp	15,820	17,753
Methuen	I-93 exit 47 NB off ramp	7,100	5,165
Methuen	I-93 exit 47 NB on ramp	16,427	6,497
Methuen	I-93 exit 47 SB off ramp	6,197	5,394
Methuen	I-93 exit 47 SB on ramp	6,762	7,481
Methuen	I-93 NB exists 45-46	58,214	60,725
Methuen	I-93 NB exits 46-47	53,507	53,236
Methuen	I-93 SB exits 45-46	58,214	63,231
Methuen	I-93 SB exits 46-47	58,214	54,425
Methuen	Lowell Street west of Elm Street	10,168	8,072
Methuen	Lowell Street west of Forest	7,950	7,362
Methuen	Lowell Street west of Haverhill St	31,482	30,181
Methuen	Pelham Street east of I-93	11,636	18,365
Methuen	Pelham Street west of I-93	18,322	17,249
Andover	River Road east of North	25,368	26,825
Andover	River Road west of I-93	20,300	21,259
Methuen	Riverside Drive west of Burnham	8,272	8,497
Methuen	Rotary between NB on/SB off	19,190	20,466
Methuen	Rotary between SB on/NB off	14,048	13,866
Methuen	Route 110 at Dracut Line	12,296	7,000
Methuen	Route 110 at Lawrence Line	17,634	17,012
Dracut	Route 110 west of Burnham	21,170	26,336
Lawrence	Route 110 west of I-93 & Route 113	18,095	19,482
Dracut	Route 113 @ Dracut Line	15,740	16,864
Methuen	Route 113 east of Branch Street	18,658	25,633
Methuen	WB Route 110 west of Rotary	9,959	8,063

2.5.3 No-Build (2025) Traffic Volumes

Once the base year assignment was calibrated to an acceptable level, the model was run again with socioeconomic projections (population, households, and employment) input for the year 2025. Historic background growth, planned and programmed developments, and roadway improvements were also considered when determining the 2025 No-Build traffic volumes. Results from the travel demand model indicate that traffic volumes in the study area are anticipated to increase 1% per year. Thus, existing peak hour traffic volumes were increased by 1.0% annually to reflect future 2025 No-Build.

2.5.4 No-Build (2025) Traffic Operations

In general, an intersection having a poor level-of-service under the existing conditions will continue to function poorly or will deteriorate further if additional demand from future growth is added, and no improvements are made to the roadways. However, to fully determine what deficiencies or problems result from this additional traffic growth, a future year no-build traffic operations analysis was conducted using output from the travel demand model. The following section documents this analysis, and the Appendix contains more detailed traffic volume information.

Results from the future no-build analysis indicate that the delay or level-of-service will slightly worsen from the existing condition at all study area intersections. The intersections and critical movements identified as failing under the existing condition will continue to fail under the future no-build condition. Also, all approaches to the Route 110 and 113 Rotary will continue to operate at failing levels-of-service during the AM or PM peak hour. Results from the no-build operations analysis are shown in Table 2-11, Figure 2-32, and Figure 2-33.

Table 2-11: Level-of-Service Summary for the Future No-Build 2025 Condition

	Existing Condition (2006)				No-Build Condition (2025)			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
Intersection	LOS	Average Delay (sec/veh)	LOS	Average Delay (sec/veh)	LOS	Average Delay (sec/veh)	LOS	Average Delay (sec/veh)
Signalized Intersections								
Route 110 & Route 113 (west of rotary)	C	22	C	22	C	35	D	37
Route 110 & Route 113 (east of rotary)	B	13	E	67	B	15	F	>80
Route 110 (Haverhill Street) & Burnham Road	B	13	C	25	B	16	D	44
Unsignalized Intersections								
Route 110 & Riverside Drive (Riverside lefts)	F	72	F	>80	F	>80	F	>80
Riverside Drive & Burnham Road (Burnham lefts)	C	17	F	52	C	20	F	>80
Route 113 & Branch Street (Branch lefts)	F	>80	F	>80	F	>80	F	>80
Rotary								
Northbound Approach	A	6	F	>80	A	7	F	>80
Southbound Approach	F	>80	F	>80	F	>80	F	>80
Eastbound Approach	F	>80	A	4	F	>80	A	5
Westbound Approach	C	32	F	>80	F	>80	F	>80
(#) = Delay expressed in seconds per vehicle								

Figure 2-32: Intersection Level-of-Service Summary for Future No-Build 2025 Condition

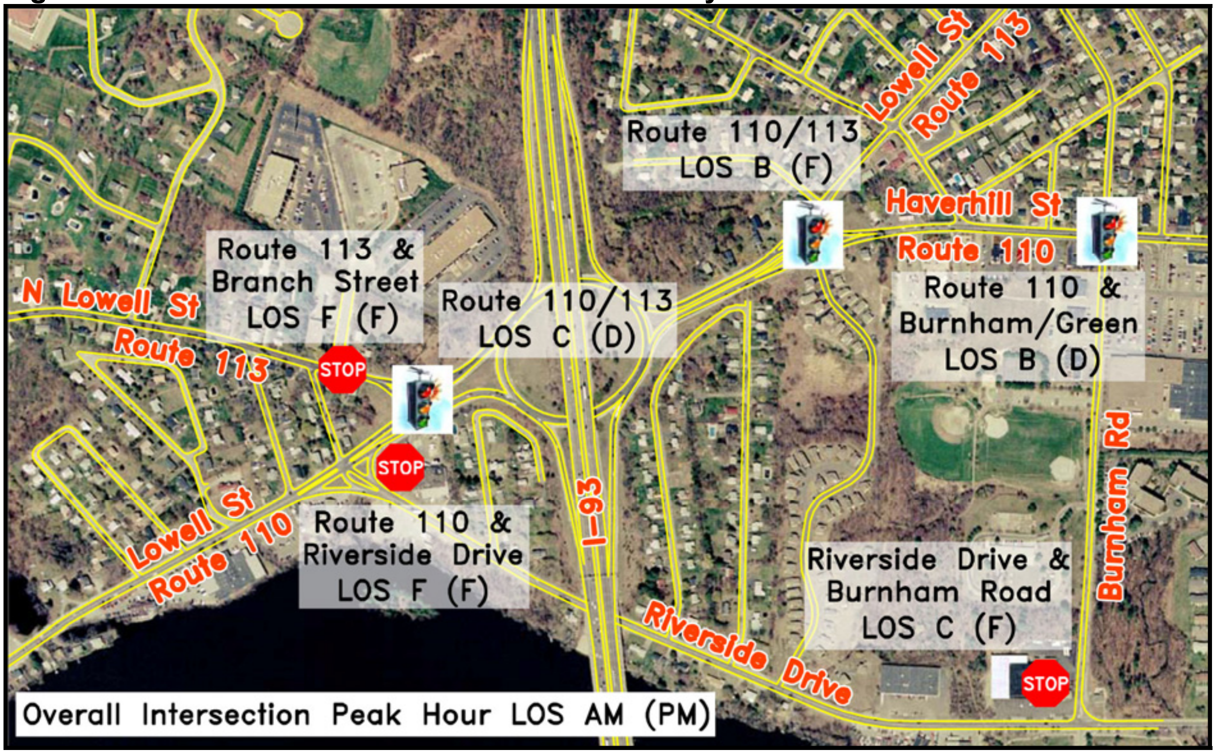
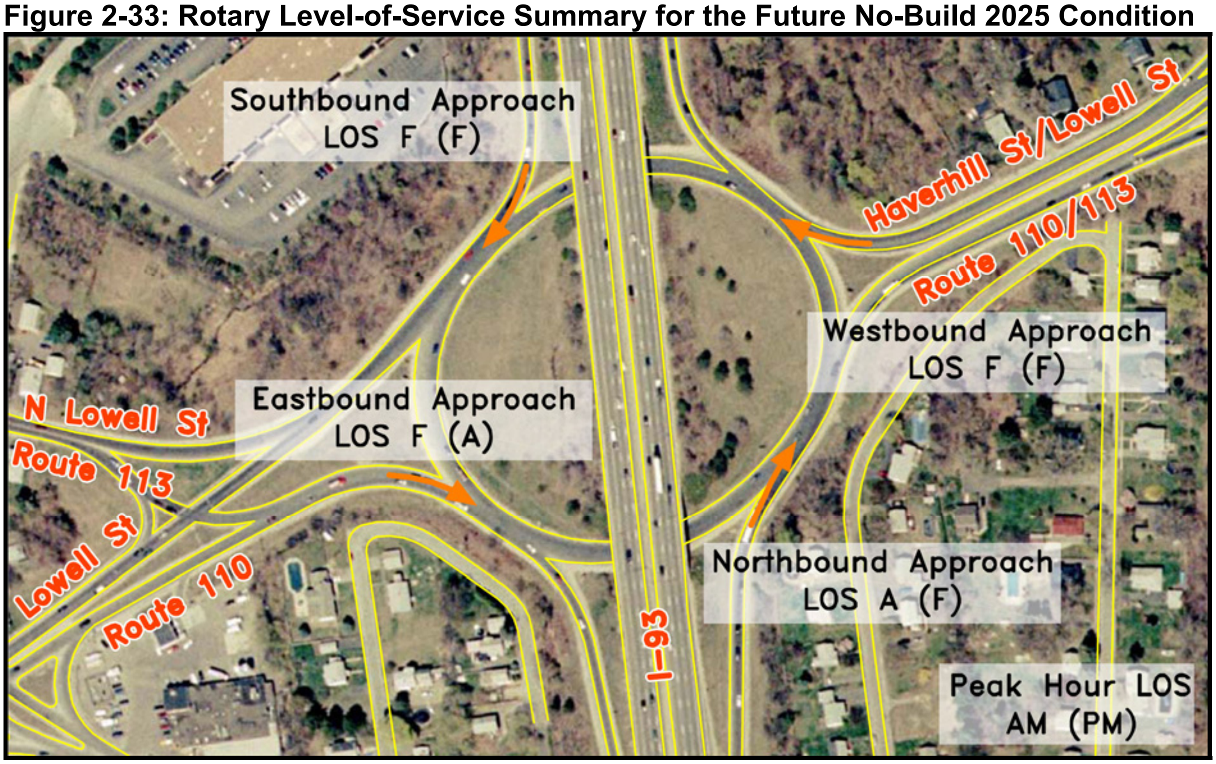


Figure 2-33: Rotary Level-of-Service Summary for the Future No-Build 2025 Condition



2.5.5 No-Build (2025) Traffic Simulation

The future no-build 2025 peak hour traffic volumes were also input into the calibrated micro-CORSIM model to simulate the level of traffic congestion at the interchange. As in the traffic operations analysis, given the growth in traffic and if no improvements are made, traffic congestion at the Route 110 and 113 Rotary interchange will grow significantly. Figure 2-34 graphically shows the congestion during the 2025 AM peak hour. This congestion, which is mostly at the entrance to the I-93 southbound on-ramp under existing conditions, would spread throughout the rotary.

Figure 2-34: No-Build AM Peak Hour Congestion at Rotary

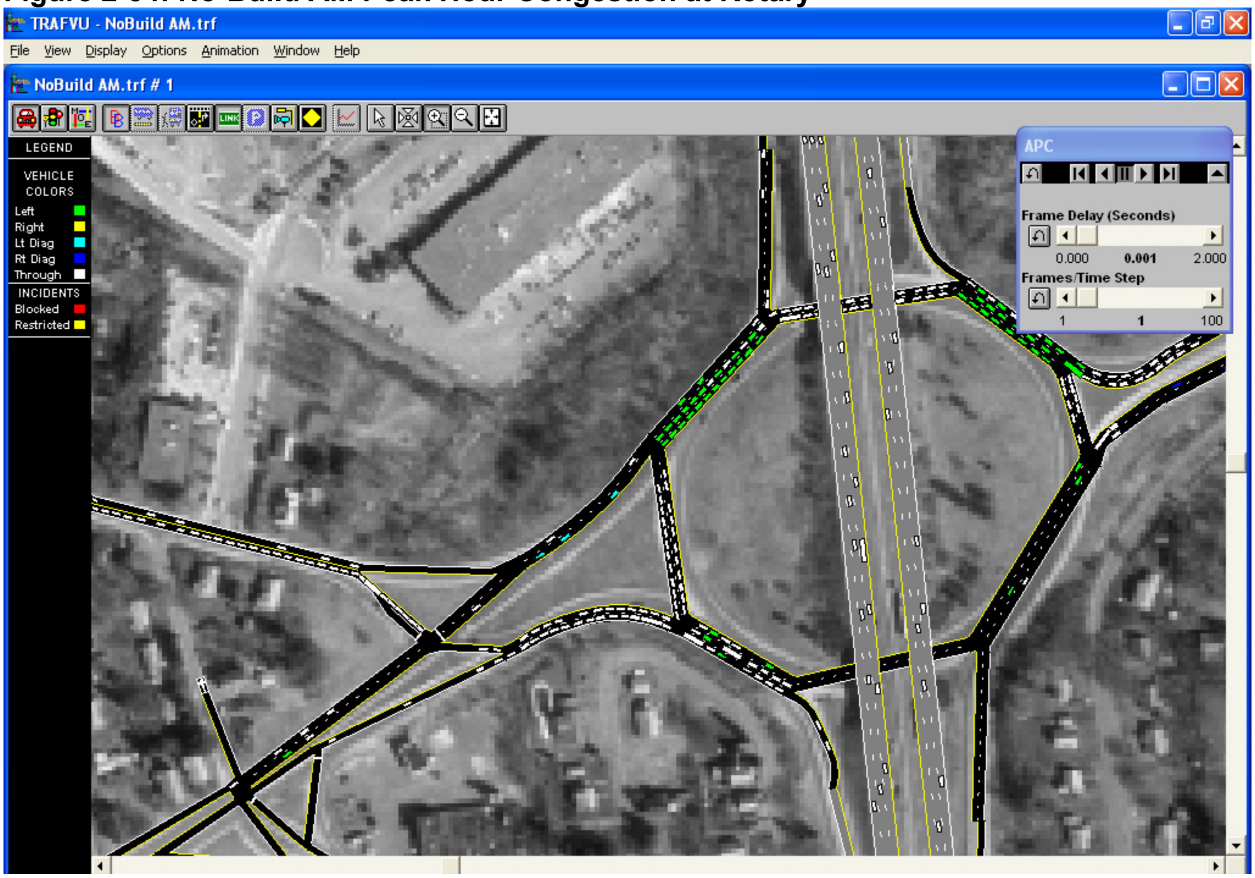
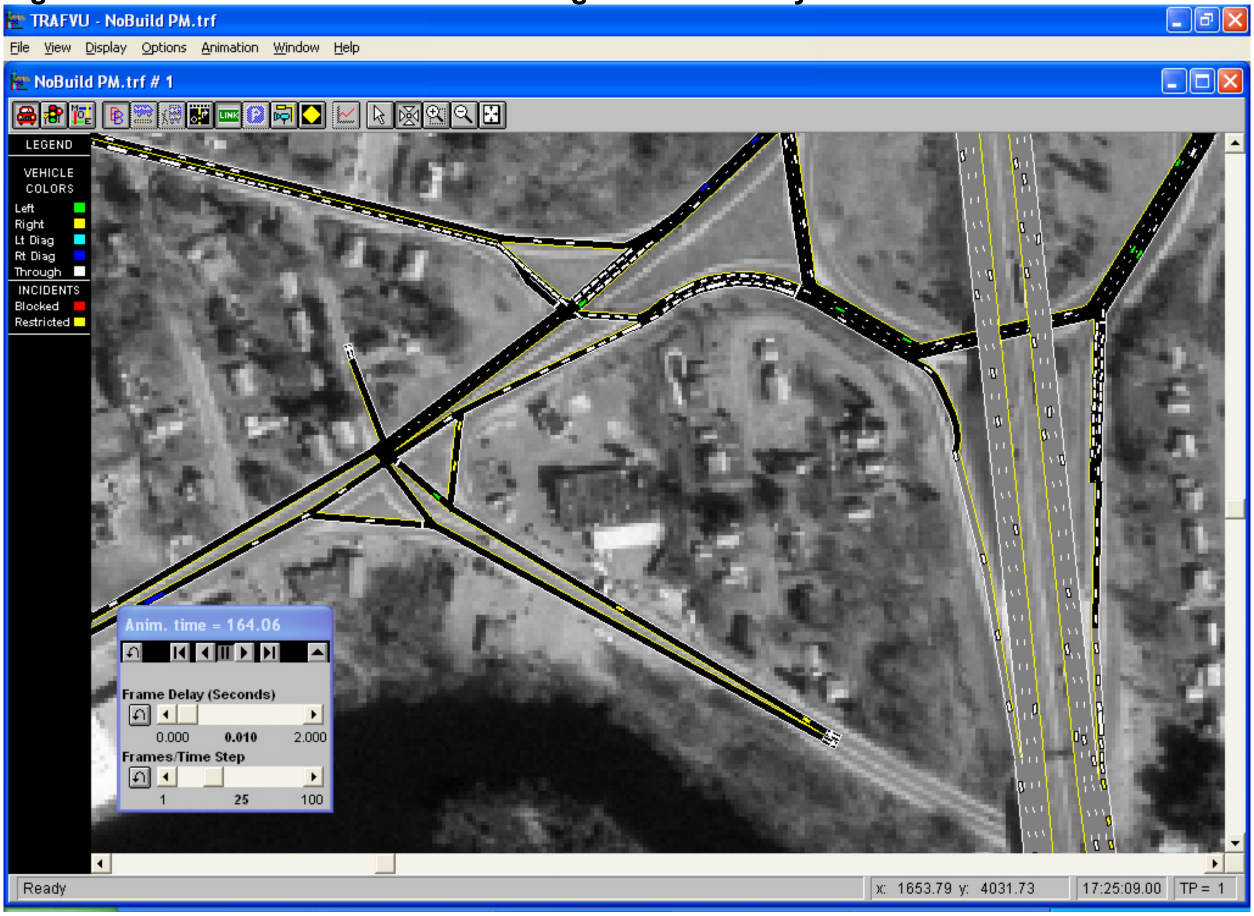


Figure 2-35 shows the congestion during the 2025 PM peak hour. While the long queues on the I-93 northbound off-ramp would get much worse in 2025 from existing conditions, the traffic congestion would also spread to Route 113 (North Lowell Street) west of the rotary.

Figure 2-35: No-Build PM Peak Hour Congestion at Rotary



2.5.6 Forecasted Transit Ridership

While the state has not developed transit ridership forecasts for local services provided by the regional transit authorities, year 2025 commuter rail ridership forecasts developed by CTPS project a 20% increase in ridership on the Haverhill-Reading Line and a 15% increase in ridership on the Lowell Line. It is expected that the MBTA will gradually add capacity to accommodate this demand.

2.6 Identification of Issues and Inventory of Project Constraints

2.6.0 Identified Study Area Issues

Study area issues that were identified through analyses or in discussion with the SAC and general public are documented in the following summary list of issues, and guided the development of improvements and alternatives.

Summary of Issues:

- Congestion and excessive delays at the Route 110 at Route 113 signalized intersections east and west of the rotary.
- Excessive delays for side-street approaches at the three unsignalized intersections in the study area.
- Under the existing AM peak hour conditions, the rotary at the entrance to the I-93 southbound on-ramp is a major source of congestion and results in queues on the rotary as well as onto Route 110 (Lowell Street). Given the anticipated increase in traffic volumes and based on traffic analyses, this situation is expected to worsen by the year 2025 and queues would extend completely around the rotary.
- Under existing PM peak hour conditions, the I-93 northbound off-ramp queuing extends back into the mainline, resulting in rear-end collisions and congestion on I-93. Given the anticipated increase in traffic volumes and based on traffic analyses, this queuing is expected to continue into the future, exacerbating congestion and potentially increasing the number of crashes on I-93 and at the rotary.
- Anticipated future traffic volume growth on both Route 110 and Route 113 west of the rotary, will place a higher demand on the current infrastructure and exacerbate the existing problems.
- Safety concerns related to speeds higher than the posted limits, and the high volume of truck traffic on Route 113 west of the rotary. Based on the speed assessment analysis and input from area residents, excessive westbound vehicle speeds on Route 113 west of the rotary between Appaloosa Drive and Presidential Lane.
- The rotary has a statistically significant higher rate of crashes than the statewide average for unsignalized intersections.
- Both signalized intersections of Route 110 and Route 113 east and west of the rotary have higher crash rates than the statewide average for signalized intersections.
- The crash data analysis indicated that there may be substandard lighting conditions at the rotary.
- Decreased air quality due to congestion and delays throughout the study area.
- Based on SAC input, there is a safety issue regarding a school bus stop on Route 113 just west of the rotary. Vegetation growth at the northwest corner of the rotary, limits the sight distance of vehicles exiting the rotary heading westbound. This can also be exacerbated by vehicles exiting I-93 down the southbound off-ramp at higher speeds, entering the rotary and continuing on to Route 113 westbound.
- Potential gaps in service and a lack of Intelligent Transportation Systems (ITS) use were identified in the inventory of existing transit services.

- There are no park & ride services identified in the study area.
- During field observations, westbound traffic on Route 110 east of the rotary was observed detouring onto Riverside Drive to avoid congestion at the rotary during the AM peak period. This allows drivers to bypass the rotary and perform two right-turn movements (onto Route 110 and onto I-93 southbound on-ramp) to access the I-93 southbound on-ramp. This detour passes by a large recreational facility on the Merrimack River, which would limit recreation access during peak periods. This detour also worsens traffic congestion at the intersection of Riverside Drive and Route 110.
- Two locations within the study area identified by MassHighway that currently meet the criteria for installation of sound barriers.

2.6.1 Inventory of Project Constraints

Constraints are defined by those attributes either natural or man-made that limit or might limit the development of options for alternatives due to the severity that the constraint represents. Generally, such constraints are usually environmental resources or land uses that restrict the ability of a project to mitigate their effective removal thus causing alternatives to avoid such known resources or structures. The following list is a summary of identified constraints:

Constraints:

- The built environment constraints include residential and commercial property takings, as well as potential elimination of buffer areas to wetland areas. There is a large commercial building near the southbound off ramp from I-93, which limits ramp modifications or other changes in geometry.
- Narrow right-of-way on Route 113 (North Lowell Street) and limited depth setbacks of homes limit the ability to widen Route 113 (North Lowell Street) west without takings.
- 100-year and 500- year floodplains southwest of the rotary would require permitting and fill analysis for displacement of floodwaters if any alternative alters the floodplain.
- Wetlands permits would be required and compensation or mitigation for drainage for affected areas.
- A scrub-shrub swamp located just west of the rotary and also an emergent wetland to the northeast and east of the rotary could potentially be impacted.
- Although no listed historic sites exist in the vicinity of the proposed project, several older structures could be eligible for listing on the National Register. Further research would be warranted as the project progresses. The same is true for archaeological resources.
- No hazardous materials or potentially contaminated sites appear to pose constraints.
- The close proximity of the Merrimack River and the I-93 bridge over the river to Exit 46 and the Route 110/113 Rotary could represent constraints to any alternatives.
- Substandard geometry of the rotary requires that any alternative would have to replace or reconstruct the rotary with current engineering design standards.

The preceding identified issues and constraints were used during the remainder of the study for development and analysis of alternatives. Additionally, they were also a key part of working with the SAC to refine, propose, and recommend improvements and alternatives.

Chapter 3: Alternatives Development

3.0 Introduction

The following chapter documents the development of alternative solutions intended to address the deficiencies identified in Chapter 2. The process was comprehensive, methodical, and iterative to ensure that the improvements carried forward into the analysis task would provide solutions to the identified problems, while being cognizant of the importance of quality of life for Methuen residents including minimizing property, environmental, and visual impacts.

3.1 Alternative Development Process

The development of alternatives began with a thorough review of the alternatives previously developed in the Route I-93 Corridor Study conducted for the MVPC. This review included identification of the major components of each alternative, what existing deficiencies were being addressed, and a listing of the major advantages and disadvantages of each concept. This information was then presented to the Study Advisory Committee (SAC) where it was reviewed in detail. The SAC evaluated each alternative and made recommendations to either carry the alternative forward for additional analysis, or to remove the alternative from further consideration.

In reviewing the seven alternatives from the Route I-93 Corridor Study, which can all be found in the Appendix, Alternatives 1 and 2 were determined by the SAC to be insufficient in addressing the identified problems in this area and the SAC recommended not carrying these alternatives forward. In reviewing Alternatives 3, 4 and 5, the SAC considered the level of property and environmental impacts too significant given the operational improvements predicted and were likewise not recommended for further evaluation. In reviewing Alternatives 6 and 7, the SAC identified some features that were judged to have merit. Although these two alternatives did not adequately address the congestion issues, the SAC recommended that their basic concepts be carried forward contingent upon modifications that would serve to improve the identified deficiencies.

Figure 3-1: Partial Cloverleaf Interchange

To begin the development of new and modified alternatives, the study team first looked at Alternatives 6 and 7 from the I-93 Corridor Study in more detail to determine if improvements could be made as recommended by the SAC. Two variations of Alternative 6 and three variations of Alternative 7 were developed in an attempt to provide the benefits of the original alternatives while addressing their shortfalls.

In addition to these five modified alternatives, seven entirely new alternatives were developed for a total of twelve (please refer to the Appendix for a complete listing). These seven new alternatives were based on three basic interchange configurations: a partial cloverleaf

(Figure 3-1), a diverging diamond (Figure 3-2), and a trumpet (Figure 3-3). The development of these alternatives consisted of conceptual alignments overlaid on aerial photographs. Although basic engineering principles including MassHighway and American Association of State Highway and Transportation Officials (AASHTO) standards were used in the development of these alternatives, this was a conceptual planning study and no formal surveying, mapping, or engineering was conducted.

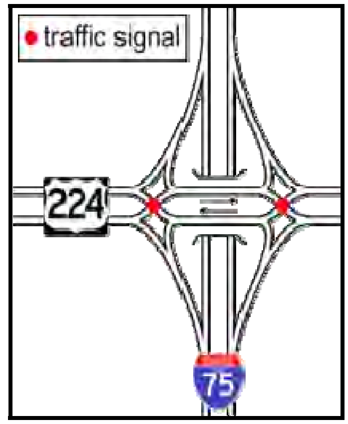


Figure 3-2: Diverging Diamond Interchange

Once the study team felt that all reasonable approaches to alternative development were exhausted and the alternatives were discussed with MassHighway highway design personnel, the team presented the developed alternatives to the SAC and requested their input. After reviewing the five alternatives based upon Alternatives 6 and 7 from the I-93 study as well as the seven new alternatives, the SAC recommended that four alternatives be carried forward for additional analysis.


Figure 3-3: Trumpet Interchange

Additionally, the study team developed conceptual short-term roadway improvements, transit, park & ride, and Intelligent Transportation Systems (ITS) options that could help to improve safety, mobility, and provide additional transportation choices in the interchange study area.

The following sections present descriptions of each of the four long-term roadway alternatives, three short-term improvement packages, and five non-roadway options recommended for additional analysis in the next chapter.

3.2 Long-Term Alternatives

The four alternatives recommended for further analysis represent substantial alterations to the existing built environment, which would require a significant amount of time to advance through the necessary environmental, design, and right-of-way processes. It is typical for projects of this nature and size to require five to ten years from completion of the planning study to the start of construction, and another two to five years for construction. As such, the following four alternatives were identified as long-term alternatives. A discussion of short-term improvements, requiring substantially less time to implement, will be presented later in this chapter.

3.2.0 Alternative 2A – Modified Single Point Urban Interchange (SPUI)

Alternative 7 of the Route I-93 Corridor Study proposed a Single Point Urban Interchange (SPUI) to replace the existing interchange configuration. A SPUI is a modification of the standard diamond interchange configuration with the ramps compressed to intersect at a central intersection either directly below or above the mainline highway. In Alternative 7 of the I-93 Study, the central intersection was located beneath I-93 at a relocated combined Route 110/113 (See Figure 3-4). As described in the AASHTO Policy on Geometric Design of Highway and Streets (Pg 787), the primary operational advantage of a SPUI is that "vehicles making opposing left turns pass to the left of each other rather than the right, so their paths do not intersect. In addition, the right-turn movements are typically free-flow movements." However, because of the large central intersection either directly over or under the mainline highway, this configuration typically requires a large single span structure resulting in a relatively high construction cost.

Figure 3-4: I-93 Corridor Study Alternative 7 (SPUI)

While the study team and the SAC felt that this alternative had merit, the previous study identified several shortcomings. First, the central intersection was projected to operate at Level of Service (LOS) E during the PM peak hour for the design year 2025. Also, the northbound off-ramp from I-93, which experiences heavy volumes during the PM peak hour, was still projected to operate at LOS F.

Alternative 2A (Figure 3-5) was developed to address these issues by removing the northbound off-ramp to westbound Routes 110 and 113 traffic from the central intersection, and providing an independent ramp that would directly connect with the intersection of Routes 110 and 113 to the west of I-93. After exiting I-93, the northbound off-ramp would divide into eastbound and westbound lanes. While the eastbound lane would descend to intersect with the combined Route 110/113, the westbound lane would climb to pass over Route 110/113 before beginning to descend at a 4%-5% grade as it loops to the west. This bypass would remove the northbound off-ramp to westbound Routes 110 and 113 movements from the central intersection, with the intention of increasing storage length for the northbound off-ramp and providing an acceptable LOS for the central intersection.

It should be noted that although this alternative is the first presented in this Chapter it is identified as Alternative 2A. An Alternative 1 was developed, but was eliminated as discussed previously in this chapter. To avoid confusion, this alternative maintains its identification as 2A despite the elimination of Alternative 1, and subsequent long-term alternatives also retain their original designation. Please note that all twelve of the developed alternatives are included in the Appendix for reference.

Alternative 2A Key Components:

- Modified SPUI configuration
- Rotary would be eliminated
- Western portion of Route 113 and eastern portion of Route 110 would be realigned as the continuous through movement
- The intersections of Routes 110 and 113 west and east of the interchange would be reconfigured as a four-leg and "T" intersection, respectively
- Northbound off-ramp to westbound Routes 110 and 113 would bypass the central intersection via grade separation over Route 110/113 and under I-93

Pros:

- Relatively small interchange footprint would lessen impacts
- Realignment of Routes 110 and 113 would allow for continuous through movement to better accommodate projected growth in traffic along Route 113 in Dracut
- Although three phases would still be needed for the signal operation at the central intersection, it is anticipated that removing the northbound off-ramp to westbound Routes 110 and 113 traffic from the intersection would allow the phase serving the southbound off-ramp to be substantially shortened, thereby improving overall signal operations
- Would minimize potential wetland impacts in the northeast quadrant

Cons:

- Would require the construction of three bridges including two under the I-93 mainline
- New I-93 bridges along with demolition of the two existing bridges could create significant traffic management issues during construction
- New I-93 bridge over the central intersection would require considerable length and width resulting in a significant cost for construction
- Could create a weaving condition for traffic traveling from the southbound off-ramp to eastbound Route 110/113 with those traveling from the northbound off-ramp to westbound on Route 113.
- Given the 4% to 5% downgrade, significant horizontal curve, and relatively high truck traffic on the northbound off-ramp, particular attention would be needed during the design development to ensure that the ramp meets the appropriate design standards while still meeting the goal of reducing impacts
- Ramps in northwest quadrant would potentially impact emergent and scrub wetlands and could require the relocation of an open watercourse
- Elevated northbound off-ramp in southeast quadrant could create additional visual impacts on Noyes Street
- High anticipated cost for construction
- Avoiding modifications to the I-93 bridge over the Merrimack River would require design exception approval for merging and acceleration distances for the southbound on-ramp.

Figure 3-5: Alternative 2A Modified SPUI

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3.2.1 Alternative 2B – Modified SPUI

Alternative 2B (Figure 3-6) was also based on the prior study's Alternative 7. Similar to Alternative 2A, this concept would remove the northbound off-ramp to westbound Route 110 and 113 movement from the central intersection, while maintaining the general characteristics of the SPUI design. However, in this alternative the northbound off-ramp would stay parallel to the I-93 mainline for a longer distance and cross Route 110/113 at the level of the I-93 mainline, and then separate from the mainline looping to the northeast. After crossing the northbound on-ramp, the off-ramp would descend to merge with Route 110/113 westbound with a right-turn only movement.

Alternative 2B Key Components:

- Modified SPUI configuration
- Rotary would be eliminated
- Western portion of Route 113 and eastern portion of Route 110 would be realigned as the continuous through movement
- The intersections of Routes 110 and 113 west and east of the interchange would be reconfigured as a four-leg and "T" intersection, respectively
- Northbound off-ramp to westbound Routes 110 and 113 would cross central intersection at the same elevation as the I-93 mainline before looping to the northeast and merging into westbound Route 110/113 with a right-turn only movement

Pros:

- Realignment of Routes 110 and 113 would allow for continuous through movement to better accommodate projected growth in traffic along Route 113 in Dracut
- Although three phases would still be needed for the signal operation for the central intersection, it was anticipated that removing the northbound off-ramp to westbound Routes 110 and 113 movement from this intersection would allow the phase serving the southbound off-ramp to be substantially shortened, thereby improving overall signal operations
- Would not require second bridge under I-93
- Realignment of southbound off-ramp would eliminate potential weaving problem of southbound off-ramp and northbound off-ramp traffic identified in Alternative 2A

Cons:

- Would require the construction of two bridges, including one under the I-93 mainline
- A new I-93 bridge combined with demolition of the two existing bridges could create significant traffic management issues during construction
- A new I-93 bridge over the central intersection would require considerable length and width, resulting in a significant cost for construction
- Northbound off-ramp to westbound Routes 110 and 113 traffic would still need to pass through the central intersection along Route 110/113 as a through movement. This would likely require that additional green time be allocated to this movement
- Aligning the northbound off-ramp loop to westbound Route 110/113 would potentially increase property and wetland impacts in northeast quadrant
- Avoiding modifications to the I-93 bridge over the Merrimack River would require design exception approval for merging and acceleration distances for the southbound on-ramp.

Figure 3-6: Alternative 2B Modified SPUI

- Ramps in northwest and northeast quadrants would likely impact emergent and scrub wetlands and could require the relocation of an open watercourse
- Weaving concern in the northeast quadrant between vehicles merging with westbound Route 110/113 from the northbound off-ramp and westbound vehicles exiting Route 110/113 to the northbound on-ramp.

3.2.2 Alternative 3A – Partial Cloverleaf

Alternative 3A is the first of two alternatives based upon a partial cloverleaf configuration. Similar to the previous alternatives, Alternative 3A (Figure 3-7) would eliminate the rotary and realign Routes 110 and 113 under I-93. To accommodate the projected growth in traffic volumes along the Route 113 in Dracut, the roadway realignment would result in a continuous through movement for Route 113 west of the rotary to Route 110 east of the rotary. Routes 110 and 113 west and east of the rotary would be realigned to provide a four-leg and a “T” intersection, respectively.

The interchange ramps would be realigned as a partial cloverleaf, with the loops located in the northeast and northwest quadrants. The first loop would provide the movement from westbound Route 110/113 to the southbound on-ramp in the northwest quadrant, and the second from the northbound off-ramp to westbound Route 110/113 in the northeast quadrants. These two loop ramps would cross Route 110/113 adjacent to, and at a similar elevation to the I-93 mainline.

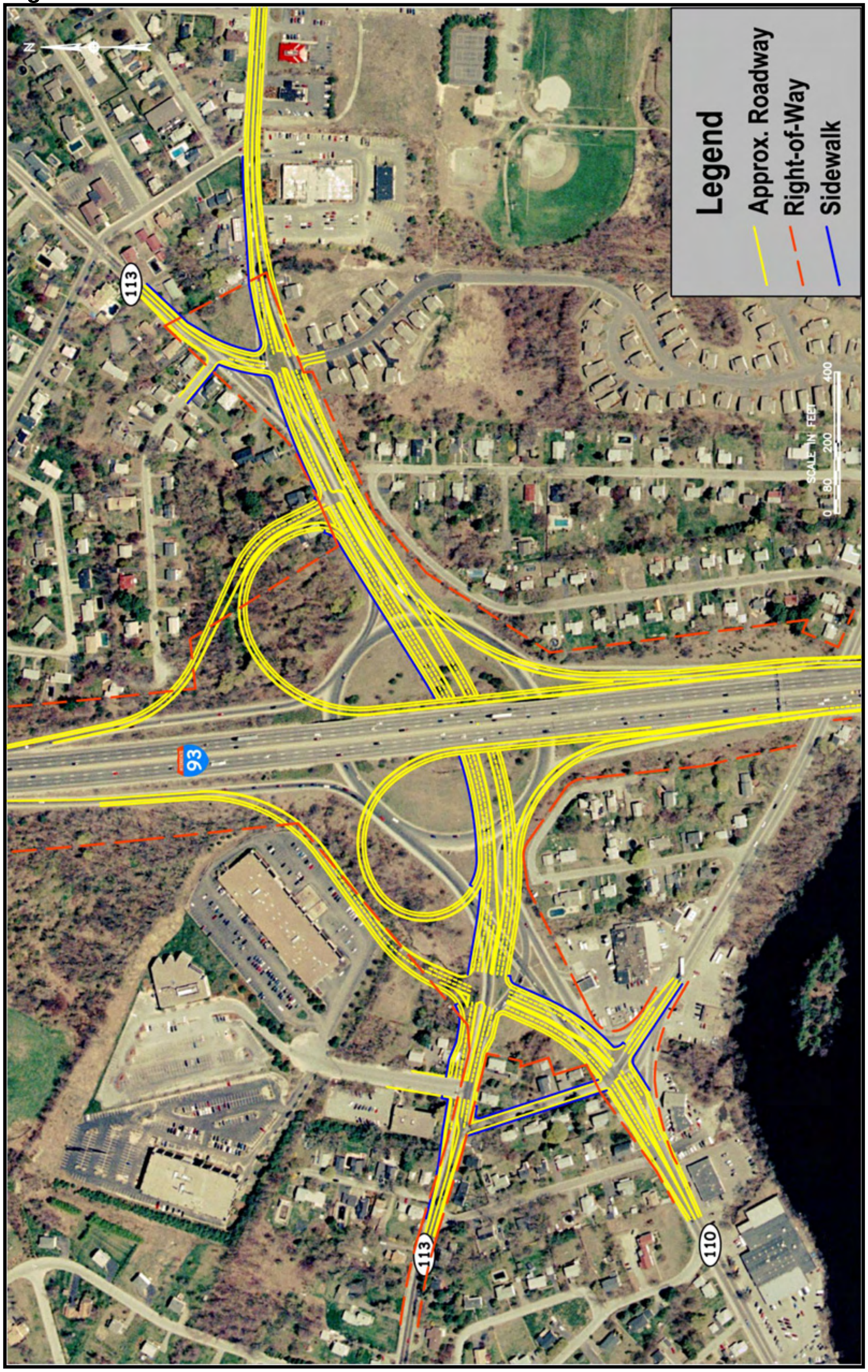
The ramp movements to and from the south would provide for separate entrance and exit points for Route 110/113 traffic, respectively. For the northbound off-ramp, this would involve splitting the eastbound and westbound traffic after exiting the mainline. The eastbound traffic would descend along a curvilinear alignment before intersecting Route 110/113 via a right-turn only movement. The westbound traffic would stay elevated at the highway level crossing over Route 110/113 before beginning to descend as it loops to the northeast. It would continue to descend until it intersects Route 110/113 via a right-turn only movement.

Similarly, the southbound on-ramp would have two separate entrance points for eastbound and westbound Route 110/113 traffic. Westbound traffic would enter the southbound on-ramp to the north, where it would begin climbing as it loops around before running parallel to I-93. At this point, it would cross over Route 110/113 and merge with the mainline I-93. The eastbound Route 110/113 traffic enters the southbound on-ramp to the south, where it would travel along a climbing curvilinear alignment before merging with mainline I-93.

Alternative 3A Key Components:

- Partial cloverleaf configuration
- Rotary would be eliminated
- Western portion of Route 113 and eastern portion of Route 110 would be realigned as the continuous through movement
- The intersections of Routes 110 and 113 west and east of the interchange would be reconfigured as a four-leg and “T” intersection, respectively
- Eastbound Route 110/113 to southbound on-ramp and northbound off-ramp to eastbound Route 110/113 ramps would follow an alignment generally consistent with the existing ramp alignments
- Westbound Route 110/113 to southbound on-ramp and northbound off-ramp to westbound Route 110/113 ramps would have loop configurations in the northwest and

Figure 3-7: Alternative 3A Partial Cloverleaf



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northeast quadrants, respectively, and would cross Route 110/113 on a structure at approximately the elevation of I-93

Pros:

- Realignment of Routes 110 and 113 would allow for continuous through movement to better accommodate projected growth in traffic along Route 113 in Dracut
- All movements to and from the south would have unrestricted right-turn movements
- Southbound off-ramp traffic would intersect Routes 110 and 113 at a four-leg intersection
- Would require only one bridge
- No major weaving conflicts would be anticipated
- Lowest anticipated construction cost

Cons:

- The new I-93 bridge along with demolition of the two existing bridges could create significant traffic management issues during construction
- Ramps in northwest and northeast quadrants would potentially impact emergent and scrub wetlands and could require the relocation of an open watercourse

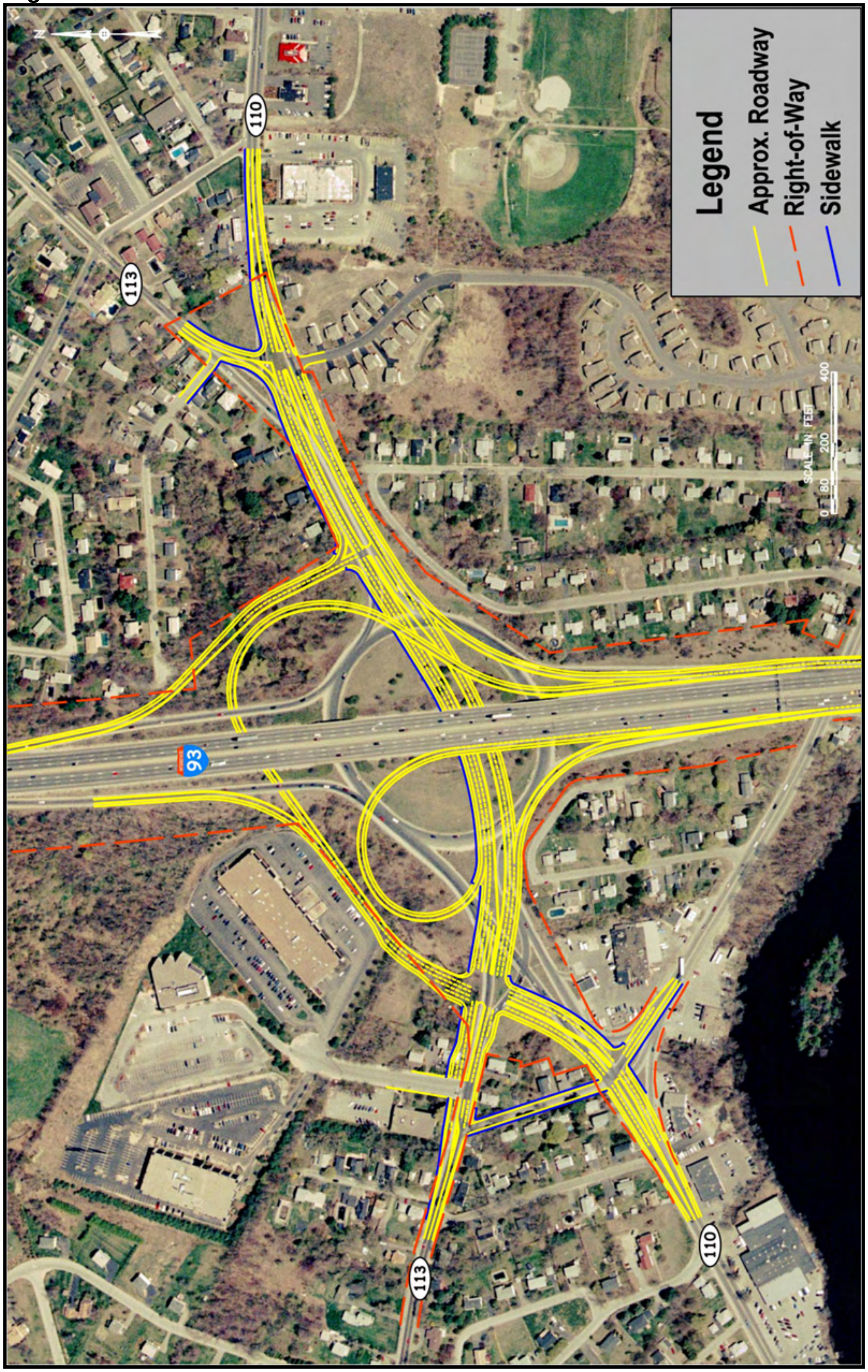
3.2.3 Alternative 3B – Partial Cloverleaf

Alternative 3B is a variation of the partial cloverleaf configuration as described in Section 3.2.3. Alternative 3B maintains many of the same movements as Alternative 3A and is shown in Figure 3-8. The primary difference between these two alternatives would be the realignment of the loop ramp in the northeast quadrant. The northbound off-ramp would be realigned to separate from the mainline I-93, south of its crossing of Route 110/113. It would cross Route 110/113 on a separate structure east of I-93 before descending and looping to the northwest and under I-93, similar to Alternative 2A. Once under I-93, the ramp would merge with the southbound off-ramp before entering the signalized intersection of Routes 110 and 113 west of I-93.

Alternative 3B Key Components:

- Partial cloverleaf configuration
- Rotary would be eliminated
- Western portion of Route 113 and eastern portion of Route 110 would be realigned as the continuous through movement
- The intersections of Routes 110 and 113 west and east of the interchange would be reconfigured as a four-leg and "T" intersection, respectively
- Eastbound Route 110/113 to southbound on-ramp and northbound off-ramp to eastbound Route 110/113 ramps would follow an alignment generally consistent with the existing ramp alignments
- Westbound Route 110/113 to southbound on-ramp would have a loop configuration in the northwest quadrant and cross Route 110/113 on a structure at the highway level
- The northbound off-ramp to westbound Routes 110 and 113 would cross over Route 110/113 then loops under I-93
- Northbound on-ramp would be shifted west from Alternative 3A

Figure 3-8: Alternative 3B Partial Cloverleaf



Pros:

- Realignment of Routes 110 and 113 would allow for continuous through movement to better accommodate projected growth in traffic along Route 113 in Dracut
- All movements to and from the south except the northbound off-ramp to westbound Route 110 would have free right-turn movements
- Southbound off-ramp to eastbound Route 110/113 and northbound off-ramp to westbound Route 110/113 traffic would intersect Routes 110 and 113 at a four-leg signalized intersection
- Would reduce potential property and wetland impacts in the northeast quadrant from Alternative 3A
- The bridge for the northbound off-ramp to westbound Routes 110 and 113 at I-93 would be reduced in length from Alternative 2A, thereby reducing the anticipated construction cost

Cons:

- Would require the construction of three bridges including two under the I-93 mainline.
- New I-93 bridges along with demolition of the two existing bridges could create significant traffic management issues during construction.
- Given the 4% to 5% downgrade, significant horizontal curve, and relatively high truck traffic on the northbound off-ramp, particular attention would need to be paid during design development to ensure that the ramp meets appropriate design standards while still meeting the goal of reducing impacts.
- Ramps in northwest and northeast quadrants would potentially impact emergent and scrub wetlands and may require relocation of an open watercourse.
- Elevated northbound off-ramp in southeast quadrant could create additional visual impacts on Noyes Street.
- Potential weaving concern for the combined southbound and northbound off-ramp west of I-93, from the merge point to its intersection with Route 110 and Route 113.

3.3 Short-Term Improvements

3.3.0 Introduction

The four long-term alternatives described in the prior section would significantly impact the existing infrastructure, requiring a considerable amount of time (5 to 10 years) to advance through the environmental, design, right-of-way, and to the beginning of construction. Recognizing there are already substantial congestion issues at this interchange that are projected to worsen over time, several improvements that could be completed in a relatively shorter time frame (within 5 years) were developed. Although not as comprehensive in addressing the identified issues as the long-term alternatives, short-term improvements were developed to provide some relief in the study area until a long-term solution could be implemented.

In consultation with MassHighway and the SAC, these improvements were grouped into three packages to facilitate their advancement through the project development process. The first package includes minor improvements that could be implemented more quickly using MassHighway personnel and annual maintenance funding. The next package includes improvements that could be implemented relatively quickly, but would require slightly more time to accommodate an increased level of design. The third package of improvements consists of several more significant improvements. While still short-term in time frame, the nature of these improvements would require more time for design and construction. Also, given the anticipated construction cost of this final package, it would need to be programmed in the Merrimack Valley Planning Metropolitan Planning Organization's Transportation Improvement Program.

It should be noted that numerous residents expressed concerns regarding excessive vehicle speeds particularly on Route 113 West. While the speed analysis discussed in Section 2.1.4 of Chapter 2 showed that 85% of eastbound vehicles are traveling 35mph or less, there was consensus among residents about this issue. The most effective method of curtailing excessive speeds along this stretch of roadway is with police enforcement.

The following section provides various types of operational analyses of the short-term packages to the extent possible.

3.3.1 Short-Term Improvement Package 1

Short-term Improvement Package 1 generally consists of a series of improvements that could be implemented more quickly than Packages 2 and 3. They would not require significant time for design and construction and could be accomplished using MassHighway District 4 personnel and existing maintenance contracts. Each of these improvements was developed in direct response to existing shortcomings identified in Chapter 2.

- ***Clear growth in the northwest quadrant to improve sight lines for vehicles exiting the rotary.*** Vegetation is in close proximity to the roadway in the northwest quadrant of the rotary and extending along Route 113 westerly to the first residence on the north side of the road. This vegetation creates unsatisfactory sight lines for vehicles exiting the rotary. To improve sight distance for vehicles exiting the rotary and traveling west on Route 113, this vegetation would be cut back from the roadway.

- ***Install warning signs for westbound vehicles exiting the rotary to watch for stopped traffic ahead.*** Vehicles exiting the rotary and traveling west on Route 113 are confronted with a relatively sharp horizontal curve that limits sight distance. This situation is frequently exacerbated by stopped traffic at the intersection of Route 113 / Branch Street, as well as the presence of a school bus stop in the vicinity. To warn drivers of this potential condition, warning signs would be installed on the westbound rotary exit.

- ***Install "No Engine Brakes" signs along Route 113 west of rotary.*** The issue of truck noise was identified as a significant concern among residents in both the SAC meetings as well as the general public meetings. A number of comments were received regarding the particular problem of noise generated by trucks traveling along Route 113 to and from industrial land uses in Dracut. Given the existing truck volumes percentages, the projected increase in traffic volumes along this portion of Route 113, and the expected industrial development in Dracut, this area was identified as a possible location for the installation of signs limiting the use of engine brakes.

  While there obviously are benefits to limiting the use of engine breaks along residential streets, particularly overnight, there are a number of issues that would need to be looked at more closely. These include the effectiveness of police enforcement, MassHighway's policy regarding the installation of these signs, and most importantly, whether or not it is proper to take steps to reduce the use of trucks' engine brakes. It should also be noted that a comment was received at the second public meeting requesting that similar signs also be included along the northbound off-ramp.

- ***Install flashing yellow warning beacon at bottom of southbound off-ramp.*** Through field observations as well as through discussions with the SAC, it became evident that the merge of the southbound off-ramp with the rotary presented safety concerns. Given the horizontal and vertical geometry of the ramp as well as the prevailing highway speeds, vehicles generally proceed down the ramp at a high rate of speed. These vehicles are then forced to decelerate quickly as they are confronted with the rotary merge. Exacerbating this condition is that the existing configuration of the rotary encourages vehicles traveling from the southbound off-ramp to the west to perceive that they have a free flow movement. To alert drivers to the need to reduce speed and yield to rotary traffic, a flashing yellow beacon coupled with oversized yield signs would be installed at the bottom of the off-ramp.

- **Investigate the possibility of additional lighting at the rotary, and on Route 110 and 113 in the immediate vicinity.** The crash data analysis showed that a high percentage of crashes occurred during dark ambient light conditions. This indicates that there may be a lighting deficiency. Additional lighting at night could aid drivers in negotiating movements in and around the rotary by increasing visibility and sight distances.

3.3.2 Short-Term Improvement Package 2

At the beginning of this study, the lane assignments within the rotary were generally unguided with little to no striping. However, the existing width provided sufficient room to support the operation of two lanes. Based on field observations and input from the SAC, this contributed to driver confusion regarding lane assignments and created difficulties with maintaining two lanes.

Striping was applied in 2006 to help define lane assignments. This striping maintained two lanes throughout the rotary (See Figure 3-9). While the intent was to designate the inside (left) lane as the primary through lane with the outside (right) lane handling entering and exiting traffic, field observations showed that the right lane was often used as a through lane which led to weaving difficulties for vehicles from the left lane attempting to exit the rotary.

Figure 3-9: Rotary Striping (2006)

In 2007, MassHighway reapplied the striping in a modified configuration. This striping provided two lanes in the east and west movements but tapered to only one lane in the north and south movements. This approach to the rotary striping is similar to what was developed as part of the Short-Term Improvement Package 2, but with some modifications.

To help channelize traffic flow and facilitate merging and weaving maneuvers through the rotary, Short-Term Improvement Package 2 (Figure 3-10) was developed and would include the reapplication of striping and pavement markings through the rotary and on the approaches.

The restriping would maintain two lanes in the east and west directions within the rotary. The outside (right) lane would be dedicated to the east/west through traffic while the inside (left) lane would be to carry traffic continuing around the rotary. This would restrict the north and south movements to one lane, which would help drivers select the proper lanes as they continue around the rotary.

Figure 3-10: Short-Term Improvement Package 2

Additionally, each entrance and exit point would be striped as two lanes. The outside (right) lane would be striped as a dedicated right-turn only lane, essentially acting as a rotary bypass lane, while the inner lane would be used by vehicles entering the rotary. Pavement markings indicating lane assignments would also be added for all approach lanes to the rotary.

The second key component of Short-Term Improvement Package 2 would be the installation of advance signage at all approaches to the rotary. Intended to optimize efficiency and improve safety, advance signage would aid drivers in the selection of the appropriate lanes approaching the rotary and provide guidance to the proper traffic patterns while traveling in the rotary. This advance signage is critical to the successful implementation of the striping described previously.

3.3.3 Short -Term Improvement Package 3

The third short-term improvement package consists of three improvements that would likely take a longer period to implement than the previous two packages. This longer period would be necessary to accommodate an increased level of design, more substantial construction, and a higher anticipated construction cost. This higher construction cost would also more than likely require that the improvements be programmed in the Merrimack Valley Metropolitan Planning Organization's Transportation Improvement Program to access the necessary funding. Short-Term Improvement Package 3 consists of the following three components:

- Addition of rotary bypass lanes on three of the four approaches to the rotary
- Realignment of the westbound exit from the rotary
- Intersection improvements including the installation of two new signals and modifications to an existing signal

These improvements are depicted in Figure 3-11, and more detailed descriptions of these components are discussed below.

Rotary Bypass Lanes

In reviewing the existing traffic conditions during the peak hours, queuing at the approaches to the rotary was identified as a deficiency. To help alleviate this problem, a short-term alternative was developed that would provide bypass lanes in the northwest, southwest, and southeast quadrants. The intent would be to allow vehicles to bypass entering the rotary traffic flow, thereby freeing capacity on the approaches and in the rotary, while reducing the traffic volumes entering the rotary.

In the northwest quadrant this would provide a direct bypass lane from the southbound off-ramp to westbound Route 113. In the southwest quadrant, a bypass lane would be added from eastbound Route 110 to the southbound on-ramp. In the southeast quadrant, this would add a bypass lane from the northbound off-ramp to eastbound Route 110.

In all cases, the bypass lanes would separate from the existing lane prior to the rotary, run parallel to the primary lanes with a physical separation, and merge back into the existing lanes once safely past the rotary. However, the bypass lane from the northbound off-ramp would be extended past the Route 110 and Route 113 split to provide access to Route 110 eastbound only. This would prevent an unsafe weaving maneuver between vehicles exiting the rotary eastbound, and northbound off-ramp traffic destined for Route 113 eastbound. Construction would involve box widening of the pavement structure, earthwork, and possible drainage modifications.

It should be noted that a rotary bypass lane in the northeast quadrant was developed for Short-Term Improvement Package 2 because the striping was contained within the existing pavement width. Under Short-Term Package 3, a bypass lane in the northeast quadrant was not included. The primary reason was that it would require widening of the existing pavement width, and the demand and operational benefits were not sufficient to justify the costs and impacts of physical widening.

Realigned Westbound Exit from Rotary

Based on input from the SAC and verified by field observations, the existing westbound exit from the rotary operates in an undesirable condition. In particular, there is a short weaving distance between this exit point and the southbound off-ramp entrance to the rotary. This is compounded by an undesirable geometric alignment of the exit from the rotary, which is along a tangent. While this is often preferred because it provides a clear path of travel for exiting vehicles and allows them to accelerate out of the rotary, in this case it presents a problem given the proximity of the southbound off-ramp. This tangent alignment creates a "sling shot" effect for vehicles traveling down the I-93 southbound off-ramp to Routes 110 and 113 westbound. Instead of slowing and yielding to enter the rotary, many vehicles were observed accelerating into the rotary to continue westbound. Additionally, the higher than preferred exiting speeds creates additional difficulties for drivers traveling to westbound Route 113 as they are confronted with a horizontal curve with limited sight distance. This is particularly problematic given the possibility of stopped traffic from the nearby signals and the school bus stop at this location.

A possible short-term improvement would be to realign the exit from the rotary closer to a 90 degree angle. This realignment would accomplish three main goals:

- Provide additional weaving distance between the southbound off-ramp and the westbound rotary exit
- Force vehicles to slow as they exit the rotary, potentially increasing the safety of the weaving movement
- Reduce the horizontal curve along the westbound Route 113 alignment to improve sight distance

Intersection Improvements

Based on the identified deficiencies in the existing conditions evaluation, the following intersection improvements were developed for the study area intended to provide relief in the short-term until a long-term alternative could be implemented:

- Signalization at the intersections of Route 113 with Branch Street and Route 110 with Riverside Drive
- Signal coordination of the three (3) signalized intersections west of the interchange
    - Route 110/113 (west of the interchange)
    - Route 113 at Branch Street
    - Route 110 at Riverside Drive
- Optimal timings at the Route 110/113 intersection east of the interchange.

Figure 3-11: Short-Term Improvement Package 3

Guidelines for a signal warrant in accordance with the Federal Highway Administration's (FHWA) Manual on Uniform Traffic Control Devices (MUTCD), 2003 Edition was reviewed. Using available peak hour traffic volumes, an assessment of Warrant 3 Peak Hour Vehicular Volume was conducted at unsignalized intersections in the study area. Based on the results, peak hour volumes do exceed the minimum vehicular volume warrants for Warrant 3 Peak Hour Vehicular Volume at the intersections of Route 113 Branch Street and Route 110 with Riverside Drive. Please note, to confirm that signalization is warranted based on MUTCD guidelines, it is recommended that a full signal warrant analysis be conducted. However, for purposes of this planning study, it is assumed that conditions for signalization at the intersections of Route 113 with Branch Street and Route 110 with Riverside Drive are met based on the results of Signal Warrant 3 Peak Hour Volumes.

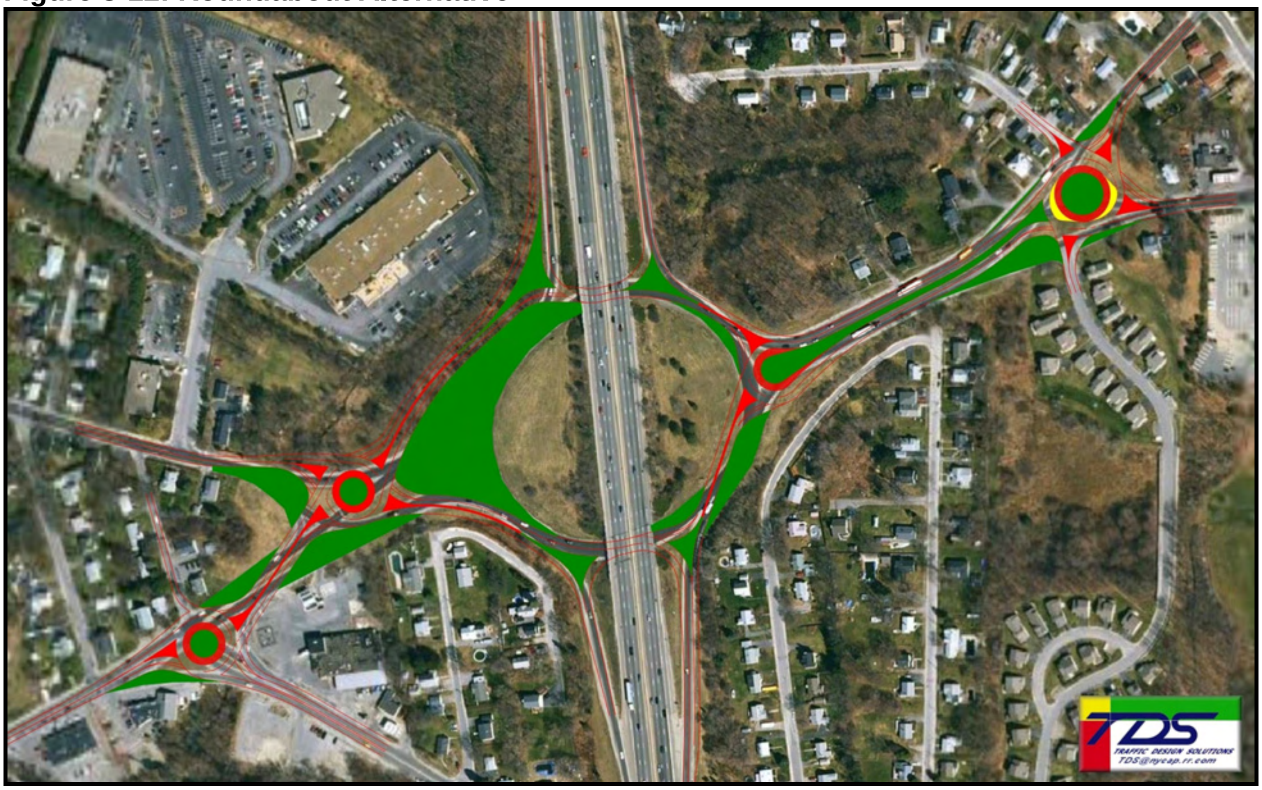
In summary, Short-Term Improvement Package 3 would combine the rotary bypass lanes, the realignment of the westbound exit, and the intersection improvements into a single packaged alternative. However, this alternative could also be implemented to varying degrees since the construction of any one bypass lane, the realignment of the westbound exit, and the traffic signal improvements would not be dependent on each other.

3.3.4 Roundabouts

An alternative to the reconstruction of the I-93 interchange was submitted to the study team at one of the public informational meetings by a private citizen (Figure 3-12). This alternative would construct four roundabouts at the following intersections:

1. Route 110 at Riverside Drive
2. Route 110 at Route 113 west of the rotary
3. Route 110/113 at Rotary
4. Route 110 at Route 113 east of the rotary

Figure 3-12: Roundabout Alternative



The existing rotary would be modified to have a roundabout at each end, one at location 2 above and the other at location 3. Traffic flow at the existing rotary would be reversed with the Route 110/113 eastbound traffic flowing on the northern end of the rotary and the westbound traffic flowing on the southern end. Traffic would be one-way under the existing I-93 bridges: one-way eastbound at the northerly bridge and one-way westbound at the southerly bridge. The remaining portion of the existing rotary would be two-way, with the exception of the I-93 on and off-ramps.

A key feature is that under the existing I-93 bridges, where the traffic is one-way, there would be a weaving section to allow traffic from the rotary to access the I-93 on-ramps as well as for the traffic from the I-93 off-ramps to access Route 110/113.

3.4 Transit, Park & Ride, and Intelligent Transportation Systems (ITS) Options

This section presents conceptual transit, park & ride, and (ITS) options that were developed for the study. As noted in Section 3.2, these options were developed based on a review of existing and future planned conditions in the study area, discussions within the study team, and feedback received from the SAC and the public.

The following is a summary of the options that were identified to benefit the study area:

1. Expand Park & Ride capacity in the vicinity of the rotary interchange
2. Add signage along Routes 110 and 113 to promote alternative transportation options
3. Extend MVRTA Route 35 and LRTA Route 1 to meet and create a timed transfer
4. Create a new Lawrence-to-Lowell bus route along Route 113
5. Add Dynamic Message Signs (DMS) on I-93 promoting the existing Park & Ride at Pelham Street

These options are shown in Figure 3-13 below and are described in the following sections.

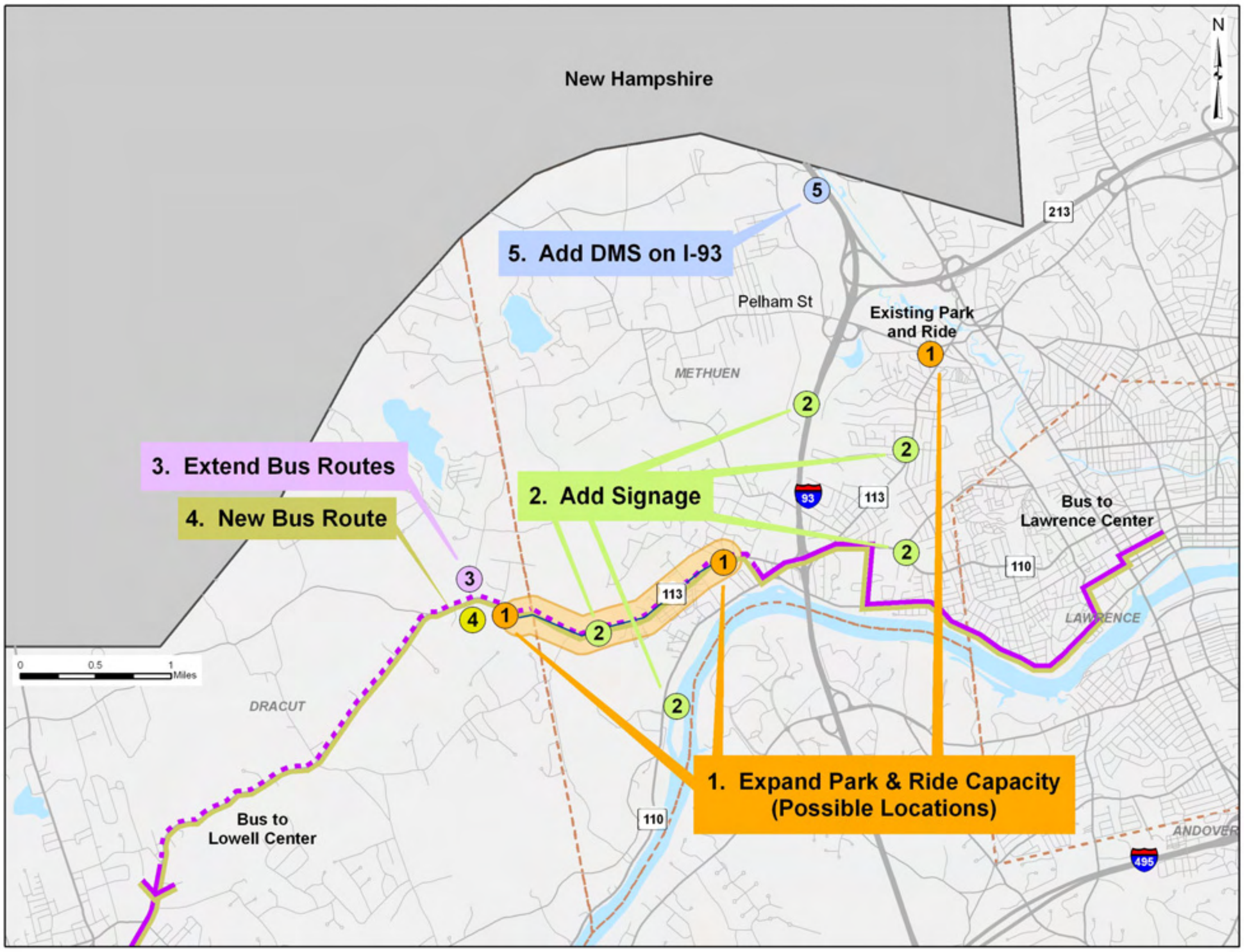
3.4.0 Option 1: Expand Park & Ride capacity in the vicinity of the rotary interchange

In this option, park & ride capacity would be expanded within or near the study area. This would provide additional opportunities for commuters to either park and join carpools or vanpools, or park and ride commuter buses to Boston or local buses to Lawrence and Lowell. There are several potential locations in the vicinity of the rotary interchange where additional Park & Ride spaces could be constructed:

- At the existing Pelham St. Park & Ride facility north of the rotary interchange
- At a new location west of the rotary along Route 113 in Methuen
- At a new location west of the rotary along Route 113 in Dracut

An expansion of the Pelham Street facility near Exit 47 would primarily benefit commuters from the north, including northern portions of Methuen as well as New Hampshire. This location serves commuters who wish to carpool, vanpool, or ride the MVRTA Boston Commuter Bus. The latter two locations would benefit commuters from the west; a facility in Methuen could benefit both Methuen residents and Dracut residents, while one located in Dracut would primarily benefit Dracut residents. These new locations could accommodate carpools and vanpools, and could also be served by MVRTA and LRTA buses to the Lawrence and Lowell commuter rail stations.

Figure 3-13: Conceptual Transit/Park & Ride/ITS Options



A new park & ride facility could include any or all of the following elements:

- Daily parking area
- Passenger pick-up and drop-off area
- Bus stop for MVRTA and/or LRTA services
- Covered passenger waiting area
- Public telephone
- Newspaper vending machines
- Lighting
- Fencing

An expansion of the existing Pelham St. Park & Ride facility would likely involve less infrastructure construction – primarily additional surface parking spaces, lighting, and fencing.

The size of the proposed Park & Ride capacity expansion would need to be determined in a later planning stage by estimating commuter demand. As a point of reference, park & ride facilities serving primarily carpools and vanpools with only local bus service (which would be the case for a location west of the rotary) typically consist of under 100 spaces. Facilities such as the Pelham Street lot, which serve carpools and vanpools and have longer-distance express bus service, may have larger capacities.

At the November 2007 Public Informational Meeting, several comments were received that favored either expanding the existing Pelham St. facility or constructing a new facility in Dracut, rather than constructing a new facility in Methuen. As a result, the study team revised this option to more generally recommend an expansion of Park & Ride capacity. The specific location of the additional capacity, the number of spaces to be added, and the specific benefits and costs of such an expansion would be evaluated in a later planning stage. Chapter 4 of this report presents an evaluation of the conceptual benefits and costs these options.

3.4.1 Option 2: Add static signage to promote alternative transportation options

Option 2 would involve the addition of static signage to Route 110, Route 113, and Interstate 93 in the vicinity of the rotary interchange that would promote alternative transportation options. These signs would inform drivers of the existing Park & Ride facility at Pelham Street and local and express bus options, and would include phone numbers for transit and ridesharing information. If a new Park & Ride facility were to be established in the vicinity of the rotary interchange as proposed in Option 1, static signage could be added to the nearby roadways to direct drivers to the new facility.

3.4.2 Option 3: Extend MVRTA Route 35 and LRTA Route 1 to meet and create a timed transfer

This option would involve extending two existing transit routes: MVRTA Route 35 would be extended to the west along Route 113 to the Methuen/Dracut town line. LRTA Route 1 would be extended to the east along Route 113 to the Methuen Dracut town line. A new timed transfer point could be created between the two routes near the Methuen/Dracut town line. The goal of these route extensions would be to provide new transportation options to the rapidly growing portions of Dracut and Methuen along Route 113 (which were identified and documented in Chapter 2).

Service on these routes would allow residents to access the Lowell and the Lawrence commuter rail stations, as well as commercial areas and businesses located along and at the destination end of the routes. The advantage of this option operationally is that it would build on existing routes which are operated by the two respective transit authorities (MVRTA and LRTA) without requiring significant coordination. The disadvantage is that riders who wished to travel across town lines (for instance, Methuen residents wishing to travel to the Lowell commuter rail station) would have to make a transfer. A timed transfer between the routes would make this more desirable to potential riders.

At the November 2007 Public Informational Meeting, a comment was raised about noise and emissions associated with transit buses traveling in the study area. In response to this issue, the study team suggests that the local transit agencies (LRTA and MVRTA) may wish to consider the feasibility of using smaller, neighborhood-size buses fueled by low-emissions diesel or Compressed Natural Gas (CNG) on these routes. The feasibility of using such vehicles will likely depend on the cost-effectiveness of operations, the compatibility of these vehicles with the rest of the agency's fleet, and the agency's vehicle storage and maintenance infrastructure.

3.4.3 Option 4: Create a new Lawrence-to-Lowell bus route along Route 113

As an alternative to Option 3, a new Lawrence-to-Lowell bus route could be created that would travel along Route 113 connecting residents of Methuen and Dracut with the Lowell and Lawrence Commuter Rail stations as well as commercial areas. This would serve essentially the same purpose as the route extensions in Option 3, but would allow through-travel by travelers across the town lines. The disadvantage of this option is that it would require greater coordination between the two transit authorities to create the new through-route. However, a precedent for such a route already is in place with the existing MVRTA Lawrence-to-Lowell Route 41.

The same comment and study team suggestion regarding vehicle size and type mentioned in Section 3.4.2 applies to this option as well.

3.4.4 Option 5: Add Dynamic Message Signs (DMS) on I-93 promoting the existing Park & Ride at Pelham Street

This option would involve installing highway DMS on Interstate 93 north of the Pelham Street exit, promoting the availability of Park & Ride parking as well as the MVRTA commuter bus service to downtown Boston from this location. The DMS could simply mention the facility, could display the next schedule bus departure time, or could show whether parking is available. The ability to provide real-time parking availability information would require either an electronic system to monitor availability (which is usually tied to an electronic parking payment system) or periodic monitoring by transportation agency personnel.

3.4.5 Benefit of Transit/Park & Ride/ITS options to Dracut residents and employees

The Transit, Park & Ride and ITS options described in Sections 3.4.1 through 3.4.5 would improve mobility and provide additional transportation options to residents and employees in the vicinity of the Route 110/Route 113 rotary interchange. All of the above options would benefit local residents and employees in Methuen and Dracut, some more directly than others. Options 1, 2, 3 and 4 would most directly benefit residents of Methuen and Dracut by providing additional Park & Ride and transit options, and promoting options that already exist in the area. These options could help address the growing travel demand from rapidly developing residential and commercial areas in eastern Dracut along Route 113.

Option 5 would still benefit Methuen and Dracut because promoting the existing Park & Ride at Pelham Street could help divert some drivers from the I-93 mainline, which would incrementally help the Exit 46 interchange. Similarly, in Option 1 if the Park & Ride expansion were to take place at Pelham Street, this could still benefit Methuen and Dracut residents by providing an additional transportation option nearby, and by diverting some drivers from the I-93 mainline and incrementally helping the Exit 46 interchange.

Chapter 4: Alternatives Analysis

4.0 Introduction and Alternatives Analysis Process

Detailed analysis and evaluation of the alternatives was a critical step in the development of comprehensive and workable solutions to the problems identified in Chapter 2. As discussed in Chapter 3: Alternatives Development, a wide variety of alternatives were developed that included both long and short-term solutions. The alternatives were initially developed to address existing deficiencies, by improving traffic flow and safety, and also with the intent of minimizing property and environmental impacts. Working closely with the Study Advisory Committee (SAC), this list of alternatives was narrowed to four long-term alternatives and a number of short-term improvements.

During the next part of the study process, each of the build alternatives was analyzed in more detail using the evaluation criteria described in Chapter 1 of this report. This includes potential improvements in traffic operations and safety, the potential effects on the natural, socio-economic and cultural environments, and estimated construction costs. The intent of this step is to compare the expected benefits and impacts of each of the alternatives.

The results of this analysis were compiled in an evaluation matrix and presented to the SAC. Working with the SAC, the long-term alternatives were narrowed to two and the short-term improvements were consolidated to three packages. The two long-term alternatives recommended by the SAC and MassHighway personnel and selected by the Study Team are Alternative 2B and Alternative 3A. The following presents a detailed description of the results of the alternatives analysis for the short term alternatives, all four long-term alternatives, as well as transit, park and ride and Intelligent Transportation Systems (ITS) options.

4.1 Mobility Analysis – Traffic Operations

4.1.0 Interstate/Interchange Mobility

An analysis was conducted for each alternative of the Route 110/113 interchange ramps at I-93. The analyses were conducted in accordance with the procedures contained in the Highway Capacity Manual 2000 (Transportation Research Board). The Highway Capacity Software (version 5.2), which implements the HCM procedures, was used to perform the analyses.

The term Level of Service (LOS) is used to denote the operating conditions of the merge and diverge areas at ramp junctions with the mainline at an interchange. For ramp analyses, the LOS is defined in terms of density, which is measured as the number of passenger cars per mile per lane. The LOS at ramp junction areas is also divided into a range of six letter grades, ranging from A to F, with A being the best and F the worst. LOS F exists when the demand exceeds the capacity of upstream or downstream freeway sections, or when the demand exceeds the capacity of an off-ramp.

The results of the ramp analyses are show in Figure 4-1 and indicate the following for the long-term alternatives:

- The northbound off-ramp would continue to operate with similar conditions as the No-Build condition, LOS B during the AM peak hour and a LOS F during the PM peak hour for each alternative.
- The northbound on-ramp would continue to operate with similar conditions as the No-Build condition during the AM peak hour at LOS B for each alternative. Operations would decline slightly from a LOS B under the No-Build condition to a LOS C during the PM peak hour for alternatives 2A, 2B, and 3B, while it would continue to operate at LOS B under alternative 3A. This decline on the northbound on-ramp LOS for 2A, 2B, and 3B would be primarily due to minor changes in expected vehicle trip distribution assumed by the modeling software. It should be noted that LOS C is still considered an acceptable condition.
- The southbound off-ramp would improve from a LOS D under the No-Build condition to a LOS C during the AM peak hour for each alternative. During the PM peak hour, operations would continue to operate as the No-Build condition at LOS C for each alternative.
- The southbound on-ramp would significantly improve from the No-Build condition for each alternative. During the AM peak hour, the LOS for alternatives 2A and 2B would operate at LOS B and LOS C for alternatives 3A and 3B compared to a LOS F under the No-Build condition. During the PM peak hour, the LOS for alternatives 2A and 2B would operate at LOS A and LOS C for alternatives 3A and 3B compared to LOS D under the No-Build condition.

Table 4-1: Ramp Merge and Diverge LOS Summary Future No-Build and Alternatives

	No-Build		**Alternative 2A**		**Alternative 2B**		**Alternative 3A**		**Alternative 3B**	
	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour	AM Peak Hour	PM Peak Hour
Ramps										
NB off-ramp	B	F	B	F	B	F	B	F	B	F
NB on-ramp	B	B	B	C	B	C	B	B	B	C
SB off-ramp	D	C	C	C	C	C	C	C	C	C
SB on-ramp	F	D	B	A	B	A	C	C	C	C

NB: northbound
SB: southbound

4.1.1 Local Roads/Intersections Mobility

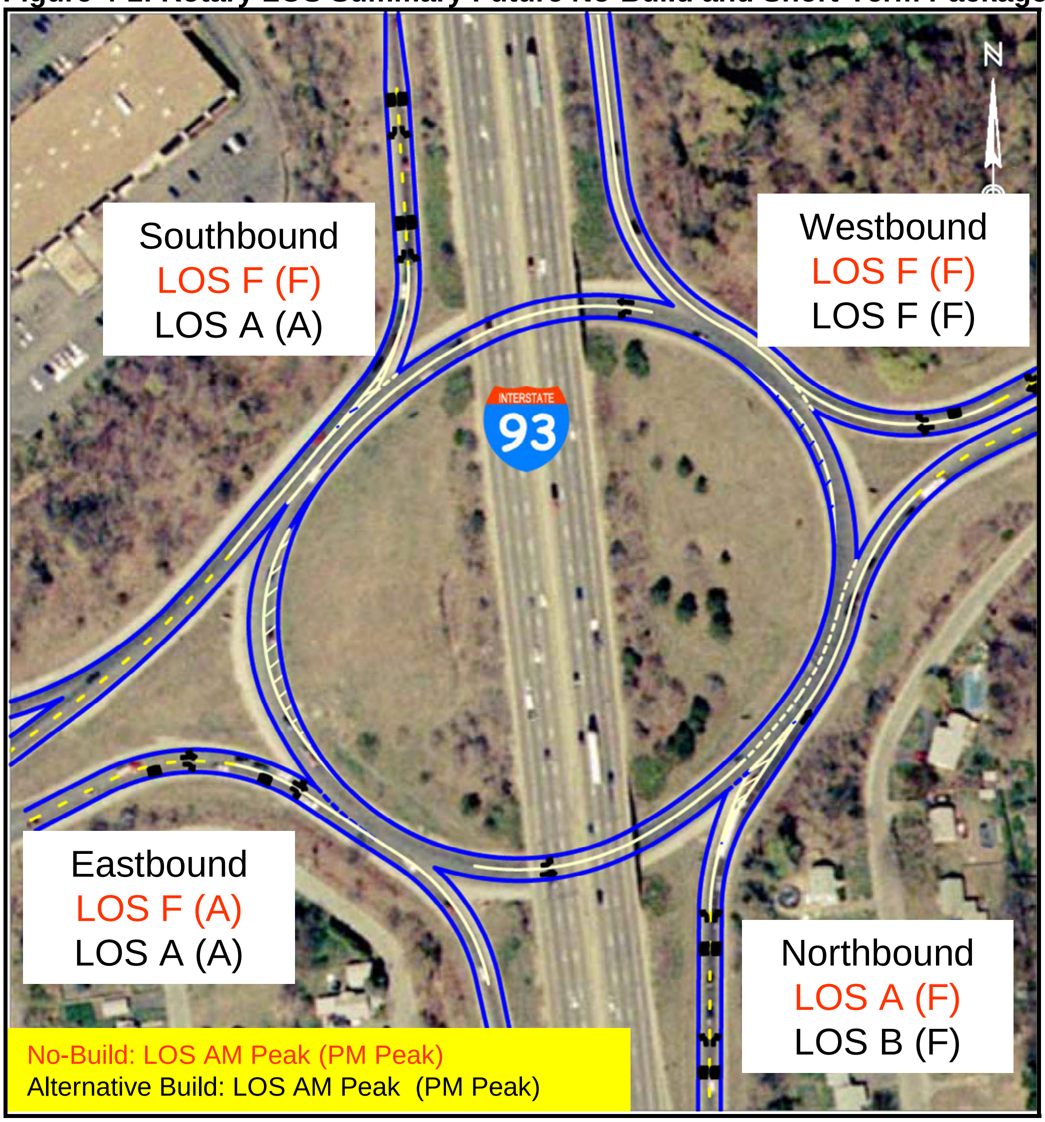
Short-Term Improvement Package 1 would not modify or change any roadway geometry or traffic signals, therefore no traffic operations analysis was conducted for this alternative.

An analysis was conducted to determine the future operations of the rotary under the **Short-Term Improvement Package 2** conditions. Results from the analysis, as shown in Table 4-2 and Figure 4-1 conclude:

- The northbound I-93 approach operations would decline during the AM peak from LOS A under the No-Build condition to LOS B.

- The southbound I-93 approach would significantly improve from LOS F under the Future No-Build condition during the AM and PM peak hours to LOS A during the AM and PM peak hours.
- The eastbound approach (Route 110/113) west of the rotary would significantly improve during the AM peak hour from LOS F under the Future No-Build condition to a LOS A. The LOS during the PM peak hour would continue to be LOS A as under the No-Build condition.
- The westbound approach (Route 110/113) east of the rotary would continue to operate with similar conditions as the No-Build condition, LOS F during the AM peak hour and PM peak hours.

Figure 4-1: Rotary LOS Summary Future No-Build and Short-Term Package 2



EOT Massachusetts Executive Office of Transportation

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Table 4-2: Intersection LOS Summary Future No-Build and Short-Term Package 2

		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Rotary									
Northbound (I-93)		7.0	A	> 80.0	F	17.0	B	> 80.0	F
Southbound (I-93)		> 80.0	F	> 80.0	F	10.0	A	5.0	A
Eastbound (Route 110/113 west of the rotary)		> 80.0	F	5.0	A	6.0	A	5.0	A
Westbound (Route 110/113 east of the rotary)		> 80.0	F	> 80.0	F	> 80.0	F	> 80.0	F

The **Short-Term Improvement Package 3** alternative would include the following traffic operational improvements:

- Signalization at the intersections of Route 113/Branch Street and Route 110/Riverside Drive
- Signal coordination of the three (3) signalized intersections west of the interchange
    - Route 110/113 (west of the interchange)
    - Route 113/Branch Street
    - Route 110/Riverside Drive
- Optimal timings at the Route 110/113 intersection east of the interchange.

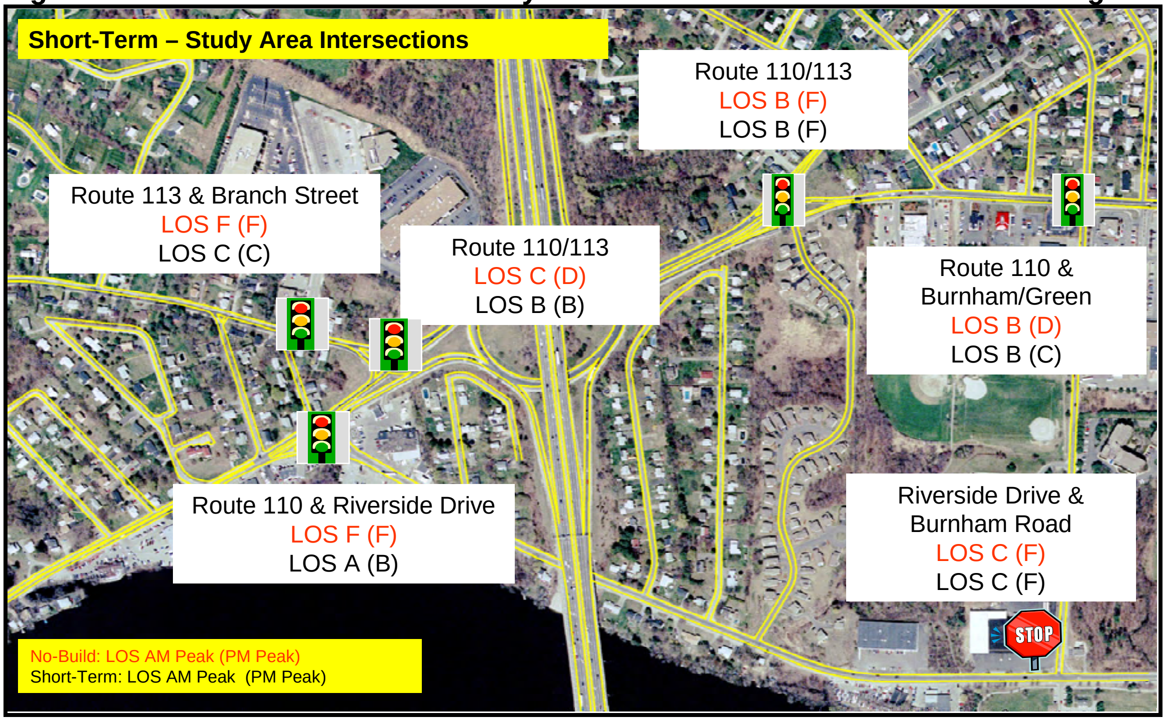
Results from the intersection LOS analysis under the Short-Term 3 are shown in Table 4-3 and Figure 4-2. Signalization of the Route 113/Branch Street and Route 110/Riverside Drive intersections would significantly improve traffic operations at study area intersections west of the interchange.

Table 4-3: Intersection LOS Summary Future No-Build and Short-Term Package 3

		No Build				Short-Term 3			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Signalized Intersections									
Route 110 / Route 113 (western split)		35.0	C	36.7	D	13.6	B	14.8	B
Route 113 / Branch Street		> 80.0	F	> 80.0	F	30.5	C	22.5	C
Route 110 / Riverside Drive		> 80.0	F	> 80.0	F	5.2	A	12.4	B
Route 110 / Route 113 (eastern split)		13.8	B	> 80.0	F	14.9	B	> 80.0	F
Route 110 / Burnham Road		15.3	B	43.7	D	15.8	B	34.5	C
Riverside Drive / Burnham Road		20.2	C	> 80.0	F	20.2	C	> 80.0	F

However, the Route 110/Route 113 intersection east of the interchange would continue to operate at an unacceptable LOS (F) in the PM peak hour. The Route 110/Burnham Road/Green Street intersection would increase from an LOS D to LOS C in the PM peak hour, while the Riverside Drive/Burnham Road intersection would remain relatively unchanged.

Figure 4-2: Intersection LOS Summary Future No-Build and Short-Term Package 3



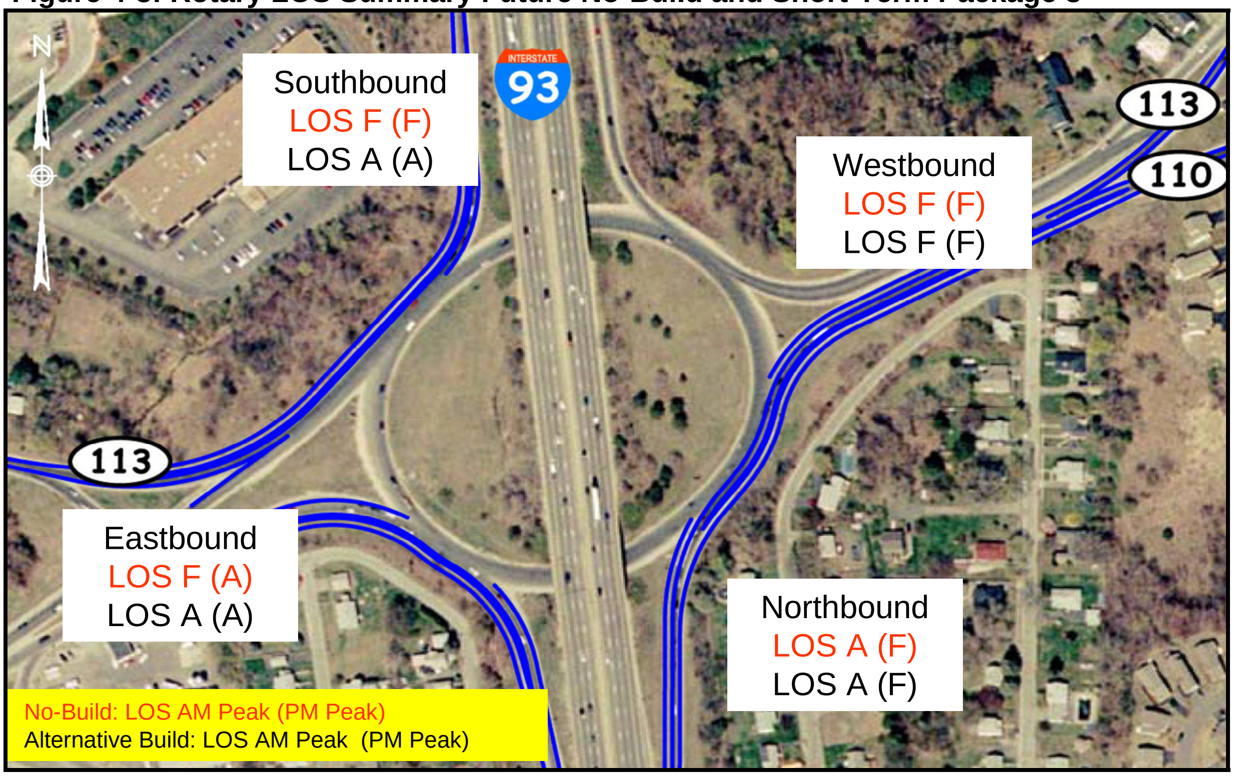
An analysis was also conducted to determine the future operations of the rotary under the Short-Term Improvement Package 3 conditions. Results from the analysis, as shown in Table 4-4 and Figure 4-3, conclude:

- The northbound I-93 approach would operate under similar conditions as the Future No-Build condition, with LOS A during the AM peak hour and a LOS F during the PM peak hour.
- The southbound I-93 approach would significantly improve from LOS F under the Future No-Build condition during the AM and PM peak hours, to LOS A during the AM and PM peak hours.
- The eastbound approach (Route 110/113) west of the rotary would significantly improve during the AM peak hour from LOS F under the No-Build condition to a LOS A. The LOS during the PM peak hour would continue to be LOS A as under the No-Build condition.
- The westbound approach (Route 110/113) east of the rotary would continue to operate under similar conditions as the No-Build condition, with LOS F during the AM peak hour and PM peak hours.

Table 4-4: Rotary LOS Summary Future No-Build and Short-Term Package 3

		No Build				Short-Term 3			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
Rotary									
Northbound (I-93)		7.0	A	> 80.0	F	17.0	B	> 80.0	F
Southbound (I-93)		> 80.0	F	> 80.0	F	10.0	A	5.0	A
Eastbound (Route 110/113 west of the rotary)		> 80.0	F	5.0	A	6.0	A	5.0	A
Westbound (Route 110/113 east of the rotary)		> 80.0	F	> 80.0	F	> 80.0	F	> 80.0	F

Figure 4-3: Rotary LOS Summary Future No-Build and Short-Term Package 3



4.1.2 Multiple Roundabouts Alternative Analysis

Traffic analysis was conducted for the 2025 No-Build for both the AM and PM peak hours. The traffic analysis was restricted to the roundabouts at locations 2 and 3, and to the two weaving sections under the existing I-93 bridges. The aaSIDRA software was used to analyze the roundabouts and the HCS+ software used to analyze the weaving sections.

Assumptions:
Roundabout
Roundabout center island diameter: 100 feet
Roundabout type: multi-lane roundabout
Speed at the roundabout: 35 mph

Weaving
Weaving length: 200 feet
Weaving section type: Type B
Speed: 35 mph

The analysis indicated the following:

- The proposed roundabout at Location 2 would operate at LOS E during the AM peak hour at the Route 113 approach
- The proposed roundabout at Location 2 would operate at LOS F during the PM peak hour at the Route 110/113 South approach
- The queuing due to the LOS F on the Route 110/113 South approach would impact the upstream weaving section and the two roundabouts. It would result in poor traffic operations similar to the 2025 No-Build conditions.
- The proposed roundabout at Location 3 would operate acceptably during both the AM and PM peak hours
- The proposed weaving section (north) would operate acceptably during both the AM and PM peak hours
- The proposed weaving section (south) would operate at LOS E during the AM peak hour
- The proposed weaving section (south) would operate at LOS F during the PM peak hour

Finally, given that the proposed alternative envisions a reversal of traffic flow at the rotary (clockwise), guidance signing would be crucial. Significant confusion would be expected by the motorists who have been used to traveling counter-clockwise around the rotary for several years, when the roadway re-opened after construction.

Because this alternative would do little to improve traffic flows or levels of service, it is no longer being considered for further study.

4.1.3 Long-Term Alternatives

Each of the long-term build alternatives would improve traffic operations at the study area intersections. Results from the LOS analysis indicate that all intersections will operate with an acceptable overall intersection LOS (LOS D or better) during AM and PM peak hours. The results from the LOS analysis are provided in Tables 4-5 through 4-8 and Figures 4-4 through 4-7.

Table 4-5: Intersection LOS Summary Future No-Build and Alternative 2A

	No Build (2025)				Alternative 2A (2025)			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
Intersections								
Route 110 / Route 113 (western split)	35.0	C	36.7	D	28.1	C	21.3	C
Route 113 / Branch Street*	> 80.0	F	> 80.0	F	4.2	A	21.4	C
Route 110 / Riverside Drive*	> 80.0	F	> 80.0	F	7.3	A	11.2	B
Under / East of Interchange	--	--	--	--	26.8	C	19.6	B
Route 110 / Route 113 (eastern split)	13.8	B	> 80.0	F	5.5	A	10.5	B
Route 110 / Burnham Road	15.3	B	43.7	D	15.4	B	16.1	B
Riverside Drive / Burnham Road	20.2	C	> 80.0	F	17.6	C	14.6	B

* Intersections are stop-controlled under the No-Build condition and become signalized under the long-term alternative.

Figure 4-4: Intersection LOS Summary Future No-Build and Alternative 2A

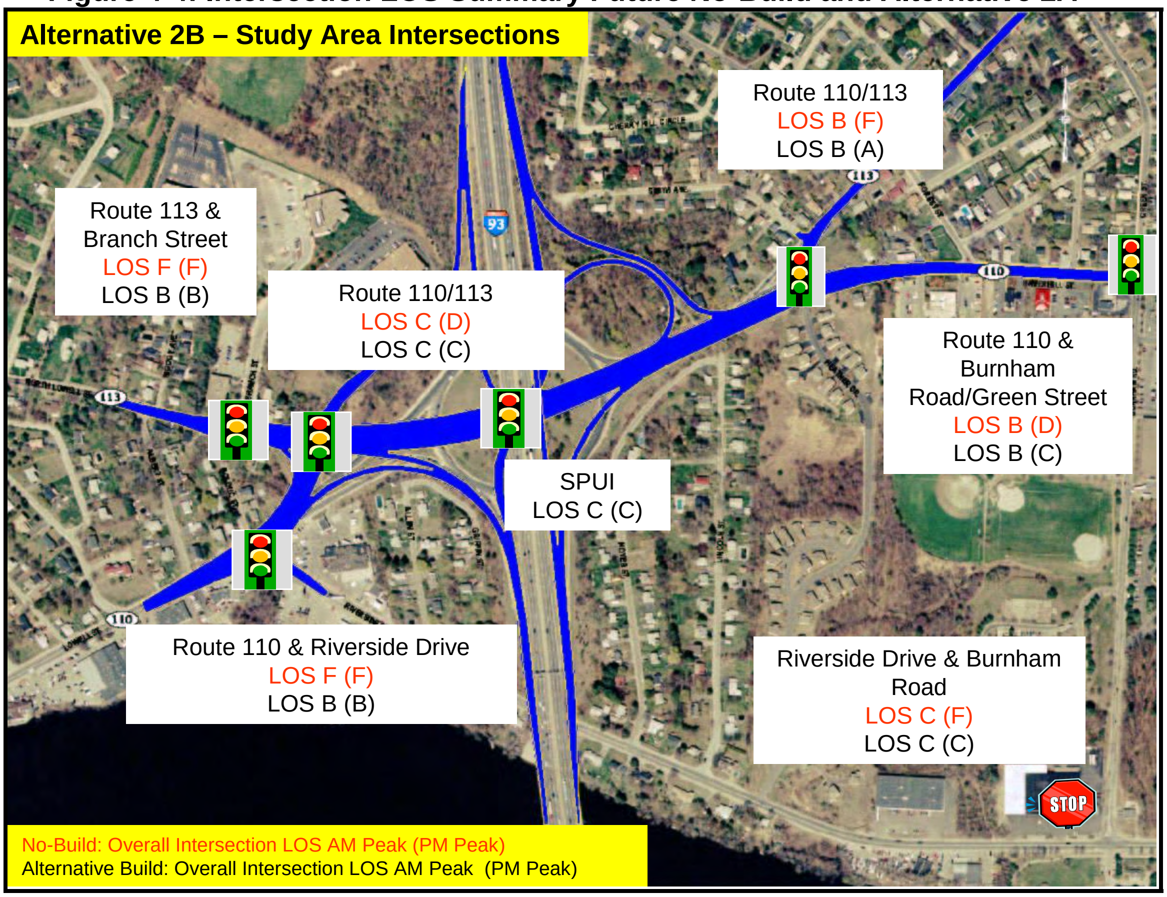


Table 4-6: Intersection LOS Summary Future No-Build and Alternative 2B

	No Build (2025)				Alternative 2B (2025)			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
Intersections								
Route 110 / Route 113 (western split)	35.0	C	36.7	D	22.6	C	22.8	C
Route 113 / Branch Street	351.1	F	> 80.0	F	11.3	B	13.6	B
Route 110 / Riverside Drive	280.4	F	> 80.0	F	11.2	B	14.9	B
Under / East of Interchange	--	--	--	--	21.9	C	27.2	C
Route 110 / Route 113 (eastern split)	13.8	B	> 80.0	F	13.7	B	9.1	A
Route 110 / Burnham Road	15.3	B	43.7	D	15.2	B	21.1	C
Riverside Drive / Burnham Road	20.2	C	> 80.0	F	21.6	C	23.1	C

* Intersections are stop-controlled under the No-Build condition and become signalized under the long-term alternative.

Figure 4-5: Intersection LOS Summary Future No-Build and Alternative 2B

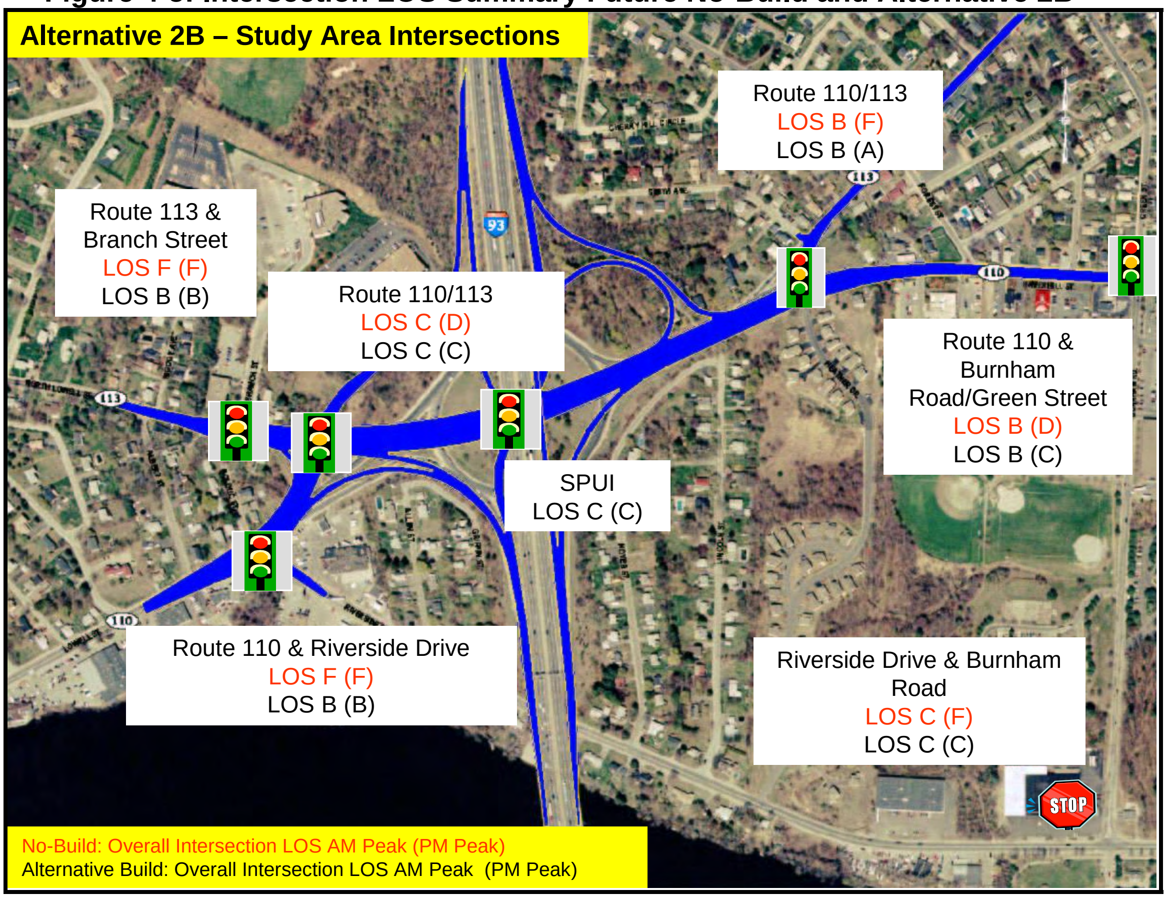


Table 4-7: Intersection LOS Summary Future No-Build and Alternative 3A

	No Build (2025)				Alternative 3A (2025)			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
Intersections								
Route 110 / Route 113 (western split)	35.0	C	36.7	D	33.5	C	18.1	B
Route 113 / Branch Street	> 80.0	F	> 80.0	F	12.8	B	23.8	C
Route 110 / Riverside Drive	> 80.0	F	> 80.0	F	11.2	B	12.9	B
Under / East of Interchange	--	--	--	--	15.8	B	12.9	B
Route 110 / Route 113 (eastern split)	13.8	B	> 80.0	F	17.1	B	11.3	B
Route 110 / Burnham Road	15.3	B	43.7	D	17.2	B	29.1	C
Riverside Drive / Burnham Road	20.2	C	> 80.0	F	24.6	C	25.0	D

* Intersections are stop-controlled under the No-Build condition and become signalized under the long-term alternative.

Figure 4-6: Intersection LOS Summary Future No-Build and Alternative 3A

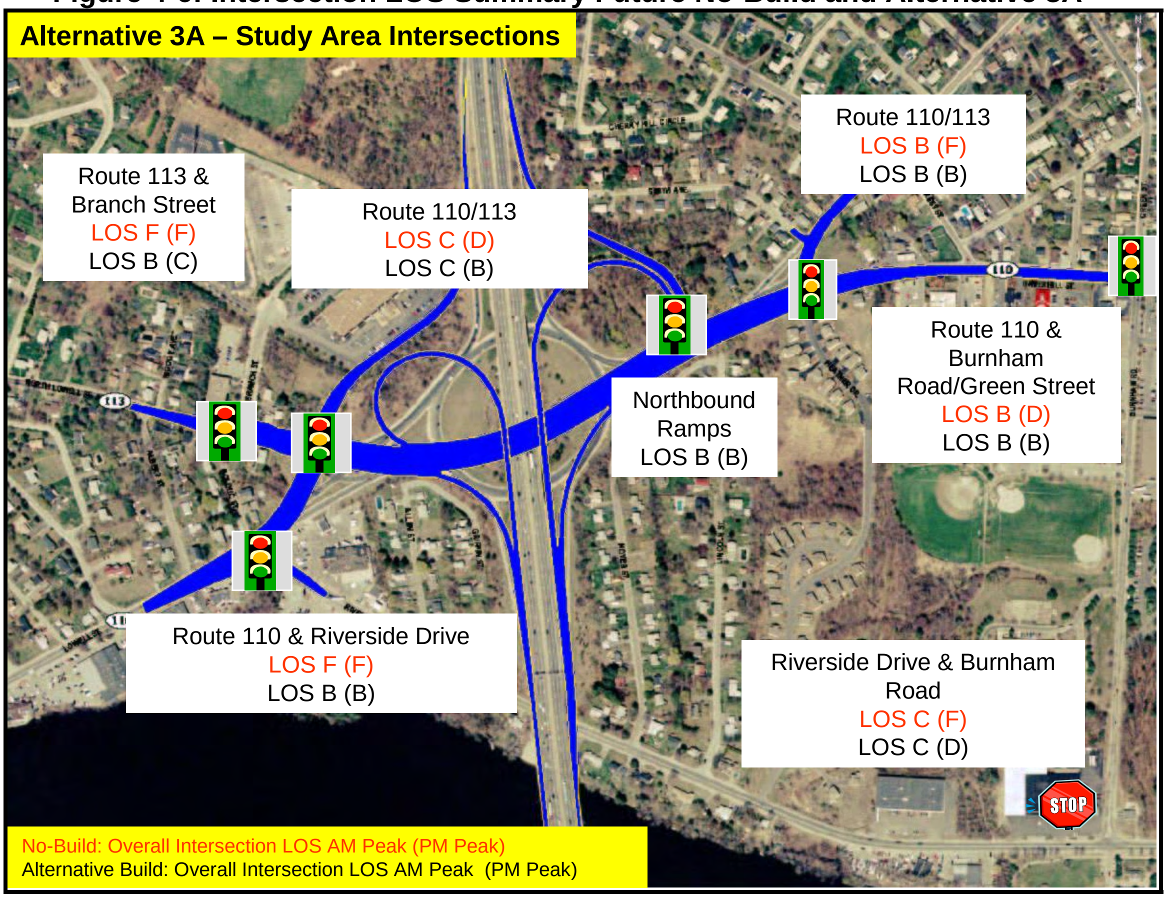
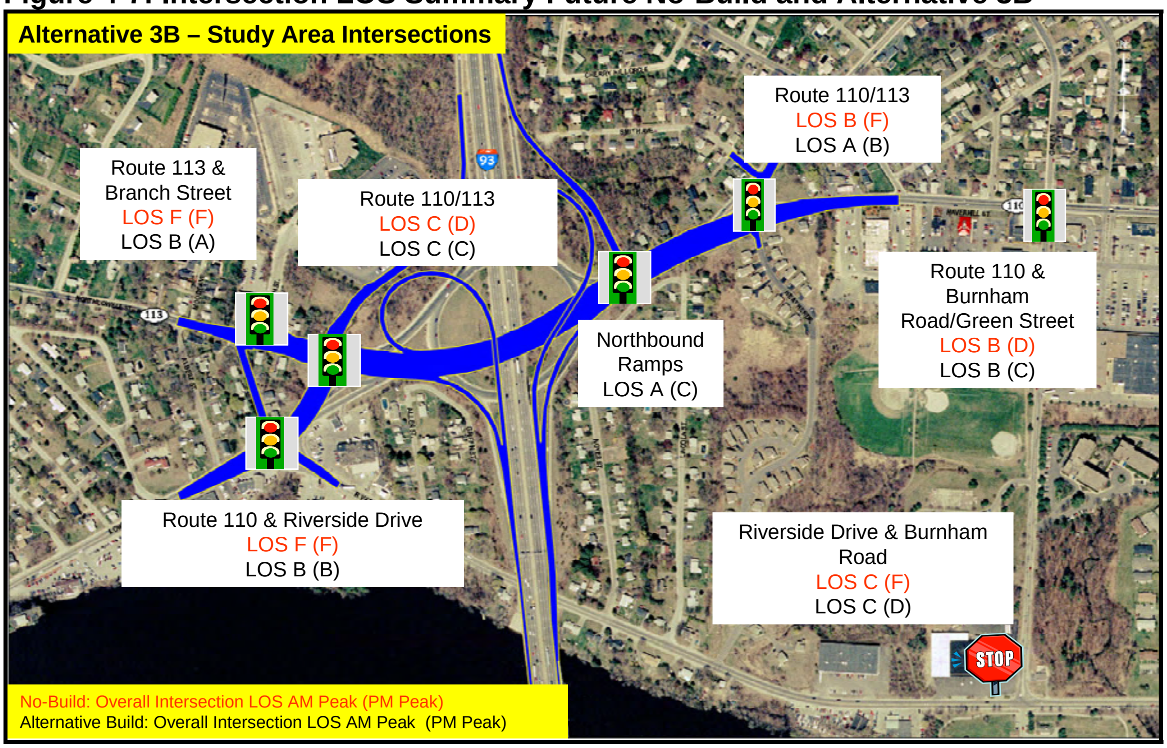


Table 4-8: Intersection LOS Summary Future No-Build and Alternative 3B

	No Build (2025)				Alternative 3B (2025)			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS
Intersections								
Route 110 / Route 113 (western split)	35.0	C	36.7	D	20.4	C	24.1	C
Route 113 / Branch Street	> 80.0	F	> 80.0	F	16.2	B	9.6	A
Route 110 / Riverside Drive	> 80.0	F	> 80.0	F	10.2	B	11.6	B
Under / East of Interchange	--	--	--	--	9.5	A	34.0	C
Route 110 / Route 113 (eastern split)	13.8	B	> 80.0	F	5.9	A	12.7	B
Route 110 / Burnham Road	15.3	B	43.7	D	16.4	B	24.2	C
Riverside Drive / Burnham Road	20.2	C	> 80.0	F	24.6	C	25.0	D

* Intersections are stop-controlled under the No-Build condition and become signalized under the long-term alternative.

Figure 4-7: Intersection LOS Summary Future No-Build and Alternative 3B



4.1.4 Pedestrian/Bicycle Mobility

Each of the build alternatives would significantly improve pedestrian and bicycle mobility in comparison to existing conditions. The existing rotary is not conducive for bicyclists or pedestrians due to the narrow pavement width, merging and weaving traffic, traffic volumes and speeds, sight distances, and a lack of sidewalks through the rotary. The rotary is also not a place that drivers would expect to encounter bicyclists or pedestrians, since the rotary also accommodates the entrance and exit ramps for the I-93 mainline, where bicyclists and pedestrians are prohibited.

The build alternatives would improve pedestrian access and safety by the construction of sidewalks along sections of reconstructed Routes 113/110 and some of the adjacent side streets such as Bolduc Street. Bicycle access and safety would also be improved by eliminating the rotary and improving traffic flow.

There would also be less traffic attempting to avoid the rotary by using Riverside Drive. There is currently a town park on Riverside Drive (Raymond T. Martin Riverside Park) and a second park slated to be built on Riverside Drive, west of I-93. There is another town owned park on Burnham Road (Francis J. Morse Memorial Park). All of these parks are destinations for bicyclists and pedestrians, and many of them would pass through sections of the project study area, particularly Riverside Drive. Reducing traffic volumes along Riverside Drive would benefit the bicyclists and pedestrians trying to access the parks, as well as the commercial and retail centers off of Burnham Road.

4.2 Safety Analysis

An important evaluation criteria is the relative safety potential of each alternative. Unlike traffic volumes, where future volumes are estimated using a computer model, it is difficult to estimate the number of crashes that may happen in the future under each of the alternatives. In lieu of crash prediction models, the safety comparison of alternatives is typically conducted by evaluating other factors that contribute to the safety potential of an alternative, such as the changes in volume relative to the type of conflict.

The existing crash data analysis presented previously (Chapter 2) indicated a predominance of rear-end collisions followed by angle collisions. Rear-end collisions and angle collisions are indicative of a combination of congestion and merging/weaving maneuvers. The highest number of crashes within the study area was recorded at the existing rotary, which is not only congested but also has circulating traffic from the various approaches merging and weaving into the rotary. The existing crash analysis also showed a relatively lower number of crashes at the two existing signalized intersections, one west of the rotary at Route 110 (Lowell Street)/ Route 113 (North Lowell Street), and the other east of the rotary at Route 113 (Lowell Street)/Haverhill Street.

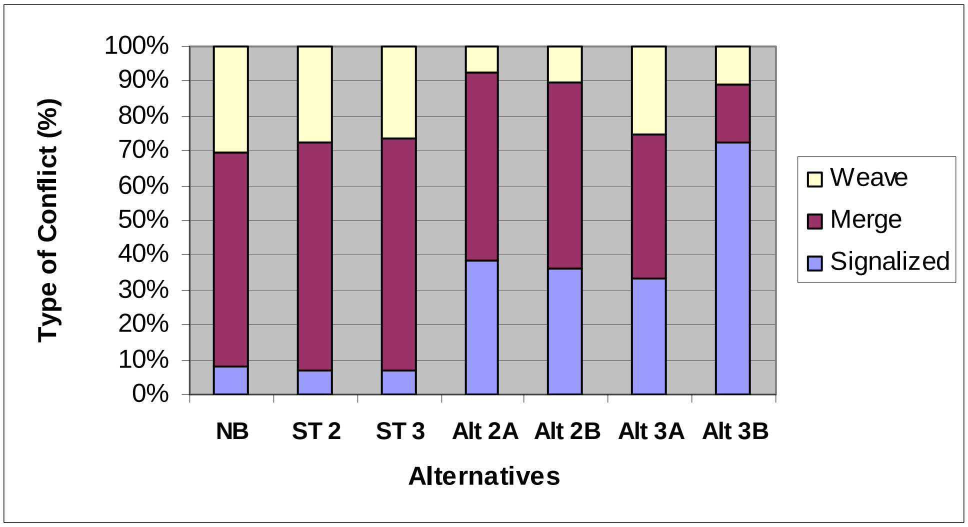
Based on the existing crash data analysis, it was surmised that the type of conflict area and the amount of traffic passing through that conflict area, provides a surrogate measure of the safety potential of an alternative. Each alternative, including the No-Build, were analyzed for conflict types that would exist under each alternative on Route 110/113 between the two signalized intersections on either sides of the existing rotary. It was found that among all alternatives there would be three types of conflict areas: weaving, merging and signalized intersection.

The next step was to estimate the total volume of entering traffic during a 24-hour period at each of the conflict areas. The total entering traffic in the peak hour was converted to a 24-hour volume by applying a 'K' factor of 0.9, which is a factor used to convert peak hour volumes to the average daily volume. All entering traffic for all the weaving conflict areas was then totaled. Similar total entering volumes for all the merge conflict areas as well as signalized intersections were also added together. Figure 4-8 shows the percent distribution of volumes that would occur among the three conflict area types for each of the alternatives including the No-Build, the two short-term alternatives (ST 2 and ST 3), and the four long-term alternatives (2A, 2B, 3A, and 3B).

Under the No-Build alternative, where the existing rotary is assumed to remain, the conflict type with the greatest volume is the merge area followed by the weave area. This remains approximately the same under the three short-term alternatives. However, under the four long-term alternatives, there would be a significant shift. While there still would be a significant level of merging conflict types under the long-term alternatives. There would be a major shift in traffic, which was previously in the weave conflict type to the signalized intersection conflict type.

Given the greater safety potential of signalized intersections as compared to weaving sections, it can be concluded that the four long-term alternatives would result in a significant improvement in safety when compared to the No-Build alternative.

Figure 4-8: Conflict Types by Alternative



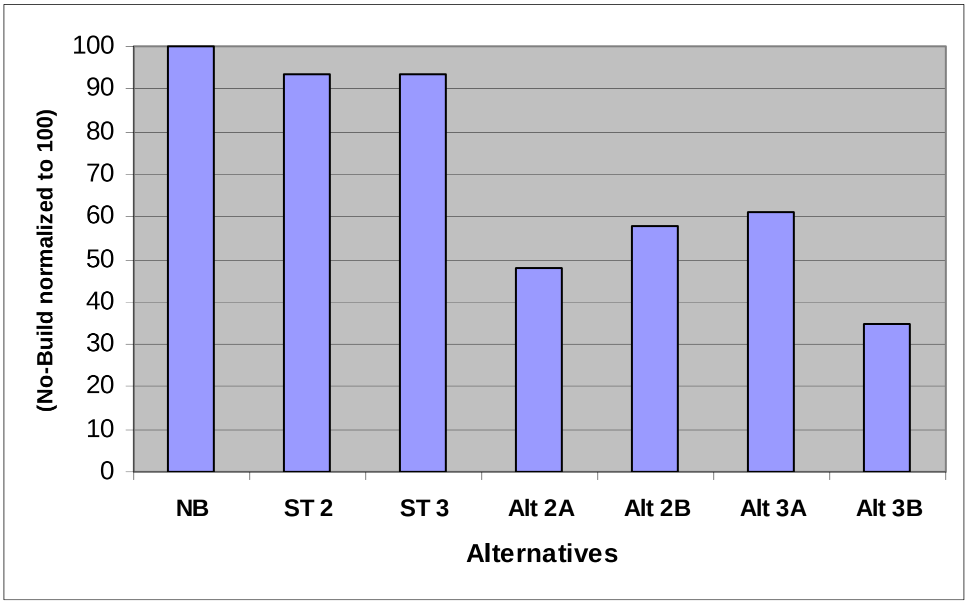
The next step in the analysis was to weigh each conflict type with a factor that was indicative of the average number of crashes. For the signalized intersection conflict type, the weighting factor was assumed to be the existing crash rate (number of annual crashes per million entering vehicles) of 1.06 for existing signalized intersections and the statewide average crash rate of 0.88 for new signalized intersections. The lower weighting factor for a new signalized intersection was considered reasonable, as the new intersections would be designed to meet new design standards and have an acceptable operational level.

Similarly the weighting factor for existing merge locations was assumed to be 0.98 (statewide crash rate for unsignalized intersections) and for new merge locations a factor of 0.81 (assuming certain reduction in crash rate given the improved geometry) was assumed. The reduction in weighting factor between existing and new was intended to reflect the potential reduction in crashes due to improved highway geometry of the new facility.

Finally, the weighting factor of existing weaving locations was assumed to be 1.97 (the existing crash rate at the rotary) and for new weaving locations to be 1.63, again to reflect that any new weaving locations would necessarily have between weaving distances consistent with newer highway design standards and guidelines.

The weighting factors for each conflict type as discussed above were then applied to the total entering volumes for each conflict type for each of the alternatives. Figure 4-9 shows the crash potential of each alternative, with the crash potential of the No-Build alternative normalized to a 100.

Figure 4-9: Crash Potential by Alternatives



The short-term alternatives would result in small reduction in the number of crashes in comparison to the No-Build alternative. While the short-term alternatives would involve some important safety improvements, they would not be comprehensive enough to cover all of the existing problem locations.

The long-term alternatives can be expected to result in significant safety improvements with reduction in number of crashes given the elimination of weave sections and a greater use of signalized intersections. It is important to note that Figure 4-9 does not attempt to predict the number of crashes, but is an assessment of the crash potential under each alternative with respect to the No-Build alternative.

In general all four long-term alternatives would result in major safety improvements over the No-Build alternative. Among the long-term alternatives, Alternatives 3B and 2A would likely have lower crash potential given the greater use of signalized intersections as opposed to merging or weaving conflict types.

4.3 Environmental Effects Analysis by Alternative

4.3.0 Introduction

Existing environmental conditions for the project area were assessed by obtaining data from the MassGIS database and superimposing this information onto aerial photographs of the project study area. This GIS data was then supplemented with resource information reported in the Route I-93 Corridor Study as well as in the Merrimack Valley Metropolitan Planning Organization's (MVMPO) 2003 Regional Transportation Plan. Information gleaned from reviewing a variety of natural resource websites and mapping was also used to document existing conditions in the study area. No field reconnaissance was conducted to verify the specific location and quality of identified resources and only limited coordination with resource agencies was undertaken for this conceptual planning study. These tasks would be undertaken as a project moves forward into the project development phases, and the preparation of the required environmental documents pursuant to the National Environmental Policy Act (NEPA) and the Massachusetts Environmental Policy Act (MEPA) as well as all other federal, state and local regulations.

This section summarizes the potential environmental impacts that would be anticipated for each of the proposed long-term (4) and short-term (3) alternatives. To conduct this alternatives analysis, representations of the proposed design alternatives were superimposed onto the above-referenced aerial photographs and this information was used in conjunction with the GIS data and other resource information as described in Chapter 2.

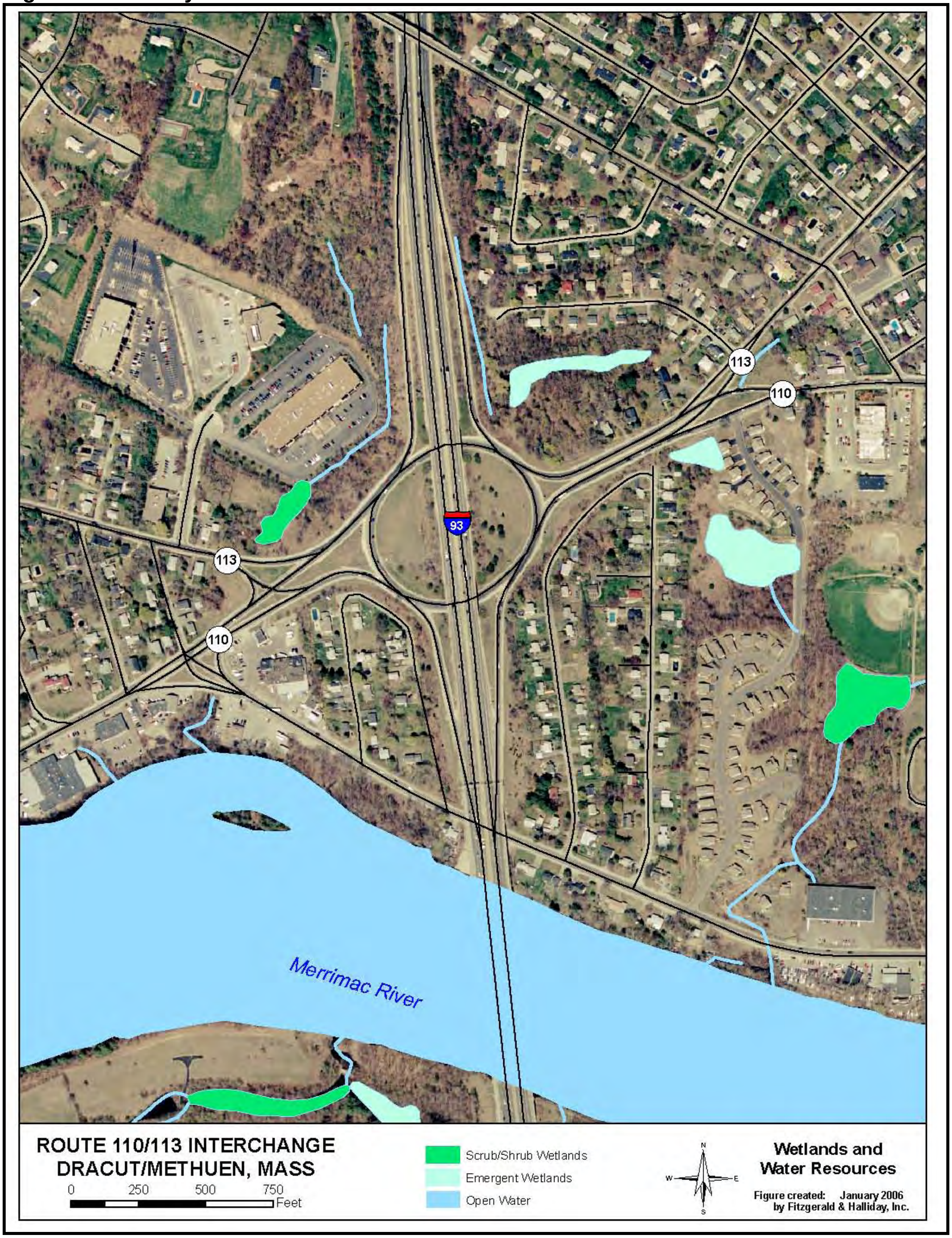
4.3.1 Wetlands

The MassGIS database entitled DEP Wetlands (1:12,000 scale) was used to identify wetland resources within the vicinity of the Methuen Rotary. Figure 4-10 depicts the study area wetlands.

There is an emergent wetland and associated drainage ditches in the northeast quadrant, two emergent wetlands and a scrub-shrub wetland, each with associated drainage ditches, in the southeast quadrant, and another scrub-shrub wetland, with an associated drainage ditch, in the northwest quadrant.

As previously mentioned, field investigations to delineate the wetland boundaries and evaluate the wetlands for their representative functions and values, would provide more detailed and accurate information. As any engineering designs proceed, these wetland areas would be noted as sensitive natural resources and appropriate measures would need to be taken to avoid or minimize impacts. Impacts that are unavoidable would likely require mitigation.

Figure 4-10: Study Area Wetlands



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Based on the conceptual designs completed to-date, and the preliminary mapping of the wetlands using existing resource maps (MassGIS), the following is a summary of the relative wetland impacts that would occur for each alternative:

Alternative 2A – This alternative would impact some of the wetland in the northeast quadrant, much of the wetland in the northwest quadrant, and little or no impact to the wetlands in the southeast quadrant. Wetland area impacts are estimated to be approximately 14,500 square feet. **Wetland Impacts – Moderate.**

Alternative 2B – Wetland impacts would be similar to 2A, with slightly greater impacts to the wetland in the northeast quadrant. Wetland area impacts are estimated to be approximately 24,000 square feet. **Wetland Impacts – Moderate.**

Alternative 3A – Wetland impacts would be similar to 2B, in total square foot area of impact. Wetland area impacts are estimated to be approximately 23,500 square feet. **Wetland Impacts – Moderate.**

Alternative 3B – Wetland impacts would be similar to 2A, in total square foot area of impact. Wetland area impacts are estimated to be approximately 14,600 square feet. **Wetland Impacts – Moderate.**

Pursuant to the Massachusetts Wetlands Protection Act (WPA) MGL Chapter 131, Section 40 as administered by 310 CMR 10.00, impacts to Bordering Vegetated Wetlands that may exceed 5000 square feet, would require a variance request to the Massachusetts Department of Environmental Protection (DEP). Each of the build alternatives would exceed this threshold, based on the wetland boundaries derived from the MassGIS maps and the conceptual engineering studies completed to date.

Table 4-9 below summarizes wetland impacts that would occur by alternative:

Table 4-9: Wetland Impacts

Alternative	*Approximate Wetland Impacts (sq. ft.)
2A	14,500
2B	24,000
3A	23,500
3B	14,600

***** impact areas are based on conceptual designs and MassGIS data

4.3.2 Aquifers and Public Water Supplies

Aquifer and groundwater information was obtained from the US Geological Survey (USGS) Hydrologic Atlas produced by the USGS Water Resource Discipline (WRD) via MassGIS (1960's to the present). In the Merrimack River watershed, principal aquifers are composed of unconsolidated sand and gravel that were deposited by meltwater streams during the last glacial period. Based on available data, there are no known principal or "sole source" aquifers or significant groundwater resources in the project study area.

The Merrimack River serves as the public drinking water supply for approximately 300,000 residents in the communities of Methuen, Lowell and Lawrence, Massachusetts. In Methuen, source water undergoes several treatment processes before it is distributed to the consumer, which includes residents and businesses within the project study area. The city of Methuen Water Department operates the Burnham Road Water Treatment Plant and the associated drinking water distribution system. There would be no direct impacts to the Merrimack River. The drinking water distribution system would be researched as the project moves through the project development phases.

Alternatives 2A, 2B, 3A, and 3B – No impacts to aquifers or public water supplies would be anticipated with any of these alternatives. **Impacts - None.**

4.3.3 Protected and Recreational Open Space

Based on the preliminary mapping review, there are recreational fields (baseball and/or softball) within the project study area. These fields are located approximately 1,000 feet to the southeast of the existing rotary. No negative impacts to these fields, or any other recreational open space, are anticipated with any of the alternatives currently under consideration. There are no known protected open space areas, other than the softball fields, skateboard park and playground off of Burnham Road at Francis J. Morse Memorial Park, and Raymond T. Martin Riverside Park, a scenic but narrow oasis between Riverside Drive and the Merrimack River. The City of Methuen is currently developing plans for an additional section of Riverside Park, which will also be located between Riverside Drive and the Merrimack River, west of I-93.

It should also be noted that each of the build alternatives would represent a net benefit to the parks mentioned above. Presently, local commuters use Riverside Drive and Burnham Road, along with connecting streets, to bypass the existing rotary because of the congestion at the rotary. Since the build alternatives would improve traffic flow and reduce congestion, fewer vehicles would travel on Riverside Drive and Burnham Road, which in turn would improve the utility of these parks, and enhance the recreational aspects experienced by park visitors. Without the implementation of a build alternative, these local roads will continue to be used by drivers to bypass the rotary, detracting from the utility of the parks along these roadways. **Alternatives 2A, 2B, 3A, and 3B –** No negative impacts to protected and/or recreational open space areas would be anticipated with any of these alternatives. **Impact – Positive impact.**

4.3.4 Areas of Critical Environmental Concern (ACEC)

A review of the Massachusetts Department of Conservation and Recreation (DCR) digital map of ACECs contained on the MassGIS website revealed that there are no ACECs within the project study area. **Alternatives 2A, 2B, 3A, and 3B –** No impacts to any ACECs would be anticipated with any of these alternatives. **Impacts - None.**

4.3.5 Hazardous Materials

As discussed in Chapter 2, a review of hazardous materials GIS data for the project area revealed the locations of eight underground storage tank (UST) sites and one Tier II Oil/Hazardous material disposal site. None of the hazardous materials sites are located within or directly adjacent to the existing rotary and no impacts are expected. Field verification and/or visual inspections would need to be undertaken, however, in order to definitively evaluate any potential impacts. During a preliminary field visit three gas stations were noted within the project study area: one at the corner of Route 110 and Riverside Drive, one at the corner of Route 110 and Burnham Road, and one on Route 110 just east of the Route 110/113 intersection, east of the rotary.

Alternatives 2A, 2B, 3A, and 3B – No impacts to any known hazardous materials sites would be anticipated with any of the alternatives. However, additional studies, including field reconnaissance, research and coordination with the Massachusetts DEP would be necessary as a project moves through the project development phase and the MEPA and NEPA documentation is developed. **Impacts – Additional studies needed (all alternatives)**

4.3.6 Noise Levels

MassHighway completed a statewide noise attenuation study of all Interstate highways in March 1989 that prioritized locations to be considered for noise barriers. The study determined, through noise monitoring and modeling, those sites that were predicted to exceed 78 decibels during the loudest hour of the day, and the ability to mitigate noise through the construction of a barrier was assessed. A list of 53 priority sites was defined in accordance with MassHighway's Type II Noise Abatement Program. Two of these sites are located along I-93 in Methuen within the project area, and they are currently ranked numbers 42 and 47 based on MassHighway's priority ranking system. Priority Location 42 is focused on the residential areas east of I-93 and south of the rotary including Noyes Street and sections of Riverside Drive and Lincoln Street. Priority Location 47 is on the west side of I-93 south of the rotary including Allen Street, Griffin Street, and sections of Riverside Drive.

MassHighway's Type I noise abatement program covers noise barrier construction coincidental with construction of major highways on new location, or physical alteration of an existing highway, including widening or realignment. As part of the analysis required for the preparation of NEPA and MEPA environmental documents, the need for a noise barrier will be evaluated for this project and if determined to be reasonable and feasible could be constructed as part of the project.

The Study Advisory Committee established for this project, as well as the general public, have repeatedly noted that ambient noise levels within the project area under existing conditions are a significant concern. As a result, it's imperative that a thorough analysis of existing noise levels would be completed and noise receptors are clearly identified, as a project advances through the project development phases. Potential positive and negative noise level impacts would need to be assessed for the build alternatives along with possible mitigation measures. It is anticipated that the build alternatives as proposed in this study would not result in an increase in noise levels in exceedance of the state and federal guidelines, but this would need to be verified by the noise analysis.

Noise sensitive land uses include a) residences, hotels, and other buildings where people sleep, b) institutional resources such as churches, schools, hospitals, and libraries, and c) various tracts of land where quiet is an essential element of the land's intended purpose.

Aerial photographs were again reviewed to identify noise sensitive land uses and to obtain a better understanding of the existing noise environment. The site is located in a predominantly suburban area surrounded by medium and high density residential neighborhoods that are adjacent to I-93, Route 110 and Route 113. In general, residences located to the southeast of the rotary within the Noyes Street neighborhood and residences to the southeast of the rotary along Allen Street are closest to the project site, and would potentially be the most sensitive to potential project noise. Residences to the west of the rotary along Bolduc Street, Branch Street, Moody Avenue, Albert Street, and Alexander Circle, and residences to the east along the extreme northern end of Lincoln Street and Heather Road and the southern end of Smith Street, may also be somewhat affected by project noise depending on which interchange improvement alternative is ultimately implemented.

Intuitively, the shifting of the existing roadway alignments further away from noise receptors would result in a reduction in noise levels, and a shift closer to receptors would result in an increase in noise levels. A shift of only a few feet in either direction would not result in any noticeable change in noise levels. The following is a summary of the potential noise level impacts for each alternative:

Alternative 2A – In the southeast quadrant, the northbound I-93 off-ramp to Route 110/113 east would be slightly closer to the northern ends of Lincoln Street and Heather Drive and some of those receptors may experience a very slight increase in noise levels. A reconfigured Route 113/Route 110/Heather Drive intersection would require the widening of Route 110 to the east and west of Heather Drive, moving the roadway closer to commercial buildings on both sides of Route 110, and these receptors may experience slight increases in noise levels.

In the northeast quadrant, a new northbound I-93 off-ramp connecting to Route 113 westbound would pass through a forested area behind some of the residences on the western end of Smith Avenue and those residences may experience a slight increase in noise levels.

In the northwest quadrant, a new southbound I-93 off-ramp, together with a new northbound I-93 off-ramp to Route 113 westbound, would be located closer to a commercial building in this quadrant, compared to the existing ramp and rotary, resulting in a possible increase in noise levels. The reconstruction of Route 113 west in this same quadrant would involve widening and an alignment shift. Some of the receptors along this stretch of Route 113, as well as some receptors along Bolduc Street, may experience increased noise levels.

In the southwest quadrant, the widening of Route 110 would move the roadway slightly closer to the receptors along Route 110, on either side of Riverside Drive. A new southbound I-93 on-ramp would encroach upon some receptors along Griffin Street, and those receptors may experience increased noise levels. **Alternative 2A Noise Level Impacts - Low**

Alternative 2B - In the southeast quadrant, the noise level impacts would be similar to those discussed for Alternative 2A.

In the northeast quadrant, a new northbound I-93 off-ramp connecting to Route 113 westbound would pass through a forested area behind some of the residences on the western end of Smith Avenue, and those residences may experience a slight increase in noise levels. A new I-93 northbound on-ramp adjacent to the off-ramp would be located even closer to Smith Avenue, which would likely increase noise levels as well.

In the northwest quadrant, a new I-93 southbound off-ramp to Route 113 westbound would be located closer to a commercial building in this quadrant compared to the existing ramp and rotary, resulting in a possible increase in noise levels. The reconstruction of Route 113 west in this same quadrant would involve widening and an alignment shift. Some of the receptors along this stretch of Route 113, as well as some receptors along Bolduc Street, may experience increased noise levels.

In the southwest quadrant, the noise level impacts would be similar to those discussed for Alternative 2A. **Alternative 2B Noise Level Impacts - Low**

Alternative 3A - In the southeast quadrant, the noise level impacts would be similar to those discussed for Alternative 2A.

In the northeast quadrant, the noise level impacts would be similar to those discussed for Alternative 2B.

In the northwest quadrant, a new I-93 southbound off-ramp to Route 113 westbound would be located closer to a commercial building in this quadrant compared to the existing ramp and rotary, resulting in a possible increase in noise levels. A new I-93 southbound on-ramp from Route 110/113 west would be adjacent to the southbound off-ramp. The reconstruction of Route 113 west in this same quadrant would involve widening and an alignment shift. Some of the receptors along this stretch of Route 113, as well as some receptors along Bolduc Street, may experience increased noise levels.

In the southwest quadrant, the noise level impacts would be similar to those discussed for Alternative 2A. **Alternative 3A Noise Level Impacts - Low**

Alternative 3B - In the southeast quadrant, the noise level impacts would be similar to those discussed for Alternative 2A.

In the northeast quadrant, the noise level impacts would be similar to those discussed for Alternative 2B.

In the northwest quadrant, the noise level impacts would be similar to those discussed for Alternative 3A.

In the southwest quadrant, the noise level impacts would be similar to those discussed for Alternative 2A. **Alternative 3B Noise Level Impacts - Low**

4.3.7 Air Quality

As discussed in Chapter 2, this project has been formally included in the State Implementation Plan (SIP) and the Transportation Improvement Program (TIP) in conformance with the Clean Air Act of 1970 (as amended). At this point in the planning study, there have not been any detailed analyses of the potential positive or negative effects the project may have on air quality. However, similar to noise level impacts, there are some intuitive observations that can be made. Assuming a project would improve mobility and traffic flows, a beneficial affect on air quality can be anticipated when compared to the existing traffic conditions.

It is very difficult to compare the proposed alternatives currently under consideration for their potential affects on air quality at this time. Such comparisons can only be based on known parameters with the focus on mobility. Therefore, based on projected improvements in traffic flow and mobility it can only be assumed that Alternative 3A would have the greatest positive affect on air quality, the No Build Alternative would have the least, and Alternatives 2A, 2B, and 3B would be somewhere in between.

Alternatives 2A, 2B, 3A, and 3B - Additional and much more detailed traffic studies and air quality analyses would need to be undertaken as part of the project development process, particularly during the development of the required MEPA and NEPA documents, for all alternatives. **Air Quality Impacts – Additional Study is Needed (all alternatives)**

4.3.8 Wildlife Habitat

As discussed in Chapter 2, the project study area is predominantly developed with numerous residential and commercial properties and roadways. Any naturally vegetated habitat areas are limited to relatively small fragmented forest areas and wetland and drainage systems located adjacent to I-93 and the existing rotary. There is some additional habitat in the emergent and scrub-shrub wetlands located east of Heather Drive and south of the baseball fields. Although there may be some wildlife use of these areas, due to the generally disturbed nature of the area, there should be no substantial negative impact on wildlife habitat for any of these alternatives.

Alternatives 2A, 2B, 3A, and 3B - In general, those alternatives that disturb the least amount of presently undisturbed land would have the least impact on wildlife habitat. However, all of the proposed alternatives would pass through the relatively undisturbed forested areas in the northeast and northwest quadrants, and none would impact the areas east of Heather Drive or south of the baseball fields. **Wildlife Habitat Impacts - Low (all alternatives)**

4.3.9 Cultural, Historical and Archeological Resources

As discussed in Chapter 2, there are no sites or structures currently listed on the National Register of Historic Places within the project area. However, additional studies, including field reconnaissance, research and coordination with the Massachusetts SHPO would be necessary as a project moves through the project development phase and the MEPA and NEPA documentation is developed. These studies would need to be completed for both historic properties (standing structures) and potential archeological resources (historic and pre-historic).

Alternatives 2A, 2B, 3A and 3B - At this stage, no comparisons of alternatives regarding potential impacts on cultural resources can be made. **Cultural Resources Impacts– Additional Study Needed (all alternatives)**

4.4 Land Use and Economic Development Analysis by Alternative

The traffic analysis indicates that there would be peak period travel time savings of less than 2-minutes per auto and truck trip, as shown by the data in Table 4-10 below:

Table 4-10: Travel Time Savings by Alternative

Travel Times Per Trip by Alternative (in minutes)		
Alternative	**AM Peak**	**PM Peak**
No Build	3.16	2.25
2A	1.80	1.83
2B	2.10	1.83
3A	1.93	1.85
3B	2.09	1.80
Time Saved Per Trip by Alternative (in minutes)		
Alternative	**AM Peak**	**PM Peak**
2A	1.36	0.42
2B	1.06	0.42
3A	1.23	0.40
3B	1.07	0.45
Source: Trafinfo Communications, Inc.		

The differences between no-build and the build alternatives would not be significant enough to change the "effective market reach" of the project area for labor force, freight, or consumer markets. None of the research conducted for previous studies or reported in the literature, suggests that average travel time savings of less than five minutes per trip would induce measurable additional economic opportunities. Economic development effects would therefore be **"low" or "neutral" for each of the alternatives**.

4.4.0 Right-of-Way

See section 4.5.1 below

4.4.1 Property Values

The value of residential property abutting the taking areas may be adversely affected by increased roadway traffic volumes. Additional study would be needed to determine the size of the impact. Noise impacts are rated as "low" across all alternatives, suggesting that other nearby properties would be unlikely to be adversely affected by noise.

The value of commercial properties served by the roadway could increase slightly based upon the slight improvements in average travel times estimated in the traffic analysis, particularly for distributive industries. **Additional study – including interviews with a sample of affected businesses -- would be needed to determine the extent of the impact for each alternative**.

4.4.2 Tax Base

The tax base would be reduced by the value of the actual takings, as well as by any diminution in value for residences. If commercial properties increase in value, then the tax base would reflect that as well. **Additional study would be needed to determine the magnitude of the impact for each alternative**.

4.4.3 Planned and Potential Zoning Changes

No zoning changes would be needed as a result of any of the alternatives. **Impact on Planned and Potential Zoning Changes – low (all alternatives)**

4.4.4 Planned Developments Including 40B

The baseline report discusses the Towns' development plans, as summarized in Table 4-11 below:

Table 4-11: Planned Developments

Methuen	Residential Units	Commercial Sites*
Market Rate	685	1
Chapter 40 (B)	109	N/A
Dracut	Residential Units	Commercial Sites*
Market Rate	437	5
Chapter 40 (B)	368	N/A

*major sites currently in planning stages
Source: Municipal planning departments

Although improvements to the rotary traffic flows would improve the accessibility of the planned development sites for both towns, none of the developments depend on the project for their implementation. **Impact on Planned Development - low (all alternatives)**

4.4.5 Parking

A commercial office building in the northwest quadrant of the project study area would lose some existing parking spaces due to the construction of the I-93 southbound off-ramp (all alternatives) and the I-93 northbound off-ramp (Alternatives 2A and 3B). The exact number of parking spaces lost was not determined by this study and would require more detailed design information. Any parking losses at other commercial and/or office facilities would become apparent as a project moves forward. During the project development phase, replacement parking options would be investigated. For example, replacement parking could be accommodated within the remnants of some of the properties slated for acquisition as a result of the build alternatives. In addition, park and ride options, as discussed in Section 4.1.5, should be investigated. **Parking Impacts – Low (all alternatives)**

4.4.6 Labor Force Impacts

See 4.4 above. No labor force impacts are expected to result from any of the alternatives. **Labor force impacts – Low (all alternatives)**

4.4.7 Regional and Local Employment

See 4.4 above. No regional and local employment impacts are expected to result from any of the alternatives. **Regional and Local Employment impacts – Low (all alternatives)**

4.5 Community Effects/Environmental Justice Analysis

Community cohesion may be affected by the loss of residences to right-of-way takings. However, all four of the build alternatives include extensive bicycle and pedestrian accommodations, which would provide reconnections of various neighborhoods that were previously bisected by the existing rotary and I-93.

No environmental justice issues have been identified but characteristics of households to be displaced have not yet been determined. **Community Effects – Positive for all build alternatives. Environmental Justice – Additional study should be undertaken for all alternatives.**

4.5.0 Right-of-Way Issues and Conceptual Plans

With the exception of the No-Build alternative, each of the alternatives would require the displacement of residences and businesses, as shown in Table 4-12:

Table 4-12: Right-of Way Impacts by Alternative

	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B
Residential	1	3	3	2
Structures	3	5	5	4
Acreage	3.1	5.6	5.9	4.5

Although primary data on the households affected was not collected for this study, secondary source information provides a likely profile of the residents that would potentially be displaced by any project moved forward. Table 4-13 summarizes the characteristics of residences in the immediate area of the rotary that would be affected by the right-of-way impacts.

It is important to note that the area defined contains more residences than would actually be displaced; it encompasses the one to three residences identified at this preliminary stage, as well as other residences in the surrounding area. The characteristics of those likely to be taken can be estimated from the characteristics of the larger area, at least for purposes of assessing the likely degree of difficulty that would be encountered in any future relocation process.

Table 4-13: Characteristics of Residences in the Area of Alternatives

Tenure	
owner-occupied	15
tenant-occupied	1
Average length of residence	15 years
Median value of owner-occupied	$325,000
Structure type	
single family detached	15
two family	1
Median year built	1966

Source: Claritas, Inc., *Site Reports, 2006.*

Table 4-14 displays the characteristics of households in the area of the takings. While the same caveats apply to use of these data, they enable planners to estimate what difficulties or special measures might have to be taken to ensure successful relocation.

Table 4-14: Socioeconomic Profile of Residents in Vicinity of Alternatives

Population (2006 estimate)	48
Race	
white	45
black	1
Hispanic	2
Male	24
Female	24
Age	
under 18	14
over 65	6
Households	17
Average household size	2.9
Median income	$75,625
Families below poverty level	0
Female-headed households	1
Average vehicles	1.98
Population over 16	27
Unemployed	1
Employed	26

Source: Claritas, Inc., *Site Reports, 2006.*

What is fairly clear from the tables is that the group of households from which relocatees would be likely to come does not display characteristics that suggest special measures might be needed in relocation. Based on the data shown, a typical household in this area would be white, have a household income of over $75,000, be employed, occupy a single family detached home worth over $300,000. Of course, at the individual household level, these characteristics would vary, but it appears at this preliminary stage that households who might have to relocate would not be likely to have characteristics that would require special measures beyond the relocation benefits normally payable to displacees. For example, large families with low incomes might have difficulty finding appropriate rental housing, even with the rental supplement benefit. Similarly, elderly people who have lived in their homes for many years often find relocation particularly burdensome.

Using only estimated values of homes to be taken, an examination of the current housing market indicates that residents would have few difficulties in finding comparable replacement housing adequate to meet their needs and meeting the criteria defined in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (as amended). In the month of August 2007, 41 single family homes were sold in Methuen, at a median price of $260,000.[1] This compares to a median price of $326,000 in August of 2006, reflecting the current slump in the housing market. In calendar year 2006, 432 single family homes were sold in Methuen. Current multiple listings show 18 single family homes for sale in Methuen in the price range of $250,000 to $350,000. While the housing market is expected to recover over the next 12 to 18 months, likely before any displacements would occur for the project, there is no reason now to believe that displacees would not be able to find comparable replacement units.

[1] The Warren Group, *Town Stats*, September 2007.

Missing from the above analysis is information on the degree of neighborhood cohesion, which would enable an analysis of how disruptive of social networks and community ties relocating these households may be. Many years of experience in relocation has demonstrated that most often households want to relocate as close as possible to their old neighborhoods and to live in housing much like that which they have lost. The structure of the relocation program of benefits and assistance provided by the displacing agency, in this case, MassHighway, reflects this experience. Benefits are intended to enable affected households to replace as closely as possible their former housing situation, with regard to both the type of structure and the type of neighborhood. **Right of Way Relocation Impacts – Low (all alternatives).**

4.5.1 Emergency Response

By improving traffic operations and reducing peak hour delay and congestion, it is anticipated that emergency response times would improve with any of the build alternatives, both short-term and long-term. Additionally, any intersection improvements would include the hardware to allow priority to emergency vehicles, thereby improving response time. **Emergency Response – Positive (all alternatives)**

4.5.2 Elevation and Visual Impacts

Alternatives that would require roadways elevated above the existing roadway systems would have greater visual impacts than those that more closely matched the existing roadway elevations. The alternatives developed for the study approximately match the existing roadway elevations with some exceptions.

Alternative 2A - The I-93 northbound off-ramp exiting to Route 113 west would require a bridge over the 110/113 roadway. This off-ramp would then cross under two I-93 northbound on-ramps, the I-93 mainlines, and a new I-93 southbound off-ramp before matching the at-grade roadway system at Route 113, west of the existing roadway. The bridge carrying the northbound I-93 off ramp would likely be designed at about the same elevation as the I-93 mainline. **Alternative 2A Elevation and Visual Impacts - Moderate**

Alternative 2B - The I-93 northbound off-ramp exiting to Routes 110/113 west would require an extension of the I-93 bridge over Routes 110/113. A second bridge carrying that ramp over the northbound I-93 on-ramp would also be required. **Alternative 2B Elevation and Visual Impacts - Moderate**

Alternative 3A - The I-93 northbound off-ramp exiting to Routes 110/113 west would require an extension of the I-93 bridge over Routes 110/113 (on the eastern side of I-93) but no second bridge carrying that ramp over the northbound I-93 on ramp would be required. A southbound I-93 on ramp, for vehicles heading west on Routes 110/113, would require another extension of the I-93 bridge over Routes 110/113 on the western side of I-93. **Alternative 3A Elevation and Visual Impacts - Moderate**

Alternative 3B – The northbound I-93 off-ramp exiting to Routes 110/113 west would require a separate bridge crossing over Routes 110/113, and then crossing under the I-93 mainline before matching the at-grade roadway system at Route 113, west of the existing rotary. A southbound I-93 on-ramp, for vehicles heading west on Routes 110/113, would require an extension of the I-93 bridge over Routes 110/113 on the western side of I-93. **Alternative 3B Elevation and Visual Impacts - Moderate**

4.6 Cost Analysis

4.6.0 Construction Costs

Conceptual level construction cost estimates were developed for the four long-term alternatives and Short-Term Improvement Package 3. The costs presented in Table 4-15 below are based upon MassHighway's 2007 weighted average bid prices. These costs account for construction costs only and do not include costs for property impacts, design, or environmental mitigation. They also do not include any costs that might be associated with the construction of noise barriers. Given the conceptual level of this estimate and the precise nature of determining the need and extent of noise barriers, it was deemed premature to include these costs at this point. It is anticipated that these costs will be factored in should they be deemed necessary in the environmental phase of this project.

Table 4-15: Estimated Construction Costs
Long-Term Alternatives

Alternative	Construction Costs (2007)
Alternative 2A	$60,000,000
Alternative 2B	$48,000,000
Alternative 3A	$44,000,000
Alternative 3B	$58,000,000

As shown in Table 4-16, the estimated construction costs in present day (2007) dollars range from $44,000,000 for Alternative 3A to $60,000,000 for Alternative 2A. Bridge construction constitutes the primary difference in estimated construction costs between the alternatives. The estimated construction costs of the bridges in present day dollars range from just over $15,000,000 for Alternative 3A to $25,000,000 for Alternative 2A. Alternatives 2A and 3B each would require three bridges with relatively long spans; while Alternative 2B would require two bridges with only one long span; and Alternative 3A would require just one bridge. It should be noted that in all cases, the bridge carrying I-93 over the relocated Route 110/113 would require a substantial span, particularly for Alternatives 2A and 2B which do not allow for the use of a center pier.

A conceptual level construction cost estimate was also developed for Short-Term Improvement Package 3. This alternative is the only short-term alternative that would involve significant changes to the physical environment that likely fall beyond the capacity of MassHighway's maintenance program. Like the long-term alternatives, the conceptual cost estimate for the short-term alternative was developed using MassHighway's 2007 Weighted Average Bid Prices. This cost does not include consultant design fees. The conceptual level construction cost estimate for Short-Term Improvement Package 3 in present day value is $2,430,000. This cost consists of $1,530,000 for construction centered on the rotary and an additional $900,000 for construction involved in the signal improvements.

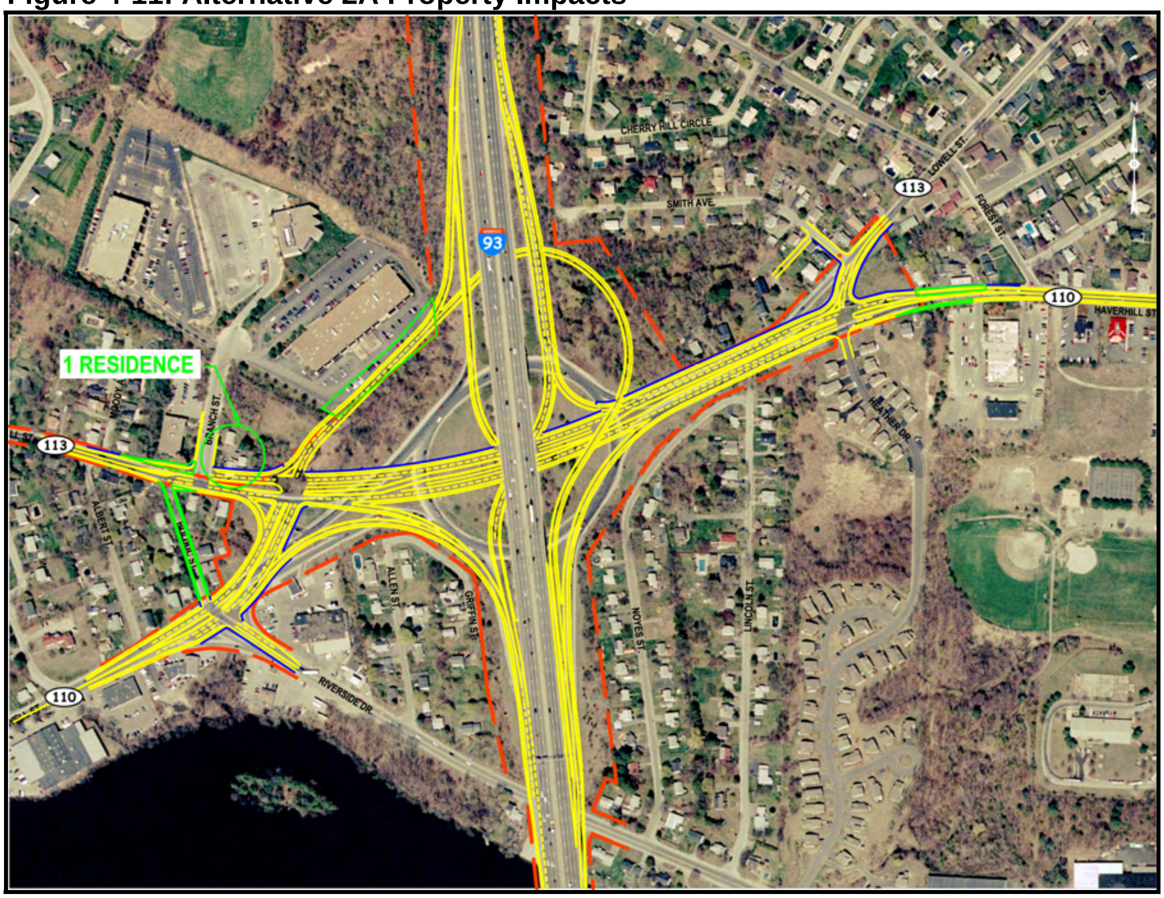
4.6.1 Right-of-Way Costs

Potential property impacts for all alternatives were based on conceptual level engineering design plans. Property lines and engineering layout lines on the conceptual plans were not located by field survey at this stage. Therefore these impacts could be modified as any concept moves through the environmental evaluation and documentation phase, and the different levels of engineering design.

The property impacts identified were generally similar for all of the remaining alternatives. Alternative 2A would require the acquisition of one residence. This residence may be open to relocation within the remaining parcel. Alternatives 2B and 3A would each require the acquisition of three residences, one of which may be open for relocation on the exiting property, and some land acquisitions in other areas. Alternative 3B would require acquisition of two residences. The evaluation of these property acquisitions will be determined during the preparation of the final engineering design plans, and will be subject to The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1978 as amended, as well as certification of the design layout by the MassHighway Right of Way Bureau pursuant to MGL Chapter 81.

The following exhibits (Figures 4.11 through 4.14) show the proposed property acquisitions based on the conceptual engineering designs as explained above.

Figure 4-11: Alternative 2A Property Impacts



MASSACHUSETTS EXECUTIVE OFFICE OF TRANSPORTATION

Figure 4-12: Alternative 2B Property Impacts

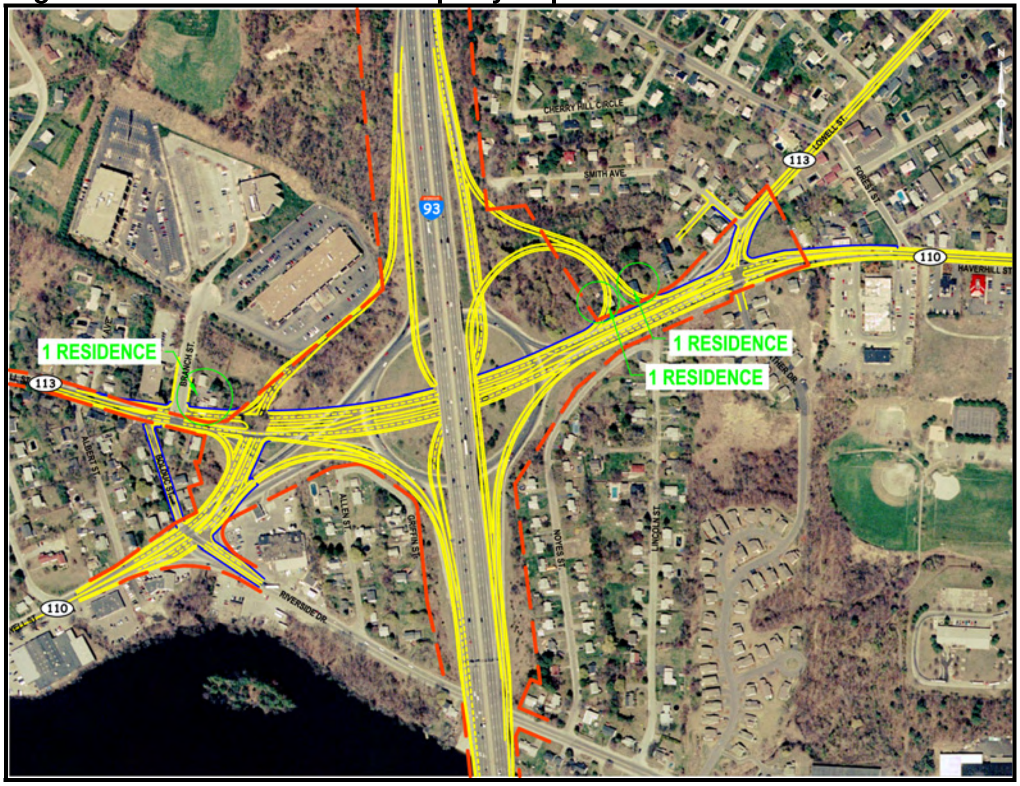


Figure 4-13: Alternative 3A Property Impacts

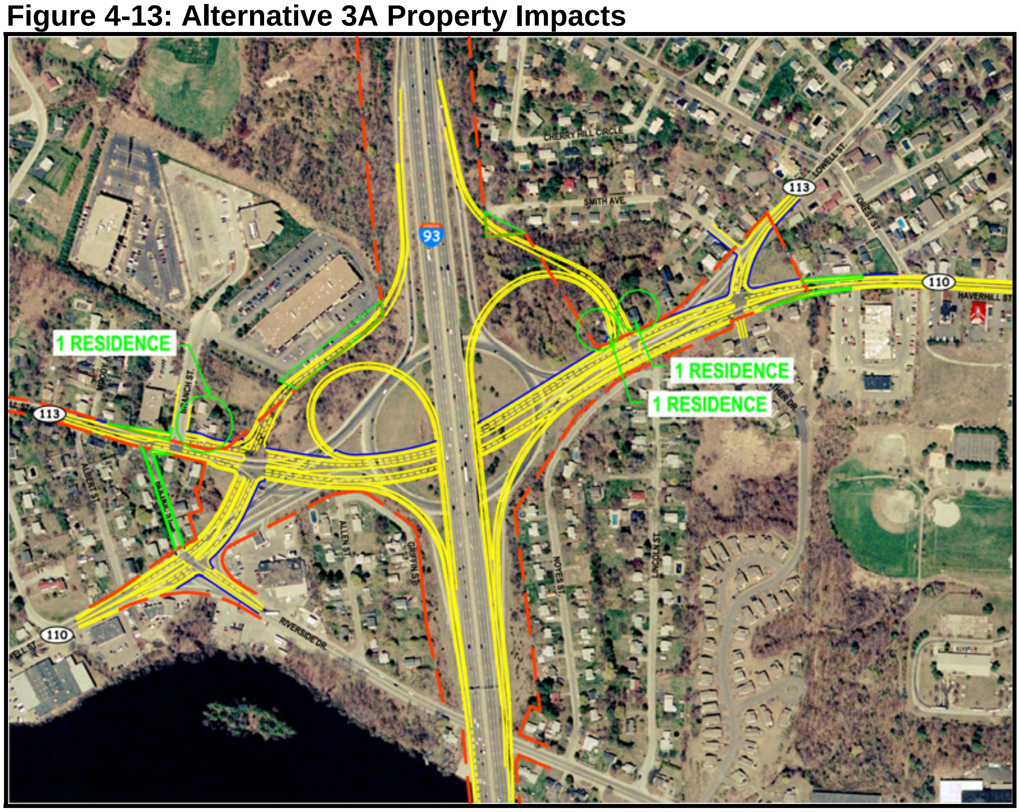


Figure 4-14: Alternative 3B Property Impacts

4.6.2 Mitigation Costs

In accordance with the Massachusetts Wetlands Protection Act (WPA), any unavoidable impacts to wetlands would need to be replicated at a ratio of 1:1. For any wetland resource area impacts, a wetland replication plan would be developed that includes the location of the replication areas, typical cross sections, conceptual grading plans, test pits or soil borings logs, groundwater elevations, the hydrology of areas to be altered and replicated, and a full description of the vegetative species to be altered as well as the vegetative species of the replacement areas, planned construction sequence, and a discussion of the required performance standards and post-construction monitoring. Cost estimates for the design and construction of wetland mitigation areas would range from $150,000 to $300,000.

4.7 Evaluation of Transit, Park & Ride, and ITS Options

The transit, Park & Ride, and ITS options developed in Chapter 3 were evaluated to identify conceptual-level benefits and costs. A set of evaluation criteria for these options was developed using the same base criteria that were defined early in the study (summarized in Chapter 1) to respond to the study goals and objectives. For each of the relevant base criteria, an appropriate evaluation measure (or measures) was selected. Evaluation measures were not selected for some of the base criteria, because the study team believed that the transit, Park & Ride, and ITS options would not vary in these areas, or because these areas could not be evaluated given the conceptual level of development of the options.

Table 4-16 summarizes the evaluation criteria and measures that were developed for the transit, Park & Ride, and ITS options.

Table 4-16: Evaluation Criteria and Measures for Transit/Park & Ride/ITS Options

Criteria	Measure
Mobility	Demand Shift – The potential of the option to shift travelers from Single-Occupant Vehicle (SOV) travel to alternative modes, or to reduce Vehicle Miles Traveled (VMT)
Environmental	Air Quality and Noise – The potential of the option to reduce emissions due to SOV travel and improve air quality, and the potential of the option to reduce noise associated with vehicular travel.
Cost and Schedule	Capital Cost – The scale of the cost to implement an option; this may include construction costs, the costs of acquiring vehicles, or the cost of implementing ITS technologies.
	Operations and Maintenance Cost – The scale of the ongoing cost to operate and maintain an option.
	Short-Range Constructability/Feasibility – The feasibility of constructing or implementing the option in the short-term.

Based on these evaluation criteria and measures, the transit, Park & Ride, and ITS options were evaluated qualitatively. For the Mobility and Environmental evaluation criteria, the ratings refer to the anticipated benefits of the improvements. For the Cost and Schedule criteria, the ratings refer to the anticipated impacts of the options. Table 4-17 summarizes the conceptual evaluation that was performed for the transit, Park & Ride, and ITS options based on the evaluation criteria and measures described above.

Table 4-17: Conceptual Evaluation of Transit/Park & Ride/ITS Options

Criteria/ Measure	Conceptual Evaluation
Mobility/ Demand Shift	• All of the options have the potential to produce a modest shift from SOVs to alternative modes and to modestly reduce VMT in the study area. • It is possible that Option 1 could produce a minor increase in automobile traffic in the localized area where the Park & Ride expansion would take place.
Environmental/ Air Quality and Noise	• All of the options have the potential to produce a modest reduction in emissions and noise from SOV use in the study area. • Option 1 could produce a minor increase in emissions and noise from automobiles in the localized area where the Park & Ride expansion would take place. • Options 3 and 4 could produce minor increase in emissions and noise due to bus travel. This could potentially be mitigated by using smaller, neighborhood-size buses and/or buses fueled by low-emissions diesel or Compressed Natural Gas (CNG), if this is determined to be feasible by the transit agencies that would operate the services.
Cost and Schedule/ Capital Cost	• The capital cost of all of the options is identified conceptually to be in the low to moderate range. • As a point of reference, construction of surface parking (as proposed in Option 1) typically costs on the order of $2,500 to $5,000 per space, a new transit bus (as might be required to operate Options 3 or 4) typically costs about $300,000, and signage can range from several thousand dollars to up to $100,000 depending on sign size and type (static vs. dynamic signage).
Cost and Schedule/ Operations and Maintenance Cost	• The operations and maintenance cost of the options is identified conceptual to be in the low to moderate range. • Maintenance of static signage (as proposed in Option 2) is very low cost, while maintenance of surface parking areas (as proposed in Option 1) or Dynamic Message Signs may cost several thousand dollars per year. • The cost of additional bus service (as proposed in Options 3 and 4) will depend on the cost structure of the agency or agencies who would operate the service.
Cost and Schedule/ Short-Range Constructability/ Feasibility	• The proposed transit, Park & Ride, and ITS options could all potentially be implemented in the short-term. • Option 2 (static signage) would require the shortest lead time, while Option 1 (expanded Park & Ride capacity) would require several years to implement.

As shown in Table 4-17, the proposed transit, Park & Ride, and ITS options are generally expected to produce modest benefits at a low to moderate cost, with few other impacts. Each of these options would improve mobility, provide additional transportation choices, and produce a more balanced transportation system in the vicinity of the rotary interchange. Additional analysis would be required in later planning stages to more fully develop these options and to evaluate their benefits and costs in greater detail. Further, these evaluation criteria and measures are also only part of the decision-making process. If these improvements are to be pursued, further input will be required from the relevant transit agencies, municipalities, residents, and other stakeholders as planning progresses.

It is important to keep in mind when considering the transit, Park & Ride, and ITS options that, unlike in the case of the roadway alternatives, it may be desirable to select more than one option for further development and ultimately to recommend and implement. For instance, Option 1, which would expand Park & Ride capacity, and Option 2, which would add signage promoting alternative transportation options, would work well together and produce additional benefits. The same could be said for coupling a number of the other options. Option 3 and 4, however, are mutually exclusive; if you were to extend the local bus routes, you would not implement a new through-route, and vice versa. Ultimately, this study recommends a package of transit/Park & Ride/ITS improvements, which would complement the recommended roadway improvements and alternatives.

4.8 Evaluation Criteria Summary Matrix

The following Table 4-18 is a summary of the evaluation criteria used in the evaluation of the alternatives as discussed in this chapter. A rating of Low, Moderate (Mod) or High constitutes a negative impact on that particular resource, whereas a rating of Positive (Pos) indicates that the alternative would be an improvement over existing conditions. There are some criteria for which it is difficult to determine impacts at this time, pending additional studies, and these are designated with an asterisk (*).

Table 4-18: Evaluation Criteria Summary Matrix

Criteria	No Build	Short-Term Packages 1,2,3	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B
Mobility	High	Pos	Pos	Pos	Pos+	Pos
Safety	Mod	Pos	Pos	Pos	Pos	Pos
Wetlands	None	Low	Mod	Mod	Mod	Mod
Aquifers	None	None	None	None	None	None
Protected/ Recreational/ Open Space	Low	Pos	Pos	Pos	Pos	Pos
Hazardous Materials	None	*	*	*	*	*
Noise	Low	Low	Low	Low	Low	Low
Air Quality	Low	Pos*	Pos*	Pos*	Pos*	Pos*
Wildlife Habitat	None	Low	Low	Low	Low	Low
Cultural Resources	None	Low*	*	*	*	*
Right-of-way	None	Low*	Low*	Low*	Low*	Low*
Parking	None	Low*	Low*	Low*	Low*	Low*
Emergency Response	Low	Pos	Pos	Pos	Pos	Pos
Visual Impacts	None	Low	Mod	Mod	Mod	Mod
Costs	None	$2.4M	$60M	$48M	$44M	$58M

Chapter 5: Recommendations

5.0 Introduction

The development and analysis of alternative solutions to address the deficiencies identified in Chapter 2 was a comprehensive and methodical process. This process was followed to ensure that the alternatives chosen to be advanced forward into the project development phases represent the most optimum solutions to the deficiencies, while being cognizant of the importance of minimizing property and environmental impacts.

Throughout this process, a wide variety of alternatives covering both long and short-term solutions were developed. Working closely with the Study Advisory Committee (SAC), this list of alternatives was narrowed to four long-term alternatives as well as a number of short-term improvements. Using the evaluation criteria identified in Chapter 1 of this report, a complete analysis of the identified alternatives was prepared, as described in Chapter 4. Continuing to work with the SAC, the recommended list of long-term alternatives was narrowed to two and the short-term improvements were consolidated to three packages. The result of this work was then presented to the general public to solicit input at the second of two scheduled Public Informational Meetings.

The following chapter presents a summary of the recommended short-term improvements, the two long-term alternatives, and potential non-highway, transit, and Intelligent Transportation Systems (ITS) options.

5.1 Short-Term Recommendations

The Short-Term Improvement Packages 1 through 3 summarized below, are described in more detail in Chapter 3. All three of these packages are recommended for implementation and/or construction to provide short-term relief to the identified issues until major long-term improvements can be designed, permitted, and constructed.

5.1.0 Short-Term Improvement Package 1

Short-term Improvement Package 1 would consist of a series of improvements that could be implemented rapidly and at a relatively low cost. As detailed in Chapter 3 of this report, the five components of this Short-Term Improvement Package are:

- *Clear growth in the northwest quadrant to improve sight lines for vehicles exiting the rotary.*
- *Install warning signs for westbound vehicles exiting the rotary to watch for stopped traffic ahead.*
- *Install “No Engine Brake” signs along Route 113 west of rotary.*
- *Install flashing yellow warning beacon at bottom of southbound off-ramp.*
- *Investigate the possibility of installing additional lighting at the rotary and in the vicinity.*

It is recommended that these five improvements and/or modifications be implemented as soon as practical. It is assumed that they could be completed as part of MassHighway's highway maintenance program.

It should be noted, however, that careful consideration needs to be given to the use of "No Engine Brake" signs. While truck noise and specifically the noise believed to be generated by the use of engine brakes was commonly raised as a major concern of residents, any installation of these signs needs to be consistent with any existing or future statewide policy on the use of these signs along state routes.

Additionally, the installation of lighting in and around the rotary is under the jurisdiction of MassHighway District 4 and further investigation is necessary to determine the need, feasibility, and cost of this improvement.

5.1.1 Short-Term Improvement Package 2

Short-Term Improvement Package 2 would consist of the application of pavement markings in the rotary and on the approaches, and the installation of advance signage on all four approaches to the rotary. A detailed description of this short-term improvement package is included in Chapter 3 of this report. Short-Term Improvement Package 2 would provide a relatively lower cost improvement to the existing condition by using pavement markings and signs to channelize traffic flow through the rotary, in order to improve operations and aid drivers in lane selection approaching and within the rotary.

As discussed in Chapter 4, MassHighway recently placed pavement markings in the rotary that are similar to what was developed and recommended. Given the similarities between the proposed pavement markings and what is currently in place, it is recommended that MassHighway refrain from making modifications to the pavement markings within the rotary until reapplication is necessary. However, what is proposed and what was recently applied do differ slightly, so implementing advance signage and pavement markings on the approaches would require a reapplication and modification within the rotary. Any striping or sign installation would be done in conformance with the Manual on Uniform Traffic Control Devices.

5.1.2 Short –Term Improvement Package 3

The third set of short-term improvements, Short-Term Improvement Package 3, would address several critical shortcomings in the project area. First, the construction of bypass lanes at three of the four approaches to the rotary would allow some vehicles to avoid entering the rotary.

Specifically, vehicles that would previously enter the rotary and take the first exit point out of the rotary would be able to bypass the rotary via an additional lane, and the lane would lead directly to the eastbound or westbound arterial. This would reduce the number of vehicles required to merge into the rotary, resulting in improved operations through the rotary and on the approaches. This is particularly critical for the northbound off-ramp where off-ramp queues often extend onto the mainline I-93 during the PM peak period.

Figure 5-1: Short-Term Improvement Package 2

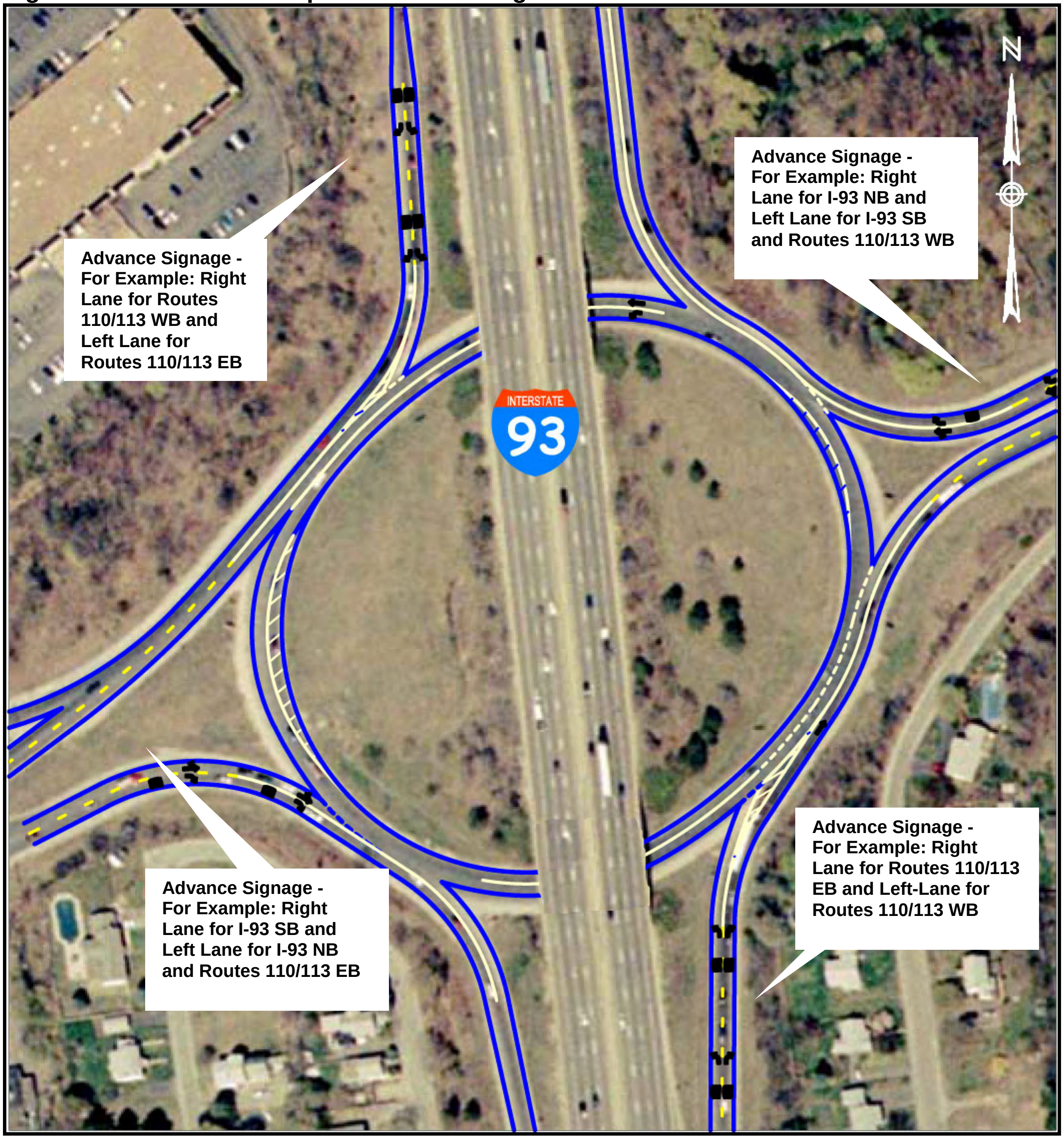


Figure 5-2: Intersection LOS Summary Future No-Build and Short-Term Package 3

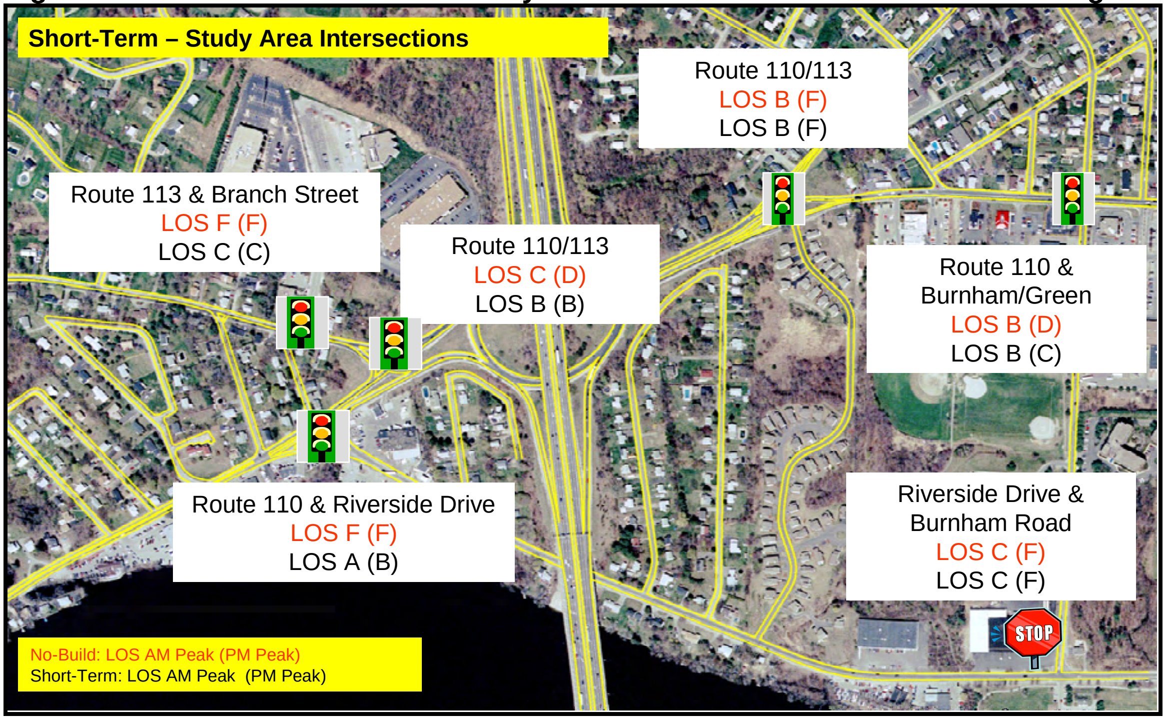


Figure 5-3: Short-Term Improvement Package 3 Components

This improvement package would also realign the westbound exit of the rotary. Realigning this exit farther to the south would lengthen the weaving distance between the southbound off-ramp and westbound exit; it would improve the sight distance for vehicles traveling westbound on Route 113; and it would force vehicles to exit the rotary at a slower rate of speed, which is critical given the identified problem of drivers being confronted with unexpected stopped traffic extending from Route 113 westbound.

As described in Chapter 3, Short-Term Improvement Package 3 would also make signal improvements to three intersections west of the rotary. The addition of two new signals at Route 110/Riverside Drive and Route 113/Branch Street intersections, timing improvements to the existing signal at the intersection of Routes 110/Route 113, and the coordination of all three signals would significantly improve the operations of these intersections. This is reflected in the improved Levels of Service as shown in Figure 5-2.

Short-Term Improvement Package 3 would combine the benefits of the three components into a single alternative. The alternative as shown in Figure 5-3 presents a full-build approach with the construction of all three bypass lanes, the realignment of the westbound exit and traffic signal improvements. Any of these components could be constructed independently of one another, although it is recommended that all of them be implemented to achieve the greatest benefit.

Short-Term Improvement Package 3 Construction Cost: $2,430,000

Additionally, there was a concern among local residents regarding excessive vehicles speeds along Route 113 west of the rotary. The data analysis contained in Chapter 2 confirmed that westbound vehicles between Appaloosa Drive and Presidential Lane were traveling at speeds significantly higher than the posted limits.

This type of identified issue is under the jurisdiction of the municipality. Therefore, it is recommended that local residents contact the Mayor's of Methuen's Office as well as the Methuen Police Department to increase patrols and speed enforcement in the identified area.

5.2 Long-Term Recommendations

5.2.0 Introduction

While providing some relief to the existing congestion and safety issues in the project area, the short-term improvements would not provide sustainable long-term improvements for the future year no-build conditions. Therefore, it was necessary to recommend the implementation of a long-term solution that would adequately address the existing and expected future deficiencies, while minimizing environmental and Right-of-Way impacts, and was supported by the SAC and general public.

Working with the SAC, and with the general public through the Public Informational Meetings and other outreach efforts, two long-term alternatives were identified that should be advanced for further study into the environmental phase. The two long-term alternatives recommended for additional study are Alternative 2B (Figure 5-4) and 3A (Figure 5-5). **Additionally, working with the SAC Alternative 3A was identified and recommended as the preferred long-term alternative.**

Alternative 2B Construction Cost: $48,000,000
***Alternative 3A Construction Cost: $44,000,000 (Preferred Alternative*)**

5.2.1 Alternatives Analysis

The development of long-term alternatives was a methodical process beginning with an assessment of existing conditions and identification of infrastructure deficiencies. Based on this assessment, eleven (11) preliminary alternatives were prepared. Many of these alternatives were eliminated relatively quickly as not sufficiently addressing the identified shortcomings. From this initial development, four alternatives were identified as having potential for advancement. These four alternatives were analyzed based on the evaluation criteria identified in Section 1.3 of this report. A more detailed description of this alternatives analysis is contained in Chapter 4.

In general, the four alternatives identified provided a similar level of benefits and impacts. The primary difference among these alternatives was the anticipated construction cost. Alternative 2A and 3B are projected to cost between 25% and 35% more than Alternatives 2B and 3A. Because Alternatives 2A and 3B were projected to cost significantly more than Alternatives 2B and 3A to construct with little additional benefit, it was determined that these two alternatives should be removed for further consideration.

5.2.2 Recommended Long-Term Alternatives

Alternatives 2B and 3A would provide workable solutions to the deficiencies identified in Chapter 2. Both alternatives would provide operational and safety improvements for the local roads and I-93, improve bicycle and pedestrian connectivity, minimize impacts to abutters and natural resources, and would provide a feasible solution to the identified issues that could be moved forward as a project. However, through further review with the SAC, several key features served to help identify Alternative 3A as the preferred alternative. These differences include:

- ***Southbound on-ramp queues*** – Based upon CORSIM analysis of the future build condition, there is a potential for queues from the southbound on-ramp in Alternative 2B to extend into the central intersection. If queued traffic extends into this intersection, it would have significant impacts to the operations of Route 110 and 113 and all four ramps.
- ***Spacing between signalized intersections*** – Alternative 2B would require a signal at the central intersection approximately half-way between the signals at the Routes 110 & 113 intersection west and east of the rotary. By not requiring this signal, Alternative 3A would provide more spacing between signalized intersections to allow for more vehicle

storage, which would result in less likelihood for interference between signals as well as provide additional space for proper sign installation.

- ***Signal under the I-93 Bridge*** – Alternative 2B requires a major signalized intersection directly under the I-93 bridge. This could create difficulty developing an acceptable profile that provides sufficient sight distance for the traffic signal heads.
- ***Large I-93 Bridge over Routes 110/113*** – While both Alternatives 2B and 3A would require a large bridge carrying I-93 over the combined Route 110/113, the bridge for Alternative 2B would need to be larger and more costly than the one for Alternative 3A. This larger bridge would span the additional distance required to accommodate the on and off-ramps as they curve towards the central intersection. Also, this intersection would prohibit the use of a central pier for the bridge, resulting in substantial structure depth. This would likely require lowering Route 110/113 or raising the I-93 mainline, further complicating construction staging and possibly increasing costs.
- ***Southbound on-ramp merge*** – The southbound on-ramp for Alternative 2B would have a series of lane merges as the ramp approaches the highway where it would merge as a two lane on-ramp. The southbound on-ramp for Alternative 3A would separate the eastbound and westbound traffic and merges them at separate points. This would provide fewer potential conflict points, resulting in a safer configuration.
- ***Driver familiarity*** – The Single Point Urban Interchange configuration is not as common as the partial cloverleaf configuration, particularly in Massachusetts. This would result in reduced driver familiarity and potentially increase driver confusion for the configuration proposed in Alternative 2B.

  Design Waiver – While the operations of the southbound on-ramp in Alternatives 2B is projected to provide acceptable levels of service, the merging and acceleration distances provided do not meet minimum AASHTO criteria. The configuration of this alternative as currently depicted would require design exception approval. Providing the necessary distances would require widening of the I-93 bridge over the Merrimack River.

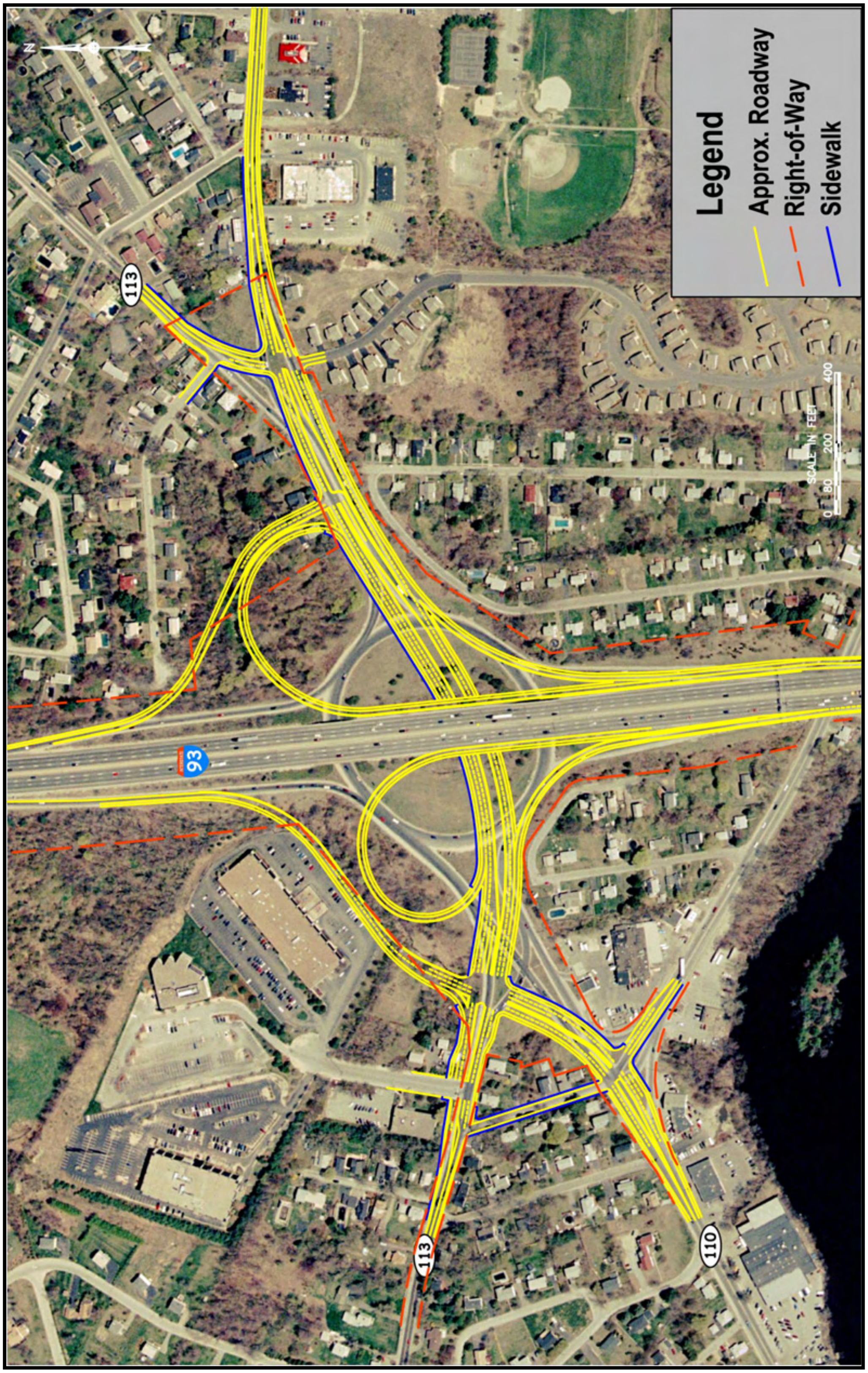
Additionally, it is recommended that the following should also be considered as part of the long-term recommendations:

- If sound barriers are determined to be warranted during the environmental process, all efforts should be made to install the barriers at the beginning of construction of the long-term improvement project in order to mitigate noise from construction as well as the ambient noise levels from the I-93 mainline.
- During the environmental and design phases, closing Bolduc Street at the northern end or the southern end should be investigated in cooperation with the City of Methuen and local residents. This would prohibit vehicles from using Bolduc Street as a cut-through northbound between Route 110 or Riverside Drive and Route 113, while still allowing residential access.

Figure 5-4: Long-Term Alternative 2B

MASSACHUSETTS EXECUTIVE OFFICE OF TRANSPORTATION

Figure 5-5: Long-Term Alternative 3A



5.3 Transit, Park and Ride, and ITS Options

The transit, park and ride, and ITS options developed as part of the Route 110 and 113 Methuen Rotary Interchange Study are described in Chapter 3, and the evaluation of the conceptual-level benefits and costs are described in Chapter 4. All of these components were presented to the SAC, and to the public at the Public Informational Meeting held on November 8, 2007. Subsequently, the comments received from the public were discussed by the SAC on December 11, 2007. All of these options were viewed favorably by the general public with the exception of the park and ride lot.

Several members of the public felt strongly that the proposed locations of the park and ride lot on Route 113 in Methuen, west of the rotary, would actually result in an increase in traffic movements through the rotary, and to the west of the rotary. Many of these individuals felt that the location of the park and ride should be further towards the west in Dracut, or not constructed at all. Therefore, this study does not recommend a park and ride lot in Methuen along Route 113. However, if the Town of Dracut has interest in locating a park and ride lot on Route 113, it is recommended that the Town of Dracut contact MassHighway to begin discussions on a proposed location.

5.4 Implementation Scenarios and Construction Schedules

As discussed previously, the alternatives developed present two general levels of improvements: those that could be implemented in a relatively short time frame (1 to 5 years) and those that will require a much longer time frame to develop and implement (5-12 years).

In terms of initiating and implementing any or all of the recommended the improvements, MassHighway, the City of Methuen, legislators, and the Merrimack Valley Planning Commission (MVPC) were all members of the SAC and were thoroughly involved in all aspects of the study process. However, it is recommended that the City of Methuen, legislators, the MVPC, and/or any interested parties send a project initiation request letter to the Massachusetts Highway Department Commissioner and District 4 Highway Director to express support for the study's recommendations.

Further, it is recommended that a committee, with a similar makeup as the SAC, continue to meet on a regular basis in order to track the study recommendation's progress, as a show of continued support, and to continue the local, regional and state coordination efforts.

Short-Term Improvement Packages
The short-term improvement packages consist of improvements that could be implemented with varying timelines, but all within five years of the completion of this study. These packages are further grouped into three levels of improvements.

- Short-Term Improvement Package 1 consists of a number of improvements that would fall under the category of general maintenance and, as such, could be implemented within 6 months depending on MassHighway District 4's staff availability.

- Likewise, Short-Term Improvement Package 2 consists of improvements that could generally be implemented under existing maintenance programs. It should be noted that as part of its ongoing maintenance program, MassHighway personnel recently restriped the rotary similar to what is included in Short-Term Improvement Package 2. Given the similarities between the proposed pavement markings and what is currently in place, it is recommended that MassHighway refrain from making modifications to the pavement markings within the rotary until reapplication is necessary. However, what is proposed and what was recently applied do differ slightly, so implementing advance signage and pavement markings on the approaches would require a reapplication and modification of striping within the rotary. Any striping or sign installation would be done in conformance with the Manual on Uniform Traffic Control Devices.

- Short-Term Improvement Package 3 consists of modifications which, given their design complexity and anticipated construction cost, extend beyond the typical extents of maintenance operations. These improvements will require programming of funds by the Merrimack Valley Metropolitan Planning Organization (MVMPO) in the regional Transportation Improvement Program (TIP).

  Concurrently, MassHighway could procure an outside design consultant or proceed with an in-house design, depending on funding and staff availability. It is anticipated that it would require approximately one to two years for completion of the design phase. Once the design phase is complete, the project will need to be funded through the MVMPO's TIP. Once funding is secured, the project will need to be advertised and awarded to a contractor for construction, and then construction would follow. This phase of the project is anticipated to require two years to complete.

  At a minimum, this results in a total time period of three to four years to fully implement this improvement package.

Long-Term Alternatives

Given the similarities between the Long-Term Alternatives, they would follow the same implementation process and have generally the same required time frame.

The alternatives will need to be advanced to the Environmental Study Phase by the Massachusetts Highway Department as the proponent. This phase will review the identified alternatives in terms environmental impacts and prepare an Environmental Assessment at the Federal level, and an Environmental Notification Form followed by a Draft and Final Environmental Impact Report at the State level. This phase will result in a selected alternative that can be advanced to the Final Design Phase. The Environmental Phase of the project including consultant procurement or in-house preparation, environmental documentation, and design development is anticipated to require approximately three to four years for completion.

The Final Design Phase of the project will consist of engineering design, acquisition of all necessary environmental permits, and completion of the Right-of-Way process. This phase is anticipated to require three to four years to complete.

Upon completion of design and permitting and acquisition of all necessary ROW, this project will need to be programmed for funding in the regional and Statewide TIP. Next it will need to be advertised for construction. It is anticipated that the construction phase of the project will require approximately three to four years for completion.

This results in a minimum total project time frame of between nine and twelve years upon completion of this study to completed construction. However, a number of variables could extend the time frame, such as the complexity of the environmental process and determining mitigation; the right-of-way process; project design; the availability of funding for construction; and construction staging.