Transportation Plan

North River Canal Corridor

City of Salem, Massachusetts

Mayor Kimberley Driscoll

Office of Planning and Community Development

ENGINEERS FST Since 1914

FAY, SPOFFORD & THORNDIKE

June 2012

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1. INTRODUCTION

1.1 OVERVIEW

The City of Salem retained Fay, Spofford & Thorndike, LLC, and (FST) to conduct a transportation study within the North River Canal Corridor (NRCC). NRCC is a diverse neighborhood district a mix of commercial, residential, and industrial uses adjacent to vibrant residential neighborhoods. Once a predominantly industrial area known as Blubber Hollow, the NRCC had tanneries and mills located along the canal that fell into decline by the mid-20th century. Many of these properties presently remain vacant and dilapidated. Proposed redevelopment of five sites within the NRCC will result in the transformation of what was once a primarily industrial area into an updated array of residential and commercial uses consistent with the surrounding neighborhood and special NRCC zoning. During the past 5 years, the City of Salem has approved the redevelopment of three of the five NRCC sites, a fourth area is under review, and the fifth is expected to submit concept plans by 2013. This study focuses on the cumulative transportation impacts associated with the redevelopment of these five sites.

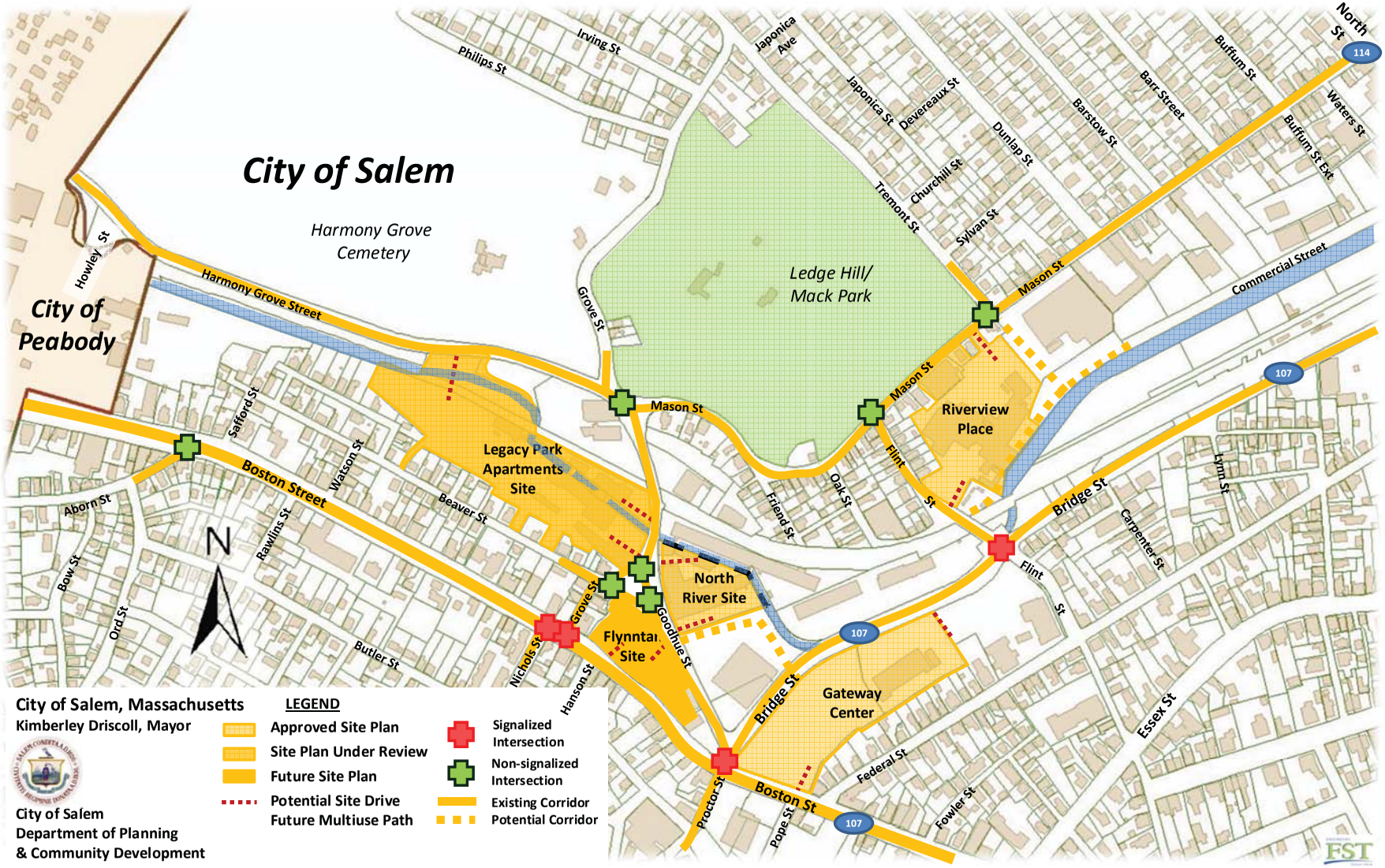
Figure 1 provides an overview map of the NRCC study area defined by considering the location of the proposed and potential project sites, primary access routes to and from the sites, and key intersections likely to be affected by project-generated vehicle, pedestrian, and bicycle trips. Figure 2 summarizes historical traffic counts that have been performed in the area. Locations of the five programmed and potential development sites within the next five years are illustrated on Figure 3.

Corridor study area limits include portions of the NRCC and comprise Mason Street/Harmony Grove to the north, Boston Street/Federal Street to the south, Flint Street/Tremont Street to the east, and Howley Street to the west. Redevelopment of the five potential sites will result in the renovation of what was once a predominantly industrial area into residential and commercial uses consistent with the nearby neighborhood. Study area intersection traffic operations, crash history, traffic controls, roadway and lane requirements, and overall geometric features were evaluated.

Most study counts used for evaluating traffic conditions were performed during 2011. The City of Salem selected a 5-year horizon period of 2016 to assume full build-out of five potential mixed-use developments in the study area with programmed roadway modifications. This study evaluates consolidated trip generation characteristics, and future projections of the five potential development site locations to assess the safety, access and egress, layout, and overall corridor impacts associated with them over the next five years and whether programmed traffic mitigation measures are sufficient to accommodate their projected traffic impacts. The 5-year horizon or year 2016 build-out is standard procedure for transportation studies conducted in the State as outlined in the Massachusetts Environmental Policy Act (MEPA) regulations[1].

[1] *Guidelines for EIR/EIS Traffic Impact Assessment;* Executive Office of Energy and Environmental Affairs/ Executive Office of Transportation

Intersections & Corridors Addressed



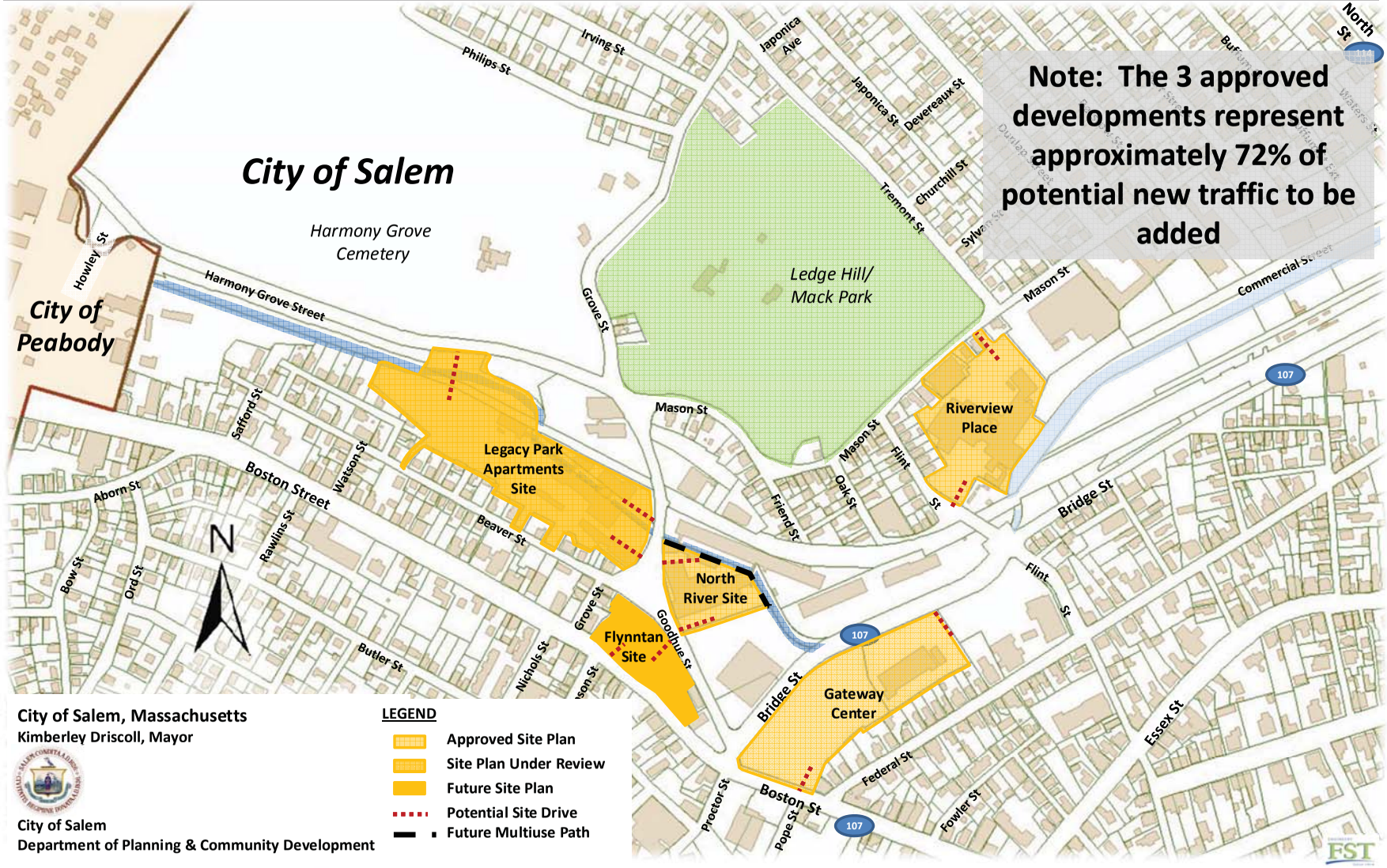
North River Canal Corridor Transportation Plan

Figure 1

Historic NRCC Count Locations

Figure 2

Key Redevelopment Parcels



North River Canal Corridor Transportation Plan

Figure 3

1.2 PURPOSE AND KEY INTERSECTIONS EVALUATED

Purposes of the study are to:

- Identify the potential cumulative traffic impacts of the five permitted or potential redevelopment projects;
- Determine what, if any, transportation improvements should be implemented beyond what has already been proposed or planned, including proposed roadway connections;
- Identify priorities for implementation; and
- Provide preliminary order-of-magnitude cost estimates for proposed improvements *within public rights-of-way*.

Key study area intersections as identified by the City of Salem, by control type, include:

Traffic Signal Controlled

- Boston Street/Bridge Street/Goodhue Street/Proctor Street
- Bridge Street/Flint Street
- Boston Street/Nichols Street/Grove Street

Unsignalized

- Grove Street/Mason Street/Harmony Grove Road
- Mason Street/Flint Street
- Mason Street/Tremont Street
- Goodhue Street/Grove Street/Beaver Street
- Aborn Street at Boston Street

The public process for the study included three public community meetings held at the City of Salem Planning Board. Two meetings, one of which was 'pro bono', reviewed options evaluated and Presentations for each meeting were provided to the City in pdf format and posted on the City's website. Written and verbal comments received were considered along with City coordination meetings to develop the recommended strategy for the NRCC transportation mitigation measures included in this report. A third meeting was held to present FST's recommendations based on the analysis and community input received.

2. EXISTING CONDITIONS

2.1 GEOMETRICS AND LAND USE

FST conducted a field reconnaissance during late afternoon on June 16, 2011 to observe late afternoon traffic operations, measure roadway and intersection geometry, record speed limits, note the presence of traffic control devices and pavement markings, identify land uses, and the general roadway network layout and general topography of the roads. All roads in the study area are under the City of Salem's jurisdiction.

Boston Street/Bridge Street/Goodhue Street/Proctor Street

This five-way signalized intersection consists of Boston Street running in an east/west direction, and Bridge Street approaching from the north. Proctor Street is a one-way southbound away from the intersection and Goodhue Street is one-way north-eastbound away from the intersection, thereby resulting in a five legged intersection being controlled by three legs only. The southbound Bridge Street approach is comprised of a shared left-turn/through lane and right-turn lane. The westbound approach of Boston Street has a shared left-turn/through lane and an exclusive right-turn lane. The eastbound approach of Boston Street has a left-turn lane and shared though/right-turn lane. Goodhue Street is located off Bridge Street just north of Boston Street. It is one-way in the westbound direction. The stop line for the southbound approach is located in front of Goodhue Street to allow turning traffic from Boston Street to enter it. Surrounding this intersection are the Flynntan and Gateway sites in addition to a Walgreens on the south side of Boston Street and a Dunkin Donuts on the northwest corner of the intersection. See Figure 4 for an aerial of the intersection.

Looking north across Goodhue Street to Bridge Street southbound queue

Looking south to Boston Street and Goodhue Street on Bridge Street

Aerial Source: Salem GIS
Not to Scale

North River Canal Corridor Transportation Study
Salem, Massachusetts

City of Salem, Massachusetts
Kimberley Driscoll, Mayor

AERIAL VIEW
BOSTON STREET AT BRIDGE (ROUTE 107), GOODHUE, AND PROCTOR STREETS

City of Salem
Department of Planning & Community Development

FIGURE 4

Bridge Street/Flint Street

This four-way signalized intersection consists of Bridge Street running in a north/south direction and Flint Street approaching from the east and west. The northern approach of Bridge Street is a single shared left-turn/through/right-turn lane. The southern approach of Bridge Street consists of a left-turn lane and shared through/right-turn lane. The eastbound approach of Flint Street has a left-turn lane and shared through/right-turn lane. The westbound approach is a single shared left-turn/through/right-turn lane. To the west of the intersection is the canal and to the east is a residential area. There is a crosswalk on all approaches with pedestrian accommodations. Refer to Figure 5 for an aerial of the intersection.

Looking east across Bridge Street from Flint Street

Looking west from Bridge Street to Flint Street eastbound queue

Grove Street/Mason Street/Harmony Grove Road

This four-way unsignalized intersection consists of Grove Street running in a north/south direction, Mason Street approaching from the east, and Harmony Grove Road approaching from the west. The intersection has a steep downslope toward Grove Street and is stop-controlled approaches with a shared left-turn/through/right-turn lane. Mason Street east of the intersection has potholes and is in need of repair. To the northwest is Harmony Grove Cemetery, northeast of the intersection is Ledge Hill/Mack Park, and to the south are commercial and residential areas. Harkins Square memorial channelizes northbound free right turns from Grove Street to Mason Street by a triangular island. See Figure 6 for an aerial of the intersection.

Looking north to Harmony Grove Street on Grove Street

Looking east to Mason and Grove Streets on Harmony Grove Street

Aerial Source: Salem GIS
Not to Scale

North River Canal Corridor Transportation Study

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AERIAL VIEW
BRIDGE (ROUTE 107) AT FLINT STREETS

FIGURE 5

Aerial Source: Salem GIS
Not to Scale

North River Canal Corridor Transportation Study

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AERIAL VIEW
GROVE AT MASON, HARMONY GROVE STREETS

City of Salem
Department of Planning & Community Development

FIGURE 6

Mason Street/Flint Street

This tightly constrained three-way 'T' unsignalized intersection consists of Mason Street running in an east/west direction with Flint Street approaching from the south under stop control. Mason Street consists of a single lane in both directions and no shoulders. Flint Street is a narrow residential street with parking on its west side only. It approaches Mason Street with a single shared left/right-turn lane. The narrow Mason Street southbound approach causes left-turns onto Flint Street to stop and queue westbound Mason Street traffic. When on-street parking occurs on the west side of Flint Street, per the photo below, only one lane of traffic can traverse Flint Street at a time. To the north of the intersection is Ledge Hill/Mack Park and to the south is a residential area. Refer to Figure 7 for an aerial of the intersection.

Looking northeast to Flint Street intersection on Mason Street

Looking west on Flint Street to Mason Street with parking on south side

Mason Street/Tremont Street

This three-way unsignalized intersection consists of Mason Street running in an east/west direction with Tremont Street approaching from the north. Mason Street consists of a single lane in both directions. Tremont Street is a residential street with a single lane approach. The intersection is surrounded by Ledge Hill/Mack Park to the west and residential areas to the north and east. As indicated in the photos below, the intersection is challenging in that Tremont Street approaches on a steep downgrade, hence the guard rail, and the wall on Mason Street restricts the sight line to the east of the intersection. Refer to Figure 8 for an aerial of the intersection.

Looking south on Tremont Street to Mason Street

Looking east on Mason Street to Tremont Street

Aerial Source: Salem GIS
Not to Scale

North River Canal Corridor Transportation Study

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AERIAL VIEW
FLINT AT MASON STREETS

FIGURE 7

Aerial Source: Salem GIS
Not to Scale

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AERIAL VIEW
TREMONT AT MASON STREETS

FIGURE 8

Goodhue Street/Grove Street/Beaver Street

This four-way unsignalized intersection has a massive paved area, including some off-street parking. The intersection has a relatively steep upgrade from east to west. Beaver Street is abutted primarily by residential users, with a few easements from Salem Oil & Grease Company. Goodhue Street to the east of the intersection and Grove Street, to the north are abutted by industrial/commercial land uses. Grove Street, to the south of Beaver Street, is abutted by residential users, and is one-way southbound approaching a traffic signal at Boston Street. North of Beaver Street, Grove Street is in fair condition and its adjacent former industrial buildings are in very poor condition. Goodhue Street is one-way westbound approaching the intersection, while Grove Street north of the intersection is two-way, as is Beaver Street west of the intersection. Refer to Figure 9 for an aerial of this unusually large and unconventional intersection and the nearby signalized intersection of Boston at Grove/Nichols Streets.

Looking northwest on Goodhue Street to Grove Street

Looking east on Beaver Street to Goodhue Street and trucks parked on-street and wide paved area

Boston Street/Grove Street/Nichols Street

This off-set signalized intersection consists of Boston Street running in an east/west direction, Grove Street approaching from the north, and Nichols Street approaching from the south. Both Grove and Nichols Streets have a single approach lane and are one-way into Boston Street. The intersection operates on separate phases for traffic approaching on either street due to the offset. Traffic approaching on Boston Street is therefore not turning, only going straight either westbound or eastbound. Crosswalks are provided, though, as can be seen below, both pavement markings and their ADA compliance features are in need of an upgrade, as is the Boston Street corridor in general. Sidewalks are provided on all sides of this intersection. Figure 9 also includes an aerial view of Boston at Grove and Nichols Streets.

Looking north across Boston Street from Nichols Street at ADA-deficient Crossing

Looking south on Grove Street to Boston Street

Aerial Source: Salem GIS
Not to Scale

City of Salem, Massachusetts
Kimberley Driscoll, Mayor

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AERIAL VIEW
GOODHUE AT BEAVER, GROVE AND
BOSTON STREETS

FIGURE 9

Boston Street at Aborn Street

Aborn Street intersects Boston Street on a skew to the northeast. The Aborn Street approach to Boston Street is stop-sign controlled with a side-mounted flashing yellow hazard beacon for Boston Street and flashing red beacon facing the Aborn Street approach. Boston Street runs in an east-west direction, while Aborn Street runs in a southwest to northeast direction. The intersection of Aborn Street at Boston Street produces a long crossing for pedestrians. Motorists exiting Aborn Street must negotiate acute-angled sharp turns, with visibility to the west constricted. Crosswalks are provided across the Aborn Street approach and the eastbound Boston Street approach. Figure 10 provides an aerial of the intersection.

Looking northeast from Aborn Street to Boston Street

Looking southwest from Boston Street to Aborn Street

Aerial Source: Salem GIS
Not to Scale

North River Canal Corridor Transportation Study

City of Salem, Massachusetts
Kimberley Driscoll, Mayor

City of Salem
Department of Planning & Community Development

AERIAL VIEW
ABORN AT BOSTON STREETS

FIGURE 10

2.2 DATA COLLECTION

Traffic Volumes

In order to evaluate traffic operating conditions at the study area intersections in Salem, a traffic count program was conducted on June 23, 2011. This traffic count program consisted of new manual turning-movement counts (TMCs) at six (6) of the eight evaluated intersections in the study area. New TMC's were performed at the following study area intersections:

- Boston Street/Bridge Street/Goodhue Street/Proctor Street
- Bridge Street/Flint Street
- Grove Street/Mason Street/Harmony Grove Road
- Aborn Street/Boston Street
- Grove Street/Nichols Street/Boston Street
- Goodhue Street/Grove Street/Beaver Street

Counts from the Flint/Mason Streets and Mason/Tremont Streets were performed by EarthTech (now AEComm) during 2007 and were found to balance well with a new automatic traffic recorder counts on Mason Street between the two intersections as well as manual counts performed at Harmony Grove/Grove/Mason Streets and Flint/Bridge Streets counts performed by FST. Counts were balanced as necessary for assessing the AM and PM peak hour traffic operations. Pedestrians and bikes were also counted during the TMC's.

TMCs were taken at all six intersections for two hours during the AM peak period (7-9 AM) and two hours during the PM peak period (4-6 PM). From the data, peak-hour traffic volumes for the study area intersections were determined. Peak hours varied somewhat, but were typically 7:30-8:30 AM and 4:45-5:45 PM within the study area.

Traffic counts were also performed by Vanasse and Associates, Inc. (VAI) during March 2011 in the following locations:

- Grove Street/Mason Street/Harmony Grove Road
- Goodhue Street/Grove Street/Beaver Street
- Boston Street/Grove Street/Nichols Street

The VAI recorded traffic volumes were compared to June 2011 counts. Although the June 2011 FST counts were used for compatibility to the rest of the volumes network, the March 2011 VAI data collected by VAI was reasonably comparable to the data collected by FST during June, either slightly higher or slightly lower. Both the March and June 2011 count data was consistent with earlier counts performed by others in the area (refer back to Figure 2 for an illustration of the counts performed in the study area during the past 10 years.

Seasonality of traffic data was reviewed using the MassDOT database of seasonal factors. Data indicates that the month of June, when FST's traffic data was collected, is typically10% above the average month. To be conservative, or on the high side, no seasonal adjustments (i.e., traffic reductions) were made to the traffic data. AM and PM 2011 traffic volumes used for analysis are shown in Figure 11.

Table 1 presents a summary of existing traffic volumes recorded as part of the traffic count program. These intersections process approximately the same amount of traffic during the AM and PM peak hours. Table 1 indicates traffic volumes were typically 10-11% higher during the afternoon peak hour than during the morning peak hour. The two Bridge Street signalized intersections at Boston and Flint Streets recorded the highest volumes, while the intersection of Goodhue at Grove and Beaver Streets recorded the lowest volumes. The intersection of Aborn Street at Boston Street carries slightly higher peak hour traffic volumes than the signal-controlled offset intersection of Boston Street at Grove and Nichols Streets.

Table 1
2011 Existing Traffic Volumes Entering by Intersection*

Location	AM Peak	PM Peak
Boston Street/Bridge Street/Goodhue Street/Proctor Street	2,280	2,490
Bridge Street/Flint Street	1,925	1,915
Aborn Street/Boston Street	1,635	1,880
Grove Street/Nichols Street/Boston Street	1,615	1,825
Grove Street/Mason Street/Harmony Grove Road	840	1,075
Goodhue Street/Grove Street/Beaver Street	180	200

***** Rounded to nearest 5 vehicle trips per hour

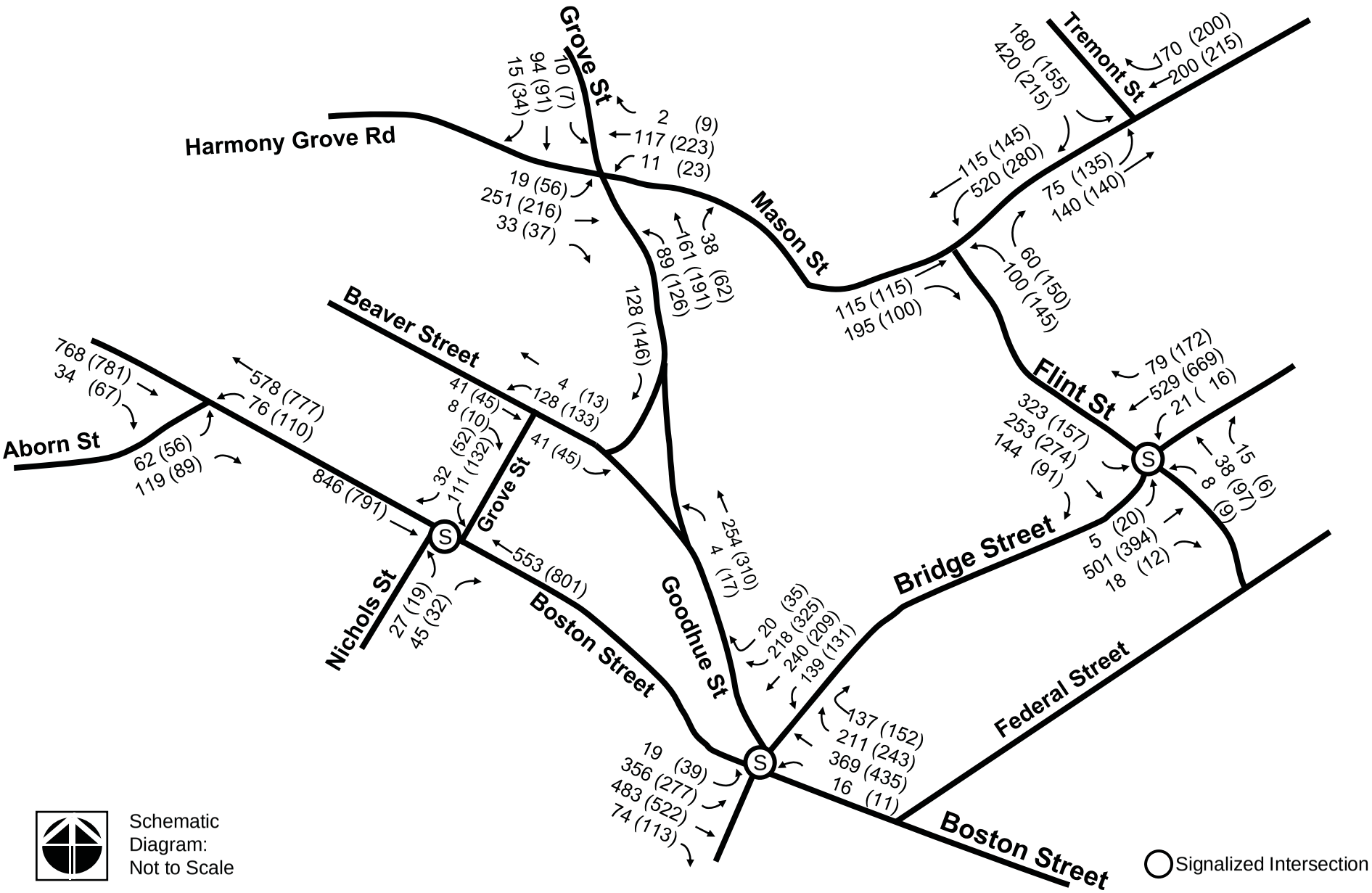
Automatic traffic recorder (ATR) counts were also conducted for this study. The results are shown in Table 2.

Table 2
2011 Existing 24-Hour Traffic Volume Summary*

Roadway	Location	Average Daily Traffic*
Boston Street	East of Grove Street	15,300
Bridge Street	East of Flint Street	14,150
Mason Street	West of Tremont St	9,200
Harmony Grove Rd	West of Grove St	7,750
Aborn Street	South of Boston St	3,950

* Rounded to nearest 50 vehicle trips per day in both directions

As anticipated, Boston and Bridge Streets, respectively, carry the heaviest average daily and peak hour traffic volumes. Bridge Street is State Route 107, while Boston Street is an east-west urban arterial that serves as an alternative to North Street (State Route 114). Mason Street, between Tremont and Flint Streets is also very busy for an Urban Collector functionally-classified roadway. Its traffic volume is highest between Tremont and Mason Streets.



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City of Salem
Department of Planning & Community Development

North River Canal Corridor Transportation Study

EXISTING 2011 AM (PM) PEAK HOUR TRAFFIC VOLUMES

FIGURE 11

2.3 EXISTING TRAFFIC OPERATIONS

Level of Service (LOS) is an expression of the quality of flow of traffic. LOS is a commonly used and accepted measure of the effectiveness of peak hour traffic operating conditions. It takes into account automobile and truck volumes, roadway width, speed, grade, parking restrictions, pedestrian activity, and traffic control devices. LOS is designated in a range from Level "A", which is the optimal condition where roadway operations are at their best, to Level "F" which indicates excessive delays. Levels "A" through "D" are typically associated with acceptable levels of peak hour traffic operations. At Level "E", the ratio of the approach volume to capacity, or v/c ratio, of an intersection is between 90 and 100 percent of its theoretical capacity. Traffic congestion is considered to be unacceptable at Level of Service "E" or "F".

All capacity analysis for the study area intersections in Salem was performed in accordance with the methodologies set forth in the 2000 Highway Capacity Manual[1] using the SYNCHRO Version 7 software approved by MassDOT Highway Division[2]. LOS at signalized and unsignalized intersections is based on estimates of delay per vehicle. Table 3 presents a summary of the Level of Service criteria for unsignalized and signalized intersections.

Table 3
Intersection Level of Service Criteria

Level of Service	Unsignalized Delay (seconds/vehicle)	Signalized Delay (seconds/vehicle)
A	≤10	≤10
B	>10 to 15	>10 to 20
C	>15 to 25	>20 to 35
D	>25 to 35	>35 to 55
E	>35 to 50	>55 to 80
F	>50	>80

Source: Highway Capacity Manual, 2000

Table 4 presents a summary of existing traffic operating conditions for the North River Canal Corridor study area intersections; trouble spots (LOS E/F and locations with excessive queuing) are highlighted.

From Table 4, of the unsignalized intersections, three are operating with excessive delays during the AM and PM peak hours -- Tremont at Mason Streets, Boston at Aborn Streets, and Flint at Mason Streets. All three involve problems with left turning operations from the side street stop-controlled approach to the main street. For Tremont at Mason Streets and Mason at Flint Streets, worst case operations occur during the morning peak hour, while the worst operations. *Overall* traffic operations at the signalized intersections are in the acceptable B-C range, but queuing on Bridge Street is an issue that emerges from the analysis and is consistent with on-site observations showing backups toward Flint Street during the afternoon peak hours.

[1] *Highway Capacity Manual*; Transportation Research Board; 2000
[2] *A Guide on Traffic Analysis Tools*, MassDOT, February 2011

Table 4
NRCC Study Area - 2011 Existing AM/PM Peak Hour Traffic Operations

UNSIGNALIZED INTERSECTIONS

Intersection and Movements	AM PEAK Delay[1]	AM PEAK LOS[2]	AM PEAK Queue[3]	AM PEAK V/C[4]	PM PEAK Delay	PM PEAK LOS	PM PEAK Queue	PM PEAK V/C
Grove Street at Beaver Street	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beaver Street EB Right/Through	0	A	0	0.03	0	A	0	0.03
Beaver Street WB Left/Through	7	A	7	0.09	7	A	8	0.10
Grove Street at Goodhue and Beaver Streets	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beaver Street EB Left	11	B	6	0.07	12	B	7	0.08
Goodhue Street NB Through/Left	<1	A	0	0.00	<1	A	1	0.01
Grove Street SB Right	0	A	0	0.11	0	A	0	0.10
Harmony Grove Street at Grove and Mason Streets	14	B	N/A	N/A	N/A	N/A	N/A	N/A
Harmony Grove EB Left/Through/Right	15	C	N/A	0.56	32	D	N/A	0.82
Mason Street WB Left/Through/Right	11	B	N/A	0.28	19	C	N/A	0.59
Grove St NB Left/Through/Right	12	B	N/A	0.46	21	C	N/A	0.68
Grove St SB Left/Through/Right	11	B	N/A	0.27	13	B	N/A	0.28
Tremont at Mason Street	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tremont Street SE Left/Right	91	F	489	1.09	47	E	229	0.87
Mason Street NB Left/Through	3	A	0	0.07	5	A	11	0.13
Mason Street SB Right/Through	0	A	<1	0.24	0	A	0	0.27
Boston Street at Aborn Street	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boston Street EB Through/Right	0	A	0	0.51	0	A	0	0.54
Boston Street WB Through/Left	3	A	9	0.11	4	A	14	0.16
Aborn Street NB Left/Right	153	F	263	1.12	256	F	259	1.31
Flint Street at Mason Street	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flint Street NW Left/Right	358	F	321	1.56	59	F	220	0.89
Mason Street NE Through/Right	0	A	0	0.20	0	A	0	0.14
Mason Street SW Left/Through	10	A	63	0.46	6	A	22	0.23

1 - Delay - Average control delay to nearest second, peak 15 minute period of the peak hour.
2 - LOS - Level of Service from A to F, where A is best, F is worst.
3 - Queue - is 95th percentile queue in feet behind the stop line; i.e, 95% of the time queue does not exceed. A + sign means analysis indicates it can be longer than shown.
4 - V/C - Volume/Capacity is measured or estimated volume to calculated capacity ratio.

Table 4 (Continued)
NRCC Study Area - 2011 Existing AM/PM Peak Hour Traffic Operations

SIGNALIZED INTERSECTIONS

Intersection and Movements	AM PEAK Delay[1]	AM PEAK LOS[2]	AM PEAK Queue[3]	AM PEAK V/C[4]	PM PEAK Delay	PM PEAK LOS	PM PEAK Queue	PM PEAK V/C
Boston Street at Bridge Street (Route 107)	**32**	**C**	**N/A**	**0.86**	**27**	**C**	**N/A**	**0.74**
Boston Street EB Through/Left/Right	40	D	292+	1.05	16	B	279+	0.72
Boston Street WB Through/Right	30	C	291+	0.73	33	C	342+	0.80
Bridge Street SB Left/Through/Right	24	C	246	0.65	33	C	298+	0.81
Flint Street at Bridge Street (Route 107)	**35**	**C**	**N/A**	**0.9**	**29**	**C**	**N/A**	**0.92**
Flint Street EB Left/Through/Right	59	E	217+	1.07	20	B	202+	0.75
Flint Street WB Left/Through/Right	13	B	32	0.12	14	B	53	0.27
Bridge Street NB Left/Through/Right	14	B	203	0.65	9	A	143	0.48
Bridge Street SB Left/Through/Right	19	B	321+	0.79	47	D	485+	1.01
Boston Street at Grove Street	**29**	**C**	**N/A**	**0.89**	**22**	**C**	**N/A**	**0.76**
Boston Street EB Throughs	33	C	842	1.03	10	B	688+	0.87
Boston Street WB Throughs	18	B	334	0.59	29	C	669+	0.85
Grove Street SB Left/Right	40	D	132	0.53	37	D	167	0.47
Boston Street at Nichols Street	**20**	**B**	**N/A**	**0.65**	**15**	**B**	**N/A**	**0.61**
Boston Street EB Through	29	C	746+	0.86	23	C	553	0.76
Boston Street WB Through	4	A	47	0.55	6	A	70 metered	0.80
Nichols Street NB Left/Right	31	C	46	0.13	32	C	257	0.09

1 - Delay - Average control delay to nearest second, peak 15 minute period of the peak hour.
2 - LOS - Level of Service from A to F, where A is best, F is worst.
3 - Queue - is 95th percentile queue in feet behind the stop line; i.e, 95% of the time queue does not exceed. A + sign means analysis indicates it can be longer than shown.
4 - V/C - Volume/Capacity is measured or estimated volume to calculated capacity ratio.

2.4 CRASH HISTORY

In addition to reviewing traffic operating conditions within the study area, FST also investigated recent crash trends in the North River Canal Corridor. As part of this effort, the accident history for the study area intersections were investigated for the three-year period of 2007, 2008, and 2009 from the MassDOT database for the following locations:

- Boston Street/Bridge Street/Goodhue Street/Proctor Street
- Bridge Street/Flint Street
- Grove Street/Mason Street/Harmony Grove Road
- Mason Street/Flint Street
- Mason Street/Tremont Street
- Goodhue Street/Grove Street/Beaver Street
- Boston Street/Aborn Street

Table 5 on the page that follows summarizes the accident types, severity, and crash rates occurring at the intersections in the study area over this three-year period.

Although the number of accidents alone is important, the actual exposure or potential for an individual driver being involved in an accident is reflected in the crash rate. The crash rate is defined as the number of accidents per million entering vehicles (MEV) at an intersection. For roadway links, or the segments between the intersections, this measure is the number of million entering vehicles over that respective link. Using MassDOT's Crash Rate Worksheet (actual computations can be found in the Appendix), it can be seen that the signalized intersection of Boston at Bridge Street has a crash rate *equal to* the MassDOT District 4 crash rate of 0.78 crashes per million entering vehicles for signalized intersections, but under the statewide crash rate of 0.82 crashes per million entering vehicles. Two of the unsignalized intersections, Mason Street at Flint Street, and Grove, Mason, and Harmony Streets *are above the* State and District 4 rates of 0.62 MEV and 0.59 MEV, respectively. The three intersections that are equal to or exceed these rates are primary candidates in the NRCC area for safety upgrades. Additionally, the signalized intersection of Boston at Flint Streets and the unsignalized intersection of Boston at Aborn Streets are just under statewide average rates and should be considered for potential safety upgrades. The remaining intersections studied have crash rates that *are far lower than* the statewide or District 4-wide crash rates for similar facilities. MassDOT intersection crash rate summary sheets are provided in the Appendix to this report.

2.5 PUBLIC TRANSPORTATION SERVICES

The NRCC corridor is served by MBTA bus routes and the Salem commuter rail station on the Newburyport/Rockport Line that provides service between downtown Boston and the City of Salem. Other MBTA buses provide service on Bridge Street (Route 107) as well as the Route 107 portion of Boston Street to the east Bridge Street to its interchange with North Street (Route 114). Nearest bus stops in the area are located on Boston Street at Nichols and Federal Streets. Details of NRCC public transportation services are provided in the Technical Appendix to this report. MBTA bus services are not provided directly on Mason, Grove, Flint, or Goodhue Streets that service the interior of the NRCC corridor.

Table 5
2007-2009 NRCC Crash Summary

	Tremont/ Mason	Boston/ Bridge/ Goodhue	Bridge/ Flint	Boston/ Nichols/ Grove	Boston/ Aborn	Boston/ Federal	Grove/ Mason/ Harmony	Beaver/ Grove/ Goodhue	Mason/ Flint
Year									
2007	4	11	3	4	4	3	2	0	5
2008	1	5	10	7	3	2	4	0	4
2009	1	7	3	2	6	0	3	1	7
Total	**6**	**23**	**16**	**13**	**13**	**5**	**9**	**1**	**16**
Average number of crashes per year	2	7.67	5.33	4.33	4.33	1.67	3	0.33	5.33
Severity									
Property Damage Only	5	12	9	10	9	2	5	0	12
Non-Fatal Injury	1	9	6	3	4	1	4	0	2
Fatal Injury	0	0	0	0	0	0	0	0	0
Not Reported	0	2	1	0	0	2	0	1	2
Total	6	23	16	13	13	5	9	1	16
Type of Accident									
Single Vehicle	1	3	2	0	0	1	1	0	0
Head-On	0	0	0	0	0	0	2	0	3
Angle	4	8	7	2	5	1	3	1	8
Rear-End	0	7	6	9	7	1	2	0	0
Sideswipe	1	2	1	1	0	1	0	0	3
	0	2	0	0	1	1	0	0	0
Pedestrian/Bicyclist									
Not Reported	0	1	0	1	0	0	1	0	2
Total	6	23	16	13	13	5	9	1	16
Crash rate	**0.47**	**0.78**	**0.75**	**0.60**	**0.57**	**0.27**	**0.69**	**0.16**	**1.40**
Average crash rates for similar facilities (District 4/ Statewide)	0.59/ 0.62	0.78/ 0.82	0.78/ 0.82	0.78/ 0.82	0.59/ 0.62	0.59/ 0.62	0.59/ 0.62	0.59/ 0.62	0.59/ 0.62

Data source: MassDOT crash statistics
Yellow highlighted crash rates are at or above District 4 and statewide crash rates for comparable intersections.

3. FUTURE CONDITIONS

To assess future year conditions, an analysis was conducted to review full build out conditions with the five proposed developments in the NRCC. To do this, a 5-year future year condition was selected. The time frame is consistent with Environmental Impact Reports submitted to the Massachusetts Environmental Policy Act (MEPA) Unit. The 5-year time frame is outlined in the *Guidelines for Traffic Impact Assessments*, produced by the Executive Office of Energy and Environmental Affairs and Executive Office of Transportation and Public Works. A future year condition network is essentially comprised of two components: Normal or general background growth and site-specific development.

3.1 GENERAL BACKGROUND GROWTH RATE

In recent years, traffic volumes in the City of Salem and the surrounding communities have generally been declining or holding steady, probably mainly due to the current long-lasting economic downturn. To be conservative, however, 'background' traffic unrelated to the five assumed NRCC development sites was assumed to increase by 1% annually. Therefore, a 5% increase in volumes was assumed between 2011 and 2016.

3.2 PLANNED NRCC DEVELOPMENTS

The City of Salem provided detailed traffic analysis data for three of the five NRCC development sites (refer back to Figure 3 in Section 1) expected to be redeveloped by the year 2016. They include:

- Riverview Place with access from Mason and Flint Streets
- Gateway Center with access from Boston and Bridge Streets
- North River (28 Goodhue Street) Condominiums with two accesses on Goodhue Street
- Legacy Park Apartments (Salem Oil and Grease site) with three accesses on Grove Street and one on Harmony Grove Street
- Flynntan development site with presumed access on Boston and Goodhue Streets

Three of the five sites have been fully permitted and the Legacy Park Apartments site is currently under review by the City. For a conservative analysis, this study assumes that all five of these projects will be constructed and fully occupied by the target year 2016. Additionally, FST contacted the owner of the Flynntan redevelopment site to obtain conceptual data on potential development plans for the site, the only one of the five sites that has not yet prepared a detailed plan for submission to the City. **Accordingly, Flynntan redevelopment data evaluated[1] in this study is preliminary and subject to change.**

Table 6 summarizes development quantity assumptions and AM, PM, and daily traffic generated from the five development projects. Development project trip generation quantities were estimated using information contained in the various site-specific studies, where available and checked against the Institute of Transportation Engineers (ITE) Trip Generation report (8th Edition, 2008).

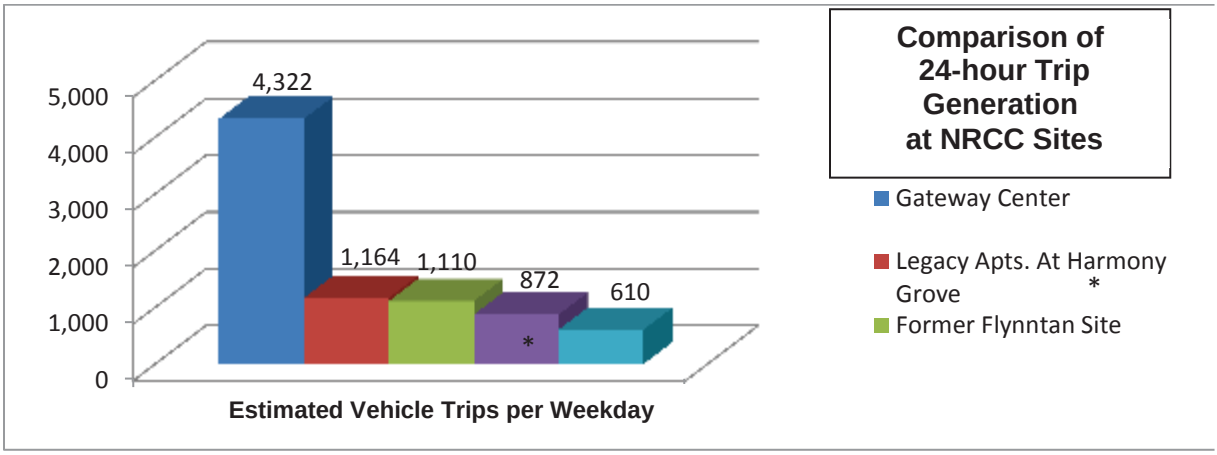
[1] Personal communication, John Penni, June 2011.

Table 6
North River Canal Corridor
New Developments/Trips Summary

Development Site/Components	AM In	AM Out	AM Total	PM In	PM Out	PM Total	AWDT In	AWDT Out	AWDT Sub-totals	AWDT Totals	Assumed Development Quantities
Riverview Place											
Apartments Component[1]	10	41	**51**	40	22	**62**	337	337	**674**		130 Apartments[1]
Retail Component[1]	3	2	**5**	11	14	**25**	99	99	**198**	**872**	5,540 SF Specialty Retail[1]
Subtotals	**13**	**43**	**56**	**51**	**36**	**87**	**436**	**436**	**872**		
Gateway Center											
Health Club Component[2]	14	16	**30**	45	34	**79**	362	362	**724**		22,000 SF Health Club[2]
Recreational Community Center Component[2]	12	20	**32**	11	18	**29**	272	273	**545**		20,000 SF Community Center[2]
Medical-Dental Office Building Component[2]	153	41	**194**	97	146	**243**	1527	1526	**3053**	**4,322**	84,500 SF Med/Dental
Subtotals	**179**	**77**	**256**	**153**	**198**	**351**	**2161**	**2161**	**4322**		
28 Goodhue Site											
Condominium Component	5	22	**27**	21	10	**31**	158	158	**316**		44 Condominiums[3]
Retail Component	20	21	**41**	16	20	**36**	147	147	**294**	**610**	6,000 SF Commercial[3]
Subtotals	**25**	**43**	**68**	**37**	**30**	**67**	**305**	**305**	**610**		
Legacy Apts. At Harmony Grove											
Apartments Component[4]	15	58	**73**	62	33	**95**	499	499	**998**		141 Apartments
Office Component[4]	20	3	**23**	4	19	**23**	83	83	**166**	**1,164**	15,000 SF
Subtotals	**35**	**61**	**96**	**66**	**52**	**118**	**582**	**582**	**1164**		
Former Flynntan Site											
Retail Component	72	78	**150**	33	42	**75**	472	472	**944**		22,000 SF Retail[5]
Office Component	16	3	**19**	3	15	**18**	66	66	**132**		12,000 SF General Office[5]
Apartment Component	1	2	**3**	2	0	**2**	17	17	**34**	**1,110**	5 Apartments[5]
Subtotals	**89**	**83**	**172**	**38**	**57**	**95**	**555**	**555**	**1110**		
Grand Total - NRCC	**341**	**307**	**648**	**345**	**373**	**718**	**4039**	**4039**	**8078**	**8,078**	

Unless otherwise noted, ITE Trip Generation is the source for trip generation of developments.
1- Source: Traffic Impact and Assessment Study, Earth Tech, Inc., October 2007.
2- Source: Traffic Impact and Access Study, Hayes Engineering, October 21, 2009.
3 - Source: 28 Goodhue Site Development Permit Plan, rev. March 22, 2006.
4- Source: Traffic Impact and Access Study, Proposed Legacy Apartments at Harmony Grove, December 2011.
5 - Source: Early preliminary estimate only, John Penni, January 5, 2012.

Trip generation estimates shown on Table 6 were added to the existing volumes grown by 5% to arrive at the 2016 Build peak hour traffic volumes. Trip distribution patterns were based on the published studies. From Table 6, in aggregate, the five new developments are expected to add approximately 650 AM peak hour trips, 720 PM peak hour trips and approximately 8,100 trips on a daily basis. Daily trip quantities estimated for each of the five development sites are shown below.



* Flynntan estimates only, subject to change, as not programmed at this time.

Figure 12 illustrates the combined year 2016 projected traffic volumes for the AM and PM peak hours, while Figures 13 and 14 graphically illustrate numerical differences between 2011 and 2016 projected AM and PM peak hour volumes.

Analysis

Procedures used for traffic analysis for year 2016 projected future traffic conditions were the same that were utilized for existing conditions that are outlined in the 2000 Highway Capacity Manual (HCM) using the Synchro® software version 7 (Build 773, revision 8)..

AM and PM peak hour trips from the potential build out of the parcels were determined using the trip estimating procedures outlined in *Trip Generation*, published by the Institute of Transportation Engineers. Trips were then assigned onto the 2016 No Build traffic network using existing and future traffic patterns presented in prior studies to create the AM and PM peak hour 2016 Build traffic networks. Analysis procedures used previously were then undertaken and the results are summarized in Table 7 for full build out of the area. Table 7 assumes that the following mitigation measures are implemented:

- Signal timing of existing signalized intersections of Boston/Bridge/Goodhue, Boston/Flint, and Boston/Grove are optimized.
- The intersection of Tremont at Mason Street is controlled under *three different conditions* – two-way stop (existing), all-way stop (to resolve sight line issue), and signal control (funded).

Table 8
NRCC Study Area - 2016 Base Traffic Operations

UNSIGNALIZED INTERSECTIONS

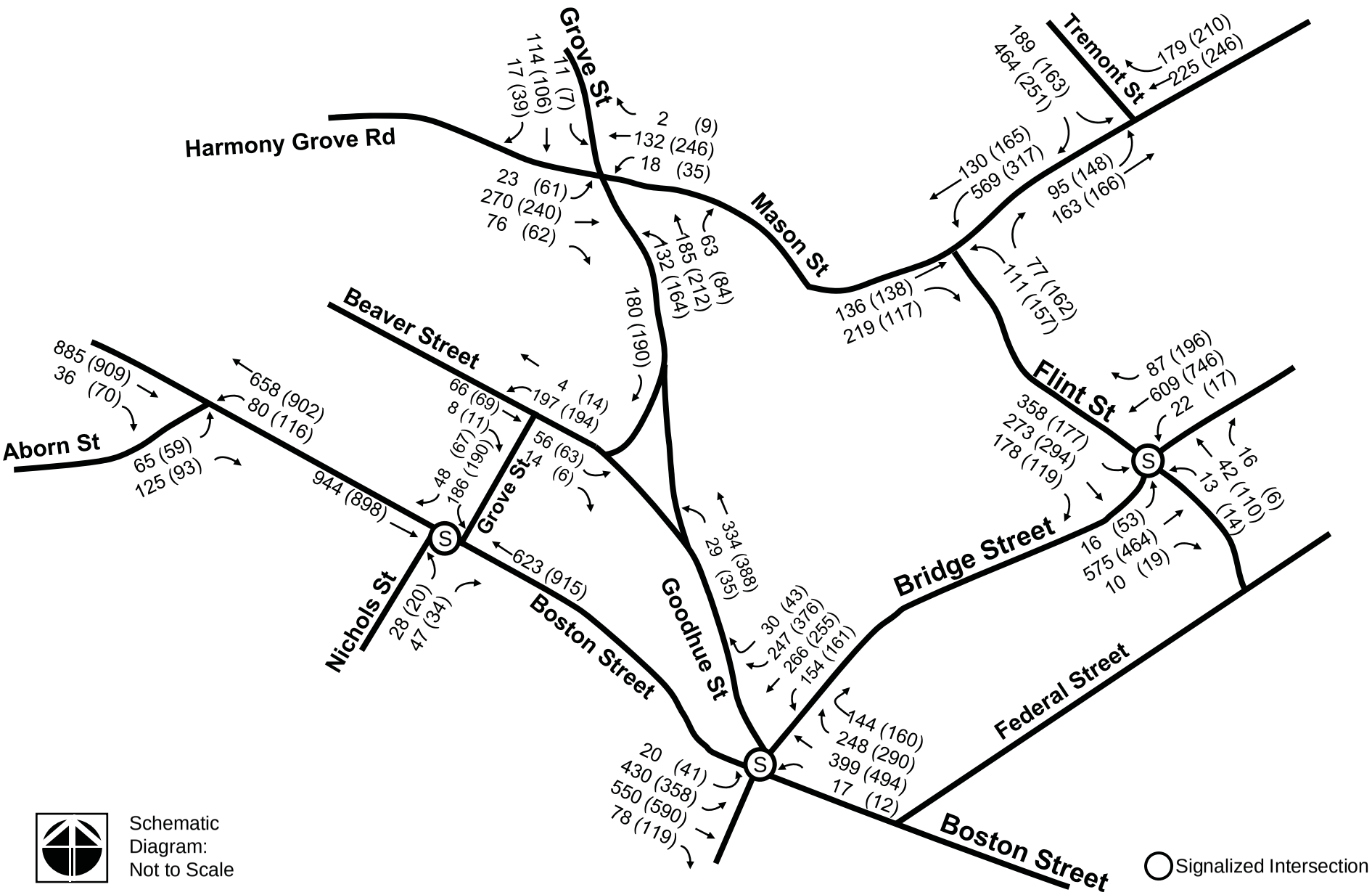
Intersection and Movements	AM PEAK Delay	AM PEAK LOS	AM PEAK Queue	AM PEAK V/C	PM PEAK Delay[2]	PM PEAK LOS[2]	PM PEAK Queue[2]	PM PEAK V/C[2]
Grove Street at Beaver Street	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beaver Street EB Right/Through	0	A	0	0.05	0	A	0	0.05
Beaver Street WB Left/Through	8	A	12	0.14	7	A	8	0.15
Grove Street at Goodhue and Beaver Streets	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Beaver Street EB Left	14	B	16	0.18	13	B	12	0.14
Goodhue Street NB Through/Left	<1	A	2	0.03	<1	A	2	0.03
Grove Street SB Right	0	A	0	0.19	0	A	0	0.13
Harmony Grove Street at Grove and Mason Streets	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Harmony Grove EB Left/Through/Right	26	D	N/A	0.76	95	F	N/A	1.08
Mason Street WB Left/Through/Right	13	B	N/A	0.33	82	F	N/A	1.04
Grove St NB Left/Through/Right	19	C	N/A	0.65	67	F	N/A	1.03
Grove St SB Left/Through/Right	14	B	N/A	0.37	21	C	N/A	0.47
Boston Street at Aborn Street	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boston Street EB Through/Right	0	A	0	0.59	0	A	0	0.63
Boston Street WB Through/Left	3	A	9	0.12	6	A	17	0.19
Aborn Street NB Left/Right	340	F	263	1.56	603	F	370	2.06
Flint Street at Mason Street	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Flint Street NW Left/Right	763	F	477	2.44	149	F	380	1.18
Mason Street NE Through/Right	0	A	0	0.23	0	A	0	0.16
Mason Street SW Left/Through	11	A	63	0.53	6	A	22	0.27

Table 7 (Continued)
NRCC Study Area - 2016 Base Traffic Operations

SIGNALIZED INTERSECTIONS (OPTIMIZED)

Intersection and Movements	AM PEAK Delay[1]	AM PEAK LOS[2]	AM PEAK Queue[3]	AM PEAK V/C[4]	PM PEAK Delay	PM PEAK LOS	PM PEAK Queue	PM PEAK V/C
Boston Street at Bridge Street (Route 107)	**32**	**C**	**N/A**	**0.95**	**34**	**C**	**N/A**	**0.99**
Boston Street EB Through/Left/Right	37	D	365+	1.03	37	D	384+	1.07
Boston Street WB Through/Right	32	C	320+	0.75	31	C	379+	0.77
Bridge Street SB Left/Through/Right	25	C	214	0.86	28	C	236 metered	0.90
Flint Street at Bridge Street (Route 107)	**34**	**C**	**N/A**	**0.93**	**28**	**C**	**N/A**	**0.91**
Flint Street EB Left/Through/Right	43	D	305+	0.96	49	D	358 metered	0.94
Flint Street WB Left/Through/Right	17	B	47	0.12	30	C	112	0.56
Bridge Street NB Left/Through/Right	17	B	165 metered	0.72	8	A	98 metered	0.45
Bridge Street SB Left/Through/Right	36	D	572+	0.92	26	C	728+	0.90
Boston Street at Grove Street	**40**	**D**	**N/A**	**1.04**	**26**	**C**	**N/A**	**0.9**
Boston Street EB Throughs	42	D	699+	1.06	12	B	737+	0.92
Boston Street WB Throughs	16	B	335	0.61	30	C	733+	0.90
Grove Street SB Left/Right	78	E	227+	0.97	56	E	266+	0.83
Boston Street at Nichols Street	**19**	**B**	**N/A**	**0.72**	**14**	**B**	**N/A**	**0.67**
Boston Street EB Through	28	C	789+	0.89	21	C	584	0.80
Boston Street WB Through	4	A	61 metered	0.58	6	A	77 metered	0.85
Nichols Street NB Left/Right	32	C	47	0.15	32	C	44	0.10
Tremont at Mason Street (with signal control)	**31**	**C**	**N/A**	**0.78**	**28**	**C**	**N/A**	**0.72**
Tremont Street SE Left/Right	23	C	448	0.71	23	C	264	0.54
Mason Street NB Left/Through	55	D	344+	0.88	46	D	369+	0.90
Mason Street SB Right/Through	31	C	346	0.68	20	B	298	0.57

1 - Delay - Average control delay to nearest second, peak 15 minute period of the peak hour.
2 - LOS - Level of Service from A to F, where A is best, F is worst.
3 - Queue - is 95th percentile queue in feet behind the stop line; i.e, 95% of the time queue does not exceed. A + sign means analysis indicates it can be longer than shown.
4 - V/C - Volume/Capacity is measured or estimated volume to calculated capacity ratio.



City of Salem, Massachusetts
Kimberley Driscoll, Mayor

City of Salem
Department of Planning & Community Development

North River Canal Corridor Transportation Study

PROJECTED 2016 AM (PM) PEAK HOUR TRAFFIC VOLUMES

FIGURE 12

Expected AM Peak Growth 2011-2016

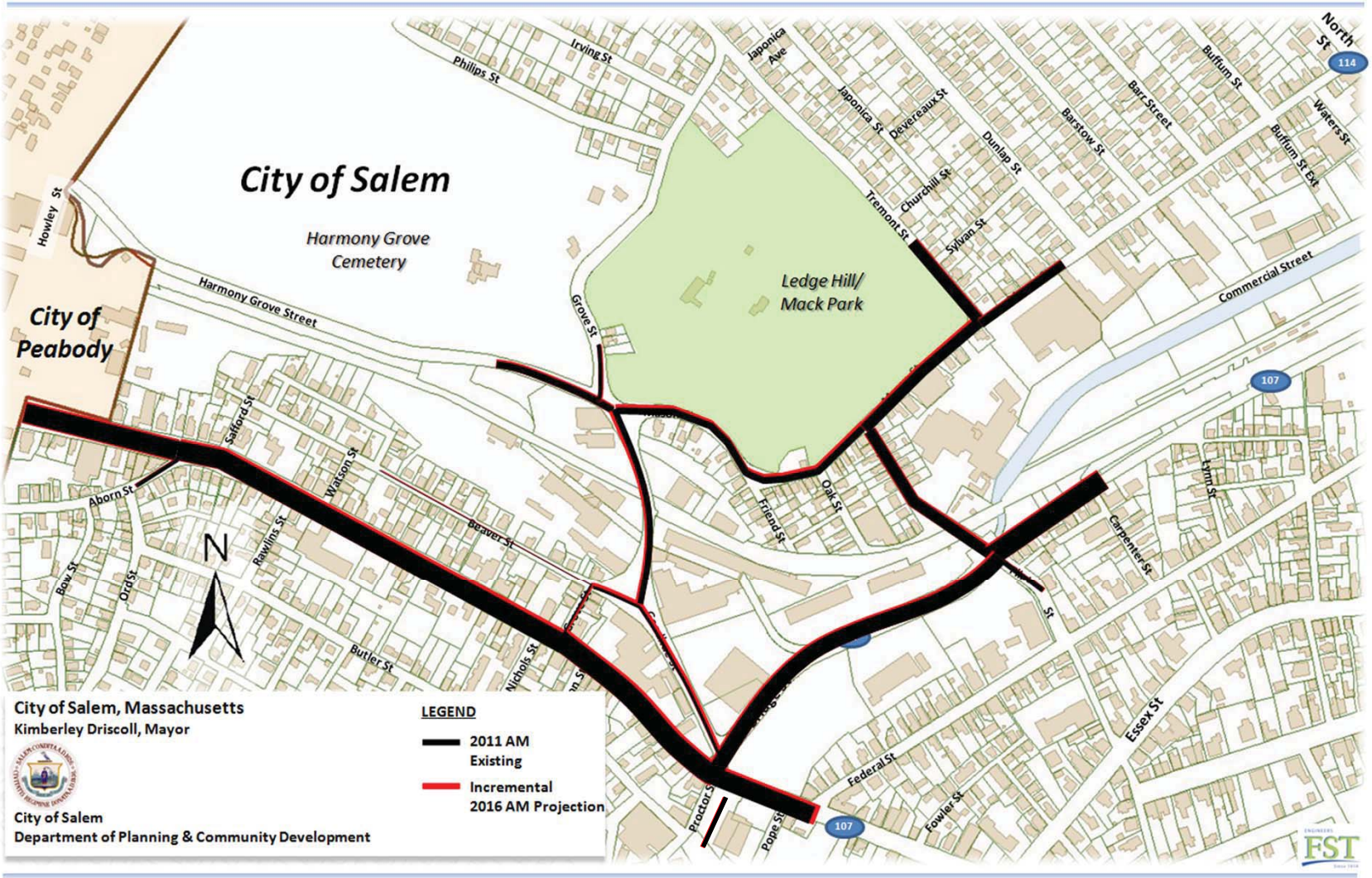


Figure 13

Expected PM Peak Growth 2011-2016

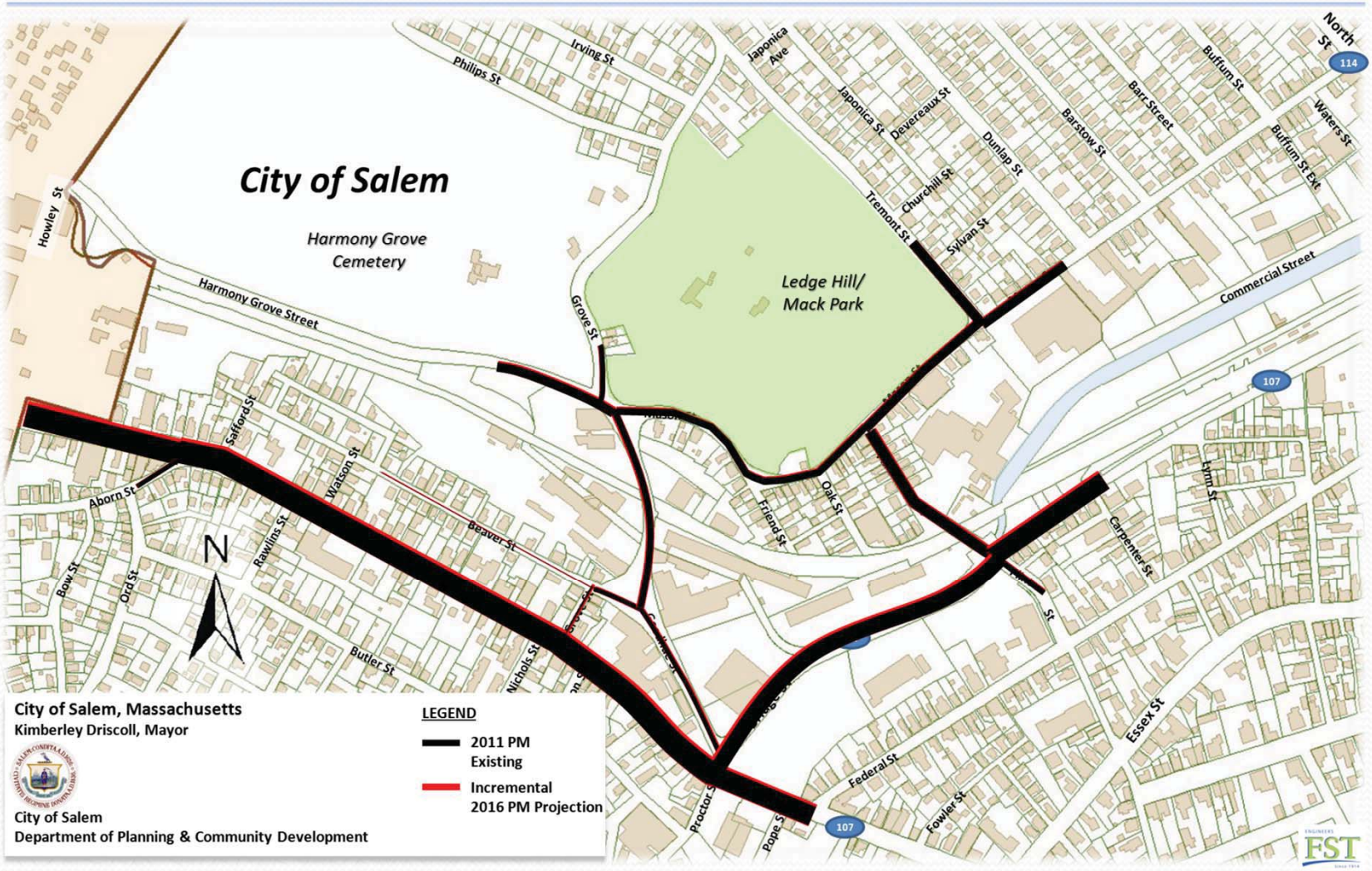


Figure 14

From Table 7, highlighted congestion spots reported on Table 4 are expected to worsen by the year 2016. Additionally, crash rates identified previously on Table 5 without future mitigation *may worsen* as future traffic volumes grow. In particular, those intersections where the existing crash rate is near the statewide average crash rates could see increased crash rates without mitigation.

Peak period congestion is expected to worsen at the following unsignalized intersections:

- Flint and Mason Streets.
- Tremont at Mason Streets.
- Boston Street at Aborn Street.
- Harmony Grove at Grove and Mason Streets (during the afternoon peak hours)

Also from Table 7, assuming all signals are optimized, all of the area's signalized intersections are expected to operate at overall acceptable levels of service B-D. However, some of the signalized intersection approaches and volume to capacity ratios exceed 1.0. This means that one or more approaches to the intersection will experience excessive queuing and delays, particularly if signal optimization does not occur in the interim.

However, the pedestrian and bicycle environment at certain evaluated intersections is not as inviting and effective as it should be to create an environment for encouraging walking, biking, and transit use for the NRCC developments. To encourage these other modes, it will be essential to address facilities provided for the walking, biking, and encouraging use of and access to public transportation services. For example, the Mason Street corridor infrastructure between Harmony Grove Road and Flint Street is in need of repair. The geometry of the sharp left turn near Friend Street is confusing to first time users, as it appears that Friend Street is the main street, not Mason Street.

Coupled with traffic operations and safety enhancements, pedestrian and bicycle environment upgrades should be included as an effective way to reduce overall traffic demands. Taken together, these will enhance the quality of life, mobility, and safety in the NRCC Area.

Table 8 ranks traffic growth projections on NRCC area roads by numerical and percent differences between 2011 and 2016. The analysis assumes all five developments are completed and a background growth rate of 1% per year to account for other growth that may occur. Table 8 highlights the extent of changes that are expected on streets in the NRCC Area.

Table 8
Ranking of Intersections by Estimated Entering Traffic Volumes
2011 AM/PM Peak Hours VS. 2016 AM/PM Peak Hours

	AM		Numerical AM	% AM
	2011	2016	Difference	Difference
Boston Street west of Bridge Street	1519	1724	205	13%
Boston Street west of Aborn Street	1442	1644	202	14%
Bridge St north of Flint Street	1468	1667	199	14%
Boston Street west of Nichols Street	1457	1642	185	13%
Grove Street north of Beaver Street	423	606	183	43%
Bridge Street north of Boston Street	1110	1271	161	15%
Goodhue Street west of Boston Street	258	417	159	62%
Boston Street east of Bridge Street	1355	1512	157	12%
Harmony Grove Street west of Grove Street	524	650	126	24%
Flint Street west of Bridge Street	842	954	112	13%
Mason St east of Flint Street	810	912	102	13%
Grove Street north of Boston Street	143	234	91	64%
Tremont Street north of Mason Street	845	927	82	10%
Mason Street west of Flint Street	525	596	71	14%
Mason Street east of Tremont Street	690	756	66	10%
Grove Street north of Mason Street	301	352	51	17%
Flint Street east of Bridge Street	343	376	33	10%
Proctor Street south of Boston Street	330	361	31	9%
Beaver Street west of Grove Street	53	78	25	47%
Aborn Street south of Boston Street	291	306	15	5%

	PM		Numerical PM	% PM
	2011	2016	Difference	Difference
Boston Street west of Bridge Street	1711	1978	267	16%
Boston Street west of Aborn Street	1681	1940	259	15%
Boston Street west of Nichols Street	1663	1900	237	14%
Bridge Street north of Boston Street	1129	1353	224	20%
Boston Street east of Bridge Street	1494	1707	213	14%
Bridge St north of Flint Street	1414	1600	186	13%
Grove Street north of Beaver Street	501	641	140	28%
Flint Street west of Bridge Street	811	943	132	16%
Harmony Grove Street west of Grove Street	692	811	119	17%
Goodhue Street west of Boston Street	327	424	97	30%
Mason St east of Flint Street	690	782	92	13%
Mason Street east of Tremont Street	710	785	75	11%
Grove Street north of Boston Street	184	257	73	40%
Mason Street west of Flint Street	505	577	72	14%
Tremont Street north of Mason Street	705	772	67	10%
Proctor Street south of Boston Street	333	386	53	16%
Flint Street east of Bridge Street	414	460	46	11%
Grove Street north of Mason Street	388	434	46	12%
Beaver Street west of Grove Street	68	94	26	38%
Aborn Street south of Boston Street	322	338	16	5%

4. Mitigation Measures – Pending and Potential

To accommodate projected full build-out year 2016 NRCC traffic volumes, prospective roadway and intersection mitigation measures were evaluated for the North River Canal Corridor. Preliminary multi-modal accommodations, i.e.., future pedestrian, bike, and transit accommodations were also assessed in a preliminary manner. Figure 15 illustrates the range of potential mitigation measures that were evaluated.

4.1 Status Review of Prior Mitigation Measures

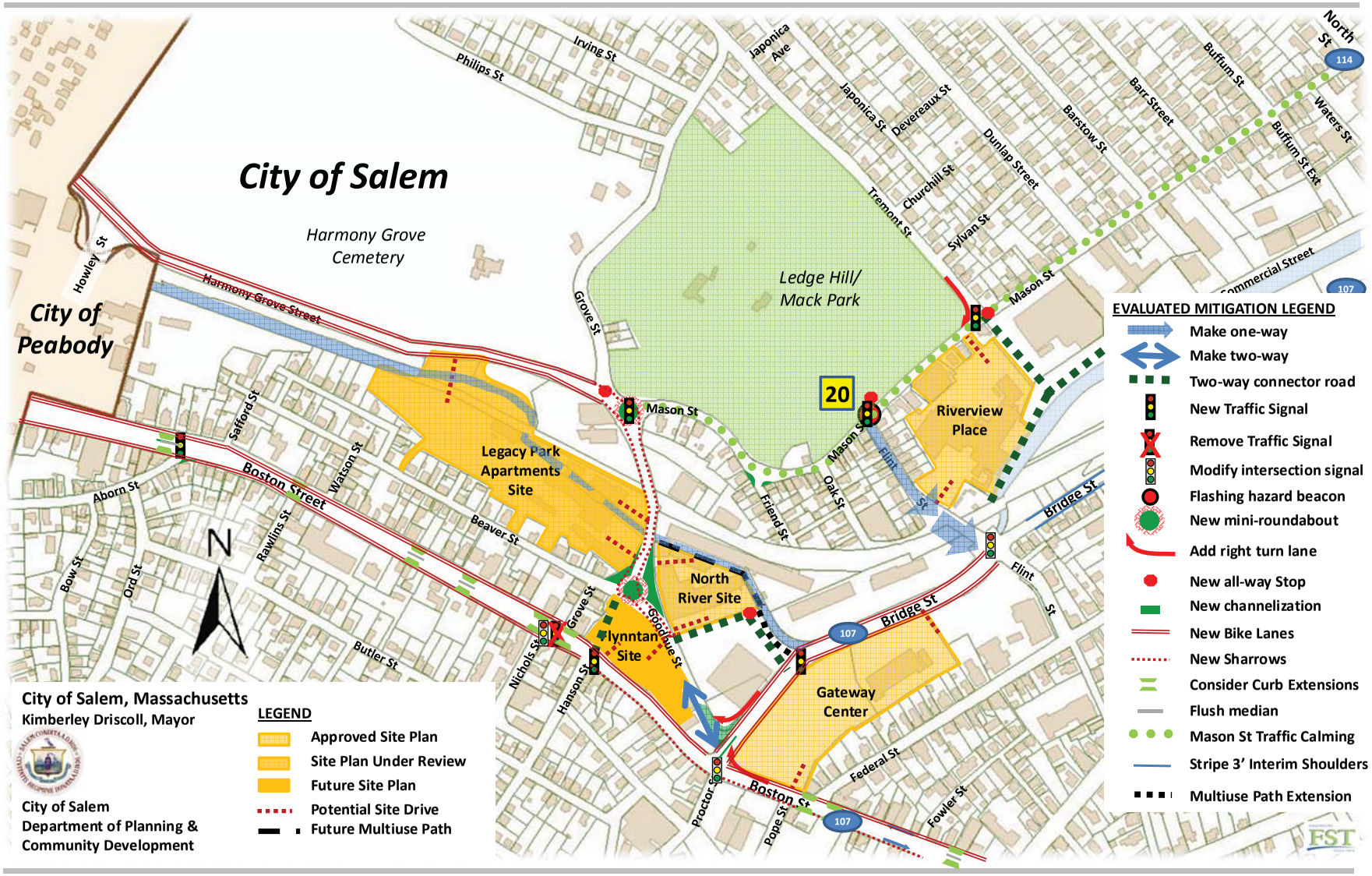
Following is a review of Traffic Mitigation Measures from prior NRCC Area studies. At the outset of the study, the City provided FST with several transportation studies pertaining to the NRCC. FST reviewed proposed or recommended transportation improvements and *has added the current status of each measure*:

4.1.1 *NRCC Neighborhood Master Plan* (City of Salem Department of Planning and Community Development, Goody Clancy with Earth Tech and FXM, 2003). This landmark study recommended the following traffic improvements:

Short Term

a. New traffic signals at North and Mason Streets (status: done)
b. Provide 'free' right turn from Bridge Street to Goodhue Street (status: not done).
c. Provide pedestrian signal (heads) at Boston and Bridge Streets (status: not done).
d. Provide pedestrian signal (heads) at North, Franklin, and Commercial Streets (status: done at Mason Street and North Street intersection).
e. Formalize unpaved pedestrian connection between Franklin Street at Bridge Street and the MBTA Commuter Rail parking lot (status: not done, T has indicated it is unwilling to create new at-grade pedestrian/rail crossings)
f. Replace four-way Grove Street/Harmony Grove Road/Mason Street with roundabout (status: not done).
g. Develop traffic calming program for Franklin Street neighborhood (status: not done).
h. Prohibit on-street parking on North Street during peak periods (status: not done).
i. Replace two-lane cross-section of Bridge Street between Flint and Washington Streets with four-lane cross-section (status: done at North/Mason signal).
j. Coordinate circulation and signalization improvements at the North Street/Bridge Street (status: done).
k. Create new pedestrian connections from Mason and Federal Streets to North River Canal (status: not done).

Evaluated Mitigation



North River Canal Corridor Transportation Plan

Figure 15

4.1.1 *NRCC Neighborhood Master Plan* (Continued):

Long Term

a. Extend Commercial Street to Mason Street (status: not done) or

b. Extend Commercial Street west to Flint Street (status: not done, but partial right-of-way in reserved i.e., Riverview Place south edge).

c. Extend Commercial Street west along rail right of way to Grove Street (status: not done).

d. Extend Commercial Street south to Bridge Street (status: not done).

e. Connect Goodhue Street to Boston Street via a new road opposite Hanson Street (status: not done).

f. Make Flint Street one-way southbound between Bridge and Mason Streets (status: not done, but tested and removed when too many negative impacts occurred on Oak and Flint Streets).

4.1.2 *Transportation Improvement Study for Routes 1A, 114, and 107, and Other Major Roadways in Downtown Salem* (Central Transportation Planning Staff, 2005), that recommended the following traffic improvements *within the NRCC study area* as defined on Figure 1 previously:

Short Term

a. Enhance pedestrian access to the MBTA Commuter Rail Station from all directions (status: partially done with completion of Bridge Street/North Street interchange).

b. North Street improvement project including Mason Street signal upgrade between the Peabody Line and Bridge Street overpass (status: done).

Long Term

a. Relocate Guildford rail tracks northerly and widen Bridge Street to a typical four-lane cross-section between Washington and Flint Streets (status: not done yet).

b. Install a new sidewalk replacing the narrow one on the north side of Bridge Street to the MBTA Commuter Rail Station (status: done with Bridge Street signal).

4.1.3 *Functional Design Report – Proposed Construction of a New Trial Court Facility J. Michael Ruane Judicial Center, Salem, MA* (Earth Tech, Inc., November 2006), that recommended the following traffic improvements *within the NRCC study area* as defined on Figure 1 previously:

Short Term

a. Remove east ramps of Bridge Street/Route 114 Interchange and create two new signalized intersections, one at a new re-aligned Federal Street/Route 114 signalized intersection and other at the Bridge Street ramps terminal (status: done).

4.1.4 Record of Decision – Site Plan Review/Wetlands and Flood Hazard Special Permit, North River Canal, LLC, 28 Goodhue Street (City of Salem Planning Board, February 2007) recommended the following traffic improvements:

a. Provide $20,000 for traffic mitigation in the immediate area or a study of the immediate area (status: reserved).

4.1.5 Record of Decision - Traffic Impact and Assessment Study of Riverview Place Proposed Residential Development Project, Salem, MA (Earth Tech, Inc., October 2007) recommended the following traffic improvements:

Short Term

a. The following traffic calming measures provided that any required City Council approvals are granted:
    i. Installation of an electronic speed monitor on Mason Street, with the location to be determined by the Traffic Division Commander (status: done opposite Flint Street);
    ii. Installation of signage and pavement markings as shown on the submitted plans (status: not done yet);
    iii. Placement of "No Parking – Tow Zone" signage on Mason Street on both sides of the site driveway, to be approved by the Traffic Division Commander (status: not done yet);
    iv. Signage at the Mason St. driveway prohibiting the entrance and exit of trucks to be added to a revised signage plan (status: not done yet);
    v. Installation of a yellow flashing beacon at the intersection of Flint Street and Mason Street, with the type and exact location to be approved by the Traffic Division Commander (status: not done yet);
    vi. Complete plans and specifications for the design of a traffic signal to be built at the intersection of Mason Street, Tremont Street and the site's Mason Street driveway prior to issuance of a Certificate of Occupancy (status: not done yet);
    vii. The Planning Department shall determine whether a traffic island is required at the base of Oak Street within six (6) months following the last Certificate of Occupancy issued in connection with the project. Should the Planning Department determine that a traffic island is necessary, the developer shall cause the same to be installed at its sole cost and expense within the timeframe determined by the Planning Department. During the interim, the developer shall be responsible for installing signage and pavement markings at the intersection of Oak Street and Flint Street as directed by the Planning Department on the basis of recommendations made by the City Engineer and/or Traffic Division Commander (status: not done yet).

4.1.6 *Traffic Impact and Access Study – Gateway Center – 401 Bridge Street, Salem, MA* (Hayes Engineering, October 2009) recommended the following traffic improvements:

Short Term

a. Bridge and Boston Streets intersection:

    i. Adjust signal timing to optimize signal operations; and (status: not done yet).

    ii. Install an exclusive right turn lane on the Boston Street northbound approach to Bridge Street to provide three approach lanes – a shared through/left lane, a through lane, and an exclusive right turn lane (status, not done yet, two-lane approach with exclusive right lane and shared through/left lane).

b. Bridge at Flint Streets intersection (status: not done yet):

    i. Adjust signal timing to optimize signal operations.

4.1.7 *Traffic Impact and Access Study – Proposed Legacy Apartments at Harmony Grove Salem, MA* (VAI, December 2011) recommended the following traffic improvements:

Short Term

a. Grove, Beaver, at Goodhue Streets intersection:

    i. Provide pavement markings to delineate lane lines (status: not done yet).

    ii. Install new traffic control signs on all four intersection approaches and a new stop sign on the northbound Grove Street island (status: not done yet).

b. Install appropriate signage to enforce one-way flow on Goodhue Street east of Beaver Street plus channelization islands and markings adjacent to the in-road neighborhood parking lot (status: not done yet).

c. Install new signage and markings at Harmony Grove Road at Mason and Grove Streets (status: not done yet).

d. Install on-site pedestrian and bicycle use measures (status: not done yet).

4.2 Evaluation of Potential Supplemental Traffic Mitigation Measures

While the programmed mitigation measures will be effective, we reviewed alternative measures to address congestion and safety issues associated with Table 7. From north to south, the following potential measures were evaluated:

4.2.1 Mason Street traffic calming

On behalf of the City of Salem, during 2009, FST reviewed for the Mason Street corridor between North and Tremont Streets for potential 'traffic calming' measures. A summary of potential traffic calming measures was presented at a Mack Park neighborhood meeting on December 14, 2010. At the meeting, there was general support for some form of Mason Street traffic calming measures. Most people were in agreement that reducing Mason Street speeds is the overall objective. Some in attendees requested extending the study to include the Flint Street/Mason Street intersection.

A copy of the presentation with options reviewed and technical data is included as part of the separate Technical Appendix to this study.

Mason Street traffic calming options evaluated included:

a. Potential for all-way stops at (note: must meet volume warrants):
   i. Tremont/Mason Streets
   ii. Buffum/Mason Streets (only if without raised crosswalks)

b. Potential for using more visible pavement markings or raised intersection or crosswalks:
   i. Add a reflectorized double yellow centerline with raised plowable markers for enhanced visibility
   ii. Add reflectorized parking edge lines where parking is permitted
   iii. Add new reflectorized transverse striping within 20 feet of intersections and driveways where sight lines will otherwise be constricted by on-street parked vehicles
   iv. Add new high visibility crosswalks, possibly raised 2-3 inches, at:
      - Tremont/Mason Streets
      - Dunlap Street/Mason Street
      - Buffum Street/Mason Street

c. Potential for alternate side parking plus transverse striping cited above to delineate parking restrictions near driveways and intersections.

   A pro/con evaluation of **adding new high visibility crosswalks to the Buffum and Dunlap intersections with Mason Street and raising the intersections or crosswalks approximately 2-3 inches with 'speed hump' transition markings in both directions on Mason Street** is given below.

   Pros

   - Reduces Mason Street speeds traversing the intersection, thereby helping reduce difficulty of motorists, pedestrians and bicyclists on Dunlap and Buffum Street accessing Mason Street.

- Should improve Mason Street safety compared to the 'do-nothing' alternative.
- Causes all traffic to slow, thereby reduces fuel consumption and air pollution compared to the all-way stop options.
- Can be tested using temporary speed humps

Cons

- Costs to implement are greater than with new crosswalks or signs and markings alone. Involves underground utility adjustment expenses and potential drainage impacts.
- Need to consider impacts fire emergency response times.
- Directly affects Mason Street direct abutters who should be canvassed to prior to installation (if less than 80% approve, consider either high visibility crosswalks alone or alternate side parking).

A pro/con summary of **converting Mason Street to alternate side parking with chicanes (i.e., street curb extensions) on parking ends** is given below:

Pros

- Reduces Mason Street speeds in affected area by forcing through motorists to alter their alignment back and forth thereby helping reduce difficulty of motorists, pedestrians and bicyclists accessing Mason Street.
- Should improve safety compared to the 'do-nothing' alternative.
- Does not cause all traffic to stop, thereby reduces fuel consumption and air pollution compared to the all-way stop option.
- Relatively low costs for signs and markings

Cons

- Need to make sure parked vehicles do not encroach on ability of motorists on the west side of Mason Street to exit their driveways.
- Affected Mason Street abutters should be canvassed prior to (if less than 80% approve, consider either high visibility crosswalks alone).

4.2.2 Tremont Street at Mason Street traffic control options

Signalization. Even though design of this mitigation measure is already funded under the Riverview Place Record of Decision, the feasibility of its implementation should be re-considered. First of all, the signal concept plan calls for widening on the south side of Tremont Street into the Mack Park (we understand this is into restricted Section 4F parklands). The estimated 9-10% *downgrade* of the Tremont Street approach to Mason Street is such that allowing Tremont Street traffic to enter the intersection *without stopping first* will potentially create a new hazard at the intersection from left and right turns potentially moving at speeds in excess of 15 miles per hour as well as a higher potential for rear-end collisions. Guardrail damage on the south side of Mason Street opposite Tremont Street is evidence that in the past this has occurred *even with the existing stop sign* requiring all Tremont Street vehicles approaching the intersection to stop. Additionally, residents along both Tremont and

Mason Streets do not want increase through traffic and make it easier for traffic to use the Tremont Street corridor that serves as an alternative for North Street (Route 114) via the City of Peabody.

A pro/con summary of **signalizing** the **Tremont/Mason Street intersection** is given below:

Pros

- Reduces peak hour congestion for Tremont Street approach.
- Addresses poor sight line from Tremont Street.
- Volumes meet warrants for signalization.
- Signal construction funding is in place with Record of Decision.

Cons

- May encourage greater use of Tremont Street as cut through route.
- Proposed widening into park would increase pedestrian crossing distance of Tremont Street intersection toward Mack Park.
- Increases maintenance costs.
- May increase rear-end crashes on all approaches.
- May increase guard rail crashes as the steep downgrade on Tremont Street is greater than 9%, with no leveling area.

An alternative to a traffic signal would be to create an all-way (3-way) stop, as evaluated with the Mason Street Traffic Calming study, or possibly a raised intersection while retaining the existing stop control on Tremont Street only.

A pro/con summary of creating an **all-way (3-way) stop** at the **Tremont/Mason Street intersection** is given below:

Pros

- Reduces peak hour congestion for Tremont Street approach.
- Addresses poor sight line from Tremont Street looking to the north on Mason Street.
- Makes pedestrian crossings of Mason Street easier than today near Mack Park, as all traffic must stop prior to entering the intersection from any direction.
- Relatively low cost involving a few signs and markings.

Cons

- Requires new round-the-clock stops on the Mason Street approaches. where none are required today, adversely affecting nearly 8,000 motorists who use Mason Street.
- Produces queuing on the Mason Street approaches to Tremont Street that does not exist today.
- Results in LOS F peak hour congestion on the Tremont Street approach during the AM peak hour.

- Increases fuel consumption/worsens localized air quality.
- With new stops, may produce rear-end crashes on Mason Street north and southbound approaches.

A pro/con summary of **raising the intersection of Tremont/Mason Streets approximately 2-3 inches with 'speed hump' transition markings on Mason Street and emphasizing the crosswalks on the south and west sides** *while retaining the existing two-way stop condition* is given below:

Pros

- Reduces Mason Street speeds traversing the intersection thereby helping reduce congestion on Tremont Street stop controlled approach.
- Slightly reduces the downgrade on Tremont Street approaching the intersection.
- Addresses poor sight line from Tremont Street looking to the north on Mason Street by reducing Mason Street approach speeds.
- Makes pedestrian crossings of Mason Street easier than today near Mack Park.by slowing all movements traversing the intersection.
- Does not cause all Mason Street traffic to stop, thereby reduces fuel consumption and air pollution compared to all-way stop option.

Cons

- Retains LOS F peak hour congestion on the Tremont Street approach during the AM peak hour.
- Involves underground utility expenses and potential drainage impacts and costs to implement are greater than signs/markings alone.
- May adversely affect fire emergency response times.
- Affects abutters and may be unpopular.

4.2.3 *Commercial Street Extension to Mason Street*

The 2003 NRCC Master plan proposed connecting Commercial Street to Mason Street approximately opposite Tremont Street (see above discussion regarding potential Tremont Street at Mason Street and Mason Street traffic calming options). The viability of this connection is tied directly to how the Tremont/Mason Streets intersection will operate if the connection is made.

A pro/con summary of **extending Commercial Street northerly to Mason Street opposite Tremont Street** is given below:

Pros

- Reduces westbound traffic on Mason Street approaching Flint Street.

Cons

- Has challenging grades, drainage, and sight lines that affect feasibility.

- Adds a new leg to the Mason at Tremont Streets intersection and potentially increases crash rates, as the viability of intersection signalization is questionable due to the steep grades on Tremont and Connector approaches.
- Requires right of way takings
- Adversely affects abutting residences.

4.2.4 Commercial Street Extension to Flint Street

As envisioned in the 2003 NRCC Master plan, Commercial Street was not only proposed to connect to Mason Street approximately opposite Tremont Street, but also to Flint Street in the vicinity of the low-volume Pan Am/Guilford railroad crossing. The viability of this connection is tied directly to how its intersection with Flint Street will operate if the connection is made as well as Flint Street's directionality.

Based on the potential Flint Street southbound only option discussed below, the southwest-bound connection of Commercial Street to Flint Street would assist in reducing southwest-bound Mason Street traffic and would reduce conflicts at the Flint/Mason Street intersection. Ideally, the Riverview Place Driveway would merge with the Commercial Street connector prior to its connection with Flint Street.

A pro/con summary of creating a **connection of Commercial to Flint Streets in the vicinity of the Riverview Place primary driveway** is given below:

Pros

- Reduces Mason Street SB traffic approaching Flint Street and Flint Street traffic southbound and northbound between Mason Street and the new Connector
- May enhance safety if Flint Street is made one-way southbound between Mason and Bridge Streets
- Provides alternative Commercial Street egress to Flint Street for all developments adjacent to Commercial Street.
- Reduces trucks on Mason and Flint Streets near adjacent homes.

Cons

- Requires adverse takings to fill in missing right of way links. Though Riverview Place has retained an easement, private and public layout rights of way are needed including takings of parking and buildings.
- Has potential safety issues with close spacing to Bridge/Flint signal and with difficult North Street approach for any added northbound traffic.
- Increases traffic near Leslie's Retreat Park and adds through traffic to Commercial Street that may divert from North Street to Bridge Street to avoid North Street bridge signals.

4.2.5 Make Flint Street one-way eastbound from Mason to Bridge Streets.

Flint Street at Mason Street has the highest crash rate of any intersections in the study area and, as such, addressing its operational issues should be a high priority.

At its narrowest point, Flint Street is only 20 feet wide just south of its intersection with Mason Streets. Adjacent residences are located right up against the intersection sidewalks creating poor sight lines for opposing stop-controlled traffic emerging from Flint Street. Additionally, cars or large trucks (even though restricted) turn left into cars parked on the south side of Flint Street. The Flint/Mason Streets intersection has tight geometry coupled with high volumes of conflicting traffic movements. Flint Street is a narrow local street with on-street parking that sometimes encroaches on the sidewalk on the south side that can reduce two-way Flint Street traffic to a single lane. Historic count data indicates that 2/3 of Flint Street traffic travels eastbound toward Bridge Street, while 1/3 travels westbound. The most difficult conflicting traffic movements occur at the intersection of Flint and Mason Streets between uncontrolled traffic turning left from Mason Street vs. a high number of left turns from the stop sign on Flint Street approaching Mason Street and the through traffic traveling eastbound on Mason Street.

The 2003 NRCC study recommended that Flint Street be one-way *eastbound* between Mason and Bridge Streets. It is our understanding a test was made of making Flint Street one-way, but during the test, traffic diverted to Oak Street and the test was cancelled within a couple of days, as the adverse traffic impacts were too severe. Oak Street, with its steep grades, was clearly not designed to accommodate high volumes of traffic.

On top of Flint Street's existing safety issues, the Riverview Place development will have a future access drive on the east side of Flint Street, which could exacerbate its safety issues if left unaddressed.

The relatively heavy volume of Mason Street traffic turning left at its intersection onto Flint Street cannot see traffic turning out of Mason Street until it is in the intersection. On-street parking on Flint Street restricts sidewalk access and can limit Flint Street to a single lane that is used for two-way traffic. As indicated in the crash analysis, the Flint/Mason intersection is the most critical 'hot spot' in the study area. Its crash rate of 1.4 crashes per million entering vehicles, more than double the statewide and MassDOT District 4 crash rate average for unsignalized intersections. Altering the Flint Street traffic flow will not be easy. A test conversion of Flint Street to one-way operation was undertaken many years ago. Apparently this situation resulted in very poor traffic conditions.

If Flint Street's operation were to be changed, logically it would be directed as one-way *away* eastbound from Mason Street *toward* Bridge Street, as counts indicate approximately 2/3 of its volume is eastbound. Ideally, an access, perhaps permitting lefts and rights would be provided into the Riverview Place by reconfiguring the Flint Street at Bridge Street intersection. At minimum, a left turn out from either the

Riverview Place development or a potential Commercial Street Extension would be provided at least 200 feet west of Bridge Street. A left turn out from a Riverview Place driveway would operate equivalent to a right turn operationally, as it would be opposing only southbound Flint Street traffic. Such a Riverview Place access would provide ingress to the Riverview Place other than via Mason Street to Flint Street or via the steep entrance off Mason Street near Tremont Street.

Any potential test of the Flint Street one way conversion concept *would require advance publicity as well as signal, sign, and marking modifications* at the Bridge Street intersection with Flint Street and strict adherence to the Manual on Uniform Traffic Control Devices, as amended. Great attention to providing public information prior to and during the test would be essential. *Regular users would need to be warned prior to and during* the test.

While the Flint Street eastbound signals could remain, street markings and the Bridge Street solid green and yellow signals would have to be converted to green and yellow arrows only with no solid green indications. Similarly, the westbound Flint Street approach would need to be converted to left and right turn arrows only, a solid green ball would be unacceptable. Pavement markings delineating through traffic only southbound on Bridge Street would be needed, and the eastbound Flint Street departure lane would need to be restriped with transverse markings to identify its closure to traffic. Northbound on Bridge Street, the left turn lane would need to be replaced, at least temporarily, with transverse yellow pavement markings. Again, solid green and yellow indications must be replaced by straight ahead and right turn arrows on the Bridge Street northbound approach. Northbound Bridge Street through and right movements from the right lane and no left turns both overhead and from new signs. A minimum 8-foot wide parking lane would be demarcated on the southbound side of Flint Street adjacent to residences, such that motorists would no longer need to park on the Flint Street sidewalk. The westbound Flint Street approach would need to show left and right out arrows only, consistent with the new signal heads facing westbound motorists.

A pro/con summary of converting Flint Street to **one-way *eastbound* operation** is given below:

Pros

- Reduces Flint Street traffic by about a third.
- Reduces Mason Street traffic volumes east of Flint Street coupled with Street left-turn out only onto Flint Street from Riverview Place.
- Should improve safety at the Mason Street/Flint Street intersection.
- Allows parking on one side of Flint Street to remain and placed off the sidewalk, rather than on as today.
- Flint Street pedestrian crossings will be easier, as they will be opposing only one lane of oncoming traffic.
- Does not affect Oak or Friend Street traffic volumes.

- Eliminates the LOS F traffic operations at the Bridge Street/Flint Street intersection.

Cons

- Diverts Flint Street residents and northbound traffic to other roadways like Goodhue and Mason Streets. Worsens traffic operations at affected diversion routes, particularly at Harkins Square, i.e., the intersection of Harmony Grove Road at Mason and Grove Streets. By the year 2016, with diversions from making Flint Street one-way eastbound, a potential mini-roundabout at Harkins Square will experience problems during the PM peak period.
- Redistributes traffic at the intersection of Harmony Grove/Grove/Mason Streets – more traffic northbound on Grove Street, less traffic westbound on Mason Street.
- Is difficult to 'test'. Any 'test' has to be done *with the intent that it will be a permanent installation*. A test diverting approximately 2,500 motorists a day must be well publicized. During the test, Bridge/Flint Street signals, signs, and markings must conform to the USDOT and Massachusetts Amendments to the Manual on Uniform Traffic Control Devices. (MUTCD), as amended. Temporary variable message signs may be needed on Bridge Street approaches to Flint Street to let motorists know that southbound right turns and northbound left turns are prohibited.
- Because temporary signs and markings alone will not suffice for such a change, a 'test' of the concept will also be more costly than simple signs and markings. Put simply, a test will require design of traffic signal, sign, and markings modifications and capital installation costs.
- May increase eastbound speeds on Flint Street. (Note: Retaining parking on the south side of Flint Street, but moved off the sidewalk should reduce the potential for higher speeds on Flint Street and southbound queues emanating from Bridge Street should keep speeds relatively low.).
- Increases the vehicle miles of travel for diverted northbound Flint Street motorists.

4.2.6 Mason Street/Flint Street intersection control options

At least three intersection control options are available for this intersection: signalize, make all-way stop, or make right turn out only from Flint Street northbound with an all-way stop. If Flint Street is made one-way eastbound, the pedestrian hybrid beacon or HAWK signal installation may be appropriate to provide traffic breaks for pedestrians and augment the existing crosswalk on the south Mason Street approach to the intersection.

A pro/con summary of **constructing a full traffic signal** at the **Flint Street at Mason Street** intersection is given below:

Pros

- Does not *require* traffic diversions and partially addresses sight line issues.
- Results in acceptable levels of service for a traffic signal (LOS D overall during the AM and LOS B overall during the PM).
- Can incorporate an exclusive pedestrian phase to allow pedestrians to cross Flint and Oak Streets.
- Allows provision of crosswalks on all three legs of the intersection.

Cons

- May result in some traffic diversions to Oak and Friend Streets due to eastbound signal queues, especially during the AM peak hour that are not a problem today.
- Requires removal of residential parking on Flint Street and a stop line on the northbound direction recessed far back from the intersection to accommodate left turning vehicles.
- Requires removal of on-street parking on the west side of Flint Street without addressing how motorists will access their vehicles.
- Has high capital costs and long-term maintenance costs.

A pro/con summary of converting the northbound Flint Street approach to **right out only operation** is given below:

Pros

- Reduces Flint Street traffic by about a sixth, if obeyed by motorists.
- Reduces westbound Mason Street traffic volumes between Flint and Harmony Grove Streets.
- Removes the most hazardous conflicts between left turns out of Flint Street and left turns and through traffic on Mason Street.
- Should not affect Oak or Friend Street traffic volumes.

Cons

- Requires difficult enforcement without Mason Street construction that would involve encroachment into Section 4f parklands, necessary to control right turn only movements from Flint Street onto Mason Street and increasing right turn visibility.
- Requires Flint Street residents and northbound motorists who would otherwise be turning left to divert to Goodhue Street which will in turn experience increased traffic volumes.
- Requires removal of on-street parking on the west side of Flint Street without addressing how motorists will safely cross Flint Street to access their vehicles.
- Requires public notification about the new traffic pattern.
- Requires Section 4f taking to move the Flint Street approach northerly.

A pro/con summary of placing Flint Street at Mason Street under **all-way stop control while retaining two-way operations on Flint Street** is given below:

Pros

- Relatively easy to implement.
- Addresses sight line/crash issue by stopping all traffic entering the intersection.
- Produces acceptable levels of service during the PM peak hour (though not during the AM peak hour).
- Allows the addition of crosswalks on all three legs of the intersection.

Cons

- Retains and worsens AM peak hour congestion.
- May cause traffic diversions to Oak and Friend Streets due to stop sign queues, especially eastbound during the AM peak hour
- Extends westbound queues at times through the Tremont Street intersection with Mason Street, again especially during the AM peak hour.
- Consumes more fuel and produces more overall delays throughout the day than the current situation.
- Worsens localized air quality.

4.2.7 Harmony Grove/Grove Street/Mason Street mini-roundabout

Harmony Grove/Mason Street/Grove Street Mini-roundabout Concept

This involves creation of a mini-roundabout smaller in size than a conventional roundabout. The available area to construct a mini-roundabout has challenging grades. As envisioned, the Grove Street southbound approach to the intersection would remain under stop control, but relocated westerly. The Harmony Grove, Mason Street, and Grove Street approaches would operate under yield control. Additional green space would be created on the northeast corner where Grove Street meets Harmony Grove Road. Raised splitter islands are envisioned on all three approaches to the new mini-roundabout. Removal of the free right turn channelizing island between northbound Grove Street and eastbound Mason Street is required. The inscribed circle of the potential mini-roundabout would be between 80-90 feet,

meaning that the roundabout center would be designed as mountable by larger vehicles making left turns and emergency vehicles with a 15 MPH design speed.

A pro/con summary of **converting the Harmony Grove/Grove Street/Mason Street intersection from an all-way stop intersection to a mini-roundabout** operation is given below:

Pros

- Produces an overall acceptable LOS for the intersection compared to the existing all-way stop option with less delay throughout the day.
- Addresses crash issue by slowing all traffic entering the intersection and
- Allows the provision of crosswalks on two legs of the intersection.
- Can be designed aesthetically to retain and incorporate the Harkin Square monument and, as envisioned, would create additional green space.

Cons

- Requires relocation and redesign of 'Harkin Square' and must be approved by the City of Salem Historical Society.
- Geometry must be carefully designed due to Grove Street grades and accommodation of truck use through roundabout.
- To be effective, requires raised splitter islands and may require a *mountable center island* to accommodate large trucks with no U-turns for trucks
- Learning curve for motorists to get used to the new configuration
- Far more costly than leaving the existing stop control in place, even if replacing all signs and creating new pavement markings.
- If Flint Street is made one-way eastbound, a potential mini-roundabout at Harkins Square will experience problems during the PM peak period, particularly the northbound approach on Grove Street.

Bridge Street/Goodhue Street Mini-roundabout Concept

4.2.8 Beaver/Grove/Goodhue Streets mini-roundabout

As envisioned, creating a mini-roundabout of this intersection will involve moving the curbs toward the intersection and elimination of what is now a parking lot in the middle of the intersection. All curb cuts would be retained and future approved curb cuts allowed. The mini-roundabout is assumed situated to the east of the intersection where grades are less severe than to the west. Sidewalks would be retained to the south and west with additions as shown on the sketch to the left to permit pedestrian crossings of mini-roundabout legs. A new sidewalk would be provided on the

east side of the Goodhue/Grove Streets intersection with added new green space serving as potential compensatory bio-retention/flood storage area.

A pro/con summary of converting the Beaver Street at Grove and Goodhue Streets to a **roundabout** operation is given below:

Pros

- Produces an overall acceptable LOS for this existing wide intersection with parking on-street and in a large paved central area.
- Works with less delays and localized air pollution than all-way stop control.
- Enhances the pedestrian/bicycle circulation environment.
- Represents an aesthetic upgrade consistent with the City's gateway status of the Harkins Square intersection and creates substantial new green space.

Cons

- Intersection has a steep downward cross slope from Beaver Street toward Goodhue Street.
- Reduces the available potential green area to serve as a retention site for the potential Goodhue/Bridge Street connector compared to a T intersection that creates additional greenspace and which should also operate acceptably.
- Is more for aesthetics and is not required to address future traffic flows.
- Geometry must be carefully designed due to grades and truck use.
- Very costly to construct and comply with ADA crosswalk requirements
- Loss of neighborhood parking area; may need to replace with curbside parking.

4.2.9 Goodhue Street to Bridge Street Roadway Connector

Bridge Street/Goodhue Street Connector Concept

As envisioned, this potential Connector would have two traffic lanes, a 5' sidewalk on the north side, and would not require building takings, but would require either a public easement or taking from two land owners. It would also require work in a floodplain area adjacent to the North River Canal. The purpose of the Connector would be to create an opportunity to access Goodhue/Grove Streets as an alternate to Flint Street, especially if made one-way eastbound, and to compress the intersection of Goodhue/Bridge/Boston Streets.

A pro/con summary of providing **a Goodhue Street to Bridge Street Connector roadway** approximately 550 feet in length **with a new traffic signal at Bridge and Goodhue Streets** is given below:

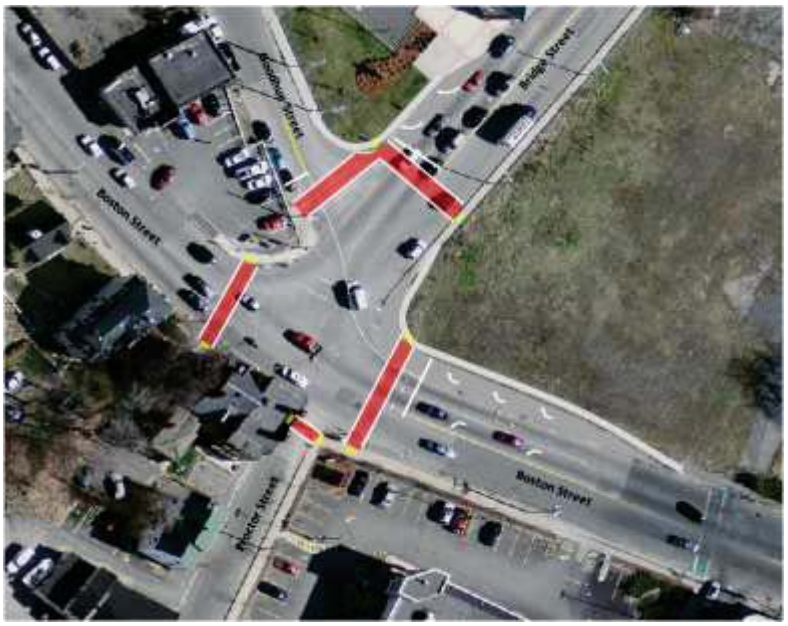
Pros

- Reduces southbound Bridge Street traffic volumes approaching Boston Street and the distance southbound traffic on Bridge Street needs to access Grove Street by approximately 400 feet.
- Provides a better option than Goodhue Street for diverting Flint Street westbound motorists if Flint Street is made one-way eastbound.
- Creates a new opportunity for traffic to access Bridge Street instead of using Flint Street with a new signal at the potential Bridge/Goodhue Street Connector.
- Creates an opportunity to make multi-modal Bridge Street/Boston Street intersection improvements to the benefit of all intersection users (see further on)
- Creates an opportunity to enhance access and egress from the primary Gateway Center development driveway entrance/exit and its peak hour operations.
- Can be constructed with minimal traffic impacts on a ground environment that does not have challenging grades and has no direct building impacts.
- Creates some opportunities for land swaps to minimize impacts on abutters and potential loss of green space.
- Slows traffic on Bridge Street in the vicinity of NRCC parcels.

Cons

- Has a relatively high cost compared to other options and is not on the State's approved Transportation Improvement Program list.
- Requires privately owned right-of-way adjacent to the canal from two directly affected landowners .
- Likely produces a net increase impervious surfaces, which is very important as it is adjacent to the North River Canal, would be within the 100-year floodplain, and will require environmental clearance and compensatory flood storage for any related excavation near the canal (e.g., will need to reconfigure the Goodhue/Beaver intersection to create compensatory flood storage with additional green space).
- Relatively high cost compared to other options and is not on the State's Transportation Improvement Plan and is unfunded at this time.
- Requires a new traffic signal on Bridge Street, which is a long term maintenance issue and increases delay to Bridge Street through motorists.
- Requires users who would otherwise can traverse Goodhue Street via Boston Street westbound or eastbound to travel an extra 400 feet.

4.2.10 Two-way Goodhue Street at Bridge Street



Two-way Goodhue at Boston& Bridge Streets Concept

As envisioned, Goodhue Street would have two lanes at its intersection with Bridge Street, one lane into the intersection and one lane departing the intersection. The new approach to the intersection would allow all movements and require traffic signal modifications to provide two signal faces and pedestrian signals on all five legs of the intersection. Most of the traffic movements exiting Goodhue Street would include those that otherwise turn left out of Grove Street onto Boston Street. Additionally, a short right turn lane would be created on the southbound approach on Bridge Street to Goodhue Street. Pedestrian crossings of Bridge Street would lengthen due to a necessitated skew of the required new crosswalk.

A pro/con summary of **converting Goodhue Street to a two-way** operation at its intersection with Bridge and Boston Streets is given below:

Pros

- Reduces traffic volumes on Grove Street for neighborhood abutters between Beaver and Boston Streets
- Improves Grove Street at Boston Street signal operations.

Cons

- Even with optimized timing, the intersection of Goodhue Street at Boston and Bridge Streets will operate with congestion (LOS E/F) during the AM and PM peak periods due to the need to provide a fully separate pedestrian phase with the four of the five intersection legs requiring separate non-conflicting phases. This would not prevent pedestrians from trying to cross during other phases.
- Undesirable from a traffic safety perspective as sharp right turns from Goodhue Street onto Boston Street would not be able to see pedestrians

crossing on Boston Street on the west side of the intersection. Sight lines from Goodhue to Boston Street are poor due to a wall and grade changes

- Produces a pedestrian and bicycle unfriendly design for the intersection of Boston at Grove and Goodhue Streets requiring longer vehicle/pedestrian exposure and crossing times and eliminates crosswalk in the middle of the intersection.
- Signal modifications will be challenging and costly to meet ADA requirements.
- Stop bar on Bridge Street will need to be relocated even further back from Boston Street than it is today.

4.2.11 Hanson Street/Goodhue Street Connector

Hanson Street to Grove Street Connector Concept

Proposed in the 2003 NRCC Master plan, this concept calls for the elimination of the offset traffic signals at Grove and Nichols Street intersections with Boston Street and the construction of new connector road from Boston Street to Goodhue/Grove Streets. The grade differential between the two intersections is approximately 22 feet and the distance between them is less than 200 feet. This produces a greater than 10% grade without consideration for intersection design requirements that would produce even steeper midpoint grades.

A pro/con summary of **connecting Boston Street to Goodhue Street**, **via a new roadway a minimum of 220- feet in lengt**h across the Flynntan parcel plus an additional 230-270 feet on Goodhue and Grove Streets in length with **a new traffic signal at Boston and Hanson Streets** is given below:

Pros

- Would reduce eastbound Boston Street traffic volumes approaching Bridge Street.
- With a new signal at the potential Boston Street/Hanson Street, a new opportunity would be created for traffic to access developments adjacent to Goodhue Street.
- Creates an opportunity to make multi-modal Bridge Street/Boston Street intersection improvements to the benefit of all intersection users
- Creates a Boston Street view corridor to Goodhue Street.

Cons

- Has a very high cost compared to other options, is not on the State's Transportation Improvement Program, and has no local funding source.
- Has questionable construction feasibility due to steep grade differential between the current elevations of Goodhue and Boston Streets. Requires major changes to the elevations of Goodhue and Grove Streets on the north side of the potential extension. Steep grades in excess of 10% make this a connection that MassDOT would likely not participate in funding.
- Requires privately owned right-of-way on the Flynntan parcel and an extension of construction northbound onto Goodhue and Grove Streets including walls or other means to create acceptable grades on the extension.
- Affects the continuity of Goodhue Street, possibly losing its connection to Beaver Street as well as affected driveways to future developments adjacent to Goodhue Street
- Requires elimination of the Grove Street/Nichols Street at Boston Street intersection traffic signals and likely reversal of their flow patterns from one-way into Boston Street to one-way away from Boston Street
- Requires loss of parking and creation of exclusive left turn lanes on Boston Street to accommodate turning movements acceptably at the new signal.
- Increases traffic on Hanson Street, as it will be absorbing its existing traffic plus traffic diverted from Nichols Street.

4.2.12 Bridge Street at Boston Street Reconfiguration

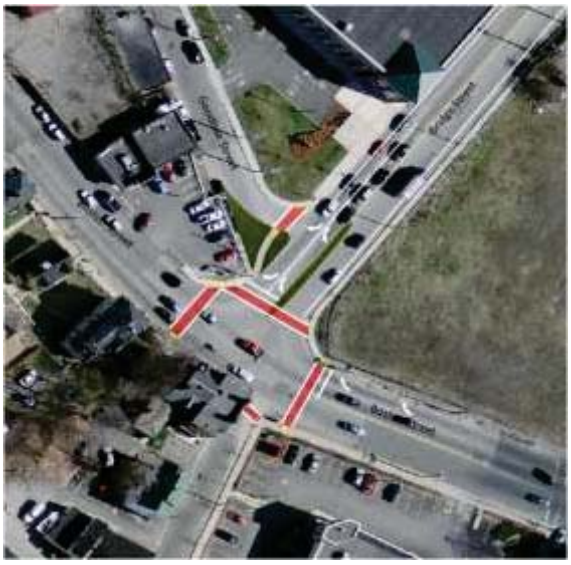
The 2003 NRCC Master plan proposed reconfiguration of the intersection of Bridge at Boston Streets to enhance its Salem 'gateway' status. A major alteration of this busy intersection is possible only if the direct access from Boston Street to Goodhue Street is altered. There are at least two approaches to achieving at new Connector – either create a new connection create a new Bridge Street Connector per subsection 4.2.9 or opposite Hanson Street per subsection 4.2.11.

As envisioned, there are at least two options (refer to the next page) for the proposed new compressed Bridge, Boston, and Proctor Streets intersection. Option 1 retains right in access to Goodhue Street from Bridge Street, while Option 2 creates a dead end of Goodhue Street at the motorcycle shop and storage building. Elimination of a Goodhue Street direct connector would benefit most intersection users, including pedestrians and bicyclists and would allow the intersection to operate better by reducing clearance intervals, reducing opposing conflicts, and allowing rights and lefts to be made concurrently. Pedestrian accommodations can more easily be made ADA compliant. The Goodhue destined traffic from Boston Street would need to be re-routed causing an increase in travel distance of approximately 400 feet per motorist. Bridge Street southbound traffic destined for Goodhue Street would benefit

from a decrease in travel distance of approximately 400 feet. This is particularly important if Flint Street northbound traffic is diverted to Goodhue Street.

The new Bridge Street approach would include an exclusive right turn lane plus a shared through/left lane. It would be reconfigured to provide a single departure lane with a 6-foot wide median approximately 100 feet in length. The new median would serve three purposes:

1) To re-direct 'cut-across' access to Goodhue Street from Boston Street to the new Goodhue/Bridge Street Connector and allow the southbound Bridge Street approach to be stopped closer to the intersection.
2) To provide further protection for pedestrians crossing the north Bridge Street leg at Boston Street
3) To provide landscaping opportunities at the Bridge Street gateway to Salem.



Option 1 – Goodhue Street remains open for rights in only (preferably with new Connector)

Option 2 – Goodhue Street closed to vehicles (assumes new Connector)

The eastbound Boston Street approach would include an exclusive left and a shared through/right turn lane.

The westbound Boston Street approach would include an exclusive right turn lane and a shared through left lane. Alternatively as approved in the Gateway Center Record of Decision cited previously, the westbound approach could include an exclusive right turn lane, an exclusive through lane and an exclusive left turn lane (toward Proctor Street).

Left and right turn access from Boston Street onto Bridge Street would occur via a single lane that would diverge back into two lanes immediately north of the potential new median, with the left lane dedicated to left turns only to the new connector. Diverted movements that would otherwise go directly onto Goodhue Street would

occur via a new signal-controlled intersection at the Bridge Street/Goodhue Connector. The signal must be designed to coordinate with the Bridge Street intersections at Boston and Flint Streets. As envisioned, it would accommodate left turn volumes from northbound Bridge Street via an exclusive left turn lane and a through lane at the new signal. In the southbound direction, Bridge Street would retain two lanes, as it does today, but the lanes would be 11-feet in width with 4-foot bike-friendly curbside shoulders within the existing 52-54-foot curb-to-curb width.

A pro/con summary of **compressing** and reorganizing **the Boston Street at Bridge and Proctor Streets intersection via the new Goodhue Street/Bridge Street Connector** is given below:

Pros

- Creates an opportunity to make multi-modal Bridge Street/Boston Street intersection improvements to the benefit of all intersection users and additional and effective landscaping opportunities at the Bridge Street/Boston Street gateway intersection.
- Allows westbound Boston Street and eastbound Boston Street to operate acceptably with overlapping left and right turn movements and signal phases, increasing the operational efficiency of the intersection at processing its traffic demands. Simultaneous left and right turns, not possible today, would be possible without conflicts with the potential signal layout.
- Provides for exclusive and/or advanced pedestrian phases on Bridge and Boston Streets with crosswalks on all legs of the intersection – i.e., the north leg of Bridge Street, east and west legs of Boston Street and the south leg of Prospect Street as well as across westbound Goodhue Street on the southbound approach from Bridge Street.
- Shortens the distance people traveling south on Bridge Street to arrive at the intersection of Goodhue and Grove Streets.
- Retains more green space and shortens pedestrian crossing exposure, as separate new exclusive right turn lanes for proposed for westbound Boston Street and southbound Bridge Street would not be necessary to construct (refer back to page 49).

Cons

- Has a relatively high cost compared to other options.
- Is not on the State's Transportation Improvement Program list.
- Is not be workable without the Goodhue/Bridge Streets Connector
- Requires diverted Goodhue Street users from Boston Street to travel an additional 400 feet to arrive at the Beaver/Goodhue/Grove Street intersection to the northwest.

4.2.13 *Aborn Street at Boston Street Options*

This intersection has an existing skewed alignment and high conflicting traffic volumes. Its 2007-2009 crash rate is just below the statewide average crash rates for similar intersections. The three evaluated options for this intersection are not mutually exclusive. They can be combined with one another. Option 1 includes striping and sign modifications only with no alterations to the intersection hazard beacons. Option 2 includes modifications with geometric changes and going to flashing beacons over the lanes, and modifications with geometric changes and bicycle lanes.

Option 1 – No Geometric Changes

Option 2 –Geometric Changes

Option 3 – Potential Full Traffic Signal with Bike Lanes

A pro/con summary of **creating an exclusive westbound left turn lane and a flush median on Boston Street approaches to Aborn Street** are given below:

Pros

- Creates a refuge area for westbound vehicles on Boston Street waiting to turn left into Aborn Street.
- Creates a mid-crossing refuge area for pedestrians crossing Boston Street at Aborn Street.
- Is relatively easy to implement with pavement markings and signs only.

Cons

- Does not address the difficult left turn movement from Aborn to Boston Street westbound
- Does little to address the crash rate at the intersection

A pro/con summary of **extending the curb on the east side of the intersection and across Boston Street** is given below:

Pros

- Reduces the crossing exposure of pedestrians who cross Boston Street and wide throat of Aborn Street
- Produces a better alignment for right and left turn movements in and out of Aborn Street.

Cons

- Costs approximately $50,000-$75,000 to design and construct.
- Does little to address the *vehicle* crash rate at the intersection.

A pro/con summary of **converting the existing Aborn at Boston Streets flashing hazard beacon to a full traffic signal** is given below:

Pros

- Permits creation of an exclusive pedestrian phase for pedestrians who need to cross Boston Street at Aborn Street
- Reduces potential angle collisions at Boston and Aborn Streets.
- Reduces congestion for Aborn Street traffic.

Cons

- Costs approximately $250,000 -$300,000 to design and construct.
- Has continuing maintenance costs and really should be coordinated with nearby traffic signals.
- While addressing angle crashes, may increase rear end crashes on Boston Street.

A pro/con summary of **adding bike lanes to Boston Street** is given below:

Pros

- Increases use of bikes along Boston Street.
- Ties well into the City of Peabody's plan to create bike lanes on its Main Street continuation of Boston Street.
- Has a relatively low cost if done with Boston Street improvements.
- Provides an added buffer for traffic exiting from Aborn Street, particularly for left turning movements and reduces the length of motor vehicle/ pedestrian conflict exposure.

Cons

- Has continuing maintenance costs and should only be done in conjunction with major Boston Street streetscape enhancements.
- Existing high traffic volumes and heavy truck use of Boston Street would suggest only *experienced* bike riders use the corridor for bicycle travel, not inexperienced, younger riders.
- East of Aborn Street toward Bridge Street, Boston Street has a narrow paved cross-section east of Grove Street where bike lanes would need to be dropped and replaced with sharrows or shared bike markings.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Conclusions were reached after reviewing pros and cons of various potential actions described in Chapter 4, within the context of City and public input received at meetings during January through the end of March 2012.

As indicated on Table 8 in Chapter 3 of this report, when the five re-developments (three of which are approved, and a fourth is under review) occur, traffic in the NRCC study area will grow appreciably. Furthermore, enhancing the NRCC's circulation environment should benefit re-investment into the NRCC land uses as well as its existing neighbors and users.

Based on input received, we conclude that, from a circulation perspective, the most significant *unaddressed* or *unmitigated* needs in the NRCC Area are as follows:

- *Flint Street safety upgrade from Mason to Oak Streets. There is a need to create an alternative(s) to serve through traffic demands on Flint Street.* Classified as a local street between Mason and Bridge Streets, a safety upgrade of Flint Street is necessary given the high crash rate at the intersection of Flint and Mason Streets. Flint Street is unable to accommodate two-way traffic simultaneously, because on-street parking is permitted on the south side of Flint Street. Flint Street residents need the parking to accommodate their vehicles, but traffic demands on Flint Street are such that the Flint/Mason intersection is unable to function effectively from capacity and safety standpoints. There are no simple, easy solutions to this problem; all potential improvements have drawbacks. Guard rail on the north side of Flint Street approach to Mason Street is indicative of the problem on this stretch of Flint Street.

- *Mason Street upgrade between Harmony Grove Road and North Street.* There are two distinct segments of the Mason Street corridor 1) from Grove to Flint Streets and 2) from Flint to North Streets. The segment of Mason Street between Harmony Grove Road and Flint Street is generally in need of rehabilitation and better demarcation. Additionally, the entire length of Mason Street could benefit from traffic calming measures specifically oriented to slowing traffic. The goal of traffic calming measures should be enhancing safety for all of its users. The goal of *diverting vehicle traffic to parallel routes should only include traffic diversions to arterials or industrial collectors like Commercial or North (Route 114) Streets*. Measures that are going to divert traffic to other residential local streets (like School Street, for example) should not be considered. Historical crash records, and guard rail at two locations on Mason Street – near Oak and Tremont Streets -- attests to the speeding/crash problems being experienced by its abutters.

- *Grove Street/Goodhue Street corridor between Bridge Street and Harmony Grove Road.* This corridor is in generally in need of better definition, better sidewalks and has a poor walking and bicycling environment. While it has relatively low

traffic volumes, its rail grade crossing treatments also require upgrading to comply with current standards. Multi-modal accommodations should be incorporated as a City-defined 'gateway' corridor. The east side of Grove Street is missing a sidewalk between the future 28 Goodhue development site and Mason Street. Grove Street's two major intersections with Harmony Grove/Mason Streets and Beaver/Goodhue Streets, proposed as roundabouts in the NRCC Master Plan, need attention if they are to function well with the new developments and as 'gateways' to the re-developments adjacent to Grove and Goodhue Streets. Refer back to Chapter 3 for photos of the Grove Street environment.

- *If possible, create an alternative(s) to serve through traffic demands on Grove Street between Beaver and Boston Streets.* Grove Street is classified as a local street between Beaver and Boston Streets. Bounded by high density multi-family residences, projected traffic increases on this segment of Grove Street should be minimized to the extent possible by creating an alternative exit for them, if possible.

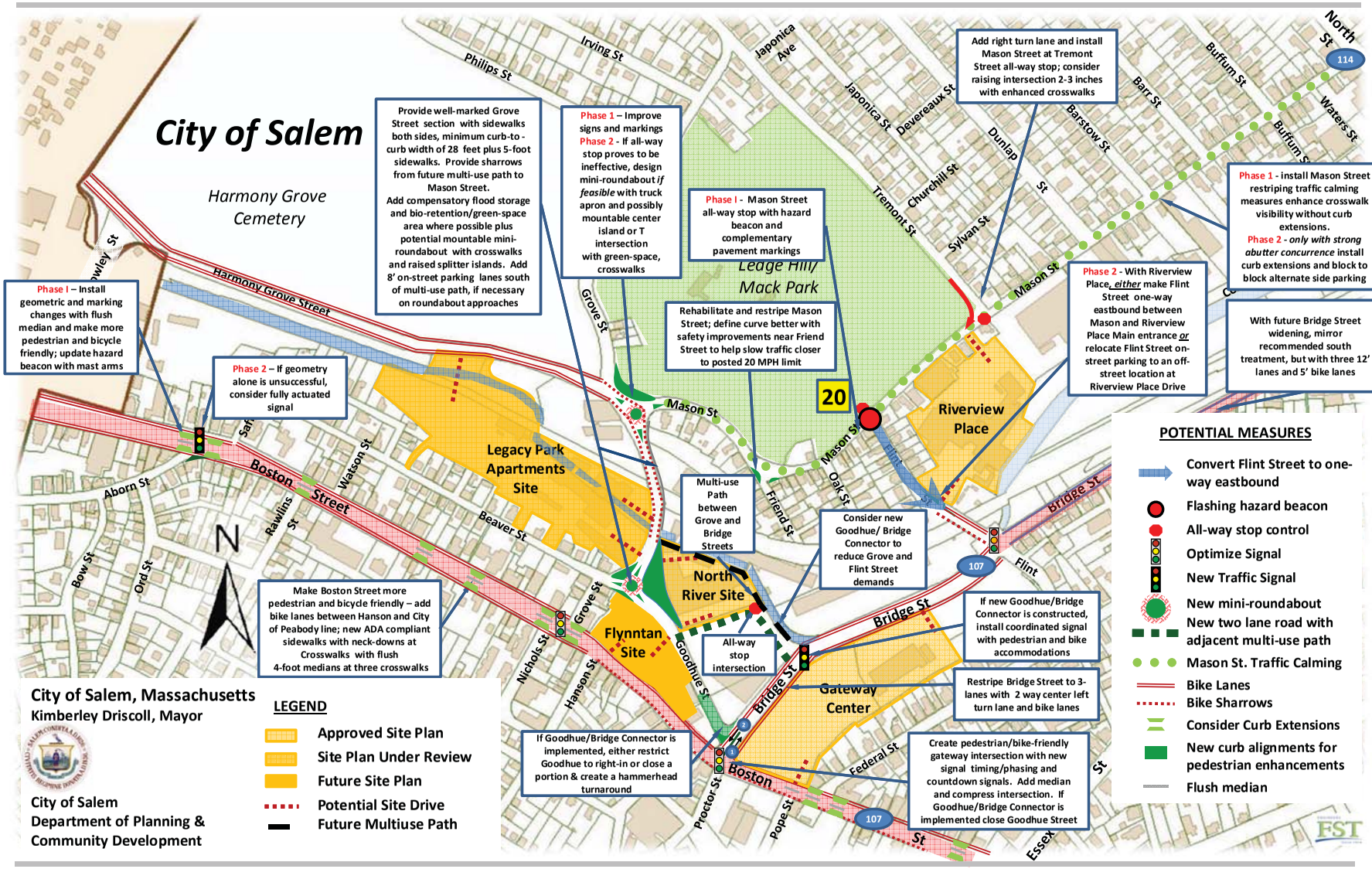
- *NRCC regional access needs are served by Boston and Bridge Streets. Both require modifications to serve 'Complete Streets' functions in support of existing NRCC neighborhoods and future NRCC developments.*

- *The critical NRCC Salem gateway intersection of Boston and Bridge Streets needs to be simplified so it can serve pedestrians and bikes more effectively while allowing general motor vehicle traffic to flow through it acceptably.* Pedestrian access to this intersection is poor and prior studies have recommended better accommodations that have not yet been implemented. Two new right turn lanes have been approved but not yet constructed. If implemented, these lanes will increase, not decrease the pavement area of this critical intersection, thereby making it even more difficult for bicyclists and pedestrians to traverse the NRCC area. A proposal to allow Goodhue Street to access this intersection will worsen, not improve its traffic operations, while degrading its environment for pedestrian and bicycle circulation.

5.2 RECOMMENDATIONS

Based on the above conclusions, Figures 16 and 17 were prepared. Figure 16 summarizes recommendations for NRCC Area circulation enhancements, while a companion display, Figure 17, provides an implementation overview for recommended measures shown on Figure 16. Figure 17 proposes three priority levels – Priority 1 - less than three years, Priority 2 - from three to five years, and Priority 3- five + years. Actual implementation will depend on funding availability. Refer to the separate March 29, 2012 presentation posted on the City of Salem website for further illustrations of the recommended features.

Preliminary Recommendations Overview

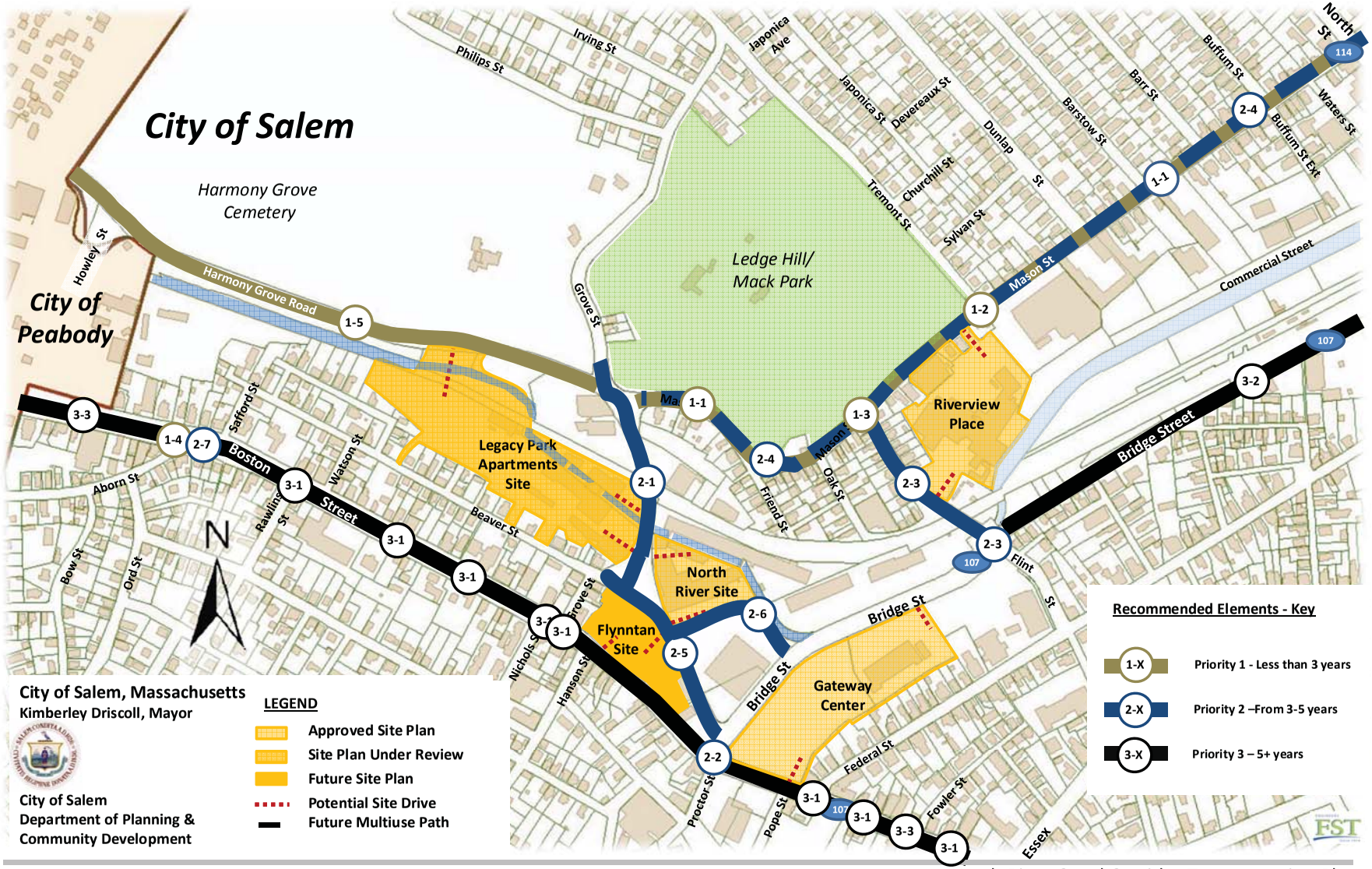


5-10 year Horizon Modifications

North River Canal Corridor Transportation Plan

Figure 16

Suggested Implementation Overview



North River Canal Corridor Transportation Plan

Figure 17

It is recommended that the top priorities be given to by addressing Mason Street and Flint Street corridor safety issues, followed by the Grove/Goodhue Street corridor as developments come on line. Measures to enhance the multi-modal effectiveness of Boston Street/Bridge Street regional access routes should be given high priority as funding becomes available.

IMMEDIATE ACTION PRIORITIES (1-3 YEARS)

- *Priority 1-1 - Mason Street Traffic Calming – Phase 1 between North and Tremont Streets*

  <u>Recommendation</u>: Install low-cost traffic calming measures if approved by City, abutters, and emergency providers

  Enhance safety and the walkability of the Mason Street corridor as follows:

  Mason Street - Create alternate side parking with enhanced markings plus high visibility crosswalks

  Consider relocating on-street parking from the south side to the north side of Mason Street on *two* blocks:

  - Between North (Route 114) and Buffum Streets
  - Between Buffum and Barr Streets

Overview- Potential Mason Street Alternate Side Parking Traffic Calming

Coupled with new enhanced centerline/edge line markings, alternate side parking should reduce travel speeds along Mason Street and retain approximately the amount of existing on-street parking as today.

Restripe Mason Street between Tremont and North Streets. Stripe a parking edge line offset 6 feet from the curb to identify outer edges where parking on Mason Street is permitted, while retaining two 11-foot wide travel lanes, one in each direction. Consider installing bicycle sharrows to note that motorists should be sharing the road with cyclists who may be using Mason Street. Restripe all existing Mason Street crosswalks with high visibility markings to

enhance their visibility. Sharrows would be beneficial to existing and future NRCC residents, as Mason Street connects to North Street, which in turn connects Salem's MBTA Commuter Rail Station.
Use center line transition markings through intersections to delineate the offset changes in travel direction along the corridor. Include raised plowable centerline markers especially to delineate centerline transitions between blocks where parking is shifted from the south to the north sides or vice versa.

After implementing alternate side parking, conduct an engineering study of 85th percentile speeds to determine whether Mason Street's speed limit can be reduced in accordance with Massachusetts guidelines.

Provide transverse markings to demarcate the no-parking zones at and across driveways where parking is to be prohibited and at public street corners where parking is to be prohibited. When doing so, leave driveway openings with no less than 15 feet no parking on either side of driveways. Restripe Mason Street from Friend Street to Grove Street to improve curve delineation and travel lanes including raised plowable markers on the approach to and through the Friend Street curve.

- *Priority 1-2 - Mason Street and Tremont Streets Intersection*

<u>Recommendation</u>: Install three high-visibility ADA-compliant crosswalks at the Mason/Tremont Streets intersection with all-way stop control.

Provide an ADA compliant corner sidewalk of Mack Park side and make sure all crosswalk landings are ADA-compliant.

Provide advance all-way stop-ahead warning signs on Mason Street to warn motorists of the new change in traffic control. Add stop bars and stop lines to all three approaches.

Mason at Tremont Streets – All-way stop control with enhanced visibility crosswalks

Create an ADA-compliant sidewalk on the north Mack Park side of Mason Street between Tremont and Flint Streets.

Repair Tremont Street pavement on its approach to Mason Street. Without widening, create a 10-foot right

turn lane with a 10-foot left turn lane on the Tremont Street approach to Mason Street.

- *Priority 1-3 - Mason Street and Flint Streets Intersection*

<u>Recommendation</u>: Phase 1 - Install three high-visibility ADA-compliant crosswalks at the Mason/Flint Streets intersection and all-way stop control.

Provide an ADA compliant corner sidewalk of Mack Park side and ensure that all crosswalk landings are ADA-compliant.

Provide advance all-way stop-ahead warning signs on Mason Street to warn motorists of the new change in traffic control. Add stop bars and stop lines to all three approaches. Provide overhead flashing red hazard beacons on all three approaches.

Consider the possibility of relocating Mason Street alignment slightly northerly per the sketch left to improve sight lines for traffic exiting from Flint Street onto Mason Street. As Mack Park is a designated park, such a change would require an Article 97 state action.

Potential Flint/Mason Streets modifications

- *Priority 1-4 - Aborn Street at Boston Street Intersection Modifications*

<u>Recommendation</u>: Modify existing Boston Street pedestrian crossing to make ADA-compliant. Create curb extensions on both sides of Boston Street. Relocate existing flashing signals to mast arms over lanes to enhance visibility and for possible future full signalization. Create a curb extension on the east side of Aborn Street at Boston Street.

Boston Street at Aborn Street has a relatively high crash rate and is congested during the AM and PM peak hours. Resolving this issue is likely to involve a

two-step approach. Phase I involves geometric, signing and pavement marking changes, while Phase II will likely involve full signalization from 3-5 years from now. Refer to the sketch on the page that follows.

Potential Phase1 Aborn/Boston Streets Intersection Enhancements

- *Priority 1-5 - Harmony Grove Road shoulder bike lanes*

Harmony Grove Road will be a significant gateway corridor that provides access to the Legacy Park Apartments site. As a two-lane roadway that typically is 35-38 feet wide, it should be restriped to provide a five-foot bike lane in each direction between the Peabody Line and its easterly end at Mason Street. This will encourage bike use to reduce reliance on private auto use and help slow traffic speeds

Looking east on Harmony Grove Road east of future residential driveway with bike lane

on Harmony Grove Road. As a 'gateway' corridor, it will send a message to motor vehicle users that Salem is a bike-friendly community.

<u>Recommendation</u>: Provide and maintain five-foot bike lanes on both sides of Harmony Grove Road from the Peabody line to Mason Street.

SHORT TERM PRIORITIES (3-5 YEARS)

- *Priority 2-1 – Grove Street between Mason and Goodhue Streets*

<u>Recommendation</u>: Either create a mini-roundabout at the Harmony Grove Road, Mason Street, at Grove Street intersection, or reconfigure to improve traffic operations as well as pedestrian and bicycle crossings.

Grove Street will provide access for the 28 Goodhue Street and Legacy Park Apartments site. To complement the building changes that will take place along this corridor, Grove Street should be redesigned to provide an attractive, functional, landscaped gateway to the existing neighborhood to the north as well as the future redeveloped neighborhood between Mason and Goodhue Streets. At some point in the future, the Grove Street bridge over the North River Canal is programmed for replacement.

Ideally, Grove Street improvements should coincide with its North River Canal bridge replacement. Grove Street should have a typical minimum 2-lane paved section of 32 feet including two 5-foot bike lanes where on-street parking is not permitted. If there are selected locations where on-street parking is permitted, it should be 'cut-out' parking approximately 8 feet in width. The streetscape could be improved with tree-lined concrete sidewalks on both sides. The seldom used Grove Street railroad crossing should be brought up to current standards. As envisioned, the current four-way stop controlled intersection at Mason Street and Harmony Grove Road would be converted to a modern single lane mini-roundabout. It should include a stone-textured center island mountable by trucks with a different stone textured truck apron along with raised and landscaped splitter islands to serve yield controlled entries by deflecting vehicles to a desired entry design speed of 15 miles per hour. Southbound Grove Street would retain stop control, but be reoriented slightly westerly away from the potential mini-roundabout.

The area for locating a three-legged mini-roundabout serving Grove Street, Mason Street and Harmony Grove Road is challenging due to grade issues. As envisioned in the NRCC master plan, the end result should be a greener, safer intersection with pedestrian and bike accommodations.

In the event that a mini-roundabout is deemed infeasible for technical reasons after further engineering review, alternatively, the intersection could be reconfigured geometrically to enhance traffic operations and pedestrian crossings through the intersection. The two Grove Street at Mason and Harmony Grove intersection options are illustrated below.

Potential Mini-roundabout at Harmony Grove Road, Grove, and Mason Streets

Potential all-way stop 'T' intersection at Harmony Grove Road, Grove, and Mason Streets

- *Priority 2-2 – Bridge Street at Boston, Goodhue, and Proctor Streets*

  <u>Recommendation</u>: Design and install traffic, bicycle and pedestrian friendly enhancements to compress the intersection of Boston, Bridge, Goodhue, and Proctor Streets consistent with NRCC Master plan objectives.

  Boston Street and Bridge Street are major arterials that join with Goodhue and Proctor Street to form a complicated five-legged intersection. A challenging intersection to negotiate under existing conditions, the NRCC Master plan called for making this a more pedestrian friendly gateway intersection.

  Two mitigation measures are already programmed for this intersection:

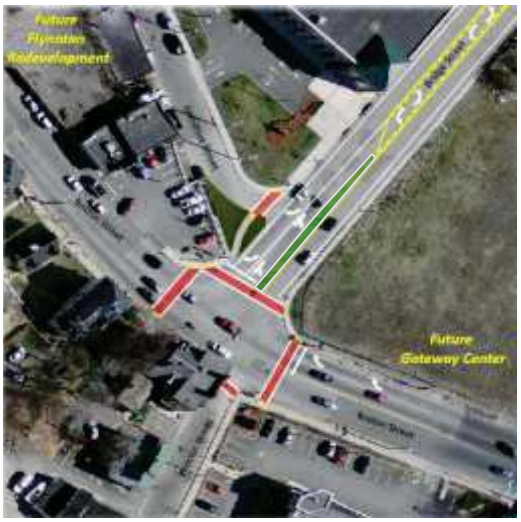
  - An easement reservation for an exclusive southbound right turn lane into Goodhue Street from Bridge Street in connection with the Storage Building approval process; and

  - An easement reservation for an exclusive westbound right turn lane into Goodhue and Bridge Streets from Boston Street in connection with the Gateway Center approval process.

  However, benefits of both actions would purely be traffic-related and would not be conducive to or making it more pedestrian-friendly or making it a gateway signature intersection in accordance with the NRCC Master plan.

- *Priority 2-2 – Bridge Street at Boston, Goodhue, and Proctor Streets (Continued)*

FST has identified two options that should be considered to help achieve NRCC Master Plan objectives.



Boston at Bridge, Goodhue and Proctor Streets – Option 1 – Goodhue/Bridge Connector preferred, but optional

Boston at Bridge, Goodhue and Proctor Streets – Option 2 – Goodhue/Bridge Connector required

In one case, the easiest to implement, the City could convert this to a four way intersection that would eliminate the direct connection to Goodhue Street from Boston Street, while retaining an exclusive right turn lane onto Bridge Street. The second option would be far more costly to implement, as it requires the implementation of the Goodhue-Bridge Connector.

This would involve creating a raised landscaped median at least 100-200 feet in length on Bridge Street and restriping Bridge Street such that it would retain two approach lanes, but would have a single departure lane. U-turns would be prohibited on Bridge Street at the end of the median. The Goodhue corner at Boston Street would be landscaped and pavement removed.

The proposed new configuration would allow southbound Bridge Street approach to stop far closer to the intersection than it does today. Traffic operations benefits would be significant. Southbound right turns from Bridge Street would be able turn onto Boston Street while eastbound Boston Street left turns and through movements would go concurrently. Similarly, it would allow westbound right turns from Boston Street to Bridge Street to go concurrently with southbound Bridge Street traffic. Both of these concurrent movements are not possible with the existing intersection configuration,

Priority 2-2 – Bridge Street at Boston, Goodhue, and Proctor Streets (Continued)

which results in long queues and inefficient traffic movements, especially during peak hours. As envisioned, pedestrian crossings would occur under an exclusive phase with countdown pedestrian signals and ADA-compliant corner landings.

While not absolutely required, Option 1 would work most effectively if implemented with a Bridge Street/Goodhue Street Connector, discussed further on. Otherwise, most motorists would have to continue westbound on Boston Street, and access Harmony Grove Road via Howley Street in Peabody. Without the Goodhue-Bridge Streets Connector, residents who live in the Beaver Street neighborhood would need to use local streets like Watson or Safford Streets, rather than Goodhue Street.

Traffic and pedestrian/bike safety benefits of Option 2 are even more significant than those associated with Option 1. Under Option 2, the portion of Goodhue Street between the west end of the Goodhue-Bridge Connector and Bridge would be reclaimed as green space, a portion of which possibly to be used as a land swap with the Public Storage, Inc. for the potential Goodhue Connector. We assume utility easements on Goodhue Street would be retained. With Option 2,efficient traffic operations would be maximized, as would pedestrian and bike accommodations. The Goodhue-Bridge Connector would eliminate accommodate movements of traffic from Boston Street westbound that normally traverse Bridge Street directly to Goodhue Street, thereby eliminating potential traffic diversions to Howley Street in Peabody, or local streets like Watson to Beaver Streets that are necessary without the Goodhue-Bridge Street Connector.

- *Priority 2-3– Phase 2 modifications of Flint/Mason Street intersection*

Recommendation: Flint Street Phase 2 - With Riverview Place, either make Flint Street one-way eastbound between Mason and Riverview Place Main entrance or relocate on-street parking on the narrowest segment of Flint Street near Mason Street to an off-street location at Riverview Place Drive.

This assumes that Riverview Place has been fully constructed and that a Phase 1 all-way stop is installed at the intersection of Flint and Mason Streets to permit relocated parkers controlled access to and from their vehicles. Motorists directly affected are those who would have to move their parked vehicles from the current on-street locations (parking on City of Salem right of way) to a new location that requires them to walk an additional couple of hundred feet plus cross Mason Street, instead of parking in front of their homes. While this is clearly an inconvenience for the residents few affected homes, converting Flint Street to a one-way operation will inconvenience

thousands of motorists each day and waste thousands of gallons of fuel annually.

Observations indicate that vehicles are parked on the west sidewalk of Flint Street close to its intersection with Mason Street creates a hazard for two-way traffic and pedestrians who may be walking on the south side of Flint Street.

The alternative of letting vehicles remain parked on Flint Street with the one-way operation is recommended only if the City concludes this potential relocation is too much of a hardship on affected users.

Concept for Riverview Access with Flint Street assumed one-way between Mason and Riverview Flint Street access driveway. Note bike access to Leslie's Retreat Park as an alternative to use of narrow Bridge Street segment prior to its programmed widening.

Only those residences on the northernmost portion of Flint Street narrower than 30 feet (FST observed fewer than six vehicles at any given time) need to be relocated. Vehicles parked on the south side of Flint Street where it widens out need not be relocated.

- *Priority 2-4– Mason Street Traffic Calming – Phase 2*

  Recommendation: ***Implement new concrete sidewalks to augment and reinforce the Phase 1 Mason Street Traffic Calming program.***

  Proposed Phase 2 traffic calming involves necessary, but more costly sidewalk and drainage and street lighting (not traffic signalization) improvements to augment Phase 1 signage and marking alterations.

- *Priority 2-5– Goodhue Street between Beaver and Bridge Streets*

  Recommendation: ***Modify Goodhue Streets between Beaver and Bridge Streets to create either a 'T' intersection or a mini-roundabout similar to that proposed for the intersection of Harmony Grove Road at Mason and Grove Streets.***

Like Grove Street, Goodhue Street is key gateway into the City of Salem. Goodhue Street provides access to two of the five developments expected in the NRCC over the next five years. It has a large unmarked ±9,200 square foot parking area at its intersection with Beaver and Bridge Streets with a steep cross-slope. We estimate the open area accommodates up to 25 autos. Modifications to this street segment include creation of a substantial amount of green space to replace the large surface parking area. Similar to the proposal for Grove Street, Goodhue Street should be tree lined and with some replacement on street parking adjacent to a newly configured intersection with relocated sidewalks and a rain garden flood storage area.

Potential Mini-roundabout at Goodhue, Beaver, and Grove Streets with two-way Goodhue Street to Public Storage site

Potential T intersection at Goodhue, Beaver, and Grove Streets with portion of Goodhue Street two-way

- *Priority 2-6– Goodhue-Bridge Street Connector*

The potential Goodhue-Bridge Street Connector is proposed as a more feasible and effective alternative to the Hanson Street Connector identified in the NRCC Master plan. The idea is to create a new connection between Goodhue and Bridge Streets that would either augment or replace the existing Goodhue Street intersection at Bridge and Boston and Proctor Streets. It also includes an extension to the future multi-use path proposed with the approved 28 Goodhue site plan along the North River Canal.

As envisioned, the multi-use path would retain the 10-foot paved width provided in the approved 28 Goodhue site plan. The proposed Goodhue-Bridge Street Connector would be 26 feet in width with no on-street parking and include an all-way stop controlled intersection at the 28 Goodhue Street corner. This also provides at multi-modal access corridor that could divert existing and future traffic off of Flint and Mason Streets to the north and join

the five development focus parcels from a circulation perspective. This creates a potential Bridge Street access route to the 28 Goodhue Street, Legacy Park development sites, as well as the Flynntan development site. The 28 Goodhue and Legacy Park development sites otherwise focus exclusively on Grove Street.

We assume the 28 Goodhue site would retain its required parking. The concept calls for the new multimodal access through what is now a landscaped passive recreational area. The idea is to replace the green space lost with new green space at the intersection of Grove and Goodhue Streets plus the east end of Goodhue Street where it intersects Bridge and Boston Streets. As envisioned, the new green space would be targeted at a 1:1 replacement of pavement added. This would replace a five-legged intersection with a four-legged intersection. It would create opportunities for reducing congestion at the Boston/Bridge Streets while enhancing pedestrian crossings of the intersection. At a proposed newly created intersection with Bridge Street at the Connector is proposed for signalization.

While this does not require a change in the approved site plan for the future Gateway Center, it creates a potential opportunity to provide a signal-controlled driveway, if the Gateway Center desired to relocate its driveway accordingly opposite the new roadway. Traffic operations at the Public Storage, Inc. would be enhanced by direct full egress out of the site that now must exit via a right turn only onto Bridge Street and only enter via Goodhue Street. Its site visibility and access options would generally be enhanced.

Potential Goodhue/Bridge Connector with replacement green space

<u>Recommendation:</u> Explore the possibility of creating a new multi-modal Goodhue/Bridge Streets Connector that will serve to link the five development sites and provide multi-modal opportunities to reduce traffic generation, traffic on Flint Street, and enhance the Boston/Bridge Streets Gateway intersection.

- *Priority 2-7– Aborn /Boston Streets Phase 2 Full Traffic Signalization*

  Aborn /Boston Streets Phase 1safety improvements discussed above will help address the traffic and pedestrian crossing problems at this intersection including its ADA compliance. Warrants, however, for full signalization are met and the relocated hazard beacons could be modified to full signalization by adding detection and

  <u>Recommendation:</u> After implementing the Phase 1 modifications, monitor for crash reductions; if problems remain, upgrade the installation to full traffic signalization.

LONG TERM PRIORITIES (5+ YEARS)

NRCC regional access needs closest to the five redevelopment sites are served by Boston and Bridge Streets.

<u>Major Long Term Recommendation:</u> Modify Bridge and Boston Streets to serve 'Complete Streets' functions in support of existing NRCC neighborhoods and future NRCC developments.

- *Priorities 3-1 and 3-2 - Boston Street Corridor from Essex Street to Peabody*

  - *Boston Street between the Peabody line and Essex Street*. This corridor was the subject of a corridor enhancements study conducted by the Metropolitan Area Planning Council (MAPC) in cooperation with the Cities of Peabody and Salem entitled *Peabody-Salem Corridor Concept Action Plan* (2011). The MAPC sub-regional planning study identified potential upgrades for a two-community corridor comprised of Main Street in the City of Peabody and Boston Street in Salem. Relative to circulation enhancements on Boston Street, the study recommended:

    - *Roadway Redesign* - Advance a two lane cross-section for corridor, with a center lane/median and on-street parking. Explore opportunities for reducing the size intersections and for the use of roundabouts.

    - *Bicycle and Pedestrian Enhancements* – Update pedestrian signals and install pedestrian refuge islands, install shared lane markings and bicycle lanes, more bicycle parking opportunities.

- *Transit Stop Amenities* – Improve visibility of bus stops of the corridor and such as benches, shelters and schedules to improve the passenger waiting experience and provide a more vibrant streetscape.

- *Green infrastructure* – Plant trees along to corridor to fill in the existing canopy explore opportunities for use of bio-retention in proposed curb extensions.

Within the City of Salem, the right-of-way of Boston Street is variable. It ranges from approximately 75-100 feet west of Hanson Street to a minimum of approximately 50 feet east of Hanson Street. East of Bridge Street to Essex Street, its right-of-way ranges from approximately 62-70 feet.

West of Hanson Street to the Peabody line, Boston Street also has a variable paved cross-section. This segment of Boston Street has excellent opportunities for *bike lanes in both directions, with flush pedestrian crosswalk medians* at the Aborn Street intersection and at other Boston Street crosswalks. There may also be an opportunity to widen sidewalks a couple of feet on each side of the Street to help create recommended streetscape tree canopy enhancements west of Hanson Street. Sharrows need only be proposed in the narrower segment of Boston Street east of Hanson Street and on the eastbound approach to Essex Street. The recent MAPC study proposed creating a center two-way left turn lane on Boston Street with intermediate medians. While placing sharrows on a busy street like Boston Street is not as effective as separate bike lanes for encouraging bike usage. Sharrows are generally recommended for lower volume bike routes, not high volume routes like Boston Street. Boston Street's paved cross-section declines rapidly from approximately 54-55 feet to an approximately 36 feet east of Hanson Street, before flaring out to approximately 42 feet and incorporating an exclusive left turn lane on its approach to Bridge Street where on-street parking is prohibited.

Except in the immediate vicinity of Aborn Street, no segments of Boston Street are wide enough to accommodate a three lane cross-section with two separate bike lanes plus on street parking. Furthermore, Boston Street's 'pinch point' segment east of Hanson Street is too narrow to accommodate bike lanes with on-street parking, even without a continuous center turning lane.

In a recent publication, the Federal Highway Administration (FHWA) of the US Department of Transportation includes short medians as one of its top safety benefit techniques. Nonetheless, because raised medians have maintenance/plowing and traffic operations issues, they should be used sparingly. In the case of Boston Street, flush medians should be considered where they will most benefit pedestrian crossing demands that are not under traffic signal control. The segment of Boston Street on its approaches to

Aborn Street is the only segment wide enough to accommodate an exclusive westbound left turn lane, either a flush or raised median, on street parking on both sides, *and* bike lanes, as opposed to shared lane markings, or 'sharrows'.

Since Boston Street has a relatively high volume of trucks and buses, care must be taken to ensure that larger vehicles along with pedestrians and bicyclists are well accommodated. Unfortunately, widening Boston Street to accommodate a typical 3 lane cross section plus on-street parking, as recommended in the MAPC report, may increase, not decrease, midblock pedestrian crossing risks if pedestrians cross at locations that do not have medians. For the high volume of traffic on Boston Street, bikes sharing an 11-foot lane with cars and trucks along with an adjacent parking lane is far less desirable to cyclists than having an exclusive bike lane plus a 2-foot buffer to reduce the hazard of 'dooring' from parked vehicles.

Therefore, for the Boston Street corridor, it is recommended that the City:

- *Re-design it for ADA-compliant crossings, better street lighting and sidewalks. Retain a typical two-lane section with bike lanes to the maximum extent possible generally without the center turning lanes, but with flush medians at all designated crosswalks whether signalized or unsignalized*. Such an approach *will decrease pedestrian crossing exposure to motor vehicles* by 10 feet while providing a more secure environment for cyclists to traverse Boston Street.

- *Install shared lane markings (sharrows) on the Boston Street eastbound approach east of Hanson Street to Essex Street.* As envisioned, a minimum five- to six-foot wide westbound bike lane would be provided on the westbound uphill direction of Boston Street. East of Bridge Street, while sharrows would continue in Boston Street's eastbound direction to Essex Street.

  Therefore, overall, Boston Street could be restriped to create a continuous westbound bike lane between Essex Street and the City of Peabody line. Eastbound, an exclusive bike lane would be available between the Peabody Line and Hanson Street with sharrows between Hanson to Essex Streets due to geometric constraints.

- *Install complementary multi-modal enhancements on Boston Street as recommended by the MAPC study*[2]. These include:

[2] *Peabody-Salem Corridor Concept Action Plan,* Metropolitan Area Planning Council, 2011.

  - Improving pedestrian accommodations at traffic signals such as count-down signals and accessible signal push buttons, advance pedestrian crossings, etc.
  - Encouraging installation of bike storage facilities at businesses and nearby institutions.
  - Creating an ADA-compliant sidewalk and enhanced cross-walks.
  - Creating a tree canopy on both sides of the street and incorporate green-space and/or bio-retention areas where practical to do so. Incorporate tree grates and good drainage methods to reduce or eliminate lifting of sidewalks by tree roots that can affect ADA compliance.
  - Improving MBTA bus stop infrastructure, such as shelters where they fit and do not impair sight lines or sidewalk ADA compliance.

- *Create ADA-compliant sidewalks on both sides of Boston Street while retaining its typical 54'-55' typical paved section*. Because drainage modifications on Boston Street will be needed to widen sidewalks in both directions, generally retaining the existing paved section provides the City with a lower cost option of replacing sidewalks with ADA-compliant features, while retaining the existing paved cross-section of 54-55 feet, restriping to accommodate bike lanes and while retaining a two-lane motor vehicle section with on-street parking and neck-downs at designated cross walks. This paved cross-section would also allow creation of four-foot flush medians at unsignalized mid-block crosswalks.

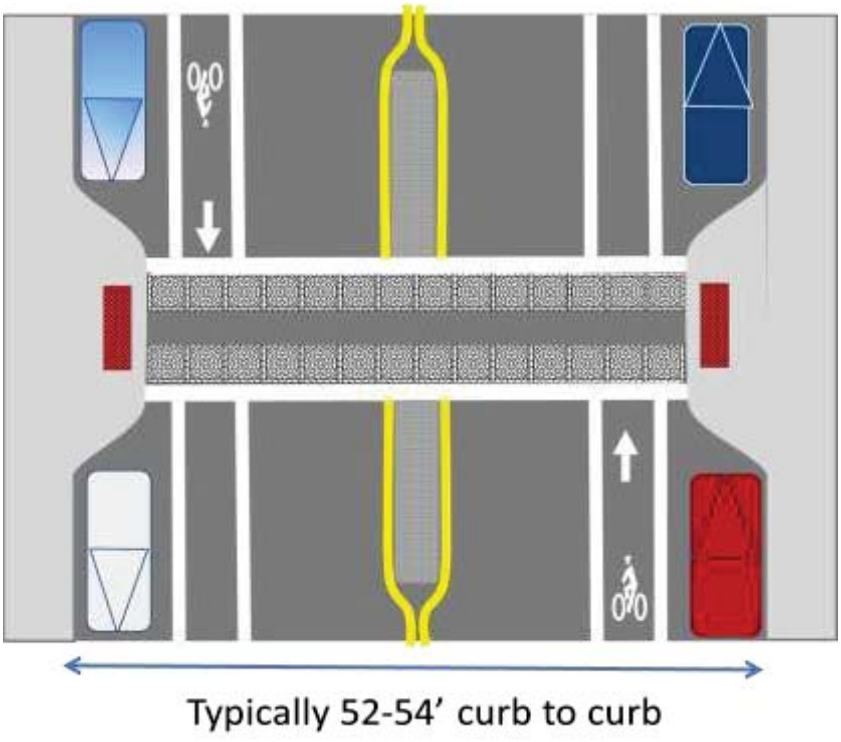
- *Provide exclusive left turning lanes only at three locations -- eastbound at Essex Street, eastbound at Bridge Street, and westbound at Aborn Street to address high left turn demands at these three intersections.* Of the three locations, only the Aborn Street westbound approach does not have an exclusive turn lane today.

- *Work with the MBTA when Boston Street is re-designed to identify candidate locations for bus stop enhancements*. Include shelters, if space is available (e.g., at future neck-downs) and demands warrant them. Always consider ADA-compliant pedestrian crossings of Boston Street where MBTA on-street stops occur.

- *Create new curb extensions, typically six-feet wide, at selected Boston Street cross-walks to improve sight lines, reduce crossing distances for pedestrians, and restrict parking within 20 feet at ten existing crosswalks located as follows*:

- West of Aborn Street (both sides);
- East of Rawlins Street (both sides, signal controlled);
- Both mid-block cross-walks between Watson and Nichols Streets (both sides, each crosswalk);
- West of Nichols Street (both sides, signal controlled);
- East of Grove Street (both sides, signal controlled);
- West of Pope Street (both sides);
- West of Federal Street (both sides)
- East of Federal Street (both sides, signal controlled); and
- West of May Street (both sides).

Where the above mid-block crosswalks are provided, the existing 54' to 55' (see below) paved section would be modified to create visual 'pinch points' through the provision of a 4' flush median mid-crossing between east and west Boston Street motor vehicle streams plus reducing the crossing distance by 6' on both sides with curb extensions. The end result is reducing exposure of pedestrians in crosswalks to motor vehicle traffic from what is now approximately 38-40 feet between on street parking to 22 feet, or 11 feet in each direction.



- *Priority 3-3 - Bridge Street – Flint to Boston Streets*

<u>Recommendation</u>: Restripe the four-lane segment of Bridge Street segment to provide a 13-foot typical single travel lane in each direction with a 14-foot two-

way center left turn lane plus two 6-foot designated bike lanes in each direction. Incorporate the proposed Goodhue-Bridge Streets Connector as discussed above.

- *Bridge Street Corridor (Route 107).*

  Bridge Street carries its heaviest traffic volumes between North and Flint Streets, but that segment has a typical two-lane cross-section and its paved width is approximately 28 feet and a substantial amount of head-in parking largely related to the MBTA Salem commuter rail station.

  As part of the Salem/Beverly Bridge Street project, the segment of Bridge Street south of Flint Street to Boston Street, was widened to typical paved width is approximately 52 feet. This segment currently is striped to provide four 12 foot lanes, two in each direction, with 2-foot unmarked shoulders. With new NRCC developments, there is a need to keep Bridge Street effective for general traffic while minimizing neighborhood cut – through diversions from it.

  Promoting biking or walking via Bridge Street is highly challenging. Right now, with 2-foot shoulders, bicycle traffic is not encouraged to use the wide segment of Bridge Street, let alone its narrower segment.

  It is possible to modify the wider 52-foot paved segment of Bridge Street to create a more bike-friendly and pedestrian-friendly environment by restriping alone while retaining capacity for necessary traffic movements. Such a change would embrace the 'complete streets' design philosophy that has become more prevalent during the past few years. A two lane approach to the intersection of Boston Street would be retained, but 5-foot bike lanes would be incorporated on both sides of the street.

  With a potential three lane cross-section, the future Gateway Center development will attract new left turn movement demands from Bridge Street to the east. Similarly, a potential new Bridge Street /Goodhue Street Connector would attract new left turn movement demands to the west, thereby occurring opposite from one another rather than two lanes offset from one another, as in a four lane cross-section. Additionally, if Flint Street were to be converted to one-way eastbound operation west of Bridge Street, it may be possible to create a well-defined, but relatively short raised median on the northbound Bridge Street approach to Flint Street. Until the segment of Bridge Street is widened, it will be necessary to transition to the narrower segment of Bridge Street north of Flint Street where the northbound left turn lane exists today.

  As noted above, the segment Bridge Street between Flint and Washington Streets is programmed to be widened to a typical four-lane cross-section,

mirroring the section between Flint and Boston Streets. However, due to environmental and rail issues, the programmed widening is not expected for several years. When this widening does occur, it may be possible to mirror *the potential restriping of Bridge Street to the south*, and perhaps lower its cost and impervious surface area in doing so. A lesser 43 to 46-foot paved cross-section would suffice with a three-lane section with either a reversible center lane or a two-way left turn only center lane with bike lanes on both sides, assuming three 11-12-foot lanes plus two 5-foot bike lanes. This would result in a 6 to 9-foot reduction in pavement width compared to the south segment between Flint and Boston Streets.

Prior to completing programmed Bridge Street widening modifications between Flint and Washington Streets, three-foot shoulders could be considered for the 28-foot two lane segment of Bridge Street with two 11-foot travel lanes to provide an interim alteration that would be slightly more beneficial to bicycle travel between the MBTA Salem Commuter Rail Station and the existing NRCC neighborhood and the tenants of its future development sites.

5.3 PRELIMINARY OPINION OF PROBABLE COSTS PROBABLE IMPLEMENTATION COSTS FOR RECOMMENDED IMMEDIATE ACTION, SHORT, AND LONG RANGE ACTIONS

Table 10 provides an initial summary of potential implementation costs associated with the Immediate Action, Short, and Long Range Action Plan identified in Section 5.2.

Costs are approximations without the benefit of detailed engineering analyses. Including Immediate Action, Short Range, and Long Range measures, total implementation costs of all actions could total from $10-$12 million.

Priority 1 actions, presumably completed within the next three years, are estimated, in aggregate, to involve costs of approximately $330,000. Priority 2 actions, assumed completed during the next 3-5 years are estimated at just under $3,000,000, while Priority 3 actions, including major investments to the rehabilitation of Boston Street, are estimated at approximately $7.4-$9.5 million.

Table 10

North River Canal Corridor
Potential Infrastructure Modifications to Accommodate Growth[1]

Priority	Location	Projected Low Cost	Projected High Costs	Action
1	Mason Street Traffic Calming - 1	$20,000	$30,000	Striping/markings/signs
1	Tremont Street/Mason St	$40,000	$60,000	Pavement repair, southbound lane & all way stop with crosswalk enhancements
1	Flint Street/Mason Streets - 1	$75,000	$90,000	All-way stop with hazard beacons and minor geometric modifications
1	Aborn Street /Boston Street (Excluding signal)	$80,000	$120,000	Geometric modifications without signalization
1	Harmony Grove Road shoulder bike lanes	$20,000	$30,000	Add bike lanes both sides
2	Aborn Street/Boston Street (with Signal)	$100,000	$150,000	Full traffic signal control
2	Grove Street between Mason and Goodhue Streets	$440,000	$550,000	Add new sidewalk/bike/ greenspace and potential mini-roundabout enhancements
2	Bridge Street/Boston Street intersection modifications	$200,000	$300,000	New median with ped friendly crossings and signal modifications.
2	Flint Street/Mason Streets - 2 plus Flint Street one-way /Riverview access	$170,000	$250,000	Geometric modifications plus sign/signal modifications striping changes
2	Mason Street Calming - 2	$300,000	$450,000	Miscellaneous improvements with new concrete sidewalks
2	Goodhue Streetbetween Beaver and Bridge Sts.	$230,000	$350,000	Add new greenspace sidewalk/bike/ geometric changes for roadway compensation and potential mini-roundabout
2	New Bridge Street - Goodhue Street Connector w/multi-use path[2]	$600,000	$800,000	Add 26-foot road with 10-foot multiuse path and signal at Bridge/Connector
3	Boston Street Cross walk enhancements	$350,000	$450,000	Curb extensions, required drainage/utility, median work
3	Bridge Street - Flint to Boston (excludes Boston/Bridge Intersection)	$25,000	$35,000	Remove existing markings; add new markings and bike lanes
3	Boston Street Corridor west of Bridge Street to Peabody line	$7,000,000	$9,000,000	Sidewalk/pavement markings/bike circulation/streetscape/lighting with pavement and sidewalk enhancements
	Sub-total - Priority 1 Actions	**$235,000**	**$330,000**	
	Sub-total Priority 2 Actions	**$2,040,000**	**$2,850,000**	
	Subt-total Priority 3 Actions	**$7,375,000**	**$9,485,000**	
	Grand Total - All Actions	**$9,650,000**	**$12,665,000**	

Priority 1 - assumes implementation within 3 years

Priority 2 - assumes implementation from 3 to 10 years, preferably concurrent with development construction schedules.

Priority 3 assumes implementation from 3 to 15 years, concurrent with more costly Boston/Bridge Street corridor modifications.

1 **Does not include the programmed Bridge Street widening between Flint and North Streets that is assumed to be implemented within the next 10 years. Design of those *portions of the plan that are approved by the City for action* should begin as soon as possible.**

2 **Does not include land easement or acquisition costs.**