APPENDIX E

IDENTIFIED CONCERNS AND RECOMMENDED IMPROVEMENTS

IDENTIFIED CONCERNS AND RECOMMENDED IMPROVEMENTS

INTRODUCTION[1]

This appendix presents the analyses and recommendations of the study. The study area is shown in Figure E-1.[2]

A series of transportation concerns were identified early in the study based on discussions with local officials. Table E-1 summarizes, by community, both those concerns and the recommended improvement measures developed by CTPS in this study. For each set of improvements it also gives an estimated level of cost, a priority level, and agency jurisdiction.

This appendix elaborates on each concern and its respective recommended improvement(s). The rationale for each recommendation is presented as well.

With respect to vehicle crash analysis in this study, it should be noted that police accident reports for the intersections analyzed in Lynn were not available from the Lynn police department. For Swampscott, police accident reports were not warranted, while for Salem, police accident reports for the three key intersections analyzed were available from the Salem police department.

LYNN (CONCERNS/RECOMMENDED IMPROVEMENTS A–C)

CONCERN/RECOMMENDED IMPROVEMENTS A

CONCERN: "There is congestion in the Route 129 (Broadway/Lynnfield Street) corridor between Parkland Avenue and Boston Street."

This is a 0.4-mile-long corridor with three signalized intersections. Two are located at either end, and one is located slightly west of the corridor's midpoint. The corridor is characterized by two or three travel lanes, exclusive right- and left-turn lanes, on-street parking, a commercial area, and a raised median in the western portion between Parkland Avenue and just east of Magnolia Avenue/Springvale Avenue. The entire corridor is in need of resurfacing and restriping. There is local bus service.

Fieldwork and capacity analysis showed that the westernmost intersection, Route 129 (Lynnfield Street)/Broadway/Parkland Avenue, has some difficult operational conditions. Traffic operations are generally acceptable, however, at the Route 129 (Broadway) at Magnolia Avenue/Springvale Avenue and the Boston Street/Chestnut Street/Carter Road intersections.

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[1] [Appendix E was originally a CTPS memorandum, distributed on 30 June, 2006, to the Mid–North Shore Subregional Transportation Study Advisory Group, entitled "Task 5: Develop and Evaluate Transportation Improvement Concepts." The contents have been revised or updated where appropriate.]

[2] For this study, only the southern half of Salem was included in the study area. The approximate dividing line runs east-west, just north of the Route 1A (Loring Avenue)/Route 114 (Lafayette Street)/West Avenue intersection, and just north of the Route 107 (Highland Avenue)/Willson Street intersection. A recent CTPS study analyzed and developed transportation improvements for the northern part of Salem (C. Wang, "Transportation Improvement Study for Routes 1A, 114, and 107, and Other Major Roadways in Downtown Salem," November, 2005).

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FIGURE E-1
Study Area

TABLE E-1
Transportation Concerns and Recommended Improvements

Transportation Concern	Recommended Improvements	Estimated Cost	Priority[3]	Jurisdiction
Lynn (pp. E-3–E-22)				
A. Congestion in the Rte 129 (Broadway/Lynnfield St) corridor between Parkland Ave and Boston St	Optimize signal timings at three intersections. Resurface roadway. Fix pedestrian buttons. Restripe crosswalks.	High	Medium	Lynn
B. Congestion in the Rtes 1A/129 (Broad/ Lewis Sts) corridor between Market St and Eastern Ave	Optimize signal timings at four intersections. Resurface roadway. Fix pedestrian buttons. Restripe crosswalks.	High	Medium	Lynn
C. Perceived dangers, poor aesthetics in the underutilized Lynn Central Square parking garage	Renovate, keep garage clean. Add police presence. Support public/community events in station area/lobby. Make parking free. Use variable-message signs and advertising to announce train schedules and publicize ample/free parking.	Medium–High	High	MBTA Lynn
Lynn and Swampscott (pp. E-22–E-25)				
D. Lynn Shore Drive traffic backing up into Swampscott	Reconstruct the Lynn Shore Dr/Nahant St intersection in Lynn	Low	High	DCR Lynn
Swampscott (pp. E-25–E-34)				
E. Truck traffic, congestion in the Essex St corridor	Corridor may become less desirable for trucks with addition of new signals, new high school. Optimize signal timing at Essex St/Danvers Rd and restripe crosswalks.	Low	Medium	Swampscott
F. Possible cut-through traffic between Rte 1A (Paradise Rd) and Rte 129 (Humphrey St) via Farragut Rd and Walker Rd	Farragut Rd does not appear to be a cut-through road. Walker Rd does appear to have some cut-through traffic.	N.A.	N.A.	Swampscott
G. Not enough parking at Swampscott commuter rail station	Increase bicycle/pedestrian access to station. Increase on-street parking. Reroute MBTA buses to serve station. Implement shuttle system to station. Encourage the use of Lynn Central Square Station garage, where ample parking exists.	Low–Medium	Low–Medium	Swampscott MBTA
Salem (pp. E-34–E-47)				
H. Some operational problems at Vinnin Square, even after recent geometric/signal improvements	Implement results from signal timing coordination. Consider moving Starbucks driveway. Fix pedestrian buttons. Add 2nd westbound left-turn lane at Vinnin St/Loring Ave. Restripe eastbound approach at Rte 1A/Loring Ave to add more left-turn capacity.	Medium	Medium	MassHwy
I. Congestion at Rtes 1A/114/West Ave intersection	Optimize signal timings. Restripe crosswalks.	Low	Medium	MassHwy
J. Congestion/poor traffic operations at Jefferson Ave/Willson St intersection	Install new traffic signal. Restripe and add new crosswalks.	Medium	High	Salem
K. Congestion and safety issues at Canal St/Jefferson Ave/Rte 1A intersection	Increase capacity by adding a 2nd eastbound left-turn lane. Optimize signal timings.	Medium	High	MassHwy Salem
Multiple Communities (pp. E-47–E-51)				
L. A general need for improvements to public transportation service in addition to the needs under C and G	Coordinate commuter rail/bus schedules. Improve express bus service to Boston, Wonderland, Logan. Improve local bus service. Continue to evaluate extending Blue Line rapid transit to Lynn.	Medium–High	Medium	MBTA
M. A general need for improvements to bicycle/pedestrian facilities in addition to the needs at several of the locations specified above	Support rail-trails where feasible. Support other bicycle measures to help reduce single-occupancy auto use.	Low–Medium	Low	Lynn Salem Swampscott

[3] As prioritized by CTPS, based on this study.

Included in the potential corridor improvements analyzed were signal improvements at the three intersections, including coordination of the signals. Based on the analysis, it was concluded that signal improvements are possible. However, the corridor was found not to be appropriate for signal coordination since phasing requirements for the Route 129 (Lynnfield Street)/Broadway/ Parkland Avenue intersection were different from those for the other two, less-congested locations. Below, for each intersection, the existing conditions and concerns are discussed and the recommended improvements presented.

Route 129 (Lynnfield Street) at Broadway/Parkland Avenue

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	D	49	127	D	52	133
2004 Optimized	C	33	71	D	39	91
2015 No-Build	D	36	88	D	41	109

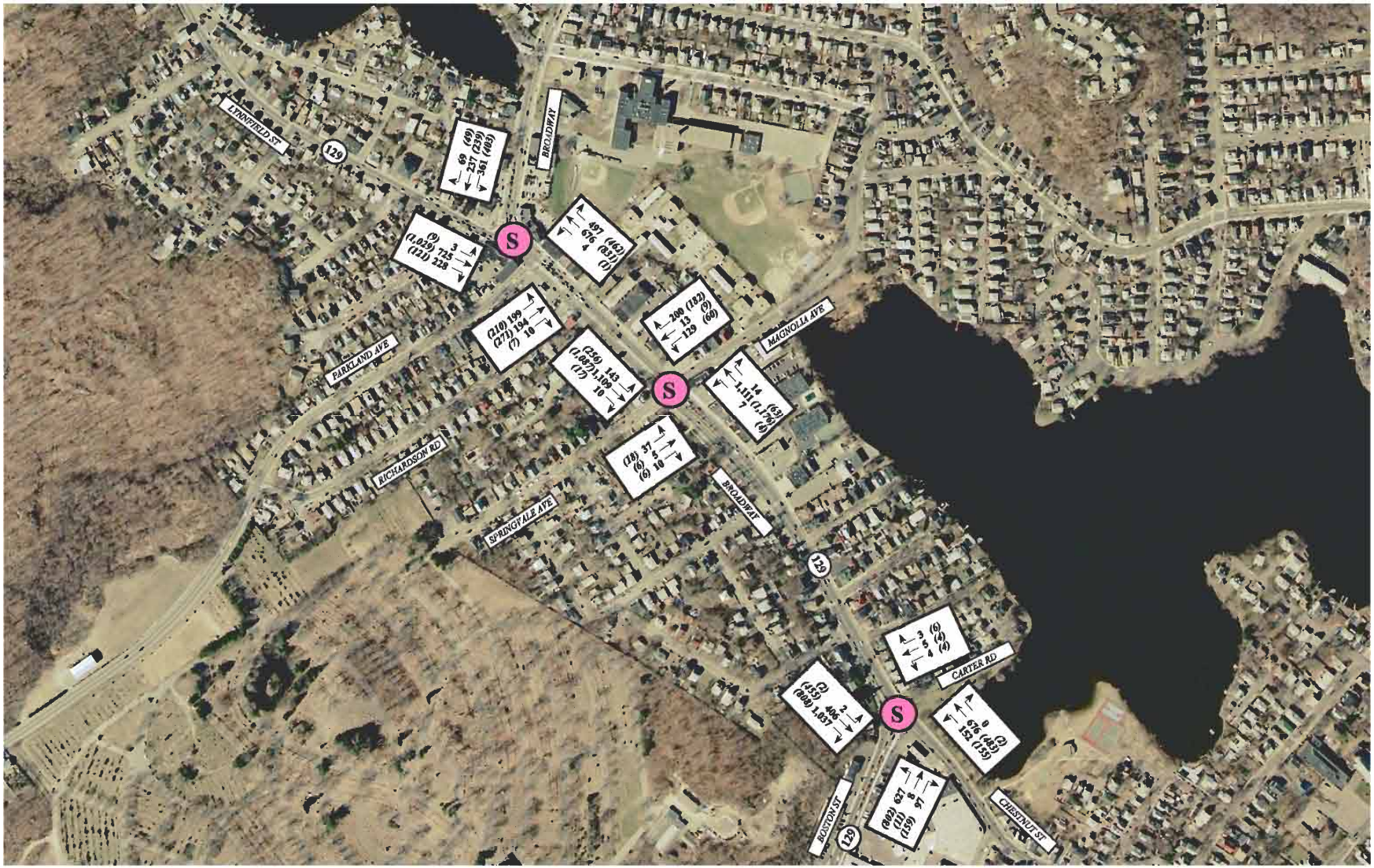
- Number of vehicle crashes, 1999–2001 (Mass Registry): 68 (22.7 per year)
- Crash rate: 1.54 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

Route 129 westbound (Broadway) has three approach lanes to this intersection (see Figure E-2). One is an exclusive right-turn lane to Broadway northbound; traffic in the remaining two lanes must go straight. Left turns onto Parkland Avenue are not permitted here. However, traffic going straight on Route 129 (to Lynnfield Street), must merge immediately since there is only one receiving lane. This contributes to overall congestion and forces westbound traffic to move slowly and deliberately through the intersection.

Two unorthodox turning movements exist which cause observed traffic operations to be worse than theoretical capacity analysis can measure. First, westbound vehicles wishing to turn left can do so onto Richardson Road, one short block east of (prior to) the intersection. After turning left, these vehicles travel parallel to Parkland Avenue about a quarter of a mile. Eventually Richardson Road curves to the right. At this point vehicles must stop at a stop sign prior to turning left onto Parkland Avenue. Although impacting overall traffic operations, the left-turning vehicles from Broadway westbound to Richardson Road are omitted from the capacity analysis since they never enter the intersection being analyzed.

Second, eastbound vehicles on Lynnfield Street are prohibited from turning left onto Broadway northbound at the intersection. Instead, the vehicles travel straight an additional short block to Richardson Road, where, at the end of the raised median, they are permitted to make an unprotected U-turn in order to continue north onto Broadway. These left/U-turning vehicles are thus included as through movements, not as left turns, in the intersection capacity analysis. However, the two unorthodox movements are close enough to the intersection that they in reality influence the through movements in both directions.



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S = Signalized intersection

FIGURE E-2
Intersection Turning-Movement Volumes: Route 129 (Broadway/Lynnfield Street) Corridor, Parkland Avenue to Boston Street, Lynn

Overall intersection crash rates are high, according to Mass. Registry vehicle crash data from 1999 to 2001. During this three-year period there were 22.7 crashes per year, a crash rate of 1.54 crashes per million entering vehicles. This exceeds by far the MassHighway District 4 average of 0.88 for signalized intersections. From the data, 43% were rear-end crashes and 38% were angle.

There are pedestrian buttons at the intersection, of which two were found not to be working. There is no exclusive pedestrian signal phase. The pedestrian movement across Route 129 is concurrent with the Parkland Avenue phase and lasts 17 seconds. Based on field observation, this was sufficient time to cross the intersection. However, occasionally it was not possible to cross all the way due to the concurrent flow of vehicles from Parkland Avenue. Instead, one was forced to remain on the island and wait for the next break in traffic before completing the crossing.

There is no room to improve capacity by expanding the intersection geometry. The phasing sequence at this signal includes a split phase in the northbound/southbound direction. Therefore, the one improvement tested was to optimize the signal timing. In so doing, the cycle length was decreased from 115 to 70 seconds in the AM peak hour and from 115 to 80 seconds in the PM peak hour. Improvements in LOS were achieved, as the table above indicates. The AM peak hour improved from LOS D and 49 seconds overall delay to LOS C and 33 seconds delay. The PM peak hour improved from LOS D and 52 seconds overall delay to LOS D and 39 seconds delay. However, the intersection would still be subject to the two unorthodox movements discussed above.

RECOMMENDED IMPROVEMENTS:

- *Optimize signal timing by decreasing the AM and PM peak hour cycle lengths from 115 to 70 and 80 seconds, respectively. Prior to optimization, two approaches in each of the AM and PM peak hours operated at LOS F. After optimization, no approach was worse than LOS D in the AM peak hour, while two operated at LOS E in the PM peak hour.*
- *Fix pedestrian buttons.*
- *Resurface roadway.*
- *Restripe lanes and crosswalk markings.*

Route 129 (Broadway) at Magnolia Avenue/Springvale Avenue

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	C	28	57	E	63	66
2004 Optimized	C	24	55	B	19	27
2015 No-Build	C	26	57	C	21	27

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 21 (7.0 per year)
- Crash rate: 0.60 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This intersection has three travel lanes on Route 129 (Broadway) westbound and two travel lanes and one exclusive left-turn lane eastbound (see Figure E-2). The southbound (Magnolia Avenue) and northbound (Springvale Avenue) approaches both have one travel lane. There is a raised median on Route 129 east and west of the intersection.

Mass. Registry data from 1999 through 2001 showed 7.0 crashes per year; however, the crash rate is 0.60, less than the District 4 signalized intersection average of 0.88. Forty-eight percent of the crashes were angle.

There are functioning pedestrian buttons on all four corners of the intersection. The pedestrian phase is exclusive and lasts 23 seconds, sufficient time to cross any of the legs of the intersection.

No geometric improvements were examined for this location. As the table above shows, the signal timing was optimized for this location. The cycle length was decreased from 112 to 100 seconds for the AM peak hour and from 112 to 70 seconds for the PM peak hour. Virtually no improvement occurred for the AM peak hour, the LOS remaining at C; the PM peak hour improved significantly, from LOS E and 63 seconds overall delay to LOS B and 19 seconds delay.

RECOMMENDED IMPROVEMENTS:

- *Optimize signal timing by decreasing AM peak hour cycle length from 112 to 100 seconds and PM peak hour cycle length from 112 to 70 seconds. Prior to optimization, one approach operated at LOS F (PM peak hour). After optimization, one approach operated at LOS D (AM peak hour), the rest at LOS C or better.*
- *Resurface roadway.*
- *Restripe lanes and crosswalk markings.*

Route 129 (Broadway) at Boston Street/Chestnut Street/Carter Road

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- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	C	30	44	C	30	64
2004 Optimized	C	28	54	C	26	66
2015 No-Build	C	32	60	C	27	72

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 42 (14.0 per year)
- Crash rate: 1.20 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

The major traffic movements at this intersection involve vehicles on Route 129 (Broadway) eastbound turning right onto Boston Street southbound during the AM peak hour, as well as the return movement from Boston Street northbound to Route 129 westbound in the PM peak hour

(see Figure E-2). To accommodate these moves, there is one channelized exclusive right-turn lane eastbound and two left-turn lanes northbound, one of them shared with throughs and right turns. Eastbound through movements use one travel lane, while westbound traffic has two travel lanes.

Crash data from the Mass. Registry showed 42 crashes from 1999 to 2001, with a crash rate of 1.20, above the District 4 average of 0.88. However, a closer look at the trend in crashes showed 24 in 1999, 10 in 2000, and 8 in 2001. It is not known whether signal or geometric improvements were made during that period that may have brought about this downward trend.

There are crosswalks and an exclusive pedestrian phase which lasts 20 seconds, sufficient time to cross any of the approaches. There are functioning pedestrian buttons on all corners.

The intersection currently operates at LOS C and 30 seconds overall delay in both the AM and PM peak hours. There is some queuing. Signal timing was optimized for this location. Very little improvement occurred from this optimization; the cycle length was increased from 107 to 120 seconds during the AM peak hour and from 107 to 110 seconds during the PM peak hour.

RECOMMENDED IMPROVEMENTS:

- *Optimize signal timing by increasing AM peak hour cycle length from 107 to 120 seconds and PM peak hour cycle length from 107 to 110 seconds. Prior to optimization, one approach in the AM peak hour and one in the PM peak hour operated at LOS D. After optimization, all approaches operate at LOS C or better.*
- *Resurface roadway.*
- *Restripe lanes and crosswalk markings.*

CONCERN/RECOMMENDED IMPROVEMENTS B

CONCERN: "There is congestion in the Routes 1A/129 (Broad Street/Lewis Street) corridor. This may affect access to downtown Lynn and thereby discourage commuter rail riders from neighboring towns from using the Lynn Station parking garage."

There are twelve signalized intersections in this 1.25-mile-long corridor, an average of one every 0.1 miles or every 550 feet. There is also a flashing beacon at Lewis Street at Chatham Street/Aubrey Terrace. The corridor is relatively narrow and slow and has one travel lane for the most part, except near some intersections where a left-turn lane or a second general-purpose lane exists. There is on-street parking on both sides throughout the corridor. A number of bus routes serve the corridor. There is dense retail development, particularly near many of the signalized intersections. There are also two elementary schools and a community college located either on or within one block of Broad Street/Lewis Street. Pedestrians are therefore plentiful, and restriping of crosswalks in the corridor is needed, as is resurfacing of the roadway generally.

Coordination of the traffic signals in the corridor was considered. However, this measure was not pursued due to the narrow and winding nature of the roadway as well as the variety of impediments and random traffic movements. These include the number of buses stopping in the one travel lane in each direction (four MBTA routes), thereby blocking following traffic; the number of on-street parking maneuvers; the existence of schoolchildren and other pedestrians accessing the schools and commercial areas; and the fact that just two of the nine intersections

analyzed have traffic operations worse than LOS D: Broad Street at Market Street, AM peak hour; and, Lewis Street at Eastern Avenue, AM and PM peak hours. Interestingly, these are the southernmost and northernmost intersections in the corridor, respectively. The remainder of the intersections in the corridor operate at LOS D or better.

Eight intersections were analyzed, and improvements were recommended for five of these. The overall conclusion is that the improvements would help mobility throughout the entire corridor. Below, for each of the analyzed intersections, proceeding from south to north, the existing conditions and concerns are discussed and the recommended improvements, if any, presented.

Route 1A (Broad Street) at Market Street

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	E	65	46	D	35	61
2004 Optimized	C	31	37	D	35	61
2015 No-Build	C	32	41	D	38	65

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 21 (7.0 per year)
- Crash rate: 0.72 crashes per million entering vehicles (2005 District 4 average: 0.88)

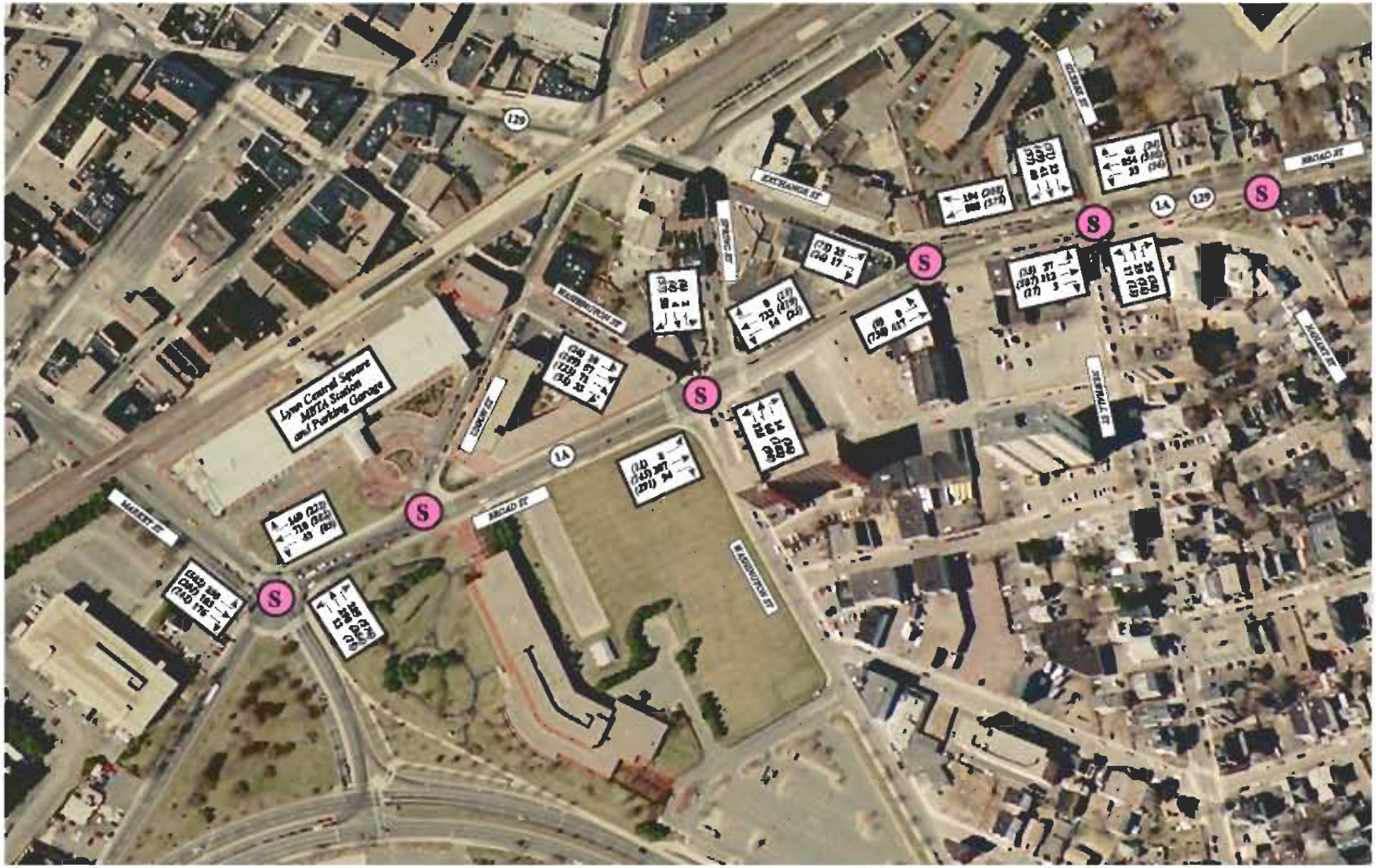
Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This is the southernmost intersection of those analyzed in this corridor (see Figure E-3a). The Route 1A (Broad Street) southbound approach consists of one exclusive right-turn lane and two general-purpose lanes. The Market Street eastbound and westbound approaches have raised medians, and each has one exclusive right-turn lane and two general-purpose lanes. The fourth leg is one-way, with vehicles traveling in two lanes southward, away from the intersection toward the Lynnway.

Mass. Registry crash data show that there were 7.0 crashes per year from 1999 to 2001. The crash rate, however, was 0.72, below the District 4 average of 0.88. Angle crashes constituted 57% of all vehicle crashes.

There are functioning pedestrian buttons on all four corners. The pedestrian phase is exclusive and lasts 28 seconds, sufficient time to cross any leg of the intersection.

Capacity analysis showed an LOS of E and 65 seconds of overall delay in the AM peak hour and an LOS of D and 35 seconds of overall delay in the PM peak hour. Through optimizing the signal timing, including decreasing the cycle length from 116 to 113 seconds, the AM peak hour improved to LOS C and 31 seconds of overall delay. Although the PM peak hour cycle length was increased from 116 to 120 seconds through optimization, the overall intersection remained unchanged at LOS D and 35 seconds of delay.



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S = Signalized intersection

FIGURE E-3a

Intersection Turning-Movement Volumes: Routes 1A/129 (Broad/Lewis Streets) Corridor, Market Street to Newhall/Silsbee Streets, Lynn

RECOMMENDED IMPROVEMENT:

- *Optimize signal timing, by decreasing the AM peak hour cycle length from 116 to 113 seconds, and increasing the PM peak hour cycle length from 116 to 120 seconds. Prior to optimization, one approach in the AM peak hour operated at LOS F and one in the PM peak hour operated at LOS E. After optimization, all approaches during both peak hours operated at LOS D or better.*

Route 1A (Broad Street) at Washington Street/Spring Street

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	D	38	41	D	38	54
2004 Optimized	C	30	27	C	33	37
2015 No-Build	C	32	27	C	33	39

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 18 (6.0 per year)
- Crash rate: 0.79 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This is a five-legged intersection where all approaches have two travel lanes except Spring Street, which has one general-purpose lane (see Figure E-3a). Washington Street eastbound is one-way. There are four signal timing phases, including a 26-second exclusive pedestrian phase, sufficient time to cross any of the legs of the intersection. Pedestrian activation buttons exist on all corners.

There were 6.0 crashes per year from 1999 to 2001, according to Mass. Registry vehicle crash data. Of these, 33% were angle crashes while 28% were rear end. Another 33% were classified as other/unknown. The crash rate was 0.79, just below the District 4 average of 0.88.

There is no severe congestion at this location during the peak hours, though fieldwork showed southbound traffic occasionally backing up northward to near the Exchange Street intersection in the AM peak hour. Capacity analysis showed both the AM and PM peak hours to operate at LOS D with 38 seconds of overall delay. When the signal timing was optimized, decreasing the cycle length from 119 to 80 seconds during both the AM and PM peak hours, some improvements were seen. The AM peak hour improved to LOS C and 30 seconds of delay and the PM peak hour to LOS C and 33 seconds of delay.

RECOMMENDED IMPROVEMENT:

- *Optimize signal timing by decreasing the AM and PM peak hour cycle lengths from 119 to 80 seconds. Prior to optimization, one approach in the AM peak hour operated at LOS E. After optimization, all approaches during both peak hours operate at LOS D or better.*

Route 1A (Broad Street) at Route 129 (Exchange Street)

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	B	16	26	B	13	29
2004 Optimized	B	11	24	B	10	25
2015 No Build	B	11	25	B	10	26

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 4 (1.3 per year)
- Crash rate: 0.20 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This is one of the intersections in the heart of downtown Lynn (see Figure E-3a). There are numerous commercial establishments in the area and on-street parking. The signal is pretimed and the intersection has three approaches. Exchange Street eastbound has one travel lane from which left and right turns are made. Broad Street northbound has one travel lane, while Broad Street southbound has an exclusive right-turn lane and a through lane.

Mass. Registry data showed very few vehicle crashes at this location, 1.3 per year from 1999 to 2001. This yields a low crash rate of 0.20, far below the District 4 average of 0.88.

Pedestrian crosswalks are marked clearly. However, there are no pedestrian activation buttons. Instead, the pedestrian phase is concurrent with the Exchange Street eastbound phase. There are small signs warning pedestrians: “WATCH FOR TURNING VEHICLES ON WALK SIGNAL.” There is sufficient time for pedestrians to cross the intersection approaches; however, care must be taken to avoid conflicts with turning vehicles.

Current LOS is good. Analysis showed the AM peak hour to operate at LOS B and 16 seconds of overall delay, while the PM peak hour operates at LOS B and 13 seconds of delay.

RECOMMENDED IMPROVEMENTS:

- *None*

Routes 1A/129 (Broad Street) at Silsbee Street/Newhall Street

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	C	21	18	C	24	25
2004 Optimized	B	19	17	B	20	20
2015 No-Build	B	19	17	C	20	20

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 14 (4.7 per year)
- Crash rate: 0.77 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

Although there are some differences, this intersection is very similar to Broad Street at Exchange Street (see Figure E-3a). They are located only a few hundred feet apart, so there are similar land uses. Both have on-street parking. Both signals are pretimed. However, this intersection has four approaches instead of three. There is an exclusive left-turn lane and two general-purpose lanes on each Broad Street (northbound and southbound) approach at this location.

According to Mass. Registry data there were 4.7 crashes per year during 1999–2001, a crash rate of 0.77, below the District 4 average of 0.88.

There are crosswalks painted clearly on all four approaches. Just as at Exchange Street, however, there are no pedestrian activation buttons. The pedestrian movements are concurrent with the two green through movement phases. There is sufficient time to cross the approaches of this intersection; however, pedestrians must take care to avoid conflicts with turning vehicles. There are small signs warning pedestrians: “WATCH FOR TURNING VEHICLES ON WALK SIGNAL.”

Also just as at Exchange Street, LOS is good at this intersection. In the AM peak hour, operations are at LOS C and 21 seconds of overall delay, while in the PM peak hour they are at LOS C and 24 seconds of delay.

RECOMMENDED IMPROVEMENTS:

- *None*

Routes 1A/129 (Broad Street/Lewis Street) at Chestnut Street/Atlantic Street

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	D	37	42	C	24	28
2004 Optimized	C	26	33	B	14	17
2015 No-Build	C	28	36	B	14	19

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 27 (9.0 per year)
- Crash rate: 1.68 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This pretimed, geometrically tight, signalized intersection is at the approximate midpoint of the corridor (see Figure E-3b). It is also at this point where the Routes 1A/129 corridor changes names from Broad Street to Lewis Street. Each approach has one travel lane from which all turning movements are made. There is a mix of commercial establishments and multiunit residential structures surrounding the intersection. There is on-street parking on all four approaches.

There were 9.0 crashes per year between 1999 and 2001. The crash rate, 1.68, was one of the highest in the study area, nearly twice the District 4 average of 0.88. The crash types included 41% angle and 37% rear end.

There are pedestrian buttons on all four corners of the intersection. However, from fieldwork it was found that three of five buttons were not functioning. Crosswalks are clearly marked on all four approaches. Pedestrian movements are concurrent with the two green signal phases. There is sufficient time to cross each approach; however, care must be taken to avoid conflict with turning vehicles.

Capacity analysis showed acceptable levels of service. The AM peak hour operates at LOS D and 37 seconds of overall delay, while the PM peak hour operates at LOS C and 24 seconds of delay. None of the individual approaches currently operates at LOS E or F. Optimizing the AM peak hour signal timing, decreasing the cycle length from 75 to 68 seconds, improved the LOS to C and overall delay to 26 seconds delay. Optimizing the PM peak hour signal timing, decreasing the cycle length from 75 to 60 seconds, improved LOS to B and delay to 14 seconds. As part of the optimization for both peak hours, the yellow and red timings combined were reduced from 8 to 5 seconds.

RECOMMENDED IMPROVEMENT:

- *Optimize signal timing, decreasing the AM and PM peak hour cycle lengths from 75 to 68 and 60 seconds, respectively.*

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S = Signalized intersection

= Flashing beacon

FIGURE E-3b
Intersection Turning-Movement Volumes: Routes 1A/129 (Broad/Lewis Streets) Corridor, Chestnut/Atlantic Streets to Eastern Avenue, Lynn

Routes 1A/129 (Lewis Street) at Chatham Street/Aubrey Terrace

- Intersection LOS data (unsignalized)

	AM Peak Hour: LOS / Delay		PM Peak Hour: LOS / Delay	
Scenario	EB, all turns	WB, all turns	EB, all turns	WB, all turns
2004 Existing	C / 23	C / 20	F / *	N.A.
No Optimization	—	—	—	—
2015 No-Build	C / 25	C / 21	F / *	N.A.

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 2 (0.7 per year)
- Crash rate: 0.13 crashes per million entering vehicles (2005 District 4 average: 0.63)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

This is the only location in the corridor where traffic is controlled by a flashing beacon (see Figure E-3b). The beacon flashes yellow for traffic on the major street, Lewis Street, and red for traffic on the minor street, Chatham Street/Aubrey Terrace. There is on-street parking on Lewis Street as well as a bus stop in the southbound direction. There is one travel lane on each of the four approaches.

There were 0.7 vehicle crashes per year between 1999 and 2001 according to the Mass. Registry. This translates to a crash rate of 0.13, far below the District 4 average of 0.63 for unsignalized intersections.

No pedestrian buttons are provided at this intersection. There are crosswalks on the Lewis Street southbound and Chatham Street eastbound approaches, but they are worn and faded.

From capacity analysis for unsignalized intersections it was seen that, during the AM peak hour, eastbound and westbound turns (from the minor streets) operated at LOS C. During the PM peak hour the eastbound turns operated at LOS F, while on Aubrey Terrace, essentially a driveway, there were no vehicles exiting.

One improvement was tested: a warrant analysis was conducted in order to determine whether a new signal would be appropriate at this intersection. Although a few of the warrants were met, installation of a signal is not recommended, because of relatively low side-street volumes and the low incidence of vehicle crashes.

RECOMMENDED IMPROVEMENT:

- *Repaint the crosswalks*

Routes 1A/129 (Lewis Street) at Ocean Street/Ocean Circle

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	B	10	13	B	16	15
2004 Optimized	B	10	13	B	14	16
2015 No-Build	B	10	14	B	14	16

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 8 (2.7 per year)
- Crash rate: 0.55 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This is a four-legged, signalized intersection (see Figure E-3b). The Lewis Street northbound and southbound approaches both consist of one travel lane. The eastbound approach, Ocean Circle, is two-way and has a very narrow travel lane in each direction. Only four vehicles in the AM peak hour and three in the PM peak hour entered Lewis Street from this approach. Ocean Street, the westbound approach, is a relatively wide one-way street and enters the intersection at an acute angle with the northbound approach. There is on-street parking on all four approaches. The land use is a mix of commercial and residential, and there is a bus stop at the corner of the northbound approach.

Vehicle crash data from the Mass. Registry showed 2.7 crashes per year between 1999 and 2001. The crash rate was 0.55, well below the District 4 average of 0.88.

There are crosswalks on all but the southbound Lewis Street approach. Pedestrian buttons are provided only on each side of Lewis Street on the northbound approach of the intersection. The pedestrian movement across Lewis Street is concurrent with the Ocean Street green signal phase and lasts 19 seconds, sufficient time to cross Lewis Street.

There are no congestion problems at this location. Capacity analysis shows LOS B and 10 seconds of overall delay during the AM peak hour and LOS B and 16 seconds of delay in the PM peak hour.

RECOMMENDED IMPROVEMENTS

- *None*

Routes 1A/129 (New Ocean Street) at Route 129A (Eastern Avenue)

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	71	E	67	72
2004 Optimized	E	65	73	D	54	79
2015 No-Build	E	73	78	E	61	86

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 31 (10.3 per year)
- Crash rate: 1.36 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This is the northernmost intersection in the Routes 1A/129 corridor, analyzed as Concern B (see Figure E-3b). The boundary between Lynn and Swampscott is immediately to the north. The intersection has four one-lane approaches, is geometrically tight, slopes downhill in both the Eastern Avenue eastbound and New Ocean Street northbound directions, and is surrounded by residential land use. The only on-street parking permitted is along both Eastern Avenue receiving lanes. There is bus traffic on all approaches except Eastern Avenue eastbound. There is no room for geometric expansion.

There were 10.3 vehicle crashes per year recorded from 1999 to 2001, according to Mass. Registry crash data. This yielded a crash rate of 1.36, well above the District 4 average of 0.88. Most of the crashes by far, 77%, were angle, while 13% were rear-end.

Pedestrian crosswalks, as well as pedestrian buttons, are provided on all four approaches. However, one button was not functioning. The exclusive pedestrian phase is 15 seconds, sufficient time for crossing any of the approaches.

This is a congested intersection. It operates at LOS F and more than 80 seconds of overall delay in the AM peak hour and at LOS E and 67 seconds of overall delay in the PM peak hour. Through optimization, the intersection improved to LOS E and 65 seconds of delay in the AM peak hour and to LOS D and 54 seconds of delay in the PM peak hour. In the optimization process, the cycle length was increased from 90 to 120 seconds for the AM peak hour and from 90 to 118 seconds for the PM peak hour.

RECOMMENDED IMPROVEMENTS:

- *Optimize signal timing by increasing the AM and PM peak hour cycle lengths from 90 to 120 and 118 seconds, respectively. Prior to optimization, one approach in each of the AM and PM peak hours operated at LOS F and with overall delays well beyond 80 seconds. Another approach operated at LOS E (PM peak hour). After optimization, the approaches operated in a much more balanced manner. Even though two approaches*

still operated at LOS F (in the AM peak hour), the overall delays were much lower, at just over 80 seconds. Two approaches also operated at LOS E, both in the PM peak hour.

- *Fix pedestrian buttons.*

CONCERN/RECOMMENDED IMPROVEMENTS C

CONCERN: "There are perceived dangers and poor aesthetics in the Lynn Station parking garage. This discourages spillover commuter rail riders/parkers from neighboring towns from using the underutilized garage."

While most North Shore commuter rail station parking lots are at 70–100% capacity each day, the Lynn Central Square Station garage, with 952 spaces, remains at about 35% capacity each weekday.[4] The garage is located at the downtown Lynn commuter rail station. It is also located at the convergence of major highways and arterials. In the north–south direction, Route 1A (the Lynnway; Broad Street) and Lynn Shore Drive either pass directly by or within a few hundred yards of the garage. In the east–west direction, Market Street is adjacent to the garage, while Route 129 (Washington Street) lies two blocks to the north.

Both the Swampscott and Salem commuter rail station parking lots are at 100% capacity each weekday. They are located about 1.7 miles and 5.0 miles north of the Lynn station and garage, respectively. This study assumes that it is possible to attract additional commuters to the Lynn parking garage not only from Swampscott and Salem, but also from other North Shore communities without commuter rail service.

During the 2004 Democratic National Convention (DNC), Lynn was utilized as one of the key public-transportation transfer points for Boston-bound travelers. Anecdotal evidence relates that commuters enjoyed a clean and safe garage and station there during DNC week. Regular daily commuters, currently and potentially parking in the Lynn Central Square Station garage today, expect an equally pleasant commute.

RECOMMENDED IMPROVEMENTS:

- *Keep the garage clean.*
- *Fix all elevators, and keep them functioning.*
- *Add Lynn police and MBTA police presence throughout the station area during the entire MBTA daily schedule.*
- *Encourage and facilitate street-level food, beverage, newspaper, and other vendors inside the station area.*
- *Encourage and advertise regular, visible public activities, such as family-style musical entertainment, food-tasting events, and the like within the station area. People perceive "safety in numbers."*
- *Consider making parking completely free to all MBTA commuters and North Shore Community College students. This could last for a year, or until a "critical mass" of commuters have switched to the Lynn station garage.*
- *Add variable-message signs on the Lynnway and other arterials nearby, stating "Next train in 12 minutes" and "Free parking," etc.*

[4] CTPS, *Mobility in the Boston Region: Existing Conditions and Next Steps: The 2004 Congestion Management System Report*, p. V-3.

- *Encourage, using means including advertising, local North Shore commuters who currently park at the Wonderland Blue Line station in Revere to switch to the Lynn Station garage. From a CTPS license plate survey in 2005 it was found that 53% of all matched vehicles parked at Wonderland originated in Lynn, Swampscott, Marblehead, or Salem. This equates to approximately 500 vehicles that essentially pass by the Lynn station and garage each day. Should even a fraction of these vehicles, 20–30%, switch to the Lynn garage, 100 to 150 additional daily commuters would be using the garage's facilities. These vehicles would be diverted from the Route 1A corridor south of Lynn, thereby reducing congestion and VMT (vehicle miles traveled).*

LYNN and SWAMPSCOTT (CONCERN/RECOMMENDED IMPROVEMENT D)

CONCERN/RECOMMENDED IMPROVEMENT D

CONCERN: "Traffic backs up on Lynn Shore Drive in Lynn onto Humphrey Street in Swampscott." According to Swampscott officials, "the cause may be traffic operations at the signal at Lynn Shore Drive at Nahant Street in Lynn."

Summary of data on on the intersection of Lynn Shore Drive with Nahant Street/Beach Road:

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	166	F	*	153
2004 Optimized	F	*	114	D	38	101
2015 No-Build	F	*	121	D	44	107
Alt 1 ('04 vols)	C	35	85	B	16	67
Alt 1 ('15 vols)	D	41	90	B	17	73
Alt 2 ('04 vols)	C	29	62	C	26	62
Alt 2 ('15 vols)	C	33	68	C	30	67

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 13 (4.3 per year)
- Crash rate: 0.45 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

Traffic operations at this three-legged, signalized intersection do not impact only Lynn: the effects extend nearly a mile northward into Swampscott (see Figure E-4). The Lynn Shore Drive northbound approach consists of one through lane and one exclusive left-turn lane; the southbound approach has one through/right-turn lane. Nahant Street eastbound has a wide lane in which vehicles line up for left and right turns, side by side.

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S = Signalized intersection

FIGURE E-4
Intersection Turning-Movement Volumes: Lynn Shore Drive at Nahant Street, Lynn

There were 4.3 vehicle crashes per year at this location, according to Mass. Registry data from 1999–2001. The crash rate was 0.45, well below the District 4 average of 0.88. Of the crashes, 46% were angle and 31% were rear-end.

The intersection has been made quite pedestrian-friendly, perhaps since it is located next to the bicycle/pedestrian path between Lynn Shore Drive and the Atlantic Ocean. There are clearly marked crosswalks, functioning pedestrian activation buttons, and an exclusive phase lasting 24 seconds. This is sufficient time to cross any of the approaches to the intersection.

Capacity analysis showed this intersection to be failing in both peak hours. In both cases the LOS is F with more than 80 seconds overall delay, and, as alluded to above, there are long queues, particularly northward in the AM peak hour. Optimization of the signal timing—including increasing the cycle length from 113 to 120 seconds and even decreasing the pedestrian phase by 7 seconds, from 24 to 17—was tested. The AM peak hour improved slightly but still operated at LOS F and more than 80 seconds of delay. The PM peak hour improved to LOS D and 38 seconds of delay.

Two build alternatives were tested. The first, Alternative 1, is a low-cost measure which eliminates right and left turns from Nahant Street eastbound onto Lynn Shore Drive. The eastbound vehicles, totaling 134 in the AM peak hour and 57 in the PM peak hour, would instead turn right onto Beach Road immediately prior to the intersection. Those vehicles that would have turned right onto Lynn Shore Drive would instead continue southbound on Beach Road, through the Nahant Rotary, either to Nahant or onto the Lynnway southbound. Those that would have turned left would likewise use Beach Road southbound to enter the rotary, but would continue around and proceed northward on Lynn Shore Drive, a detour of perhaps two to three minutes in length. Traffic from Lynn Shore Drive, northbound and southbound, could still enter Nahant Street and travel in the westbound direction.

To accomplish Alternative 1, the median between Lynn Shore Drive and Beach Road would be extended northward halfway across Nahant Street. Appropriate signage would also be added, in order to direct all Nahant Street eastbound traffic to turn right onto Beach Road southbound. As a result of this relatively low-cost measure, traffic operations would improve to LOS C and 35 seconds of overall delay in the AM peak hour and to LOS B and 16 seconds of delay in the PM peak hour. The pedestrian phase would be reduced by 3 seconds, from 24 to 21 seconds, still sufficient time to cross Lynn Shore Drive.

Alternative 2 is far more costly, as well as controversial, and involves the widening of Lynn Shore Drive between the Nahant Street Rotary northward in the direction of the Swampscott line. Hypothetically, a reversible center lane could be constructed, the necessary space being created by banning on-street parking and/or by claiming a narrow stip of land from the grass section between Lynn Shore Drive and the bicycle/pedestrian path along the ocean. The lane would serve southbound traffic during the AM peak period and reverse to serve northbound traffic during the PM peak period. This alternative would leave Nahant Street open in both directions, and when tested, the AM peak hour improved to LOS C and 29 seconds of overall delay, while the PM peak hour improved to LOS C and 26 seconds of delay. In this alternative, the cycle length would again increase from 113 to 120 seconds while the pedestrian phase would be reduced from 24 to 21 seconds.

RECOMMENDED IMPROVEMENT:

- *Alternative 1: Reconstruct the intersection so that Nahant Street eastbound traffic does not exit onto Lynn Shore Drive. Instead, redirect these relatively low traffic volumes onto Beach Road southbound. Traffic turning from Lynn Shore Drive northbound and southbound onto Nahant Street westbound would still be permitted.*

SWAMPSCOTT (CONCERNS/RECOMMENDED IMPROVEMENTS E–G)

CONCERN/RECOMMENDED IMPROVEMENTS E

CONCERN: "There is substantial congestion and excessive truck traffic on Essex Street. Essex Street is the only officially designated truck route in Swampscott." According to town officials, "most of the trucks travel to/from the Aggregate Industries quarry on Danvers Road/Swampscott Road on the Swampscott/Salem border."

CTPS performed fieldwork on and near Essex Street in order to determine the magnitude of the stated concern. Essex Street is a two-lane roadway between Eastern Avenue (just over the Lynn line in the south) and the Swampscott Mall area (near the Salem line in the north). The southern portion south of Danvers Road is especially narrow and hilly and in need of resurfacing. On-street parking was observed in the southern portion of the corridor (see Figure E-5).

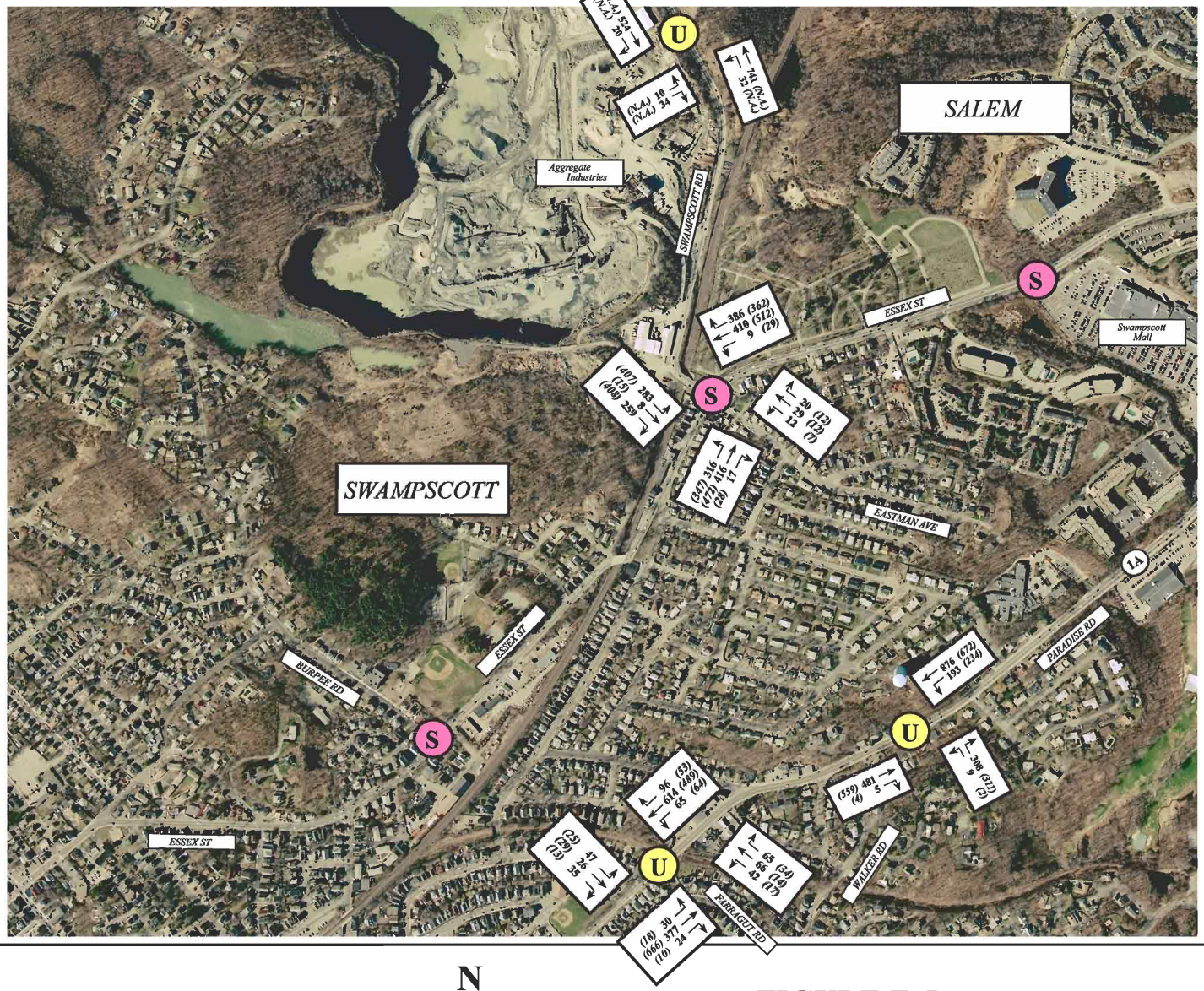
There are traffic signals on Essex Street at the Swampscott Mall driveway, Danvers Road/ Eastman Avenue, Burpee Road, and Eastern Avenue (not shown). In addition, there is a flashing green (pedestrian) signal at Stetson Avenue, a flashing yellow beacon just north of the railroad bridge (in the southbound direction), and "School 20 MPH" flashing signals near Machon Elementary School and the new high school under construction, just south of the Greenway.

Manual turning-movement counts (MTMCs) were conducted at two locations in or near the corridor: at Essex Street at Danvers Road/Eastman Avenue and at Swampscott Road at the Aggregate Industries driveway to the west, just over the Salem line. The following information was found with respect to truck traffic:

	% Trucks	
Intersection	**AM Peak Period**	**PM Peak Period**
Essex Street at Danvers Road/Eastman Avenue	6.6	1.8
Swampscott Road at Aggregate Industries driveway	10.0	N.A.
Average of all 20 study area intersections analyzed	4.6	1.9

The Essex Street at Danvers Road/Eastman Avenue intersection experiences a percentage of trucks in the AM peak period, 6.6%, that is higher than the study area average of 4.6%. In fact, this intersection has the fourth-highest AM peak period percentage of trucks of all 20 study area intersections analyzed. In the PM peak period, the percentage of trucks, 1.8%, is about the same as the study area average, 1.9%.

It is not surprising that 10.0% of all vehicles at the Swampscott Road at Aggregate Industries driveway intersection are trucks. In field observations, 100% of all vehicles entering or exiting the driveway during the AM peak period were classified as trucks (a total of 216 trucks entered



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S = Signalized intersection

U = Unsignalized intersection

FIGURE E-5
Intersection Turning-Movement Volumes: Four Intersections Analyzed in Swampscott and Salem

or exited between 6:30 and 9:15 AM). Of the 106 exiting trucks, 59 (56%) turned right toward Essex Street in Swampscott, while 47 (44%) turned left toward Route 107 in Salem.

CONCERN E CONCLUSIONS/RECOMMENDATIONS:

- *According to Swampscott officials, Essex Street is a designated truck route. Depending on the ultimate destination—local or distant—the Route 107 corridor is generally an easier way than Essex Street for trucks to reach the major highways such as Route 1, Route 128, and I-95. However, this study does not endorse a truck ban on Essex Street. In order for MassHighway to approve a community's truck ban request, a viable alternative must be presented. Should such a proposed alternative impact a neighboring community, in this case Salem, there must be approval by that community as well.*

  Finally, it is conceivable that there may ultimately be a natural shift of some truck traffic away from the Essex Street corridor. Once the new Swampscott High School on Essex Street is completed in 2007, including the installation of traffic signals at Burrill Street and perhaps at the high school driveway, Essex Street may become a slower, and therefore less attractive, thoroughfare for some trucks that could optionally travel on Route 107.

To complete the analysis in the Essex Street corridor, the following summaries describe traffic operations and vehicle crashes at the two intersections, Essex Street at Danvers Road/Eastman Avenue and Swampscott Road at the Aggregate Industries driveway.

Essex Street at Danvers Road/Eastman Avenue Summary

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	E	66	88	F	*	104
2004 Optimized	D	54	88	E	62	101
2015 No-Build	E	59	94	E	66	107

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 19 (6.3 per year)
- Crash rate: 0.59 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

Essex Street at Danvers Road/Eastman Avenue is a four-legged intersection (see Figure E-5). The Essex Street northbound approach has an exclusive left-turn lane as well as a shared through/right-turn lane. The southbound approach has an exclusive right-turn lane and a shared through/left-turn lane. The Danvers Road eastbound approach is on a railroad bridge and consists of an exclusive right-turn lane and a shared through/left-turn lane. Eastman Avenue westbound has one general-purpose lane. There is local MBTA bus service on Essex Street.

Based on vehicle crash information from the Mass. Registry for 1999–2001, there were 6.3 crashes per year at this location. This yields a crash rate of 0.59, below the District 4 average of 0.88 for signalized intersections. The breakdown of crashes was 42% angle, 32% rear-end, and 21% other/unknown.

Crosswalks are provided but are faded and in need of restriping. There are functioning pedestrian buttons on all corners, and the exclusive pedestrian phase lasts 21 seconds, sufficient time to cross any approach to the intersection.

The intersection operates at LOS E and 66 seconds of overall delay in the AM peak hour, and at LOS F and more than 80 seconds of delay in the PM peak hour. Due to the lack of space, it is not possible to expand the intersection footprint. Some improvement is achieved through signal optimization: the intersection improves to LOS D and 54 seconds of delay in the AM peak hour and to LOS E and 62 seconds of delay in the PM peak hour. It should be noted, however, that in order to obtain these improvements the pedestrian phase was reduced from 21 seconds to 17 seconds, while the cycle length was increased from 109 to 120 seconds. The 17 seconds should still be sufficient time for pedestrians to cross any of the intersection approaches.

RECOMMENDED IMPROVEMENTS FOR ESSEX STREET AT DANVERS ROAD/EASTMAN AVENUE:

- *Optimize signal timing by increasing the AM and PM peak hour cycle lengths from 109 to 120 seconds. Prior to optimization, two approaches in each peak hour operated at LOS F with overall delays beyond 80 seconds. After optimization, no approach operated at LOS F; one approach in the AM peak hour and two approaches in the PM peak hour operated at LOS E. In order to achieve these LOS improvements, the exclusive pedestrian phase would need to be reduced from 21 to 17 seconds.*
- *Restripe crosswalk markings.*

Swampscott Road at Aggregate Industries Driveway Summary

- Intersection LOS data (unsignalized)

	AM Peak Hour: LOS / Delay		PM Peak Hour: LOS / Delay	
Scenario	WB, l. turns/throughs	NB, left/right turns	WB, l. turns/throughs	NB, left/right turns
2004 Existing	B / 11	C / 19	N.A.	N.A.
No Optimization	—	—	—	—
2015 No-Build	B / 11	C / 19	N.A.	N.A.

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 11 (3.7 per year)
- Crash rate: 0.59 crashes per million entering vehicles (2005 District 4 average: 0.63)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

The intersection of Swampscott Road and the Aggregate Industries driveway is a three-legged, unsignalized intersection, with Swampscott Road running east–west between Route 107 in Salem and Essex Street in Swampscott (Swampscott Road is named Danvers Road in Swampscott; see Figure E-5). The Aggregate Industries driveway enters Swampscott Road on a

northbound approach. Swampscott Road has one travel lane in each direction, while the driveway is wide with no lane stripings.

Mass. Registry crash data from 1999 to 2001 show that there were 3.7 vehicle crashes per year, a crash rate of 0.59. This is just below the District 4 average for unsignalized intersections of 0.63.

There are no pedestrian facilities at this intersection, neither crosswalks nor sidewalks.

There is no congestion at this intersection. The driveway approach (northbound) operates at LOS C in the AM peak hour, while the Swampscott Road westbound approach operates at LOS B. The PM peak period was not analyzed.

RECOMMENDED IMPROVEMENTS FOR SWAMPSCOTT ROAD AT THE AGGREGATE INDUSTRIES DRIVEWAY:

- *None*

CONCERN/RECOMMENDED IMPROVEMENTS F

CONCERN: "There appear to be high levels of cut-through traffic between Route 1A (Paradise Road) and Route 129 (Humphrey Street). The affected residential neighborhoods are along Walker Road and Farragut Road."

CTPS conducted a license plate survey during the AM peak period to determine the existence and magnitude of "cut-through" traffic travelling between the Route 129 (Humphrey Street) and Route 1A (Paradise Road) corridors in Swampscott. Town officials had suggested that Farragut Road and Walker Road were the primary residential streets used by drivers between the two corridors (see Figure E-5).

CTPS had previously recorded AM and PM peak period manual turning-movement counts (MTMCs) at the Route 1A intersections at Farragut Road and at Walker Road. From an inspection of these MTMCs by direction and peak period, it was determined that the greatest traffic flows on both streets were during the AM peak period in the direction of Route 1A. Therefore a license plate survey—only one, because of limited resources—was conducted in order to identify as much suspected Route 1A–bound cut-through traffic as possible. This was accomplished by recording license plates at three stations during the AM peak period (7:00–9:00). These stations were:

1. Monument Avenue northbound, just south of the Farragut Road/Walker Road intersection
2. Farragut Road northbound, just south of Route 1A
3. Walker Road northbound, just south of Route 1A

The results yielded two sets of information. First, it was determined how many vehicles traveled through the residential neighborhoods by matching the license plates of vehicles observed at Station 1 with those of vehicles observed at either Station 2 or Station 3. Second, the town of origin where each recorded vehicle is garaged was determined, by station. The findings are summarized below:

Vehicles Observed

At Station 1 (Monument Ave)	At Stations 1 and 2 (Monument Ave and Farragut Rd)	At Stations 1 and 3 (Monument Ave and Walker Rd)
375	28 (7%)	135 (36%)

Source: CTPS

From the table above it may be seen that just 7% of the vehicles observed at Station 1 (Monument Avenue) were also observed at Station 2 (Farragut Road). However, 36% of the vehicles observed at Station 1 were also observed at Station 3 (Walker Road). Of this latter group of 135 vehicles, the most frequent towns of origin were Nahant (15 vehicles), Lynn (10), Revere (8), Salem and Boston (7 each), and Swampscott, Saugus, and Everett (5 each).

Vehicles Observed at Any Station,
by Town of Origin

Town of Origin	Vehicles Passing by Station 1, 2, and/or 3
Swampscott	275 (40%)
Lynn	53 (8%)
Nahant	52 (8%)
Revere	40 (6%)
Salem	38 (5%)
Boston	34 (5%)
Marblehead	30 (4%)
Others	170 (25%)
All Towns	692 (100%)

Source: CTPS

From this table, it may be seen that 40% of all license plates observed belonged to vehicles originating in Swampscott. Another 25% originated in communities in Swampscott's immediate vicinity (Lynn, Nahant, Salem, and Marblehead).

CONCERN F CONCLUSIONS/RECOMMENDATIONS:

- *The license plate survey conducted was for the AM peak period, from the Route 129 (Humphrey Street) corridor to the Route 1A (Paradise Road) corridor. Further study, of the AM peak period in the opposite direction or of the PM peak period in either direction, may yield different results and would be necessary before specific improvements could be recommended.*
- *It does not appear that Farragut Road is used as a cut-through between Route 129 (Humphrey Street) and Route 1A (Paradise Road) during the AM peak period, since just 7% of the vehicles observed at Station 1 (Monument Avenue) were also observed at Station 2 (Farragut Road).*

- *It does appear that Walker Road (Station 3) is used far more frequently than Farragut Road (Station 2) as a cut-through between Route 129 and Route 1A during the AM peak period. Of the 375 vehicles observed at Station 1, 135, or 36%, were also observed at Station 3.*
- *Of the Walker Road cut-through vehicles, only 4% originated in Swampscott (5 of 135 vehicles). Therefore, drivers from other communities make up 96% of the vehicles cutting through between Route 129 and Route 1A via Walker Road.*

Further analysis in the Farragut Road and Walker Road neighborhoods included the following assessments of the intersections of Route 1A (Paradise Road) with Farragut Road and with Walker Road.

Route 1A (Paradise Road) at Farragut Road/Norfolk Avenue Summary

- Intersection LOS data(unsignalized)

	AM Peak Hour: LOS / Delay			PM Peak Hour: LOS / Delay		
Scenario	EB, all turns		WB, all turns	EB, all turns		WB, all turns
2004 Existing	F / *		F / *	F / *		F / *
No Optimization	—		—	—		—
2015 No-Build	F / *		F / *	F / *		F / *
Alt 1 ('04 vols)	D	50	61	D	42	61
Alt 1 ('15 vols)	E	55	65	D	46	66

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 8 (2.7 per year)
- Crash rate: 0.46 crashes per million entering vehicles (2005 District 4 average: 0.63)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

Route 1A (Paradise Road) at Farragut Road/Norfolk Avenue is an unsignalized four-legged intersection where the two minor street approaches (Farragut Road westbound and Norfolk Avenue eastbound) are offset by about 150 feet (see Figure E-5). All four approaches have one general-purpose travel lane. At the Route 1A northbound approach there is a flashing green signal. This signal can be activated by pedestrians in order to provide safe crossing of Route 1A. This is particulary important since an elementary school is located on the southwest quadrant. Most of the surrounding land use is residential.

There were 2.7 vehicle crashes per year at this intersection from 1999 to 2001, based on Mass. Registry data. This translates to a crash rate of 0.46, below the District 4 average for unsignalized intersections of 0.63.

There are painted crosswalks on all four approaches. Pedestrian buttons which activate the pedestrian phase are located on the Route 1A northbound approach and function properly. The phase lasts 15 seconds, sufficient time to cross Route 1A.

Capacity analysis shows that the major street (Route 1A) approaches operate at LOS A and both minor street approaches at LOS F in both the AM and PM peak hours. The only

improvement tested was a new traffic signal. A signal would improve operations to LOS D and 50 seconds of overall delay in the AM peak hour and to LOS D and 42 seconds of delay in the PM peak hour. The intersection does meet some of the minor warrants for installing a new signal. However, it does not meet Warrant 7 concerning number of crashes per year for a three-year period.

RECOMMENDED IMPROVEMENTS FOR ROUTE 1A (PARADISE ROAD) AT FARRAGUT ROAD/NORFOLK AVENUE:

- *None*

Route 1A (Paradise Road) at Walker Road Summary

- Intersection LOS data (unsignalized)

	AM Peak Hour: LOS / Delay		PM Peak Hour: LOS / Delay	
Scenario	SB, left turns/throughs	WB, left/right turns	SB, left turns/throughs	WB, left/right turns
2004 Existing	A / 10	E / 37	B / 10	D / 30
No Optimization	—	—	—	—
2015 No-Build	A / 10	E / 42	B / 10	D / 33

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 8 (2.7 per year)
- Crash rate: 0.37 crashes per million entering vehicles (2005 District 4 average: 0.63)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

Route 1A (Paradise Road) at Walker Road is three-legged, with each approach having one general-purpose lane (see Figure E-5). The major street, Route 1A, is on an incline in the northbound direction. Land use is residential.

There were 2.7 crashes per year between 1999 and 2001 according to Mass. Registry data. This is a crash rate of 0.37, well below the District 4 average of 0.63 for unsignalized intersections.

There is a crosswalk across the Walker Road approach; however, there are none across Route 1A at this location. There is a pedestrian signal on Route 1A about 500 feet to the north of Walker Road.

The Walker Road (minor street) approach operates at LOS E in the AM peak hour and at LOS D in the PM peak hour. A major reason why the approach operates better than LOS F is that virtually all of the more than 300 westbound vehicles in each of the AM and PM peak hours, respectively, turn right onto Route 1A northbound.

RECOMMENDED IMPROVEMENTS FOR ROUTE 1A (PARADISE ROAD) AT WALKER ROAD:

- *None*

CONCERN/RECOMMENDED IMPROVEMENTS G

CONCERN: "There are not enough parking spaces at the Swampscott commuter rail station." Current capacity is 153 parking spaces and the daily utilization rate is 100%.

The commuter rail station parking lot in Swampscott usually fills up by about 7:00 AM on weekdays. There is no room in which to expand the lot. The station and parking area are located at the intersections of Burrill Street at Columbia Street and at Railroad Avenue, about 800 feet north of the Lynn line. The surrounding land use is mostly residential.

In 2004, CTPS conducted a study of how to improve access to Swampscott Station. The study was conducted in cooperation with the Metropolitan Area Planning Council and was done for the Swampscott Community Development Plan Committee. Recommended improvements were presented in a draft memorandum.[5] These are summarized below, and an additional recommendation is appended to the list:

RECOMMENDED IMPROVEMENTS:

- *Increase bicycle accessibility to the station. This can be done by (a) adding bicycle racks, perhaps even bicycle lockers, in the station area and (b) implementing a rail trail on an abandoned right-of-way that goes through Swampscott in an east-west direction. If implemented, the rail-trail would connect at its eastern end to the existing Marblehead trail. Although no decision has yet been made, Swampscott officials and private residents have discussed the possibility of constructing a trail along the abandoned corridor. The land in the corridor is currently owned by the National Grid power company.*
- *Increase pedestrian accessiblity to the station. Although the station is located in a dense residential area, improvements to increase pedestrian safety are possible. These include the restriping of existing, and the addition of new, crosswalks in the neighborhood surrounding the station area. As resources permit, it is also suggested that existing sidewalks be upgraded by eliminating tree roots which have created uneven sidewalk surfaces.*
- *Increase on-street parking in the vicinity of the station. This can be accomplished in one of two ways. Designate parking spaces along residential streets near the station, and allow Swampscott residents to obtain stickers for an annual fee in order to use the spaces. Another strategy could be to install long-term parking meters open to the general public and to charge daily.*
- *Increase accessibility via public transportation. Reroute AM and PM peak period buses on Route 1A (Paradise Road) to the station to drop off and pick up passengers. This was attempted once in the late 1980s, but with only meager results. Perhaps it is time to try this strategy again and to increase the public's awareness of this service improvement. The rerouting from Route 1A can be done using Norfolk Avenue and Pine Street to and from the station. Buses on Essex Street are closer to the station than those on Route 1A, so rerouting these are unnecessary since Essex Street is within walking distance of the station. A specific suggestion is that if some North Shore–to–Boston buses were short-turned at Wonderland Station in Revere, then new feeder routes designed specifically to*

[5] C. Lewis, "Transportation Element of the Executive Order 418 Study for Swampscott," Draft CTPS memorandum, 18 June 2004.

bring people from Marblehead to Swampscott Station (and vice versa) to meet trains could be implemented (see pp. E-48 and E-49 below for additional discussion).

- *Increase accessibility by using paratransit vehicles as shuttles to and from Swampscott Station. The shuttles could pick up passengers from remote parking areas during the AM and PM peak periods (e.g., near Swampscott Mall or other retail locations near Vinnin Square), while continuing to be available for shuttling seniors during the middle of the day.*
- *One final recommendation, not listed in the June 2004 draft CTPS memorandum, is to encourage Swampscott residents through the local media to park at the underutilized Lynn Central Square Station garage, 1.7 miles to the south of Swampscott Station (see discussion on pp. E-21–E-22 above).*

SALEM (CONCERNS/RECOMMENDED IMPROVEMENTS H–K)

CONCERN/RECOMMENDED IMPROVEMENTS H

CONCERN: "Changes/improvements may be needed at Vinnin Square. This location underwent major geometric and signal improvements in 2002." Some problems may still remain in terms of queuing, congestion, crashes, signal timing, and pedestrian operations.

The Vinnin Square area underwent major geometric and signal improvements in 2002, including the implementation of a closed-loop signal system involving six signalized intersections. Field observations of traffic operations and driver behavior revealed possible improvement opportunities at four of the intersections. The analyses and recommended improvements are described below. Following the discussions of the intersections, additional recommendations for the Vinnin Square area are presented.

Route 1A (Paradise Road) at Vinnin Street (Vinnin Square)

- Intersection LOS data(signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	120	D	48	109
No Optimization	(Intersection is part of a closed loop system)					
2004 Coord'n	D	40	59	D	38	66

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 39 (13.0 per year)
- Crash rate: 1.16 crashes per million entering vehicles (2005 District 4 average: 0.88)

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* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This is a busy, four-legged intersection (see Figure E-6). Route 1A northbound has one channelized, exclusive right-turn lane, one through lane, and one shared through/left-turn lane.

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S = Signalized intersection

FIGURE E-6
Vinnin Square
(on the Salem/Swampscott line)

Route 1A southbound consists of two general-purpose lanes. Vinnin Street eastbound has an exclusive left-turn lane and a shared through/right-turn lane, while the westbound approach has an exclusive left-turn lane, a through lane, and an exclusive right-turn lane. The surrounding land use in the Vinnin Square area is mostly commercial (banks, fast food restaurants, gas stations, office supplies, drug stores, etc.). There is MBTA bus service on the northbound and westbound approaches.

Some operational problems which were observed during field work include Route 1A southbound left-turning traffic not always clearing the downstream intersection at Salem Street at Vinnin Street. Vehicles were seen to queue from that intersection and occasionally block Route 1A northbound through traffic as well as Vinnin Street westbound traffic. Another problem involves the Starbucks plaza driveway, approximately 200 feet west of the intersection. Westbound traffic waiting to enter the driveway frequently waits for eastbound traffic to clear and in the process occasionally blocks westbound through traffic back to the Route 1A/Vinnin Street intersection.

According to Mass. Registry data, there were 13.0 crashes per year at this location between 1999 and 2001. This translates to a crash rate of 1.16, above the District 4 average of 0.88. The crashes were broken down to 51% angle and 38% rear-end. However, the incidence of crashes during the three years was as follows:

- 1999: 24 crashes
- 2000: 12 crashes
- 2001: 3 crashes

The reason for this downward trend is not completely clear. However, it may be that the geometric and signal improvements which were completed in 2002 began to be implemented during this three-year period, thereby markedly reducing the crash occurrences over time.

Crosswalks are clearly marked on all four approaches. There are also pedestrian buttons on all corners; however, from fieldwork it was found that one was not functioning properly. The exclusive pedestrian phase lasts 18 seconds. This was sufficient time to cross any leg of the intersection.

Since the intersection is part of a six-location closed-loop coordinated signal system, this study analyzed a potential modification of the coordination of four of the intersections: Route 1A at Vinnin Street, Vinnin Street at Salem Street, Vinnin Street at Loring Avenue, and Route 1A at Loring Avenue. Under the current coordination, this intersection operates at LOS F with more than 80 seconds of overall delay in the AM peak hour and at LOS D with 48 seconds of delay in the PM peak hour. Under the modified coordination with the other three intersections, traffic operations for this location improved to LOS D and 40 seconds of overall delay in the AM peak hour and to LOS D and 38 seconds of delay in the PM peak hour. This coordination involves decreasing the cycle length from 159 to 90 seconds in the AM peak hour and from 159 to 100 seconds in the PM peak hour.

RECOMMENDED IMPROVEMENTS FOR ROUTE 1A (PARADISE ROAD) AT VINNIN STREET (VINNIN SQUARE):

- *Suggest to MassHighway and/or the City of Salem that the settings for the closed-loop signal system be reviewed and recalibrated to bring about an improved coordination such as the one described above, and so that turning movements that block other movements cease doing so.*
- *It appears that making the Route 1A northbound right turns stop-controlled rather than yield-controlled will help with the merge/weave movements from Route 1A southbound left turns. However, further study is needed before implementing this change.*
- *Consider moving the Starbucks driveway about 50 feet to the west. By doing so, westbound traffic waiting to enter the driveway would be less likely to block through traffic since two westbound travel lanes exist at this point.*
- *Fix pedestrian button.*

Vinnin Street at Salem Street/Plaza Driveway (Vinnin Square)

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	B	19	30	D	39	36
No Optimization		(Intersection is part of a closed loop system)				
2004 Coord'n	B	12	18	B	10	18

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 6 (2.0 per year)
- Crash rate: 0.29 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

A mere 230 feet to the east of the Route 1A at Vinnin Street intersection is Vinnin Street at Salem Street (see Figure E-6). It consists of four approaches, of which the southbound one is a narrow, one-lane, right-turn-only driveway from a shopping plaza. Just five vehicles in the AM peak hour and 30 vehicles in the PM peak hour turn right into the intersection from this driveway. The Salem Street (northbound) approach consists of an exclusive left-turn lane and an exclusive right-turn lane. The Vinnin Street eastbound approach has an exclusive right-turn lane and a through lane, while the westbound approach has one through lane and a shared through/ left-turn lane. There is local bus service on the northbound and eastbound approaches.

According to Mass. Registry data there were 2.0 vehicle crashes per year between 1999 and 2001, a crash rate of 0.29. This is well below the District 4 average of 0.88. Five of the six crashes were angle.

Clearly marked crosswalks exist on all approaches except westbound. The pedestrian buttons, provided for all crossings, work well, and the exclusive pedestrian phase lasts 19 seconds, sufficient time to cross any of the approaches.

Since the intersection is part of a six-location closed-loop coordinated signal system, this study analyzed a potential modification of the coordination of four of the intersections: Route 1A at Vinnin Street, Vinnin Street at Salem Street, Vinnin Street at Loring Avenue, and Route 1A at Loring Avenue. Under the current coordination, this intersection operates at LOS B and 19 seconds of overall delay in the AM peak hour and at LOS D and 39 seconds of delay in the PM peak hour. Under the modified coordination with the other three intersections, traffic operations for this location improved to LOS B and 12 seconds of overall delay in the AM peak hour and to LOS B and 10 seconds of delay in the PM peak hour. This coordination involves decreasing the cycle length from 152 to 90 seconds in the AM peak hour and from 152 to 100 seconds in the PM peak hour.

RECOMMENDED IMPROVEMENT FOR VINNIN STREET AT SALEM STREET/PLAZA DRIVEWAY (VINNIN SQUARE):

- *Suggest to MassHighway and/or the City of Salem that the settings for the closed-loop signal system be reviewed and recalibrated to bring about an improved coordination such as the one described above.*

Vinnin Street at Loring Avenue (Vinnin Square)

- Intersection LOS data(signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	C	24	37	B	18	43
No Optimization	(Intersection is part of a closed loop system)					
2004 Coord'n	B	14	31	C	21	48

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 27 (9.0 per year)
- Crash rate: 1.49 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This intersection is located just under 500 feet west of Route 1A at Vinnin Street (see Figure E-6). The Loring Avenue northbound approach has an exclusive left-turn lane, a through lane, and an exclusive, channelized right-turn lane. Southbound, Loring Avenue has an exclusive left-turn lane and a shared through/right-turn lane. The Vinnin Street westbound approach has an exclusive left-turn lane and a shared through/right-turn lane. The eastbound approach is a short and narrow driveway from a small bank/office plaza and has an exclusive right-turn lane and a shared through/left-turn lane, both lanes being substantially less than 12 feet in width. There is bus service on the northbound and southbound approaches.

Vehicle crashes at this location totalled 9.0 per year during 1999–2001, according to Mass. Registry data. This amounts to a crash rate of 1.49, well above the District 4 average of 0.88. Of this total, 70% were angle crashes while another 15% were rear-end. However, just as at Route

1A at Vinnin Street, there was a downward trend in crashes during the years observed:

- 1999: 11 crashes
- 2000: 9 crashes
- 2001: 7 crashes

It appears that at this location, as well, the geometric and signal improvements completed in 2002 may already have begun to have an impact on the number of crashes occurring.

Pedestrian facilities include clearly marked crosswalks for all approaches. Pedestrian activation buttons are provided and are functioning, and the exclusive pedestrian phase is 22 seconds, sufficient time to cross any leg of the intersection.

Since the intersection is part of a six-location closed-loop coordinated signal system, this study analyzed a potential modification of the coordination of four of the intersections: Route 1A at Vinnin Street, Vinnin Street at Salem Street, Vinnin Street at Loring Avenue, and Route 1A at Loring Avenue. Under the current coordination, this intersection operates at LOS C and 24 seconds of overall delay in the AM peak hour and at LOS B and 18 seconds of delay in the PM peak hour. Under the modified coordination with the other three intersections, traffic operations for this location improved to LOS B and 14 seconds of overall delay in the AM peak hour and deteriorated to LOS C with 21 seconds delay in the PM peak hour. This coordination involves decreasing the cycle length from 128 to 90 seconds in the AM peak hour and from 128 to 100 seconds in the PM peak hour.

RECOMMENDED IMPROVEMENTS FOR VINNIN STREET AT LORING AVENUE (VINNIN SQUARE):

- *Suggest to MassHighway and/or the City of Salem that the settings for the closed-loop signal system be reviewed and recalibrated to bring about an improved coordination such as the one described above.*

Route 1A (Paradise Road) at Loring Avenue (Vinnin Square)

- Intersection LOS data(signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	B	19	42	C	25	62
No Optimization	(Intersection is part of a closed loop system)					
2004 Coord'n	B	14	30	B	15	30

- Number of vehicle crashes, 1999–2001 (Mass. Registry): 31 (10.3 per year)
- Crash rate: 1.17 crashes per million entering vehicles (2005 District 4 average: 0.88)

Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This is the northernmost intersection in the Vinnin Square closed-loop signal system (see Figure E-6). It is located 700 feet north of Route 1A at Vinnin Street. It is a three-legged

intersection, with the Route 1A northbound approach consisting of an exclusive left-turn lane and one through lane. The southbound approach has two general-purpose lanes. Loring Avenue eastbound has an exclusive left-turn lane and an exclusive right-turn lane. There is bus service on the eastbound and southbound approaches.

Mass. Registry vehicle crash data from 1999–2001 show that there were 10.3 crashes per year at this intersection. The crash rate is 1.17, above the District 4 average of 0.88. A breakdown of crash types revealed 39% to be rear-end and 35% to be angle crashes. However, there seems to be an anomaly at this location when comparing its crash trends to those of the other intersections, discussed above, within the Vinnin Square closed-loop system. At those intersections, it was seen how crashes decreased between 1999 and 2001, presumably due to the geometric and signal improvements which were being implemented. At this intersection, however, the trend was as follows:

- 1999: 7 crashes
- 2000: 10 crashes
- 2001: 14 crashes

It is not clear why this intersection differs from the previously discussed nearby locations with respect to crash trends. Further study is required to determine the current typical numbers of crashes at all the locations, especially since a number of years have now passed since the intersections were improved.

There are clearly marked crosswalks on all approaches. Pedestrian buttons are provided for all crossings and are functioning, and the exclusive pedestrian phase is 19 seconds, sufficient time to cross the intersection approaches.

Since the intersection is part of a six-location closed-loop coordinated signal system, this study analyzed a potential modification of the coordination of four of the intersections: Route 1A at Vinnin Street, Vinnin Street at Salem Street, Vinnin Street at Loring Avenue, and Route 1A at Loring Avenue. Under the current coordination, this intersection operates at LOS B and 19 seconds of overall delay in the AM peak hour and at LOS C and 25 seconds of delay in the PM peak hour. Under the modified coordination with the other three intersections, traffic operations for this location improved to LOS B and 14 seconds of overall delay in the AM peak hour and to LOS B and 15 seconds of delay in the PM peak hour. In this coordination, the cycle length was decreased from 154 to 90 seconds in the AM peak hour and from 154 to 100 seconds in the PM peak hour.

RECOMMENDED IMPROVEMENTS FOR ROUTE 1A (PARADISE ROAD) AT LORING AVENUE (VINNIN SQUARE):

- *Suggest to MassHighway and/or the City of Salem that the settings for the closed-loop signal system be reviewed and recalibrated to bring about an improved coordination such as the one described above.*

ADDITIONAL RECOMMENDED IMPROVEMENTS for the Vinnin Square area (although not discussed here in detail, other improvements tested, and showing promising results, were):

- *At Vinnin Street at Loring Avenue: add a second Vinnin Street westbound left-turn lane. This could be accomplished by redesigning the intersection using an existing*

channelization island and undeveloped land on the southeast quadrant to create an expanded footprint. On Loring Avenue northbound, the existing exclusive left-turn lane would be eliminated in order to accomplish this redesign, leaving a shared through/left-turn lane and an exclusive right-turn lane.

- *At Route 1A at Loring Avenue: restripe the eastbound lanes as an exclusive left-turn lane and a shared left-/right-turn lane. The number of eastbound AM peak hour left turns outnumber the right turns by a ratio of almost 5:1; in the PM peak hour the ratio is 12:1. Therefore, a low-cost recommendation is that the exclusive right-turn lane be restriped as a shared left-/right-turn lane. This would accommodate the heavy left turns more efficiently.*

CONCERN/RECOMMENDED IMPROVEMENTS I

CONCERN: "There is congestion at the Route 1A (Loring Avenue)/Route 114 (Lafayette Street) intersection." This location is at the northern end of the Salem State College campus.

Route 1A (Loring Avenue) at Route 114 (Lafayette Street) and West Avenue

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- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	101	D	54	84
2004 Optimized	D	45	83	D	51	89
2015 No-Build	D	51	91	D	54	92

- Number of vehicle crashes, 2002–2004 (Salem Police Department): 27 (9.0 per year)
- Crash rate: 0.99 crashes per million entering vehicles (2005 District 4 average: 0.88)

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* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

This is the northernmost signalized intersection analyzed in the study area (see Figure E-7). It is a somewhat skewed, four-legged intersection at the northern edge of the Salem State College campus. Route 114 (Lafayette Street) northbound has an exclusive left-turn lane and a shared through/right-turn lane. The Routes 1A/114 (Lafayette Street) southbound approach has an exclusive right-turn lane and a shared through/left-turn lane. The Route 1A (Loring Avenue) eastbound approach consists of an exclusive right-turn lane and a shared through/left-turn lane, while the West Avenue westbound approach has one general-purpose lane.

Vehicle crash data were obtained from the Salem police department for this intersection. The data cover the years 2002 through 2004. A total of 9.0 crashes per year were recorded, which translates to a crash rate of 0.99, above the District 4 average of 0.88. From the police accident reports it was possible to construct a collision diagram of the crashes. It was further possible to discern crash patterns, by type and by location within the intersection. The crashes were broken down as 37% rear-end and 26% each for angle crashes and sideswipes in the same direction. The

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S = Signalized intersection

= Flashing beacon

FIGURE E-7
Intersection Turning-Movement Volumes: Three Intersections Analyzed in Salem

collision diagram reveals that 6 of the 10 rear-end crashes occurred on the Route 114 northbound approach, while the remaining 4 occurred on the southbound approach. These types of crashes are often associated with stop-and-go traffic as well as locations with insufficient green time (see Figure D-6 on p. D-23 in Appendix D above).

There are somewhat faded crosswalks on each of the four approaches. Functioning pedestrian buttons are located on all four corners, and the exclusive pedestrian signal phase lasts 19 seconds, sufficient time to cross the intersection approaches.

There is essentially no room for major geometric expansion at this intersection. Even if it were feasible to take land on the northern edge of the college campus, doing so would still leave a skewed intersection and would not improve operations to any great extent. Current operations in the AM peak hour are at LOS F and more than 80 seconds of overall delay, and in the PM peak hour they are at LOS D and 54 seconds of delay. The only improvement recommended is to optimize the signal, including extending the cycle length from 108 to 120 seconds. This would give more green time primarily to the northbound and southbound approaches, and thereby reduce the risk of rear-end crashes by allowing additional time to clear the intersection. After the optimization, the AM peak hour operates at LOS D and 45 seconds of delay and the PM peak hour operates at LOS D and 51 seconds of delay.

RECOMMENDED IMPROVEMENTS:

- *Optimize signal timing by increasing the AM and PM peak hour cycle lengths from 108 to 120 seconds. Prior to optimization, looking at the AM and PM peak hours together, four approaches operated at LOS E or F. After optimization, just one approach operated at LOS E (in the PM peak hour).*
- *Restripe lanes and crosswalk markings.*

CONCERN/RECOMMENDED IMPROVEMENTS J

CONCERN: "Congestion as well as problematic traffic operations exist at the Jefferson Avenue/Willson Street intersection." This intersection is located in the vicinity of Salem High School and Salem Hospital.

Jefferson Avenue at Willson Street/Cloutman Street

- Intersection LOS data (unsignalized)

	AM Peak Hour: LOS / Delay			PM Peak Hour: LOS / Delay		
Scenario	EB, all turns		WB, all turns	EB, all turns		WB, all turns
2004 Existing	F / *		F / *	F / *		F / *
No Optimization	—		—	—		—
2015 No-Build	F / *		F / *	F / *		F / *
Alt. 1 ('04 vols)	C	30	55	C	34	60
Alt. 1 ('15 vols)	C	32	57	D	37	64

- Number of vehicle crashes, 2002–2004 (Salem Police Department): 21 (7.0 per year)
- Crash rate: 0.86 crashes per million entering vehicles (2005 District 4 average: 0.63)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.

This intersection is in a compact residential neighborhood and is controlled by a flashing beacon (see Figure E-7). The main street, Jefferson Avenue, has flashing green, while the minor streets, Willson Street/Cloutman Street, are controlled by flashing red. The Jefferson Avenue northbound approach has two general-purpose lanes, but due to the heavy northbound left turns one is a de facto left-turn lane. There is one general-purpose lane southbound. Willson Street eastbound has an exclusive right-turn lane and a shared through/left-turn lane, while Cloutman Street westbound has one general-purpose lane. Willson Street and Cloutman Street are offset by about 30 feet.

Vehicle crash data were obtained from the Salem police department for this intersection. The data covers the years 2002 through 2004. A total of 7.0 crashes per year were registered during the three-year period. The crash rate is 0.86, above the District 4 average of 0.63 for unsignalized intersections. A collision diagram was constructed from the police accident reports, displaying the intersection's crash patterns. This diagram shows that 52% were angle crashes and 29% were rear end. All but one of the angle crashes involved left-turning vehicles from Willson Street eastbound colliding with through or left-turning vehicles from Jefferson Avenue northbound. The crashes presumably resulted from insufficient gaps in the main street traffic stream and the minor street vehicles unsuccessfully rushing to complete the left turn (see Figure D-7 on p. D-24 in Appendix D).

There is one painted crosswalk across Jefferson Avenue, connecting two of the offset minor street corners. There are pedestrian buttons on all the corners, and the pedestrian phase is of the older variety where the beacon simultaneously shows red above yellow for 15 seconds, sufficient time to cross any of the legs of the intersection.

Capacity analysis as an unsignalized intersection shows the northbound approach at LOS B, the southbound approach at LOS A, and both the eastbound and westbound approaches (minor street) at LOS F. The one improvement tested, and recommended, is to install a traffic signal. Numerous signal warrants were met, and a signal would offer both increased safety and improved processing of traffic. A signal tested with 2004 volumes, based on a 120-second cycle and including an exclusive pedestrian phase of 15 seconds, yields an AM peak hour LOS of C and 30 seconds of overall delay. The PM peak hour would operate at LOS C and 34 of seconds delay. The fact that the minor street approaches are offset should not cause great concern since the westbound traffic volumes totalled fewer than 25 vehicles during each of the AM and PM peak hours.

RECOMMENDED IMPROVEMENTS:

- *Install a traffic signal, including an exclusive pedestrian phase.*
- *Restripe existing crosswalk markings and add additional ones on the remaining approaches*

CONCERN/RECOMMENDED IMPROVEMENT K

CONCERN: "There are safety concerns at the Route 1A (Loring Avenue)/Canal Street/Jefferson Avenue intersection. A traffic study by Vanasse Hangen Brustlin, Inc. (VHB), of Watertown, is under way for this area since a new CVS drug store is planned nearby."

Route 1A (Loring Avenue) at Canal Street/Jefferson Avenue

- Intersection LOS data (signalized)

	AM Peak Hour			PM Peak Hour		
Scenario	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)	LOS	Intersection Delay (sec.)	Total Avg. Queue (# veh.)
2004 Existing	F	*	127	F	*	154
2004 Optimized	E	71	111	F	*	136
2015 No-Build	E	76	116	F	*	145
Alt 1 ('04 vols)	D	55	98	E	74	130
Alt 1 ('15 vols)	E	57	102	E	79	135

- Number of vehicle crashes, 2002–2004 (Salem Police Department): 69 (23.0 per year)
- Crash rate: 1.91 crashes per million entering vehicles (2005 District 4 average: 0.88)

* = 80 or more seconds total delay for signalized intersections, 50 or more seconds for unsignalized intersections.
Note: Total average queue is the average number of queued vehicles at the intersection during a given signal cycle.

CTPS was notified by VHB in 2005 that the CVS drug store project was on hold indefinitely. It was therefore determined that CTPS would analyze the intersection and recommend improvement possibilities.

This is a congested signalized intersection (see Figure E-7). Although it is four-legged, it is offset and skewed, with the westbound (Route 1A/Loring Avenue) approach entering at an acute

angle relative to the southbound (Canal Street) approach. Route 1A northbound has an exclusive left-turn lane, a through lane, and an exclusive right-turn lane. Route 1A westbound has a short, channelized right-turn lane, a through lane, and a left-turn lane. Canal Street southbound has an exclusive right-turn lane and a through lane. Left turns are not permitted from Canal Street. Jefferson Avenue eastbound has a channelized, exclusive right-turn lane as well as a left-turn lane, from which, after turning left, vehicles can continue northward onto Canal Street or, after approximately 75 feet, continue eastward onto Loring Avenue. There is bus service on the northbound and westbound approaches, with a southbound bus stop at a large island in the middle of the intersection.

Vehicle crash data were obtained from the Salem police department for this intersection. The data covers the years 2002 through 2004. There were 23.0 crashes per year, a crash rate of 1.91. This rate is more than twice as high as the District 4 average of 0.88 for signalized intersections. From the police data, it was seen that 55% percent were rear-end crashes, 26% were angle, and 10% were sideswipes in the same direction (see Figure D-8 on p. D-29 in Appendix D).

When looking at the yearly trend in crashes, however, the following was found:

- 2002: 25 crashes
- 2003: 33 crashes
- 2004: 11 crashes

The number of crashes in 2004 was just one-third of the total in 2003, 11 as compared to 33. Upon closer inspection, one major decrease was in rear-end crashes. When examining the collision diagram, it shows that the Canal Street southbound rear-end crashes decreased from 12 in 2002 and 2003 combined, to one in 2004. Although there is no confirmed explanation, this reduction coincides with the fact that the southbound approach was restriped from one general-purpose lane to two lanes, one exclusive right-turn lane and one through lane.

There are clearly marked crosswalks throughout the intersection area. Pedestrian buttons were all working during field observation, and the exclusive pedestrian phase lasts 19 seconds, sufficient time to cross any one leg of the intersection.

There is heavy congestion, long delays, and significant queuing at this intersection. The AM and PM peak hours both operate at LOS F and more than 80 seconds of overall delay. Through optimization of the signal, the AM peak hour improved to LOS E and 71 seconds of delay. The PM peak hour remained at LOS F and more than 80 seconds of delay.

There is some room within the current layout to redesign the intersection to increase capacity. On the west side, a triangular-shaped island can be used to create an additional lane on the Jefferson Avenue eastbound approach. This study tested the addition of an exclusive left-turn lane adjacent to the existing shared through/left-turn lane and exclusive right-turn lane: the overall intersection AM peak hour improved to LOS D and 55 seconds of delay, while the PM peak hour improved to LOS E and 74 seconds of delay.

RECOMMENDED IMPROVEMENT:

- *Create an additional eastbound left-turn lane by using an existing island within the intersection footprint. The cycle length would decrease from 139 to 120 seconds. The estimated improvements in traffic operations are from LOS F and more than 80 seconds of overall delay in both the AM and PM peak hours to LOS D and 55 seconds of delay in the AM peak hour and LOS E and 74 seconds of delay in the PM peak hour.*

MULTIPLE COMMUNITIES (CONCERNS/RECOMMENDED IMPROVEMENTS L AND M)

CONCERN/RECOMMENDED IMPROVEMENTS L

*CONCERN: Local officials and private residents perceive a general need for **improvements to public transportation service** in addition to the needs under Concerns C and G. This is discussed below in terms of already planned improvements as well as potential improvements developed as part of this study.*

When this study's analysis was being conducted, the public transportation system in the study area consisted entirely of MBTA commuter rail and bus service (see Figures D-9 and D-10, above, in Appendix D). Limited commuter boat service between Salem and Boston began in June 2006. Long-range plans include the potential extension of Blue Line rapid transit from Wonderland in Revere to Lynn Central Square Station or perhaps even as far north as Salem.

The recommended public transportation improvements in this report focus mainly on the existing modes in the study area. Potential improvements are discussed below, and recommendations are summarized at the end of each subsection.[6]

Potential for Improving Coordination of Commuter Rail and Bus Schedules

At present, bus and train schedules are not well coordinated for intermodal transfers at Lynn Central Square Station, as described in this study's Task 4 memorandum (see Appendix D above).[7] In general, bus routes are well timed to meet one another at intervals of approximately 30 minutes there, but train schedules on the Newburyport/Rockport Line are designed instead to best utilize track capacity between North Station and the outer terminals. Furthermore, schedules accommodate a number of Rockport trains in the morning and afternoon peak periods that operate nonstop/express between Salem Depot and North Station.

Currently, most of the riders destined for or coming from downtown Boston on buses traveling through Lynn Central Square Station choose to make a rapid transit transfer at Wonderland Station instead because of the much closer connection times possible to/from the more frequent Blue Line service. However, if the connection times between buses and commuter

[6] The discussion on public transportation improvements is primarily based on three draft CTPS memoranda: T. Humphrey, "Potential for Improving Coordination of Bus and Train Schedules at Lynn" and "Potential for Improved Connections Between Buses and Commuter Rail at Lynn," 2006; and R. Guptill, "Summary Analysis of Mid–North Shore Express Bus Service to Haymarket, Downtown Crossing, and Logan Airport," 29 June 2006.
[7] R. Sievert, "Task 4: A Review of Existing Transportation Conditions," CTPS memorandum, 1 April 2006.

rail could be reduced to approximately five minutes, it is expected that more customers would consider using that combination to travel to/from downtown Boston.

With the purchase of two additional trainsets for the Newburyport/Rockport Line, it would be possible to operate commuter rail service at even 15-minute frequencies during peak periods. In general, trains would alternate between Newburyport and Rockport as northern terminals, and most North Shore bus routes could then be scheduled to feed into and out of Lynn Central Square Station with minimal connection times for passengers. Most existing commuter rail riders on the Newburyport/Rockport Line would also benefit from such a change, as the number of trips operating during the peak periods would increase. However, nonstop/express trains could no longer operate under this scenario between Salem Depot and North Station, thereby lengthening the travel time for passengers already on these specific trips.

RECOMMENDED IMPROVEMENT:

- *It is recommended that the potential for both instituting new 15-minute headways on the Newburyport/Rockport Line and rescheduling buses to provide better intermodal connections at Lynn Central Square Station be explored further by the MBTA and local communities. While it is not within the scope of this study to determine the net overall travel time and ridership benefits of such service changes, it is clear that they would encourage area residents to view the bus, commuter rail, and rapid transit services as a more integrated network. In addition, these changes could help to reduce the number of Boston commuters who travel to/from Wonderland Station in the morning and afternoon peak periods, either in buses or private automobiles on the heavily congested Route 1A corridor in Revere.*

Potential for Improving Express and Local Bus Service

Ten express bus routes currently operate in the Mid-North Shore Study area, seven of which serve Haymarket Station via Route 1A or Route 1 and three of which serve downtown Boston via Logan Airport. These routes, although they offer less park-and-ride capacity than either rapid transit or commuter rail and longer in-vehicle travel times, by virtue of their accessibility attract significant ridership. Riders on some routes make greater use of through service to downtown Boston than others, however. If capacity exists at Wonderland Station for accommodating some of these passengers, it seems reasonable to terminate several of the current express routes to Haymarket, downtown Boston, and Logan Airport at Wonderland station and have passengers transfer to the Blue Line. Often this can be done at lower costs and at only slightly higher travel times.

For those customers wishing to pay a premium for slightly quicker service and no transfer, some express service to Haymarket should be continued. The routes most appropriate for this service, based on accessibility and current usage, appear to be Routes 426 (from Lynn Central Square), 442 (from Marblehead), and 450 (from Salem Depot). This would provide two routes serving Haymarket that run roughly parallel to each other along Routes 1A (Route 442) and 107 (Route 450) while serving the major population centers in the Mid–North Shore area. In addition, Route 426, which originates at Lynn and serves Saugus and the lower North Shore along Route 1, would provide a third express service to Haymarket. Other current Haymarket routes could be turned into local bus service that link up to Routes 442 and 450, or allow

passengers to transfer at Wonderland Station. The four remaining Mid–North Shore express routes, Routes 424 (from Eastern Avenue/Essex Street, Lynn), 434 (from Peabody Square), 441 (from Marblehead), and 455 (from Salem Depot), would terminate at Wonderland Station.

Of the three routes serving Downtown Crossing and Logan Airport from the Mid–North Shore, Route 459 (from Salem Depot) clearly has the largest demand. Given that the vast majority of riders on these routes, as with the express-to-Haymarket routes, use them more for local travel, it does not seem necessary to maintain all three routes. Eliminating the 448 and 449 (both from Marblehead) and replacing them with better local bus–to–Wonderland Station service, while perhaps also increasing the number of Route 459 trips, would seem to better match service levels to service demand while maintaining the link between the North Shore and the South Boston waterfront.

The bus running time saved by terminating Routes 424, 434, 441, and 455 at Wonderland Station and eliminating Routes 448 and 449 was estimated to equal nearly 30 daily hours. These hours could be used in a number of ways to improve transit accessibility in the Mid–North Shore area. One potential measure would be to improve headways and run additional service on the express and Wonderland Station routes. Headways currently set at 30 minutes could be reduced to 20 minutes, while those at 60 minutes could be set at 40 minutes. Another alternative would be to provide dedicated feeder bus service to the study area's three commuter rail stations, Lynn Central Square, Swampscott, and Salem Depot. With approximately 10 hours allocated per station, five feeder trips with 30-minute one-way running times could serve five rush-hour commuter rail trips in each of the AM and PM peak periods. Finally, some combination of reduced headways and commuter rail feeder services could be implemented.

Potential for Rapid Transit Service

The Federal Transit Administration (FTA)/MBTA North Shore Transit Improvements Purpose and Need Statement issued early in 2006 stated that it had become clear that transit service to Lynn is not adequate to serve demand. This is because the origin-and-destination patterns of Lynn residents are presently not served well by the available public transportation services in Lynn.

The second-highest destination of Lynn residents is Boston, where 14% of Lynn residents are employed. Of these, 54% drive to work, 9% carpool, and 34% travel by transit. This transit share is not very high for a city with Lynn's socioeconomic profile, high population densities near existing services, and a large workforce destined for Boston. The transit mode-share includes bus to downtown Boston, the Blue Line at Wonderland Station, or commuter rail at Lynn Central Square as the primary mode, which, in most cases, is combined with the Orange, Green, or Red Line in Boston for residents to reach their final destinations.

From the 2000 Journey-to-Work files, the three most important Boston destinations for Lynn residents are the Financial District, Back Bay, and South Station**.** From the analysis of travel times by driving, taking the bus, subway, or commuter rail, the subway is the fastest of the three public transportation modes, second only to driving. From the license plate survey performed for this study at Wonderland Station, the highest percentage of those who park-and-ride there, 27% are from Lynn (about 240 vehicles).

In addition to destination patterns, the subway is less expensive than commuter rail and therefore more affordable for Lynn residents, whose unemployment rate is higher than the average for the state, whose auto ownership is the smallest in Essex County, and of whom over 30% are immigrants.

According to staff analysis, with a Blue Line extension to Lynn, if the average wait time at Lynn Central Square for commuter rail passengers arriving either by bus or by private transportation were reduced to 5 minutes, overall travel times to some Boston destinations would still be slightly longer by commuter rail than by the Blue Line. Commuter rail would provide a travel time advantage of about 7.5 minutes to the North End compared with the Blue Line extension. However, the Blue Line extension would offer time savings of about 1 minute to destinations on the Orange Line south of State Station, about 4.5 minutes to destinations on the Green Line west of Government Center, and about 7.5 minutes to the Financial/Retail district.

Finally, Lynn and other Mid–North Shore residents who currently drive daily to Wonderland Station to ride the Blue Line contribute to the significant congestion and delays that are prevalent along the Lynnway and other roads leading to the station. Diverting these vehicles to public transportation passing through downtown Lynn would benefit traffic conditions along these roads and would help rejuvenate the Lynn downtown area economically, as would attractive urban design features as part of a potential subway line station. The extension of the Blue Line to Lynn is apparently a very attractive option to City officials, who have endorsed the project, as has Governor Mitt Romney.

In closing, although taking into account important evidence that points to "sensible" answers regarding improved public transportation options to serve the city of Lynn and other North Shore communities, the discussion as part of this study is still rather limited, and its scope cannot consider all the factors. The FTA/MBTA study that began in 2001 still continues and was scoped to be performed in a comprehensive manner in order to match problems, concerns, and needs to effective solutions.

RECOMMENDED IMPROVEMENT:

- *For the City of Lynn and other affected North Shore communities to participate in the FTA/MBTA North Shore Transit Improvements Study in order to identify effective public transportation options through an informed public participation process.*

CONCERN/RECOMMENDED IMPROVEMENTS M

CONCERN: Local officials and private residents perceive a general need for ***improvements to bicycle/pedestrian facilities*** *(in addition to the needs for such improvements mentioned as part of several of the location-specific concerns addressed in this study). This is discussed below in terms of already planned improvements as well as potential improvements developed as part of this study.*

The only active off-road bicycle/pedestrian facility in the study area is the Salem–Marblehead Rail Trail between Salem State College and the center of Marblehead, crossing Route 114 near the town line at Forest River (see Figure D-12 on p. D-45 in Appendix D).

In Salem, the trail extends southeastward about 0.5 miles along a former railbed from Canal Street, just north of Kimball Road, across Loring Avenue and the college campus to Route 114 (Lafayette Street) and the Marblehead line.

The most visible potential project in the study area is the proposed conversion of an abandoned railbed in Swampscott to a multiuse path. The railbed property is owned by the National Grid power company. There have been negotiations between local officials and National Grid officials with respect to taking the land by eminent domain or by agreeing to a recreational easement. Although more than 80% of town meeting members voted to pursue the project, there are concerns by abutters and other residents that there could be potential negative impacts caused by users of the facility.

The one other proposed rail-trail project in the study area is the Bike to the Sea project. This project, founded in 1993, seeks to utilize the former Saugus Branch corridor. This nine-mile line runs from the Malden River through Everett, Malden, Saugus, Revere, and Lynn. There would be indirect access to both Revere Beach and the Lynn waterfront.

One strictly bicycle-oriented venture is a bicycle-sharing program attempted by Salem State College. This project, implemented in April 2005, involved the purchase of 25 bicycles which could be used for free by students. Students needed to sign a liability waiver form and would then receive a key which would lock and unlock the bicycles. The students could use the bicycles to travel within or between the college's four campuses (North Campus, Central Campus, South Campus, and the O'Keefe Center athletic complex).[1]

RECOMMENDED IMPROVEMENTS:

- *Support the conversion of former railbeds to bicycle/pedestrian trails whenever possible, while seeking to minimize negative impacts to abutters.*
- *Support additional bicycle-sharing programs where appropriate in order to decrease single-occupancy automobile use while also increasing overall mobility.*

[1] *Boston Globe/North Weekly,* "College goes free wheeling," 17 April 2005.