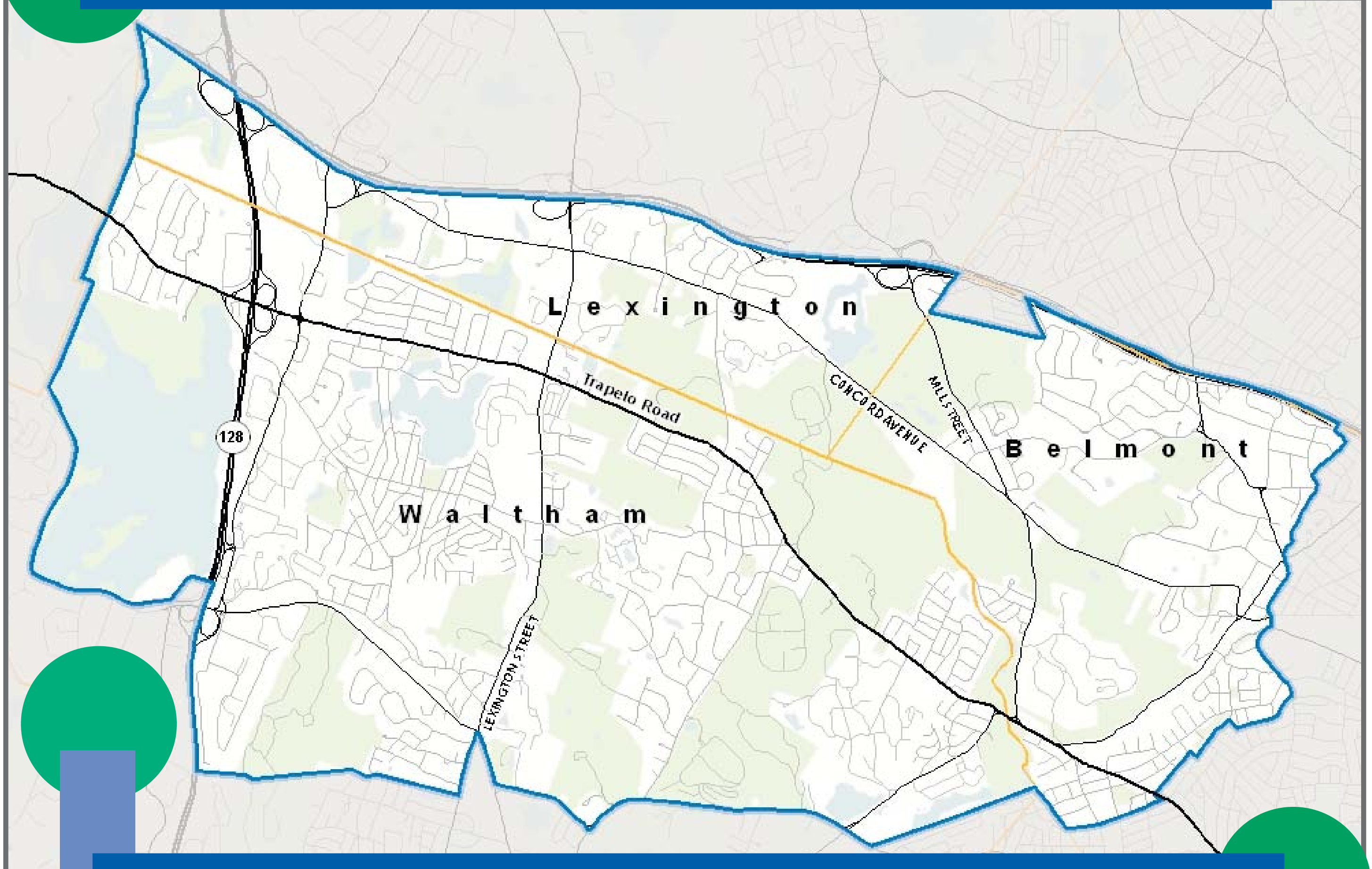
Belmont, Lexington, Waltham Subarea Study



Boston Region Metropolitan Planning Organization

September 2009

Belmont, Lexington, Waltham Subarea Study

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1.0 INTRODUCTION

Study History and Development

Increasingly, in the Boston MPO[1] region, land parcels that held public, private, or non-profit institutions are being subdivided and sold. These changes are often not anticipated in local planning documents or regional transportation plans. Communities find themselves with a sudden, and unplanned for, change in the demand for transportation.

The Trapelo Road corridor, including Belmont, Lexington, and Waltham, is an example of such land use trends. The corridor contains a substantial amount of publicly and privately owned land that is either planned, permitted, or identified as under consideration for future development. The majority of this property is located such that development in one community will have impacts in one or both of the other communities. The Trapelo Road corridor provides an opportunity to institute sustainable development principles on a multi-community scale. By coordinating the type of development implemented along Trapelo Road, creating a vision for future developments, and implementing early mitigation techniques, Belmont, Lexington, and Waltham can reduce future transportation and infrastructure expenses and maintain the character of their communities, while at the same time helping to provide for critical regional and local needs such as housing, jobs, and accessible open space.

This study of the Trapelo Road corridor land development and the related transportation impacts provides insights into how to address and plan for these developments throughout the Boston MPO region.

Study Origin and Development

The need for a subarea study in sections of Belmont, Lexington, and Waltham came to the attention of the Transportation Planning and Programming Committee of the Boston MPO during the preparation of the fiscal year 2005 Unified Planning Work Program. Before writing the work program for this study[2], MAPC and CTPS held meetings with planners, transportation officials, and other interested parties in each of the three communities to discuss options and opportunities for addressing concerns. Some of the concerns raised during these meetings included lack of mitigation for project impacts across community boundaries, the lack of connectivity between developments and to transit, and not being able to influence development near town boundaries.

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[1] MPO – Metropolitan Planning Organization

[2] Key staff who contributed to this study: CTPS – Karl Quackenbush (Principal), Alicia Wilson (Manager), Ian Harrington, Efi Pagitsas, Scott Peterson, Chen-Yuan Wang. MAPC – Barbara Lucas (Principal), Simon van Leeuwen (Manager), Bill Clark, Rebecca Dann, Alison Felix, Jim Gallagher, Mark Racicot, Jennifer Raitt.

Study Objectives

Objectives were developed by the study team based on outcomes of meetings with representatives of the three communities as well as input from the MPO. A priority of the MPO is that the process developed here be applicable to other areas facing similar development pressures within the region. The objectives were:

- Identify the total amount of new development under construction, permitted, or planned in the corridor.
- Identify the aggregate new demand for travel in the corridor from planned, permitted, and built projects.
- Identify and evaluate the impacts associated with the proposed developments and resulting corridor growth.
- Identify potential opportunities for cross-community development mitigation.
- Identify potential alternatives for evaluating growth scenarios that may be applied to the subarea.
- Identify whether alternative land uses would positively influence transportation.
- Recommend ways to meet or manage transportation demand through alternative land use coordinated with transportation.

Study Process

Form a locally appointed Advisory Committee to provide input and guidance to the study.
Chief elected officials from each community were asked to appoint members to form an Advisory Committee. This committee worked with the study team to further define the study, assist in identifying problems and future development scenarios, and to reach consensus on future solutions for the corridor. The Advisory Committee included six representatives from both Lexington and Belmont, and seven representatives from Waltham. The City of Waltham was asked to appoint the additional member in deference to the majority portion of the study area within the city. Appendix A, Advisory Committee List of Representatives, is the list of representatives and the municipalities they represent.

Identify existing land use and transportation within the study area.
The study team (comprised of MAPC and CTPS staff) worked with the Advisory Committee, local planners and officials to develop an overview of the current land use inventory and transportation conditions surrounding Trapelo Road. This overview provided the foundation for the study's land use and transportation components.

Define future development scenarios and project impacts on transportation infrastructure.
An Existing Conditions analysis based on current zoning and other land use regulations was developed and analyzed for its transportation impacts. The results of that analysis informed the development of two Alternative Future Scenarios to 2030. The two Alternative Future Scenarios were generated as follows:

1. *Future Build-Out Scenario*
   A Build-Out scenario was generated by assuming that 1) all proposed projects identified in the prior step are undertaken and completed as proposed, and 2) other land is developed, or "built-out", to its allowable zoning. For the purposes of the accompanying traffic impact study, this scenario was assumed to take place in 2030.

2. *Alternative Growth Scenarios*
   Based on the results from analysis of the Build-Out Scenario, the study team and the Advisory Committee developed two Alternative Growth Scenarios:

   - Advisory Committee Preferred Scenario
     A realistic scenario that incorporates the Advisory Committee's vision for the study area in 2030.

   - Smart Growth Scenario
     A scenario that applies smart growth principles developed through a literature review process.

Alternative design, transit accessibility, and development location alternatives were explored in this stage of the process. The effectiveness of these alternatives for changing transportation demand was evaluated using the regional transportation model and other analysis tools. The Alternative Growth Scenario development was an iterative process designed to develop tools and recommendations to help the three communities respond to growth demands and their related transportation impacts.

Analyze infrastructural mitigation for each future scenario.
The study team then analyzed areas of the transportation network that were identified as not addressed by the mitigation measures included with proposed developments. The study team defined the type of mitigating transportation infrastructure/services needed to support the growth in each future scenario. This included roadway improvements, expanded transit service, and access management as well as other improvements.

Develop recommendations for the corridor.
The study team recommended future plan(s) for the corridor that included both land use approaches and future transportation mitigation. This plan included:

- Priorities and funding estimates for additional mitigation for proposed developments.

- The state's and municipalities' role in implementing smart growth developments and implementing appropriate transportation infrastructure to support this development.

- Necessary steps for municipalities to take to become more successful in land development/transportation coordination among themselves and with the state.

Findings

Trapelo Road needs to be accessible and equitably shared by all modes of transportation – private vehicle, public transit, walking and bicycle. This study provides recommendations that better coordinate land use and transportation, creates connectivity within road networks and ensures connectivity between pedestrian, bicycle, transit, and road facilities. Concurrently, it is important to implement well-planned development that protects open space and provides more transportation choices; important components for Smart Growth.

According to all Alternative Future Scenarios to 2030, the overall rate of traffic growth is forecast to increase and Levels of Service worsen. However, the rate of traffic growth in the study area can be managed if recommended improvements are made systematically. A multi-facetted approach that evaluates proposed roadway improvements and development projects in the study area is essential. Through inter-community coordination and consensus; a balanced approach that addresses transportation and development should be implemented. In sum, this report combines a multi-modal approach to transportation with supportive development patterns.

Presently MBTA bus service is limited and expansion of existing routes is not expected to bring much service improvement. However, expanding existing shuttle services in the area, particularly to and from residential complexes, is anticipated to alleviate vehicular traffic and is recommended. Additional funding for shuttle services can come from area municipalities and developers. If bus and shuttle services are improved, there is a greater likelihood that people will choose these modes of transportation over driving. Other modal opportunities within the corridor, such as walking and bicycling, should also be improved.

Effective inter-community coordination is the keystone to improving traffic conditions and managing development in the study area. Belmont, Lexington and Waltham should collaboratively focus on coordinated mitigation requests for future developments, land use polices, bus and shuttle service enhancements, and improving roadway conditions.

2.0 EXISTING CONDITIONS

2.1 STUDY AREA

This section defines the geography of the study area and explains the rationale for its development. It also includes amendments to the study area recommended by the Advisory Committee.

Study Area Definition

The study area was initially defined to comprise an area large enough to include all new major land use changes that will produce traffic. It encompassed the area from Route 128 in the west, the Waverly MBTA station in the east, Route 2 in the north to Totten Pond Road and Beaver Street in the south.

The study area boundary was expanded along the Belmont/Waltham border in response to input from the Advisory Committee and the public during the first Advisory Committee meeting on October 18, 2005. As shown in Figure 1, Map of Study Area, the study area includes several sections that may potentially experience significant redevelopment independently of or in conjunction with other developments. Specific areas include the Waverly Square Station area and commercial zones along Pleasant Street/Route 60 and Waverly Oaks Road/Route 60. The Pleasant Street/Route 60 commercial area may redevelop and intensify in use as development proceeds at McLean Hospital. The commercial area on Waverly Oaks Road may capture redevelopment possibilities along the road in conjunction with any potential development at the Fernald Development Center.

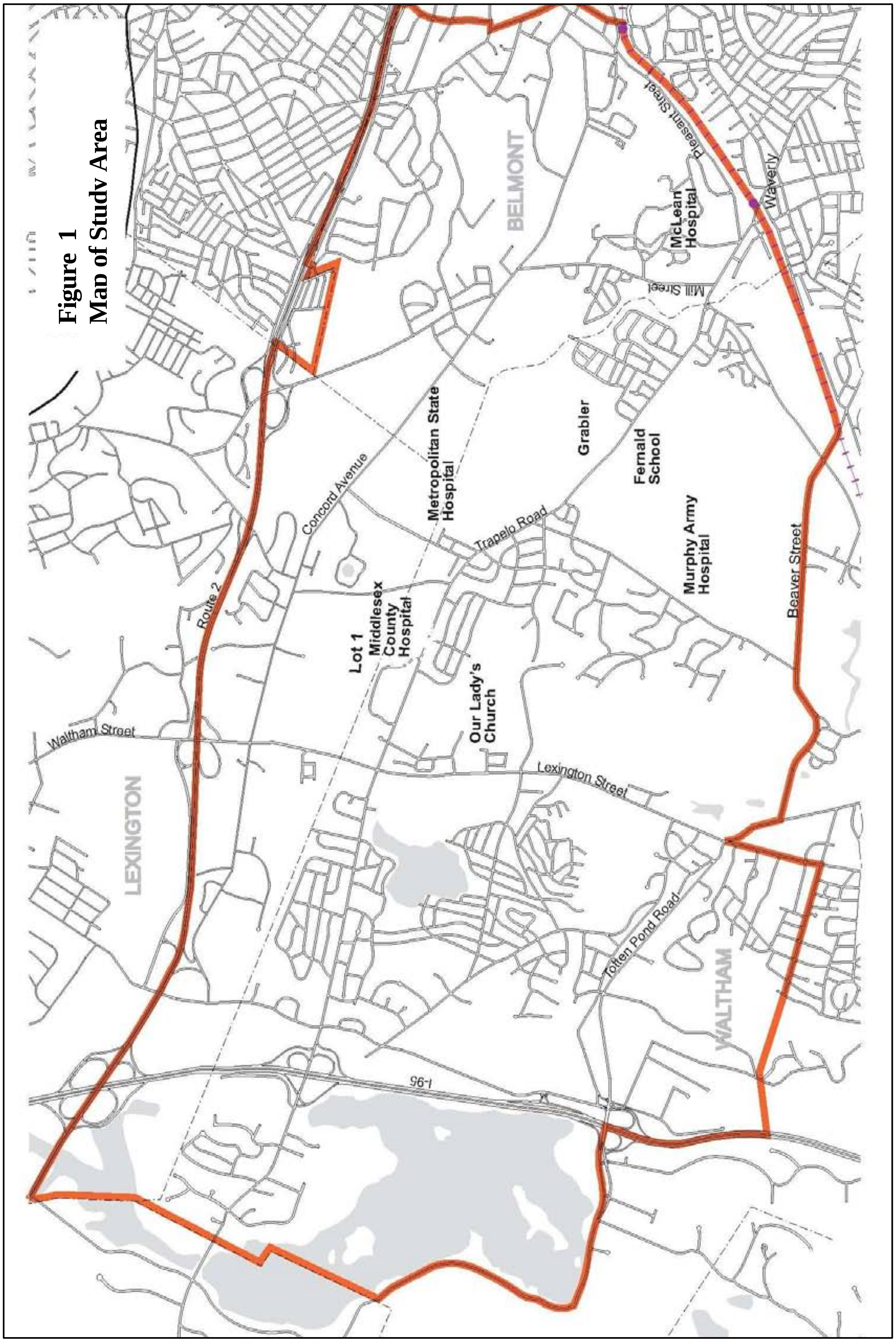

Figure 1
Map of Study Area

2.2 LAND USE

This section discusses current land use and real estate development patterns within the study area, with a focus on the potential for development of institutional land along Trapelo Road.

2.2.1 Zoning

Belmont
Institutional parcels include former Metropolitan State Hospital and McLean Hospital. Retail and commercial clusters exist around Waverly Station and Belmont Center, zoned Local Business 1 (LB1). A strip of Local Business 2 (LB2) connects the two areas along Pleasant Street/Route 60. LB1 and LB2 permit up to two floors of local retail, office, restaurant and other service establishments. The remainder of the study area is made up of residential zoning with a vast majority zoned single family (SA, SB, SC, and SD).

Lexington
Over 95 percent of the parcels within the Lexington portion of the study area are zoned single family (RO). There is one multi-unit development (RM) along Waltham Street. Portions of the former Metropolitan State and Middlesex Hospital properties have been converted to Planned Residential Districts (RD) with individualized requirements. There is land zoned as regional office (CRO) along Spring Street in the western part of Lexington parallel to Route 128/I-95 and a small hub of neighborhood business (NB) at the intersection of Waltham Street and Concord Avenue.

Waltham
Institutional parcels in the study area within Waltham include the former Metropolitan State and Middlesex Hospitals, Bentley College and the University of Massachusetts Extension Waltham Center, Fernald Development Center, and the National Archive building.

Residential zoning in the study area includes A-1, A-2, A-3, A-4, as well as Residential C and D. Parcels classified as A-1 through A-4 only allow single family development. Residential C allows 2-family structures by-right[3] and up to 18 units per acre by special permit. Residential D allows 6 unit multi-family developments per acre by-right, and up to 13 units per acre by special permit.

2.2.2 Institutional Uses and Development

The three municipalities contain a substantial amount of publicly and privately owned land that has either already been planned, permitted, or identified as under consideration for future development. Most of these properties are located such that development in one community will have major impacts on one or both of the other communities. The former Metropolitan State Hospital Campus consists of approximately 340 acres in Belmont, Lexington, and Waltham. The portion of the site in Belmont is predominantly wetlands and is slated for preservation. The site is bounded by Trapelo Road and Concord Avenue and is within three miles of I-95/Route 128. State agencies cooperated with Task Forces from the

3 By-right zoning designations eliminate the need to obtain special use permits or undergo a zoning change approval process.

three communities to define appropriate reuses for the site. The reuse plan called for a public nine-hole golf course in Waltham with vehicular access via Trapelo Road and housing and/or institutional use (the golf course is currently on hold, but the site will be preserved for recreational uses). A 387-unit apartment development with on-site parking and other amenities is being developed on the Lexington portion of the site. Primary vehicular access to the site will be from Concord Avenue in Lexington. Only emergency access will be allowed from Trapelo Road in Waltham. Measures to mitigate traffic impacts apply to Lexington only.

The former Middlesex County Hospital site is located in Waltham and Lexington along Trapelo Road east of Lexington Street. On the site of the hospital complex, 268 luxury apartments and condos have recently been constructed.

The land surrounding the hospital complex was divided into six lots in 1996 for sale and preservation. The sale of the 6.9 acre Lot 6 in 2004 for $5.6 million led the Division of Capital Asset Management (DCAM) to consider auctioning Lot 1, due to its potential development similarities. Lot 1 is the largest parcel in the complex at 54 acres. It is located in both Lexington and Waltham, and has been identified by conservation groups in the area for preservation as a portion of the Western Greenway.[4] In 2008, after years of effort by local activists and elected officials, Governor Patrick signed legislation passing ownership of Lot 1 to the City of Waltham.[5] The parcel is reserved for recreation and preservation uses.

In 2002, the Former Army Corps of Engineers site on Forest Street, in Waltham, was surplused by the Federal government and redeveloped. The site now holds two Bentley College dormitory buildings housing 116 students, the private Gann Academy, and recreational fields for the City of Waltham.

McLean Hospital in Belmont is a psychiatric care, testing, and research facility located on Mill Street close to the Waltham city line. The hospital has received approval from the town to expand development on its property. This new development includes a 150,000 square-foot research and development facility with an 800-space parking garage, a 482-unit senior living center, and 121 luxury townhouse units. The proposal also includes the potential expansion of the existing hospital to 50,000 square-feet. Developers have proposed traffic mitigation measures at three Belmont intersections.

A key site for potential future development is the 200 plus acre Fernald Development Center in Waltham. The center has been used to house and care for mentally disabled adults and in its prime had tens of thousands of residents. It currently houses 160 patients. Governor Deval Patrick has proposed to cut the funding of state facilities for the developmentally disabled by 9.8 percent. The Patrick administration expects that most of this $18.3 million cut will be accomplished by closing the Fernald Development Center. At an annual cost of $250,000 per person compared to $107,000 at other facilities, the Fernald

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[4] The Western Greenway is over 1,000 acres of undeveloped land in the communities of Lexington, Waltham and Belmont that stretches for six miles.

[5] Enactment of this legislation took place after the build-out scenario was developed. That scenario assumed 48 housing units would be developed on Lot 1.

Development Center is considered to be the most expensive facility for the mentally disabled in Massachusetts.

An October 2008 decision by the Court of Appeals of the First Circuit paved the way for the Commonwealth to move forward on its plan to resettle residents of the Fernald Development Center. The State of Massachusetts ordered all residents to move from the Fernald Development Center by June 30, 2010. Attorneys for the families of relatives who live at the Fernald Development Center filed an appeal against the closing order. However, in April 2009, the US Supreme Court formally declined to hear this appeal.[6]

Once appropriate reuse options are determined and if the Fernald Development Center properties are surplused by the State, the City of Waltham is responsible for re-zoning efforts. According to Waltham's 2007 Community Development Plan, large-scale development is anticipated for this site. For example, the Community Development Plan estimated that if the Fernald Development Center were to be redeveloped for residential uses, over 1,300 townhouses could be developed by-right and 2,850 units by Special Permit.

2.3 TRANSPORTATION

This section discusses how and where residents and employees commute, the state of motor vehicle and public transportation systems, and planned improvement projects in the study area.

2.3.1 Travel Patterns

In 2000, the total population of Belmont, Waltham and Lexington was almost 114,000. Estimated as 59,200, the City of Waltham comprised about half the total population. The populations of Belmont and Lexington are 24,200 and 30,400 respectively. Of the total population, approximately 56 percent or 63,300 work.[7] The percent of the working population is distributed evenly among the three communities.[8]

Tri-community Residents

On a regional level, the vast majority of the commuting patterns of Belmont, Lexington, and Waltham residents are within the Boston MPO region. Only 4 percent of Belmont's residents work outside the Boston MPO region, while 11 percent of Lexington's and 8 percent of Waltham's do so.

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[6] Fight for Fernald Goes to the Supreme Court, NECN, February 3, 2009 and New Suit over Fernald Center for Mentally Disabled, Boston.com, Associated Press, April 9, 2009.

[7] Of the total working population (aged 16 years and over in the labor force) (93,556), approximately 68 percent work.

[8] Census employment figures and the Massachusetts Division of Career Services (DCS, formerly Department of Employment and Training, or DET) employment numbers differ as DCS only includes employment that is subject to unemployment compensation. Census employment figures for the year 2000 are used in this discussion. In addition, the residents referred to in this study are only those residents who are employed.

Table 1, Top Ten Employment Destinations for Belmont, Lexington, and Waltham Residents, shows the commuting patterns of the residents in the three communities differ in several areas. Belmont's residents work closer to home, while the travel patterns of Lexington and Waltham residents are more dispersed. Almost half (43 percent) of Belmont residents work in Boston and Cambridge, whereas 27 percent and 20 percent of Lexington and Waltham residents respectively do so. Approximately one third (34 percent) of Waltham's working residents work within the city. Comparable numbers for Belmont and Lexington are 15 percent and 24 percent respectively. For commuting purposes, residents primarily use the roadway system for trips within each municipality or for travel to and from Boston and Cambridge. There is limited travel outside the Boston MPO region for commuting purposes.

TABLE 1
Top Ten Employment Destinations for Belmont, Lexington, and Waltham Residents

	Belmont Residents			Lexington Residents			Waltham Residents		
Rank	Destination	Workers	% Total	Destination	Workers	% Total	Destination	Workers	% Total
1	Boston	3,141	25%	Lexington	3,459	24%	Waltham	11,134	34%
2	Cambridge	2,217	18%	Boston	2,209	15%	Boston	4,567	14%
3	Belmont	1,925	15%	Cambridge	1,761	12%	Newton	1,897	6%
4	Waltham	667	5%	Waltham	818	6%	Cambridge	1,882	6%
5	Watertown	489	4%	Burlington	546	4%	Watertown	1,275	4%
6	Newton	282	2%	Bedford	498	3%	Burlington	731	2%
7	Somerville	260	2%	Newton	302	2%	Framingham	682	2%
8	Lexington	258	2%	Woburn	246	2%	Lexington	656	2%
9	Burlington	198	2%	Concord	244	2%	Wellesley	501	2%
10	Brookline	197	2%	Billerica	232	2%	Woburn	427	1%
Total		**12,612**	**76%**		**10,315**	**71%**		**32,752**	**73%**

Source: 2000 U.S. Census

Employees in the Three Communities

Travel patterns of those who work in the communities are just as diverse; there is no very large concentration of employees coming from one particular community. Lexington attracts workers from the broadest area, with 27 percent commuting from outside the Boston MPO region and 45 percent of all workers commuting from the top ten communities. This is followed by Waltham with 22 percent and Belmont with 11 percent commuting from outside the Boston MPO region and 67 percent and 73 percent respectively originating in the top ten communities. Almost three quarters (71 percent) of those who work in Belmont live in Inner Core[9] communities whereas; half of those who work in Waltham and 28 percent of those who work in Lexington do so. Table 2, Top Ten Origins of those who Work in Belmont, Lexington, and Waltham, depicts this information in detail.

[9] The Inner Core comprises 20 cities and towns within the Boston Region MPO area.

TABLE 2
Top Ten Origins of those who Work in Belmont, Lexington, and Waltham

	Belmont Employees			Lexington Employees			Waltham Employees		
Rank	**Destination**	**Workers**	**% Total**	**Destination**	**Workers**	**% Total**	**Destination**	**Workers**	**% Total**
1	Belmont	1,925	29%	Lexington	3,459	16%	Waltham	11,134	34%
2	Boston	484	7%	Boston	1,113	5%	Boston	4,567	14%
3	Arlington	371	6%	N.H.	887	4%	Newton	1,897	6%
4	Cambridge	357	5%	Arlington	849	4%	Cambridge	1,882	6%
5	Waltham	340	5%	Waltham	656	3%	Watertown	1,275	4%
6	Watertown	285	4%	Billerica	637	3%	Burlington	731	2%
7	Somerville	250	4%	Cambridge	548	3%	Framingham	682	2%
8	Woburn	159	2%	Somerville	516	2%	Lexington	656	2%
9	Medford	157	2%	Woburn	515	2%	Wellesley	501	2%
10	Newton	134	2%	Chelmsford	482	2%	Woburn	427	1%
Total		**6,672**	**67%**		**21,459**	**45%**		**32,752**	**73%**

Source: 2000 U.S. Census

Commuting Modes

For the majority of both residents and employees in the three communities, the auto is the mode of choice for commuting to work. Between 79 and 85 percent of the communities' residents either drive alone or carpool to work and between 80 and 85 percent of those who work in the three commuters arrive by auto. Reflecting the availability of transit, 12 percent of Belmont's residents and 5 percent of its workers commute by transit. Corresponding figures for Waltham and Lexington are 8 percent of residents and 3 percent of workers and 6 percent of residents and 1 percent of workers respectively. The percentage of residents and employees who walk or bicycle is even smaller.

A significantly greater percentage (82 percent) of Belmont, Lexington and Waltham residents chose to drive alone or carpool to work compared to the Inner Core residents who also commute by this mode of travel (63 percent). More than double the percentage (24 percent) of Inner Core residents commute to work by transit compared to Belmont, Lexington and Waltham (9 percent).

2.3.2 Traffic

This study focused on 17 major intersections to estimate average weekday traffic volumes and to perform level-of-service analysis. As shown in Table 3, Major Intersections in the Study Area, nine of the intersections are signalized (S-1 to S-9) and eight are unsignalized (U-1 to U-8).

TABLE 3
Major Intersections in the Study Area

Signalized Intersections			Unsignalized Intersections		
Number	**Name**	**Community**	**Number**	**Name**	**Community**
S-1	Trapelo Rd. at Smith St.	Waltham	U-1	Concord Ave. at Walnut St.	Lexington
S-2	Lexington St. at Trapelo Rd.	Waltham	U-2	Concord Av. at Pleasant St.	Lexington
S-3	Waltham St. at Concord Ave.	Lexington	U-3	Concord Ave. at Winter St.	Belmont
S-4	Trapelo Rd. at Lake St./ Bishop Allen Dr.	Waltham	U-4	Concord Ave. at Mill St.	Belmont
S-5	Lexington St. at Totten Pond Rd./ Bacon St.	Waltham	U-5	Winter St. at Marsh St.	Belmont
S-6	Trapelo Rd. at Waverly Oaks Rd.	Waltham	U-6	Trapelo Rd. at Woburn St.	Waltham
S-7	Trapelo Rd. at Mill St.	Belmont	U-7	Trapelo Rd. at Forest St.	Waltham
S-8	Trapelo Rd. at Lexington St.	Belmont	U-8	Trapelo Rd. at Pleasant St.	Belmont
S-9	Waverly Oaks Rd. at Beaver St.	Waltham			

2.3.2.1 Average Weekday Traffic (2005)

Average weekday traffic volumes on major roadways in the study area were estimated to understand traffic flow patterns for the year 2005. The estimation was based on AM and PM peak hour turning movement counts at the 17 intersections and MassHighway directional counts at ten locations. CTPS performed peak period turning movement counts in November and December 2005 at Trapelo and Smith Roads, Lexington Street/Bacon Street/Totten Pond Road, and Waverly Oaks Road and Beaver Street in Waltham. Turning movement counts were also conducted along Concord Avenue at Mill Street and Winter Street in Belmont. Turning movement counts performed in 2005 at Trapelo Road at Waverly Oaks Road, Mill Street and Pleasant Street by the BSC Group were also used. Counts from eight other intersections were taken from traffic studies conducted between 2001 and 2004 and updated to reflect existing conditions. In early 2005, MassHighway performed 72-hour, directional tube counts (reported in 15 minute increments) at ten locations within the study area, seven of which were in Waltham.

As shown in Figure 2, Estimated Average Weekday Traffic Volumes (24-Hour), Route 128 carries more than 100,000 vehicles per day in each direction. Route 2 carries about 50,000 vehicles per day in each direction, with traffic volume somewhat higher in the inbound (eastbound) than in the outbound (westbound) direction. Smith Street, parallel to Route 128, carries about 6,000 to 7,500 vehicles per day in each direction. Concord Avenue, parallel to Route 2, carries about 2,000 to 4,000 vehicles in each direction, except the section between Pleasant Street and Mill Street. This portion of the roadway carries about 5,000 inbound vehicles between Pleasant Street and Winter Street and nearly 10,000 inbound and 9,000 outbound vehicles per day between Winter Street and Mill Street.

Lexington/Waltham Street, classified as a major arterial, carries about 10,000 vehicles per day in each direction. Traffic volumes on Trapelo Road range between 7,000 and 15,000 vehicles, with higher volumes occurring near Route 128 and Waverly Square in Belmont. Low volumes occur in the section between Lexington Street and Waverly Oaks Road. Totten Pond Road carries approximately 10,000 to 12,000 vehicles per day, with higher inbound volumes than outbound. Beaver Street carries between 6,000 to 10,000 vehicles daily, with volumes generally higher outbound than inbound. Waverly Oaks Road, part of Route 60, carries about 6,000 to 7,000 vehicles in each direction per day. Mill Street, classified as a minor arterial, carries about 8,000 to nearly 10,000 vehicles in each direction per day. Forest Street, classified as a collector, carries about 4,000 to 4,500 vehicles in each direction per day.

These traffic volumes indicate that major roadways in the study area carry a high portion of through-town traffic in addition to local traffic. Traffic is attracted to Cambridge and Boston and the area near Route 128 in Waltham and Lexington. Concord Avenue, in connection with Mill Street and Trapelo Road, serves as an alternate route to Route 2 for traffic with Boston destinations. Smith Street serves as an alternate route to Route 128 for traffic coming from Route 128 north and Route 2 west with destinations for the office developments in the Route 128 vicinity.

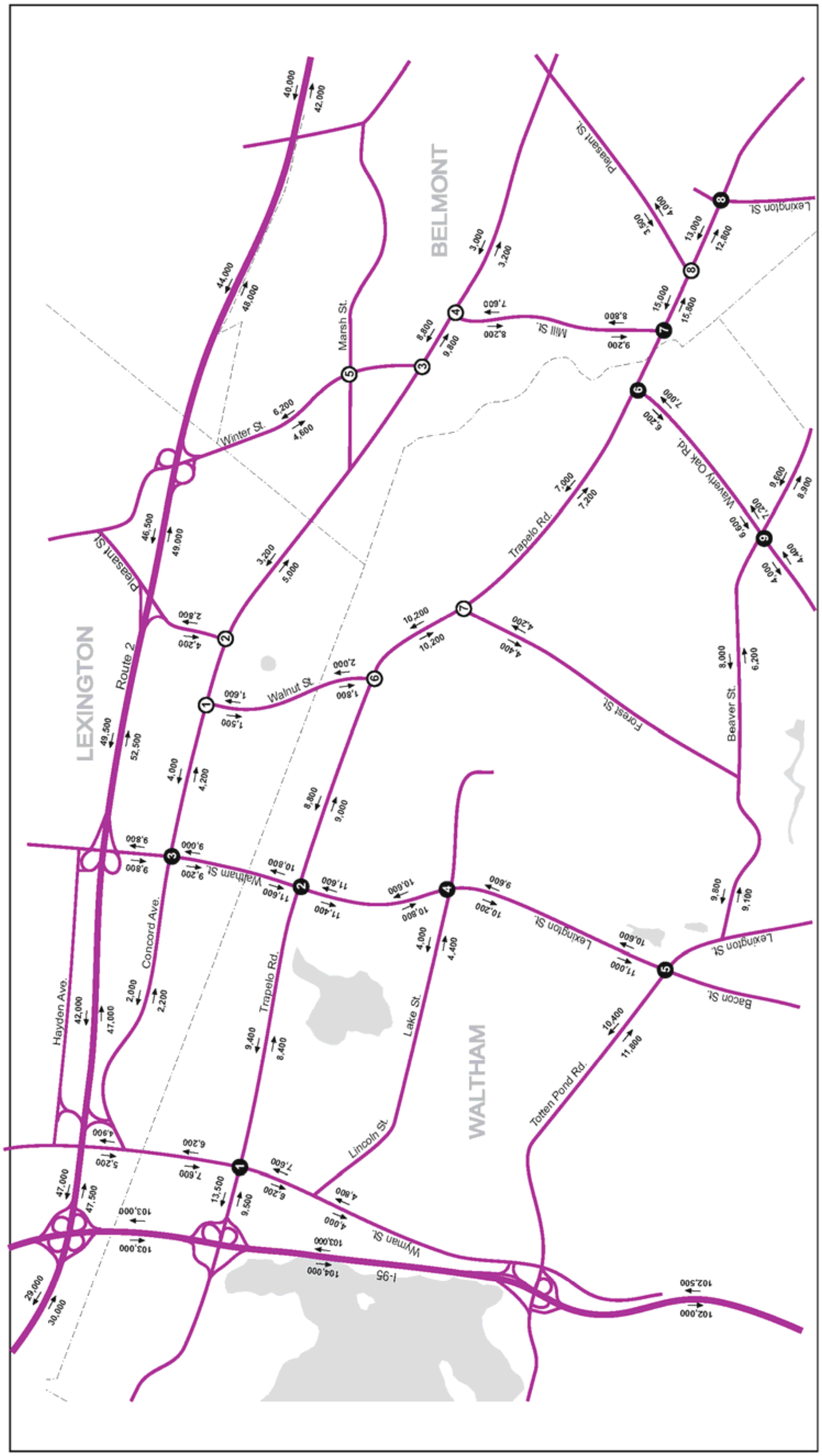

FIGURE 2
Estimated Average Weekday Traffic Volumes (24-hour)

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2.3.2.2 Traffic Volumes at Intersections

Figures 3 and 4, AM and PM Peak Hour Turning Movement Volumes (2005), show AM and PM peak hour turning movement counts at major intersections. Among the intersections examined, several have 3,000 or more entering vehicles per peak hour. These intersections—all currently signalized—are Trapelo Road at Smith Street (S-1), Lexington Street at Trapelo Road (S-2), Lexington Street at Totten Pond Road/Bacon Street (S-5), and Trapelo Road at Mill Street (S-7). The intersections of Trapelo Road at Lexington Street (S-8) and at Pleasant Street (U-8) in Belmont each process 2,500 or more vehicles per peak hour. Three intersections each process nearly 2,000 vehicles per peak hour: Trapelo Road at Forest Street/Bishop's Forest Drive (S-4), Concord Avenue at Winter Street (U-3), and Concord Avenue at Mill Street (U-4). Appendix B, Intersection Capacity Analysis Characteristics, contains a detailed summary of the intersection capacity analysis or the study area's major intersections.

2.3.2.3 Level of Service at Intersections

According to the *Highway Capacity Manual (HCM 2000)*, the concept of level of service (LOS) uses qualitative measures that characterize operational conditions within a traffic stream and how motorists and passengers perceive them. The criteria defining the levels of service are based on six ranges of intersection delay that are estimated from intersection geometry, operational parameters, and approaching traffic volumes. Table 4, Level of Service Criteria, shows the LOS criteria for unsignalized and signalized intersections from the Highway Capacity Manual (HCM 2000).

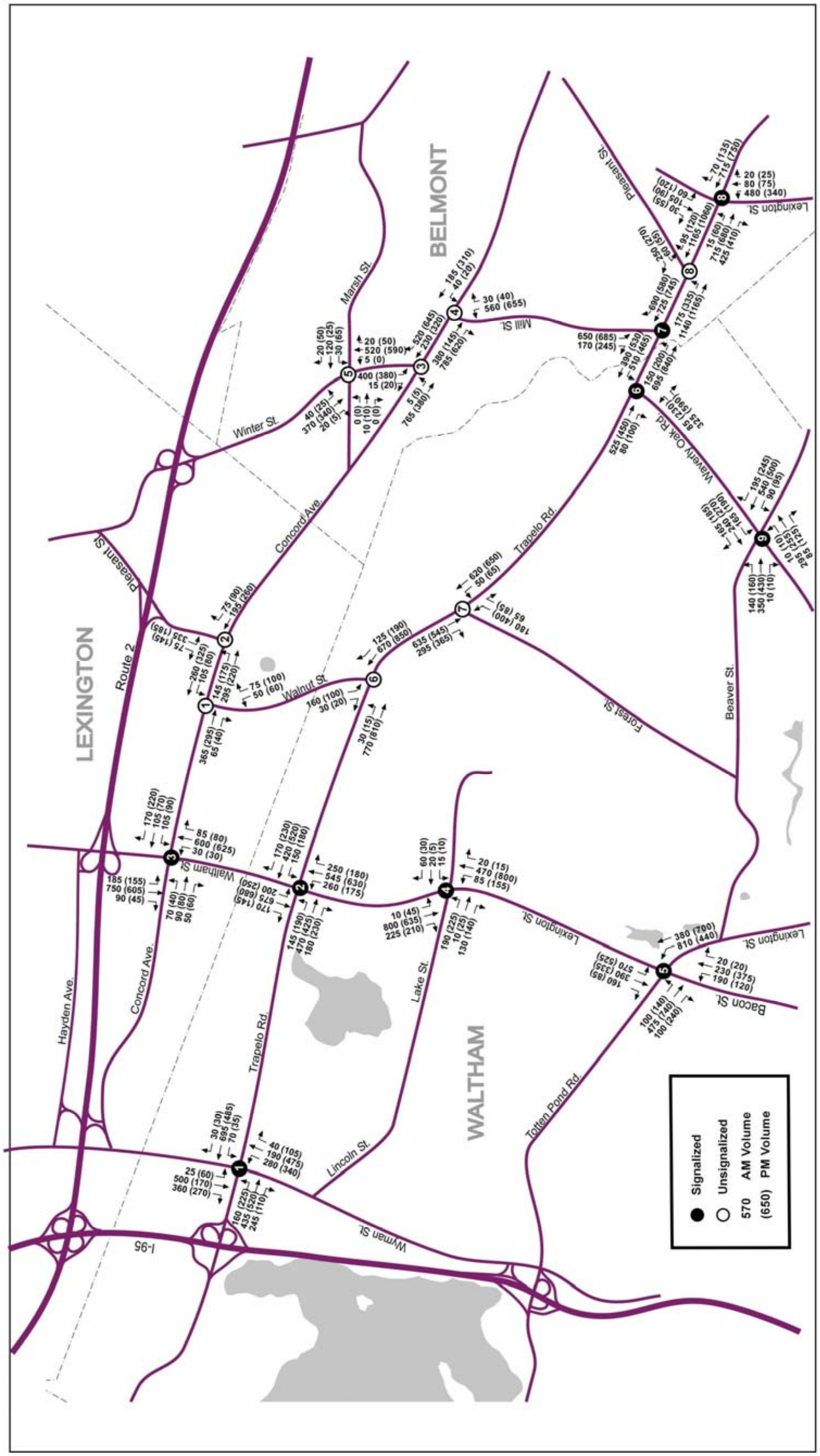

FIGURE 3.4
AM and PM Peak Hour Turning-Movement Volumes

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LOS is a qualitative measure describing operational traffic conditions. LOS assesses conditions in terms of speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. The six levels of service are defined by their designations from A to F, with LOS A representing the best operating conditions, and LOS F the worst. LOS D is generally considered acceptable in an urban environment. LOS ratings can be used to identify problems, evaluate potential solutions, compare locations, and track trends.

TABLE 4
Level of Service Criteria

LOS	Unsignalized Intersections Control Delay per Vehicle (seconds)	Signalized Intersections Control-Delay per Vehicle (seconds)
A	≤10	≤10
B	>10 and ≤15	>10 and ≤ 20
C	>15 and ≤ 25	>20 and ≤ 35
D	>25 and ≤ 35	>35 and ≤ 55
E	>35 and ≤ 50	>55 and ≤ 80
F	> 50	> 80

Source: Highway Capacity Manual, 2000.

Using the peak hour traffic volumes and intersection geometry data collected in field reconnaissance, CTPS analyzed the existing traffic operations through the application of Synchro/SimTraffic, a traffic analysis and simulation software package that contains methodologies based on HCM 2000.[10]

Table 5, Summary of Overall LOS and Average Delay for Signalized Intersections (2005), shows the estimated overall LOS and average delay for the signalized intersections. Aside from the intersection at Trapelo Road at Smith Street in the morning peak hour, the LOS for the signalzed intersections in the study area range between C and E. The overall LOS in the evening peak hour is slightly higher.

Table 6, Summary of LOS and Delay for the Minor Streets of Unsignalized Intersections (2005), shows the estimated LOS and delay for the minor street of the unsignalized intersections. A minor street is a street which permits direct access to lots and generally does not serve through traffic. Figures 5 and 6, AM and PM Peak Hour Levels of Service and Delay, shows the morning and evening peak hour intersection capacity analysis for all the selected intersections. With the exception of the intersections at Concord Avenue at Walnut Street and Winter Street at Marsh Street, the LOS for the unsignalized intersections in the study area reaches LOS F, the worst traffic condition. Concord Avenue at Mill Street, Trapelo Road at Woburn Street and Trapelo Road at Pleasant Street are at failing traffic conditions, LOS F, both during the morning and evening peak periods.

[10] Synchro/SimTraffic Version 6, Trafficware Corporation, 2003.

TABLE 5
Summary of Overall LOS and Average Delay for Signalized Intersections (2005)

			AM Peak Hour			PM Peak Hour		
	Intersection Number and Location	City/Town	Total Entry Volume	Overall LOS	Average Delay (sec.)	Total Entry Volume	Overall LOS	Average Delay (sec.)
S-1	Trapelo Rd at Smith St	Waltham	3,050	F	130	2,850	E	55
S-2	Lexington St at Trapelo Rd	Waltham	3,650	D	53	3,850	E	59
S-3	Waltham St at Concord Ave	Lexington	2,350	D	54	2,100	D	38
S-4	Trapelo Rd at Lake St	Waltham	2,050	C	25	2,300	C	30
S-5	Lexington St at Totten Pond Rd	Waltham	3,450	E	74	3,750	E	74
S-6	Trapelo Rd at Waverly Oaks Rd	Waltham	1,950	C	32	2,350	D	35
S-7	Trapelo Rd at Mill St	Belmont	3,100	D	38	3,300	E	67
S-8	Trapelo Rd at Lexington St	Belmont	2,750	C	25	2,750	C	27
S-9	Waverly Oaks Rd at Beaver St	Waltham	2,300	C	34	2,500	C	34

TABLE 6
Summary of LOS and Delay for the Minor Streets of Unsignalized Intersections (2005)

				AM Peak Hour		PM Peak Hour	
	Intersection Number and Location	City/Town	Traffic Control/ Total Approaches	LOS	Delay (sec.)	LOS	Delay (sec.)
U-1	Concord Ave at Walnut St	Lexington	2-Way Stop/3 Legs	B	14	B	13
U-2	Concord Ave at Pleasant St	Lexington	2-Way Stop/3 Legs	F	53	C	25
U-3	Concord Ave at Winter St	Belmont	2-Way Stop/3 Legs	F	118	D	30
U-4	Concord Ave at Mill St	Belmont	2-Way Stop/3 Legs	F	75	F	66
U-5	Winter St at Marsh St	Belmont	2-Way Stop/4 Legs	C/D	17/30	C/C	16/20
U-6	Trapelo Rd at Woburn St	Waltham	2-Way Stop/3 Legs	F	70	F	56
U-7	Trapelo Rd at Forest St	Waltham	2-Way Stop/3 Legs	E	38	F	> 180
U-8	Trapelo Rd at Pleasant St	Belmont	2-Way Stop/3 Legs	F	150	F	> 180

Overall, unsignalized intersections have a higher LOS compared to signalized intersections in the study area. The LOS of the signalized intersections slightly worsens during the PM peak hour whereas the LOS remains relatively constant for the unsignalized intersections during the AM and PM peak hours. For the most part, LOS for the roadway approaches (left-turn, right-turn and through movements) is consistent with the overall intersection LOS.

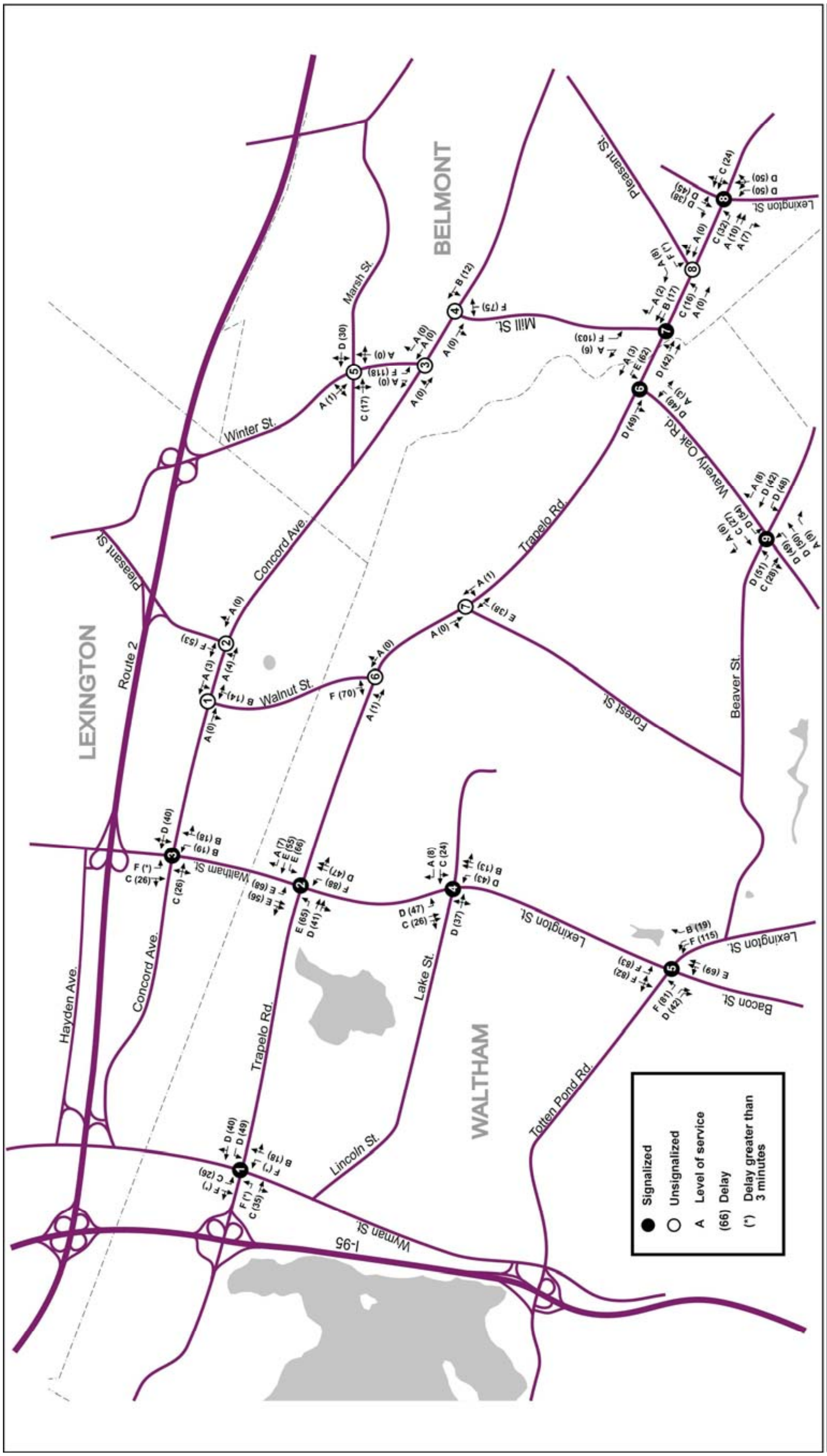

FIGURE 5
AM Peak Hour Levels of Service and Delay

Belmont, Lexington, Waltham Subarea Study

CTPS

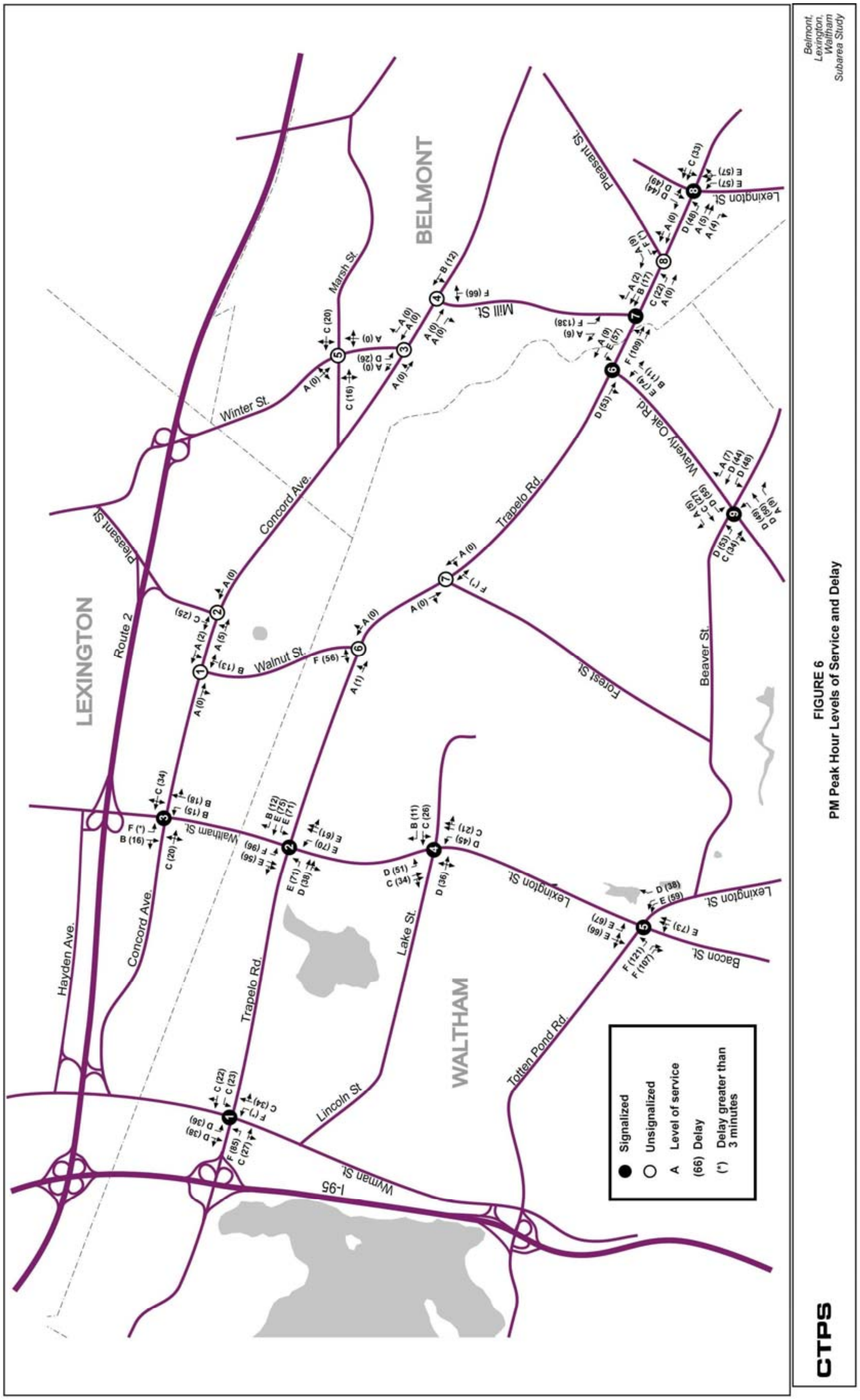

FIGURE 6
PM Peak Hour Levels of Service and Delay

2.4 Planned Roadway Improvements

Table 7, Transportation Improvement Program (TIP) Projects in Belmont, Lexington, and Waltham (Fiscal Years 2007-2010), shows projects listed in the Transportation Improvement Program (TIP) universe of projects in the study area. In addition to these projects, the City of Waltham has appropriated money to reconstruct the Trapelo Road/Smith Street intersection. Signals at three Trapelo Road intersections-Waverly Oaks Road, Mill Street, and Pleasant Street will be coordinated as part of the McClean Hospital mitigation.

TABLE 7

Transportation Improvement Program (TIP)
Projects in Belmont, Lexington, and Waltham (Fiscal Years 2007-2010)

ID Number	PROJIS Number	Status	Project Name	Project Description	Proponent	Funding
In Transportation Improvement Program						
600811	600811	Programmed in TIP	Alewife Station Bicycle Facility	Construct a bicycle path from Somerville to Belmont. This project will physically and visually connect the proposed work with the existing sections of path improving the continuity of the bike path.	Belmont, Cambridge, Somerville	$6,081,241
Not In Transportation Improvement Program						
604688	604688	Under Design	Trapelo Road/Belmont Street Reconstruction	Reconstruct Trapelo Road and Belmont Street from the Cambridge city line to the Waltham city line.	Belmont	$13.8 million
DM0190	NA	Conceptual	Trapelo Road/Forest Street	Improve the intersection of Trapelo Road and Forest Street with geometric improvements and signal installation.	Waltham	NA
DM0193	NA	Conceptual	Wyman Street and the Smith Street/Lincoln Street Intersection	Widen Wyman Street and improve the intersection of Smith Street/Lincoln Street including vertical alignments.	Waltham	NA
DM0192	NA	Conceptual	Totten Pond Road/Lexington Street/Bacon Street	Improve the intersection of Totten Pond Road/Lexington Street/Bacon Street with geometric and signal improvements.	Waltham	NA

Source: Transportation Improvement Program and Air Quality Conformity Determination, Fiscal Years 2007-2010.

2.5 Public Transportation

This section provides an overview of the existing transit services of the study area. Figure 7, Existing Transit Services, shows the commuter rail, local bus, and shuttle buses that serve portions of the study area.

Commuter Rail

Belmont has two stations, Waverly and Belmont Center, on the Fitchburg commuter rail line. Waltham has two, Brandeis/Roberts and Waltham. According to MBTA's Ridership and Service Statistics (11th edition), there were 125 daily inbound boardings at Waverly Station on 9 inbound trips ; 69 inbound boardings at Belmont Center on 13 inbound trips; 447 at Brandeis/Roberts on 16 inbound trips ; and 397 at Waltham Station on 17 inbound trips. In terms of typical weekday daily boardings throughout the entire MBTA commuter rail system, Brandeis/ Roberts is ranked 69th, Waltham is 75th, Belmont is 112th, and Waverly is 114th out of 123 stations.[11] Only the Belmont Center and Waverly Square Stations are within the study area.

Ninety-three percent of all the peak period trips on the Fitchburg line are considered to be on time. The MBTA defines on time for the commuter rail as departing from and arriving at the terminals within five minutes of the scheduled departure and arrival times. The MBTA service standard states that 95 percent of all daily train trips must be on time by line. The average passengers per seat for the peak 30 minutes on the Fitchburg line is 0.89, which meets the MBTA service standard policy of an average of 1.1 passengers per seat during the peak 30-minute period.[12]

MBTA Bus Service

Four MBTA routes serve Belmont. One connects Waverly Square to Harvard Square with frequent service during peak periods; two connect Belmont Center with Harvard Square; and one is an express service from Waverly Square to the financial district in downtown Boston. Two bus routes serve Lexington, both of which originate at Alewife Station on the Red Line. Four bus routes serve Waltham. One serves North Waltham to University Park in Cambridge. Another is a hybrid/local express route. The other two are express bus routes that serve the Financial District in Boston.

According to Table 8, MBTA Bus Routes in the Study Area, almost 200,000 passengers board the ten bus routes in the study area annually or an estimated 14,240 each weekday. With an estimated 6,300 boardings each weekday, Route 73 has the highest number of boardings. This bus route ranks 13th in terms of ridership frequency compared to the 196 routes run by the MBTA.

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[11] 2004 Congestion Management System, CTPS.

[12] MBTA Systemwide Passenger Survey Commuter Rail, CTPS.

Four MBTA routes serve Belmont. One connects Waverly Square to Harvard Square with frequent service during peak periods; two connect Belmont Center with Harvard Square; and one is an express service from Waverly Square to the financial district in downtown Boston. Two bus routes serve Lexington, both of which originate at Alewife Station on the Red Line.

Three bus routes serve Waltham. One serves North Waltham to University Park in Cambridge. The other two are express bus routes that serve the Financial District in Boston.

TABLE 8

MBTA Bus Routes in Study Area

Route Number	Route	Total Weekday Boardings	Total Saturday Boardings	Estimated Annual Boardings	Rank
62	Lexington to Alewife Station	1,122	X	13,464	91
70A	North Waltham to University Park in Cambridge	2,032	1,347	24,334	58
73	Waverly Square to Harvard Square	6,315	2,791	75,780	13
74	Belmont Center to Harvard Square	981	203	11,772	100
75	Belmont Center to Harvard Square	487	245	5,844	138
76	Lexington to Alewife Station	626	245	7,512	129
505	Express – Central Square Waltham to Downtown Boston	896	X	10,752	109
553	Roberts to Downtown Boston	662	244	10,872	126
554	Waverly Square to Financial District	659	195	7,908	128
556	Waltham Highlands to Downtown Boston	462	X	28,912	141
Total		**14,242**	**5,270**	**197,150**	

Source: MBTA Ridership and Service Statistics, 11th Edition, 2007, Bus Ridership as of January 2008.
X – No Saturday service.
Rank is based on 196 bus routes.

Bus Service on Trapelo Road

A private carrier operated bus service along Trapelo Road for approximately fifty years ending in 1979. Waltham's Citibus system operated service in the corridor briefly between 2001 and 2003. An analysis of current demand for and the cost of a new peak period bus service along the roadway indicates annual ridership of 6,800 to 18,900 with per passenger subsidies of $1.21 to $21.00 depending upon ridership and whether the service provider is the MBTA or a private operator.[13] The Advisory Committee to the

[13] Based on 2005 dollars.

Belmont/Lexington/Waltham Subarea Study is interested in restoring bus service along Trapelo Road.

Shuttle Bus Service

Lexpress is a shuttle service that operates six routes weekdays from 6:35 AM to 6:25 PM in and around Lexington. All routes serve Lexington Center and operate on one hour headways. Routes on Lexpress serve the Estabrook School, Lincoln Park, Lexington High School, Town Hall, Harrington School, National Heritage Museum, Jonas Clark Middle School, and the Bowman School. The annual ridership of all six routes combined was 68,000 in Fiscal Year 2008.

The Route 128 Business Council operates several services in the study area. The Alewife Shuttle, which provides weekday peak period service with headways of about 30 minutes from Alewife station to several businesses in Lexington and Waltham. The 128 Connection Shuttle provides weekday peak period service with headways of 60 minutes from Waltham Center to AstraZeneca, Bay Colony Corporate Center, and Foster Miller. The Bentley CitiBus Waltham Shuttle connects Bentley College with Lexington Street, Windsor Village Apartments, Hardy Apartments, and Lexington Terrace. Service is free for Bentley students. This shuttle runs seven days a week with average headways of about two hours. A shuttle operates on weekdays during peak AM and PM periods from Windsor Village Apartments in Waltham to Alewife Station. Service is for Windsor Village residents only and runs with an average headway of about 20 minutes. Although risdership is low for Windsor Village Apartment residents compared to other shuttle routes, exploring opportunities to expand shuttle service to residential complexes is recommended.

According to Table 9, Shuttles Provided by the 128 Business Council, 334,000 passengers utilized the shuttle services in 2008. With an estimated 206,000 boardings, the Bentley CitiBus Waltham Shuttle had the greatest number of boardings.

TABLE 9
Shuttles Provided by the 128 Business Council

Shuttle	2008 Annual Ridership
128 Connection Shuttle	26,018
Alewife Shuttle	95,924
Bentley CitiBus Waltham Shuttle	206,158
Windsor Village Apartments in Waltham to Alewife	5,861
TOTAL	**333,961**

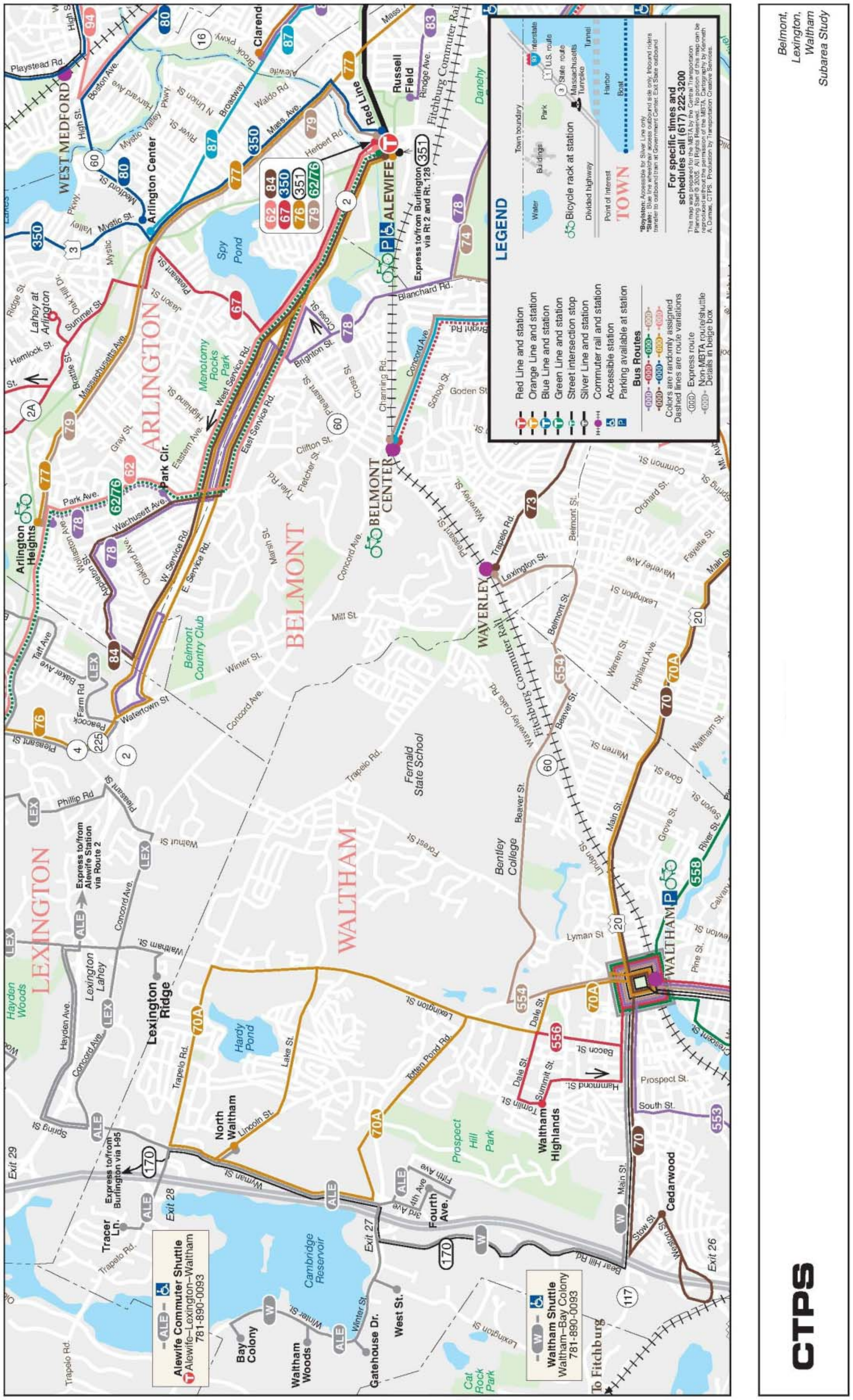
Bicycle Facilities

There are a total of 26 bicycle parking spaces at station stops along the Fitchburg Line in the study area. Brandies/Roberts Station does not have bicycle parking available. There are eight available bike parking spaces at Waltham Station with four occupied during an observation in October 2005. Also, there are ten and eight spaces available for bicycle parking at Waverly and Belmont Center Stations respectively.[14]

Open since 1993, the Minuteman Bike Trail is an 11-mile bike trail that begins in Bedford and continues through Lexington, Arlington, Cambridge, and terminates at Alewife MBTA station. In April 2005 from the hours of 10 AM to 5 PM, almost 730 bicycles were counted on the trail at Lexington Center.

[14] MBTA Bicycle Rack Inventory, updated May, 21 2007.

Figure 7 – Existing Transit Services



3.0 FUTURE YEAR ALTERNATIVES

3.1 Alternative Future Scenarios to 2030

This section discusses the parameters and analyzes the outcomes of a current trends development scenario within the study area for the year 2030. The results of this scenario, including traffic impacts, are analyzed and used as a starting point for developing Alternative Future Scenarios to 2030. The 2030 Future Build-Out scenario includes all developments in a 2010 scenario and all other land in the study area being developed to its fullest allowable zoning. Appendix C, Traffic Forecasts and Traffic Analysis Results, describes the Future Build-Out Scenario in more detail. Two Alternative Growth Scenarios, Advisory Committee Preferred and Smart Growth, are also addressed in this section.

3.1.1 Current and Potential Development (Permitted, In Process, and Under Consideration)

The purpose of a build-out analysis is to depict what land is available for development, how much development can occur and at what densities, and what consequences may result when complete build-out of available land occurs. Local zoning, other land use regulations, and physical constraints are all elements used to develop a build-out model and can estimate the amount and location of potential development for an area. An important additional element of this study involved a detailed parcel by parcel inventory and analysis of proposed and potential large scale real estate projects. This inventory was developed with guidance from the Advisory Committee and planners from each community. This step was important for a number of reasons that included the small size of the study area (where variances from zoning can have a large impact) and the preponderance of institutionally zoned properties that represent development potential. The analysis and inventory allowed for the identification of proposed mitigation for developments as well as their shortcomings.

Table 10 depicts the criteria used to develop the 2030 build-out model.

TABLE 10
Criteria used to Develop the 2030 Build-Out Model

2030 Projections	=	2000 Development	+	Permitted, In Process, and Under Consideration Projects	+	Parcel-by-Parcel Build-Out Within the Study Area

Appendix D, Population and Employment Projections, identifies parcels within the study area that have recently been developed, are currently being developed, or may be developed in the future. Not all current or proposed projects were included in the table. Projects are included that met the following criteria:

- Will substantially increase the amount of vehicle traffic on the roads in the area; and

- Previously have not been identified as developable, but may be developed now; and

- Have been highlighted by planners from one of the three communities as of interest to the community.

Projects are grouped into three categories:

1. Projects that are already built or that have recently broken ground, or projects that are permitted (have received all permits necessary to proceed with construction); and

2. Projects that are in permitting process; e.g.; development proposals that have initiated an official review process, but have not received all approvals; and

3. Projects that are under consideration; e.g.; they have been speculated, but no formal action has been taken.

The remainder of the development within the study area is calculated either by using MAPC's regional population and employment projections (prepared for a current trends land use scenario (2010[15])) or by applying the build-out calculation (2030 Future Build-Out Scenario). The methods used to calculate the build-out calculation are explained in Section 3.1.2, Future Build-Out Scenario, and Appendix D, Population and Employment Projections.

15 Assuming all developments and land development that current zoning can accommodate are completed by 2010.

3.1.2 Future Build-Out Scenario

The Future Build-Out Scenario was generated by assuming that 1) all proposed projects identified in a current trends land use scenario (2010) are undertaken and completed as proposed, and 2) other land is developed, or "built-out", to its allowable zoning, with additional restrictions applied based on geography, open space, wetland features, and input from planners from each community. For the purposes of the accompanying traffic impact study this scenario was assumed to take place in 2030. Appendix C, Traffic Forecasts and Traffic Analysis Results, discusses how the Future Build-Out Scenario was calculated.

The resulting information is a parcel-by-parcel analysis of the default future of the study area. It represents the full development potential of the area under current conditions and is a tool to help municipal officials and planners to identify and address the impacts of development based on current zoning requirements. Table 11, Summary of Population and Employment Change from 2000 to 2030, summarizes population and employment changes from 2000 to 2030. The forecasted population and employment changes to 2030 include planned and proposed projects, recently approved projects, recently constructed projects and some background growth. The 2030 build-out scenarios for population and employment are considered to be conservative.

TABLE 11
Summary of Population and Employment Change from 2000 to 2030

	2000		2030		Change Increase (%)	
	Population	Employment	Population	Employment	Population	Employment
Belmont	6,419	3,420	8,266	7,394	1,847 (28.8%)	3,974 (116.2%)
Lexington	2,401	1,967	3,664	2,912	1,263 (52.6%)	945 (48.0%)
Waltham	23,426	22,507	29,493	25,337	6,067 (25.9%)	2,830 (12.6%)
Total	**32,246**	**27,894**	**41,423**	**35,643**	**9,177 (28.5%)**	**7,749 (27.8%)**

Population and Employment numbers are for the study area only.

There are assumptions and uncertainty involved with the preparation of a build-out analysis, which is not an exact science. The primary limitations of a build-out analysis are:

- Existing zoning criteria is applied to the individual undeveloped or under-developed parcels. Zoning may be changed to allow for more or less development or variances and special permits may be granted.

- Developments may not occur quickly enough to reach full build-out by the default future date.

- Build-out analysis is meant to be viewed at a study area level. Build-out analysis is not effective when attempting to determine impacts at the TAZ (Traffic Analysis Zone) level or assessing a traffic response to development on a specific parcel. It is designed to estimate the aggregate number of units and is not accurate for individual parcels. However, it is possible to see varying growth patterns, and build-out can be used to project the extent of growth within different areas.

- A build-out analysis is not considered to be a responsive tool when evaluating changes in design, layout, use and combining uses.

A build-out analysis is an effective tool for evaluating traffic growth and impacts related to development on a regional scale. This type of analysis is the beginning of a process and should not be viewed as the presumed development outcome for the area.

Build-Out Assumptions, Results, and Analysis by Community

Belmont

After consulting with the Belmont planning staff, a number of land use changes were anticipated in this study. There are areas where increased density is either underway or anticipated, including: 1) expansion of McLean Hospital; 2) development of the air rights at Waverly Square Station; 3) redevelopment of Pleasant Street/Route 60; and 4) up-zoning of the commercial retail uses at Belmont Center. There will be an increase in intensity of commercial use at Waverly Square as a result of the increased density based on planned development of air rights over the commuter rail station (including residential over retail). The McLean Hospital redevelopment, the increased intensity of use in Waverly Square and Belmont Center, and the reconstruction of Pleasant Street/Route 60 will lead to the full use of business parcels along Pleasant Street/Route 60, which are currently underutilized.

The Belmont portion of the study area includes almost 2,000 parcels. Build-out projections estimate about 1,070 new housing units in this area and 3,970 new jobs. The McLean Hospital redevelopment will include approximately 640 new housing units and 650 new jobs by 2030. All of the housing and offices, accounting for more than 430 jobs, are already built or permitted. The expected redevelopment of Waverly Square and business parcels along Pleasant Street/ Route 60 accounts for all of Belmont's projected employment growth outside of McLean Hospital. The potential air-rights development of a mix of apartments over retail above Waverly Square Station will add 170 housing units and roughly 30 jobs. Table 12, Belmont – New Housing Units (2000-2030), summarizes the anticipated number of new housing units between 2000 and 2030.

TABLE 12
Belmont – New Housing Units (2000-2030)

Units Already Built or Permitted	**651**
Units Not Fully Committed	**420**
New Single Homes Added to Double-Sized Lots	65
Developments of 2-5 Units	87
Developments of 6-10 Units	22
Projects identified as "Under consideration" and Developments of over 10 units	246
Net New Units	**1,071**

Lexington

After consulting with the Lexington planning staff, the study team assumed that no changes to the existing residential zoning would take place within the study area and that no special permits would be issued for residential development. The study area that falls within the town is nearly all single family residential with a small business district at Waltham Street and Concord Avenue.

The Lexington portion of the study area includes almost 500 parcels. Over 560 new housing units and 940 new jobs are possible at build-out in this area. Of the new housing units identified for this area of Lexington, nearly 450 of them are already built or permitted. Out of the remaining units projected, 48 are from forecasted development on Lot One of the former Middlesex County Hospital Site and the rest are from smaller possible developments identified through the build-out analysis. The study team also anticipates a large office development on Spring Street near Route 128/I-95 and included it in the study. This is not a reflection of a current development proposal. Rather, it is based on a number of factors, including location, current zoning, ownership, similar developments, and activity on surrounding parcels. The potential new office development could generate approximately 880 new jobs. Table 13, Lexington – New Housing Units (2000-2030), summarizes the anticipated number of new housing units between 2000 and 2030.

TABLE 13
Lexington – New Housing Units (2000-2030)

Units Already Built or Permitted	**446**
Units Not Fully Committed	**115**
New Single Homes Added to Double-Sized Lots	16
Developments of 2-5 Units	37
Developments of 6-10 Units	14
Projects identified as “Under consideration” and Developments of over 10 units	48
Net New Units	**561**

Waltham

The Waltham portion of the build-out analysis is primarily based on a parcel-by-parcel build-out study conducted by the City of Waltham and MAPC in 2006. For the purposes of this study the original Waltham build-out analysis was updated to reflect the identified large scale potential developments discussed in Section 3.1.1. Current and Potential Development. Developments currently zoned recreational/conservation but identified as having redevelopment potential were included in this study as Residence D (this is consistent with past rezoning of the Middlesex and Metropolitan State Hospitals).

The Waltham portion of the study area includes approximately 5,300 parcels. Projections for the year 2030 estimate over 2,700 new housing units in this area and 2,400 new jobs within the city. Almost 600 of the projected housing units and just 77 of the estimated jobs are accounted for by developments that are already built or permitted in 2010. The potential by-right redevelopment of the Fernald Development Center represents almost half of all projected housing development between 2000 and 2030 (1,200 units). Table 14, Waltham – New Housing Units (2000-2030), summarizes the anticipated number of new housing units between 2000 and 2030.

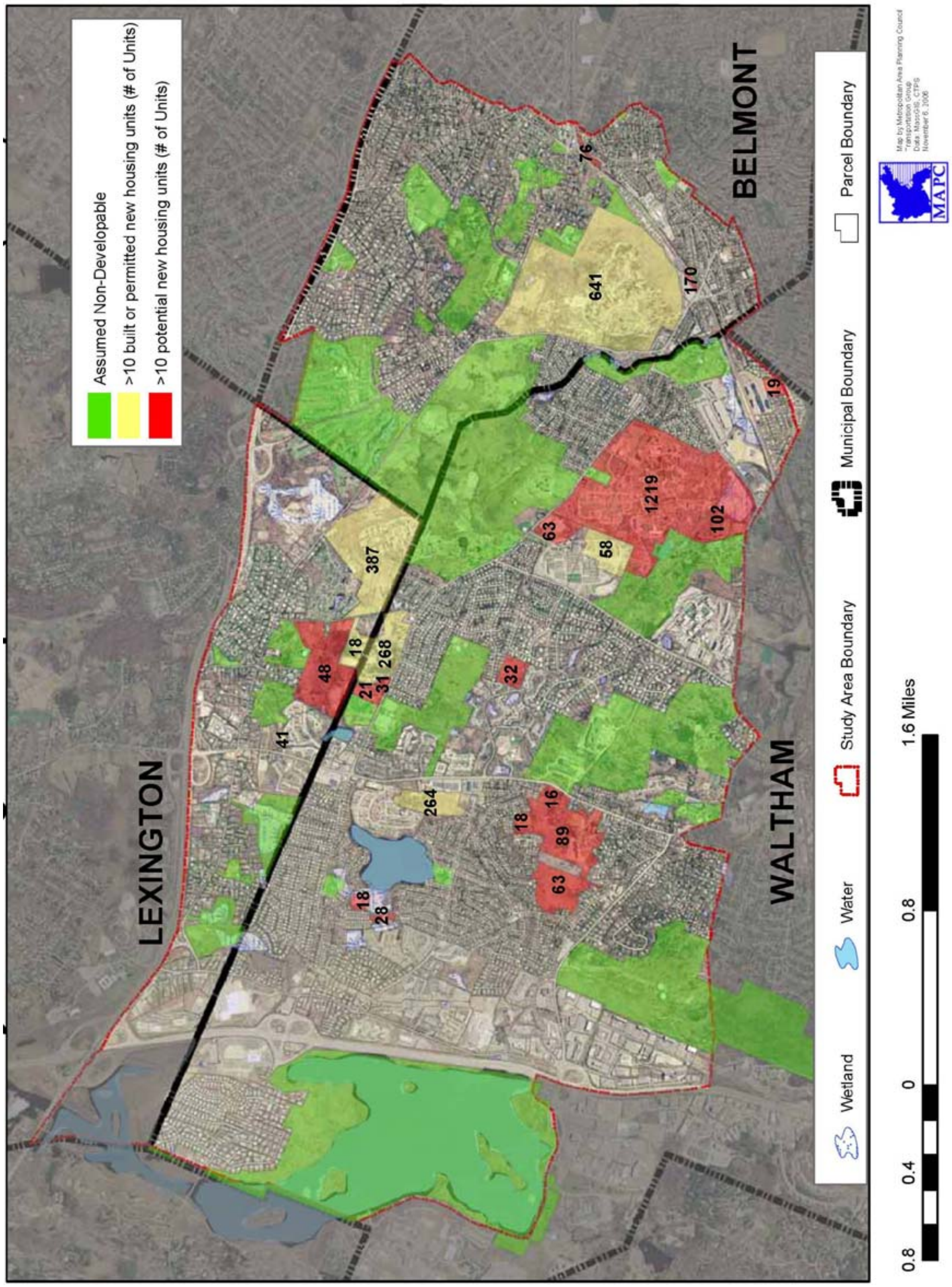
The 2,400 new jobs projected for 2030 are clustered in two main areas. Nearly 1,200 jobs are forecasted to be located in the portion of the study area adjacent to Route 128/I-95. Eight hundred additional jobs are expected along Pleasant Street, where existing business parcels are currently underutilized. The expectation is that the redevelopment of McLean Hospital and the reconstruction of Pleasant Street/Route 60 in Belmont will spark redevelopment along Pleasant Street in Waltham.

TABLE 14
Waltham – New Housing Units (2000-2030)

Units Already Built or Permitted	**590**
Units Not Fully Committed	**2,158**
New Single Homes Added to Double-Sized Lots	234
Developments of 2-5 Units	173
Developments of 6-10 Units	32
Projects identified as “Under consideration” and Developments of over 10 units	1,719
Net New Units	**2,748**

Figure 8, Major Housing Developments at Build-Out (2030), graphically depicts major housing developments for the study areas of the three communities.

Figure 8 - Major Housing Developments at Build-Out (2030)



Employment Summary by Community

Table 15, Build-Out Employment Summary by Community, summarizes the number of net new jobs (2000-2030) for developments already built or permitted and projects under construction/and other potential developments for the three communities discussed earlier in this section. Figure 9, Employment Growth by Traffic Analysis Zone (2000-2030), graphically depicts employment growth.

TABLE 15

Build-Out Employment Summary by Community

Net New Jobs (2000-2030)			
	Developments Already Built or Permitted	**Projects Under Construction and Other Potential Developments**	**TOTAL**
Belmont	432	3,602	4,034
Lexington	36	909	945
Waltham	77	2,334	2,411

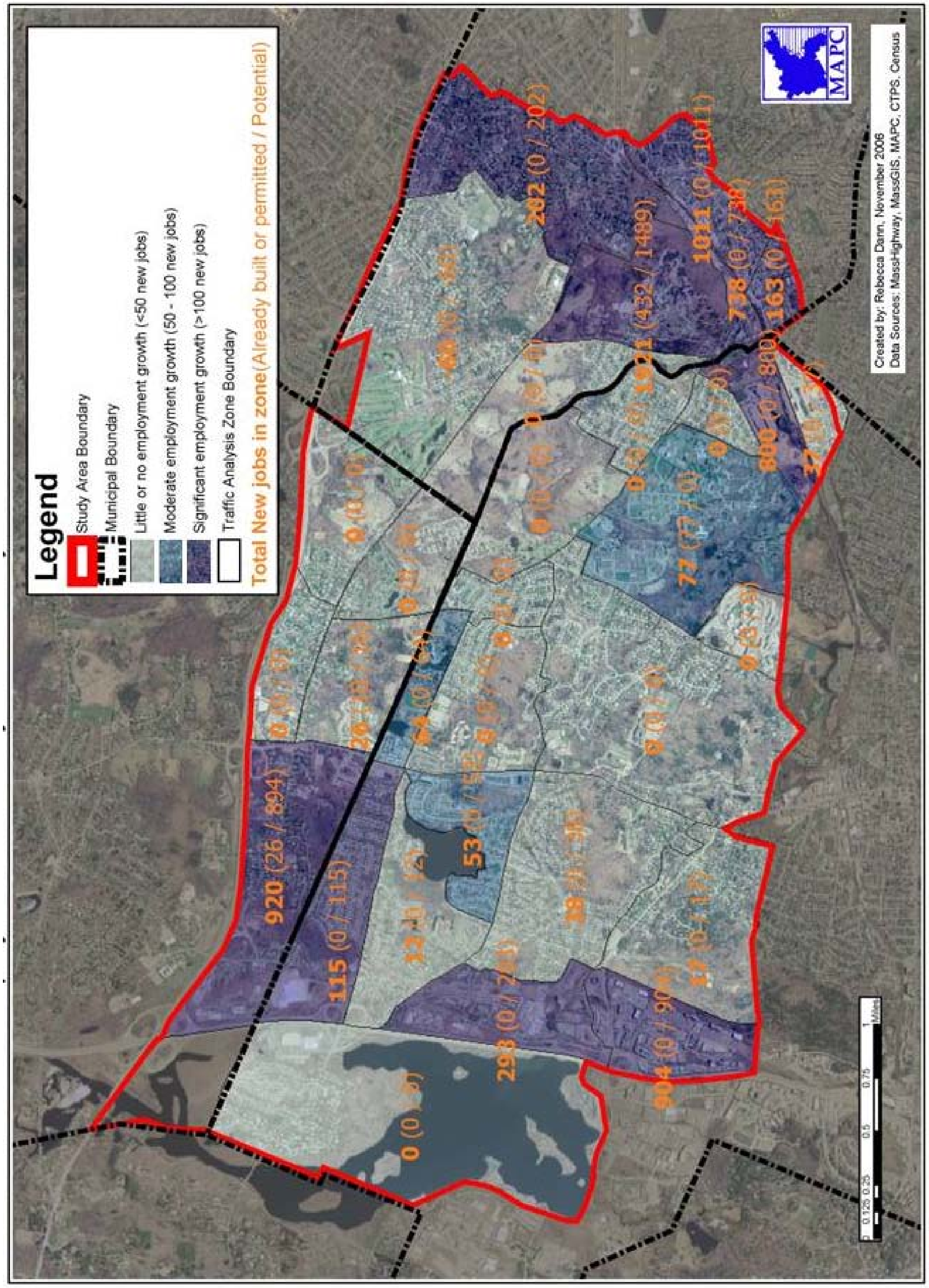
3.1.3 Travel Demand Modeling

Future travel demand for the alternatives to the year 2030 was forecast using computer-based supply and demand models that accounted for population, employment, travel time and cost characteristics of competing highway and transit modes of travel.[16] Population and employment forecasts were provided by MAPC. CTPS developed the model set which has been used extensively over the course of the last several years for a variety of projects. The models are of the same type as those used in most large urban areas in North America.

All of eastern Massachusetts, subdivided into several thousand smaller areas known as Traffic Analysis Zones is represented in the model. A total of 164 eastern Massachusetts municipalities and 2,727 Traffic Analysis Zones comprise the model. The study area consists of thirty-one Traffic Analysis Zones. The model set simulates travel on the entire transit and highway system in the geographic area. As such, it contains all MBTA rail and bus lines, all MBTA ferry service, and all private express bus carriers. The model includes service frequency (i.e., how often trains and buses arrive at any given transit stop), routing, travel time, and fares for all these lines. In the highway system, all express highways and principal arterial roadways and many minor arterial and local roadways are included. The outputs of the model set contain detailed information relating to the transportation system. On the highway side, the model output provides traffic volumes, congested travel speeds, vehicle miles traveled, average travel times on the roadway links, etc. On the transit side, the output provides information relating to the average weekday ridership on different various transit modes (commuter rail, rapid transit, local buses, express buses and private carriers), station boardings, park-and-ride demand, peak load volumes, etc.

[16] The 2030 forecast year is based on the assumption that all land development that current zoning can accommodate is completed by 2010. Appendix C, Traffic Forecasts and Traffic Analysis Results, describes the 2030 Future Build-Out Scenario in more detail.

Figure 9 – Employment Growth by Traffic Analysis Zone (2000-2030)



The models are based on the traditional four-step, sequential process known as trip generation, trip distribution, mode choice, and trip assignment. Trip generation estimates the number and the kinds of trips travelers take (i.e., work, school, and other). Trip distribution estimates the origins and destinations of travelers. Mode choice estimates the form of travel (auto, bus, and walk) used to make trips. Trip assignment estimates the specific paths used to travel from each origin to each destination.

The model was first calibrated to the existing conditions and then was used to forecast 2030 conditions. Each scenario was modeled for two peak periods: AM (6:00-9:00) and PM (3:00-6:00).

3.1.3.1 Traffic Forecasts and Traffic Analysis Results - 2030 Build-Out

This section summarizes projected traffic growth on major roadways and the results of traffic analysis performed for major intersections in the study area for the Future Build-Out Scenario. The 2030 Future Build-Out scenario includes current trends and land use scenarios assuming all developments and land development that current zoning can accommodate are completed by 2010. Transit was not included as part of the traffic forecasting. Appendix C, Traffic Forecasts and Traffic Analysis Results, describes the 2030 Build-Out Scenario in more detail. The discussion proceeds from general impacts to specific impacts with proposed mitigation measures.

Compared to existing traffic volumes the model projected a range of 15 to 30 percent traffic growth on major roadways in the 2030 Future Build-Out Scenario. Table 16, Summary of AM Peak Hour Traffic Growth on Major Roadways, summarizes ranges of AM peak hour traffic volume changes on major roadways for the two scenarios. Table 17, Summary of PM Peak Hour Traffic Growth on Major Roadways, summarizes the changes in the PM peak hour.

TABLE 16

Summary of AM Peak Hour Traffic Growth on Major Roadways

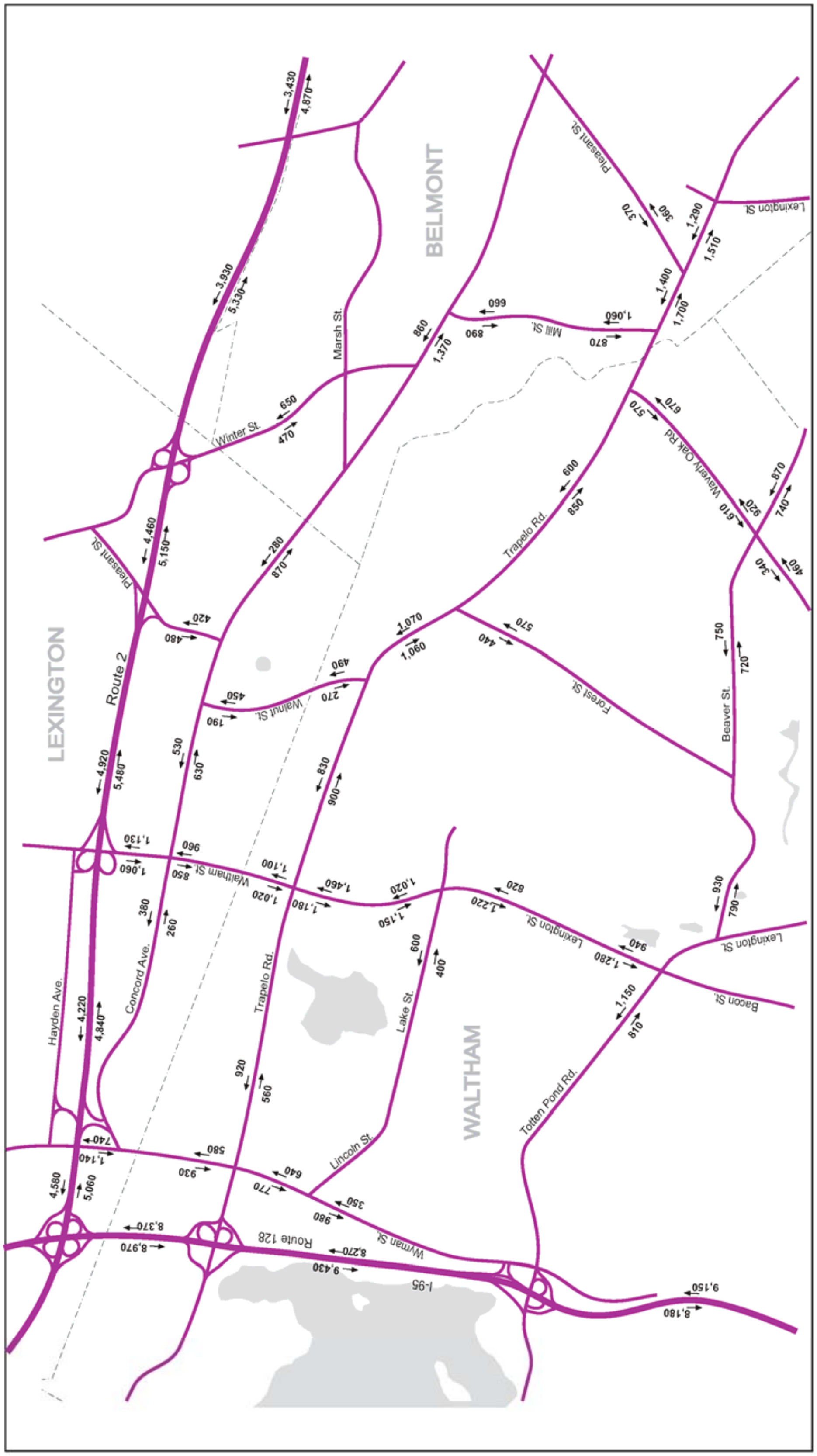
Major Traffic Corridor	Base Year 2005 Traffic Volume Range (Both Directions Total)	Traffic Growth Range 2030 Build-Out
Trapelo Road	1,150 - 2,750	12% - 27%
Waltham St./Lexington St.	1,650 - 2,200	12% - 34%
Concord Avenue	750 - 1,900	17% - 54%
Mill Street	1,400 - 1,650	10% - 18%
Waverly Oaks Road	700 - 1,150	18% - 38%
Smith Street	1,250 - 1,350	12% - 18%

TABLE 17

Summary of PM Peak Hour Traffic Growth on Major Roadways

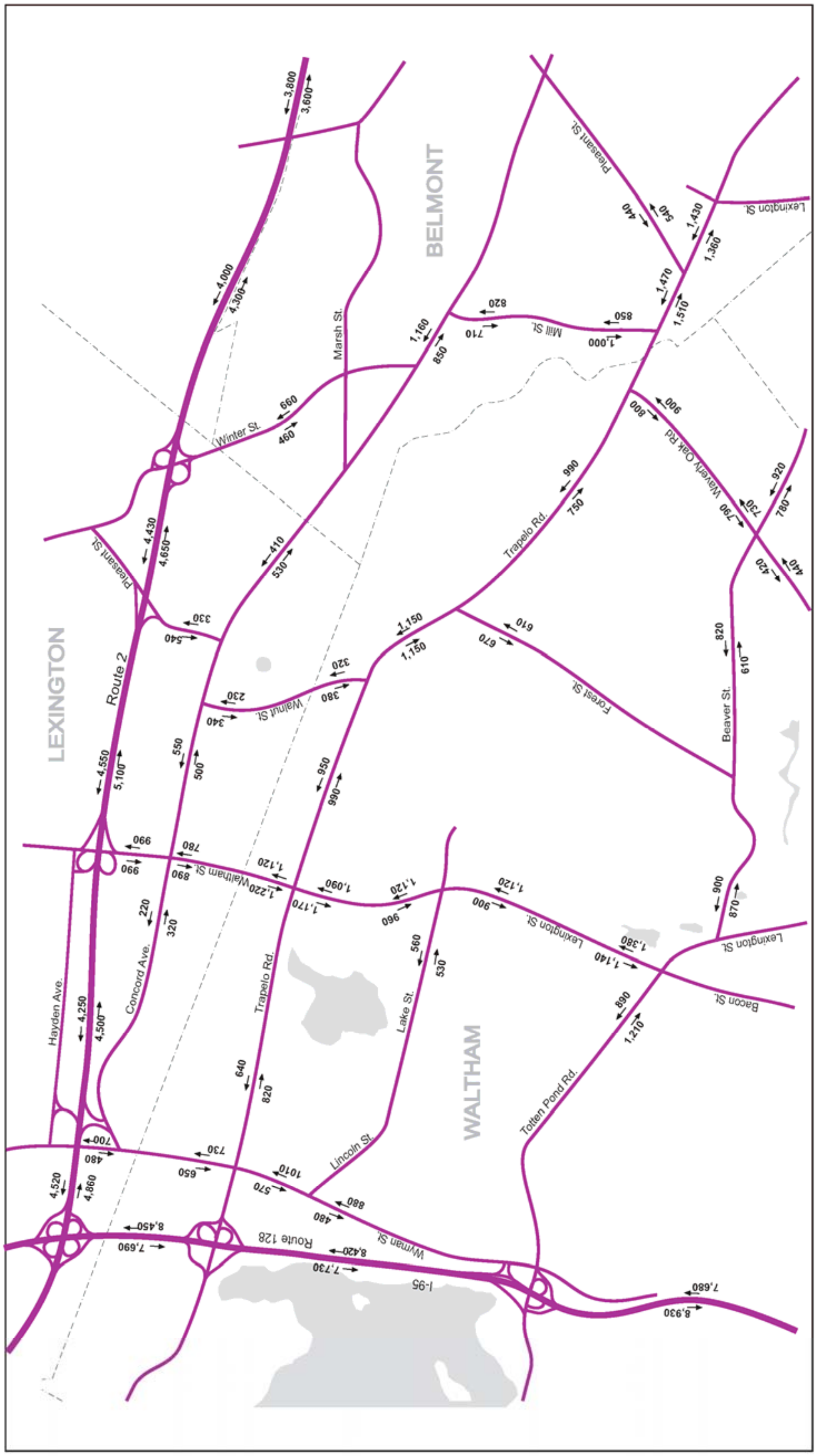
Major Traffic Corridor	Base Year 2005 Traffic Volume Range (Both Directions Total)	Traffic Growth Range 2030 Build-Out
Trapelo Road	1,300 - 2,800	8% - 23%
Waltham St./Lexington St.	1,500 - 2,150	7% - 20%
Concord Avenue	700 - 1,750	17% - 48%
Mill Street	1,350 - 1,650	15% - 16%
Waverly Oaks Road	750 - 1,450	16% - 22%
Smith Street	1,200 - 1,250	15% - 30%

Figures 10 and 11 show the Projected Peak Hour Traffic Volumes – 2030 Build-Out Scenario for the AM and PM peak hours respectively.



Belmont, Lexington, Waltham Subarea Study

Figure 10
AM Peak Hour Projected Traffic Volumes - 2030 Build Out Scenario



Belmont, Lexington, Waltham Subarea Study

Figure 11
PM Peak Hour Projected Traffic Volumes - 2030 Build Out Scenario

3.1.3.2 Intersection Capacity Analysis

Future traffic conditions at major intersections were analyzed for the 2030 Future Build-Out Scenario using the criteria described earlier. Tables 18 and 19 summarize the AM and PM peak hour capacity analysis for the signalized intersections under existing conditions (2005) and the 2030 Build-Out Scenario. For the Build-Out Scenario, the intersection layout is assumed to remain the same as in the existing conditions for all the intersections but the signal timing was adjusted according to the projected volumes of all approaches at the intersection. Tables 20 and 21 present the same type of information for the unsignalized intersections.

The signalized intersections in the study area are forecast to operate at LOS D, E or F for the 2030 build-out in the AM and PM. The LOS for the intersection approaches is generally consistent with the overall LOS for each signalized intersection with the exception of the westbound through movement at Trapelo Road and Mill Street (LOS A and LOS B in AM and PM respectively) and the eastbound right movement at Concord Ave and Walnut Street (LOS A in the AM and PM).

Almost all of the unsignalized intersections in the study area are forecast to operate at LOS F for the 2030 build-out in the AM and PM. However, there are turning movements (left and right) that comprise each of the unsignalized intersections which are forecast to perform at LOS A or B.

TABLE 18

Summary of AM Peak Hour Capacity Analysis for Signalized Intersections

Intersection Number and Location		City/ Town	2005 Existing Conditions			2030 Build-Out		
			Total Entry Volume	Overall LOS	Avg. Delay (Sec.)	Total Entry Volume	Overall LOS	Avg. Delay (Sec.)
S-1	Trapelo Rd at Smith St	Waltham	3,050	F	130	3,585	F	> 180
S-2	Trapelo Rd at Lexington St	Waltham	3,650	D	52	4,220	E	64
S-6	Trapelo Rd at Waverly Oaks Rd	Waltham	1,950	C	32	2,520	F	110
S-7	Trapelo Rd at Mill St	Belmont	3,100	D	38	3,665	F	95
S-8	Trapelo Rd at Lexington St	Belmont	2,750	C	25	3,323	D	50
S-3	Waltham St at Concord Ave	Lexington	2,350	D	54	2,910	F	132
S-4	Lexington St at Lake St	Waltham	2,050	C	25	2,695	D	45
S-5	Lexington St. at Totten Pond Rd	Waltham	3,450	E	74	4,085	F	94
S-9	Waverly Oaks Rd at Beaver St	Waltham	2,300	C	34	2,795	D	52

TABLE 19

Summary of PM Peak Hour Capacity Analysis for Signalized Intersections

Intersection Number and Location		City/ Town	2005 Existing Conditions Total Entry Volume	2005 Existing Conditions Overall LOS	2005 Existing Conditions Avg. Delay (Sec.)	2030 Build-Out Total Entry Volume	2030 Build-Out Overall LOS	2030 Build-Out Avg. Delay (Sec.)
S-1	Trapelo Rd at Smith St	Waltham	3,050	F	130	3,585	F	> 180
S-2	Trapelo Rd at Lexington St	Waltham	3,650	D	52	4,220	E	64
S-6	Trapelo Rd at Waverly Oaks Rd	Waltham	1,950	C	32	2,520	F	110
S-7	Trapelo Rd at Mill St	Belmont	3,100	D	38	3,665	F	95
S-8	Trapelo Rd at Lexington St	Belmont	2,750	C	25	3,323	D	50
S-3	Waltham St at Concord Ave	Lexington	2,350	D	54	2,910	F	132
S-4	Lexington St at Lake St	Waltham	2,050	C	25	2,695	D	45
S-5	Lexington St at Totten Pond Rd	Waltham	3,450	E	74	4,085	F	94
S-9	Waverly Oaks Rd at Beaver St	Waltham	2,300	C	34	2,795	D	52

TABLE 20

Summary of AM Peak Hour Capacity Analysis for Unsignalized Intersections

Intersection Number and Location		City/ Town	2005 Existing Conditions Total Entry Volume	Overall LOS	Avg. Delay (Sec.)	2030 Build-Out Total Entry Volume	Overall LOS	Avg. Delay (Sec.)
U-6	Trapelo Rd at Woburn St	Waltham	1,785	F	70	2,280	F	> 180
U-7	Trapelo Rd at Forest St	Waltham	1,845	E	38	2,250	F	> 180
U-8	Trapelo Rd at Pleasant St	Belmont	2,885	F	150	3,335	F	> 180
U-1	Concord Ave at Walnut St	Lexington	920	B	14	1,410	F	150
U-2	Concord Ave at Pleasant St	Lexington	1,120	F	53	1,515	F	> 180
U-3	Concord Ave at Winter St	Belmont	1,935	F	118	2,250	F	> 180
U-4	Concord Ave at Mill St	Belmont	1,980	F	75	2,325	F	> 180
U-5	Winter St at Marsh St	Belmont	1,155	C/D	17/30	1,350	D/E	33/37

TABLE 21

Summary of PM Peak Hour Capacity Analysis for Unsignalized Intersections

Intersection Number and Location		City/ Town	2005 Existing Conditions Total Entry Volume	Overall LOS	Avg. Delay (Sec.)	2030 Build-Out Total Entry Volume	Overall LOS	Avg. Delay (Sec.)
U-6	Trapelo Rd at Woburn St	Waltham	1,985	F	56	2,445	F	> 180
U-7	Trapelo Rd at Forest St	Waltham	2,110	F	> 180	2,445	F	> 180
U-8	Trapelo Rd at Pleasant St	Belmont	3,005	F	> 180	3,435	F	> 180
U-1	Concord Ave at Walnut St	Lexington	900	B	13	1,050	F	78
U-2	Concord Ave at Pleasant St	Lexington	1,075	C	25	1,420	F	70
U-3	Concord Ave at Winter St	Belmont	1,750	D	30	2,050	F	116
U-4	Concord Ave at Mill St	Belmont	1,790	F	66	2,105	F	> 180
U-5	Winter St. at Marsh St	Belmont	1,160	C/C	16/20	1,355	D/E	26/45

3.2 Alternative Growth Scenarios

This section discusses scenarios created by the Advisory Committee and the study team as alternatives to the Future Build-Out Scenario. These scenarios explore alternatives for design, transit accessibility, and development location. The effectiveness of these alternatives for mitigating transportation demand was then evaluated using the regional transportation model and other analysis tools. Development of the Alternative Growth Scenario was an iterative process designed to develop tools and recommendations to help the three communities respond to growth demands and their related transportation impacts.

3.2.1 Advisory Committee Preferred Scenario

After reviewing the outcomes of the Future Build-Out Scenario, the Advisory Committee formed subcommittees made up of Committee members from each community. These subcommittees met individually to discuss the implications of the build-out analysis for each respective community. The resulting conversations led to some very productive outcomes.

- The subcommittees provided commentary on the build-out analysis and identified alternative outcomes (discussed below);
- An Advisory Committee Preferred Scenario was developed that the Advisory Committee as a whole agreed upon; and
- Each subcommittee expressed specific transportation or land use interests or goals they asked the other communities to support (refer to Inter-Community Coordination recommendations in Section 4.5).

After the subcommittee meetings the Advisory Committee met as a whole to discuss and agree upon an Advisory Committee Preferred Scenario that was both realistic and incorporated their vision for the study area in 2030.[17] At this meeting the subcommittees from each community described the ways in which they would like to see the Alternative Growth Scenario for the part of their community inside the study area differ from the Future Build-Out Scenario. These changes are summarized below in terms of the modifications recommended by the committee and the way these modifications are captured in a scenario that can be evaluated using the transportation model.

Housing Change in the Advisory Committee Preferred Scenario

<u>Lexington</u>

- Lot 1 (Former Middlesex Hospital) – Potential development identified through the build- out analysis on Lot 1 of the former Middlesex Hospital site will be redirected through the use of a transfer of development rights to parcels along Waltham Street and Piper Road.[18]
  Impact on scenario: 48 housing units are transferred from TAZ 940-2 to TAZ 940-1. Population for TAZ 940-2 decreases by 113 and TAZ 940-1 increases by 113.

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[17] See March 22, 2007, Advisory Committee meeting minutes for full description.

[18] Discussed further in Section 4.0 Findings.

- Lots 5 and 6 (Former Middlesex Hospital) – The Lexington Planning Board has permitted 19 units on Lots 5 and 6 of the former Middlesex Hospital site instead of the originally estimated 18 units.
  Impact on scenario: 1 unit of housing is added to TAZ 940-2. Population for TAZ 940-2 increases by 2.

Waltham

- Fernald Development Center – No housing development will take place on the Fernald Development Center site.
  Impact on scenario: 1,219 units of housing are eliminated from TAZ 962. Population on TAZ 962 decreases by 2,633.
- Stigmatine Fathers and Lincoln Street Woods properties - No development will take place on the two parcels.
  Impact on scenario: 152 units of housing are eliminated from TAZ 966. Population on TAZ 966 decreases by 328.

Belmont

- McLean Hospital Senior Housing – Final town permitting for senior housing on McLean Hospital included 292 units, reduced from the original proposal of 480 units.
  Impact on scenario: 188 units of senior housing are eliminated from TAZ 920-1. Population on TAZ 920-1 decreases by 188.

Employment Change in the Advisory Committee Preferred Scenario

The Advisory Committee felt that the employment projections developed through the build-out process reflected current trends. No changes were recommended or made to the projected employment for 2030 as part of the Advisory Committee Preferred Scenario. Table 22 is a summary comparison of the Advisory Committee Preferred Scenario to the Build-Out Scenario by community and summarized for the study area.

TABLE 22
Summary Comparison of the Advisory Committee Preferred Scenario to Build-Out Scenario

	Build-Out		AC Preferred Scenario		Difference	
	Population	Employment	Population	Employment	Population	Employment
Belmont	8,266	7,394	8,078	7,394	-188 (-2.3%)	0
Lexington	3,664	2,912	3,666	2,912	+2	0
Waltham	29,493	25,337	26,531	25,337	-2,962 (-11.2%)	0
Study Area Total	**41,423**	**35,643**	**38,275**	**35,643**	**-3,148 (-8.2%)**	**0**

3.2.2 Smart Growth Scenario

The study team employed elements identified through a literature review to develop a Smart Growth Scenario. The collected research supported the fact that, generally, people living in neighborhoods where there is safe and convenient walking, biking, and/or transit access to goods, services, and jobs tends to promote less driving compared to people living in more car-dependent neighborhoods. Density in a sustainable scale is required to generate and sustain transit. Neighborhoods that provide a mix of uses (and therefore destinations) as well as good pedestrian connectivity also contribute to successful transit. Key elements from the literature review that reduce private automobile trips include:

Mix of Uses

Integrating amenities such as restaurants, services, and convenience retail within walking distance of housing and/or jobs means that residents or employees have the option of doing some of their errands on foot. Nationwide, roughly 40 percent of social, recreational, and shopping trips under a half mile are made on foot or by bike.[19]

Density and Scale

For mixed use developments to succeed there must be a sufficient customer base to support the commercial functions (not to mention walk destinations). For example, accommodating 6,500 people within a half mile of a small commercial center would require a gross density of roughly 13 people per acre or 5 to 6 housing units per acre over that area.[20]

Another benefit of developing at higher densities (for all types of development) is that it tends to make transit service more feasible, because more potential riders can be served with each stop. As density increases, it becomes viable to provide transit service more frequently. The better the transit service, the more likely it is that people will choose transit over driving.

Traditional Neighborhood Design

Traditional Neighborhood Design (TND) (also called Neo-Traditional Developments or "New Urbanism") is a development style that reflects the smaller more compact communities of the late 19th and early 20th century. Characteristics often include a mix of uses, gridded street patterns, active open space, and good pedestrian access. A study comparing similarly located communities, one TND to a conventional subdivision found that residents in the TND made more walk trips and 20 percent fewer car trips per household than the conventional subdivision residents.[21] TND residents made 78.4 percent of all their trips by car and 17.2 percent on foot, compared with 89.9 percent by car and 7.3 percent on foot in the conventional subdivisions. Trips by residents of the TND were also more likely to remain within the neighborhood – 20.2 percent of TND resident trips were internal to the development, compared with just 5.5 percent of trips by conventional subdivision resident.

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19 Reid Ewing, *Transportation & Land Use Innovations: When you can't pave your way out of congestion*, Chicago: Planners Press, 1997, p. 61.

20 Assuming an average household size of 2.3 persons per household.

21 Residents of the TND also made 8.6% fewer total trips per household.

Bicycle and Pedestrian Networks
A more connected street network provides shorter, more direct routes, and off-road paths. Sidewalks and/or bike lanes can make it safer and more pleasant to take short trips without a car.

Developing the Smart Growth Scenario
Using the elements discussed in Section 3.2, Alternative Development Scenarios, the study team developed a Smart Growth Scenario. This scenario attempted to develop a land use solution to the increasing traffic problem along Trapelo Road and its vicinity. For comparative purposes, the study team used the projections generated for the Advisory Committee Preferred Scenario as a starting point. The team then employed a Transfer of Development Rights system (see Section 4.0 Findings for more detail) to redistribute development in a manner that reduces private vehicle trips. In an effort to maintain the realism of the exercise no developments were moved across communities. They were only transferred within the community of origin. It would take a multi-community agreement to transfer development across municipal borders.

Belmont
By clustering retail and commercial development in Waverly Square and Belmont Center; working towards dense mixed use air rights development over Waverly Station; and improving walkability along Trapelo Road and Pleasant Street Belmont is already taking meaningful steps to employ these elements and improve multi-modal opportunities. These changes are all reflected in the build-out scenario. The rest of the Belmont study area is comprised of small residential lots that are unlikely to be redeveloped or have transfer of development rights.

Lexington
The Lexington portion of the study area is small and primarily developed with single family homes on small lots. There is also minimal projected new development within Lexington (113 new housing units), therefore, the community does not provide an opportunity for growth redistribution.

Waltham
Waltham represents the largest area with the majority of new development in the study. It also includes a number of larger undeveloped or underdeveloped areas that are projected to have multiple new units of housing (335 total units). These larger parcels are spread throughout the area and could potentially further congest roadways while being difficult to be efficiently served by transit. Among these parcels are sites that have been identified by the community as important for preservation, recreational, and cultural uses. They include the University of Massachusetts Extension Waltham Center, land surrounding Hardy Pond, portions of the Western Greenway, and sports fields adjacent to the former Middlesex Hospital. These dispersed units could be transferred to the Fernald Development Center property and be developed as a clustered neo-traditional neighborhood design that preserves the existing uses of Fernald while providing a better foundation for transit along the Trapelo Corridor.

The Fernald site is in close proximity to the existing transit hub of Waverly Station and is located on a corridor underserved by transit. The Fernald site is in a prime location to increase density to develop a viable transit extension. The site is large enough to create a walkable mixed-use community integrated into the existing developments along Trapelo Road. Development could be clustered along the Trapelo Road, and would allow for existing uses to continue, as well as the plans to formally improve the portion of the Western Greenway that cuts across the parcel. A transit supportive density of 7 to 9 units per acre would only require the use of 50 to 40 acres of Fernald's 200 acre site.

There is an overall modest reduction in traffic in the study area when the Alternative Growth Scenarios are compared with the Future Build-Out Scenario. Larger reductions occur around the Fernald Development Center site due to less dense development proposals included in the Alternative Growth Scenarios. Slight volume increases at some locations are partly attributable to route changes due to less congestion. The same patterns appear in the Smart Growth Scenario with smaller decreases in traffic attributable to the increase in development on the Fernald site.

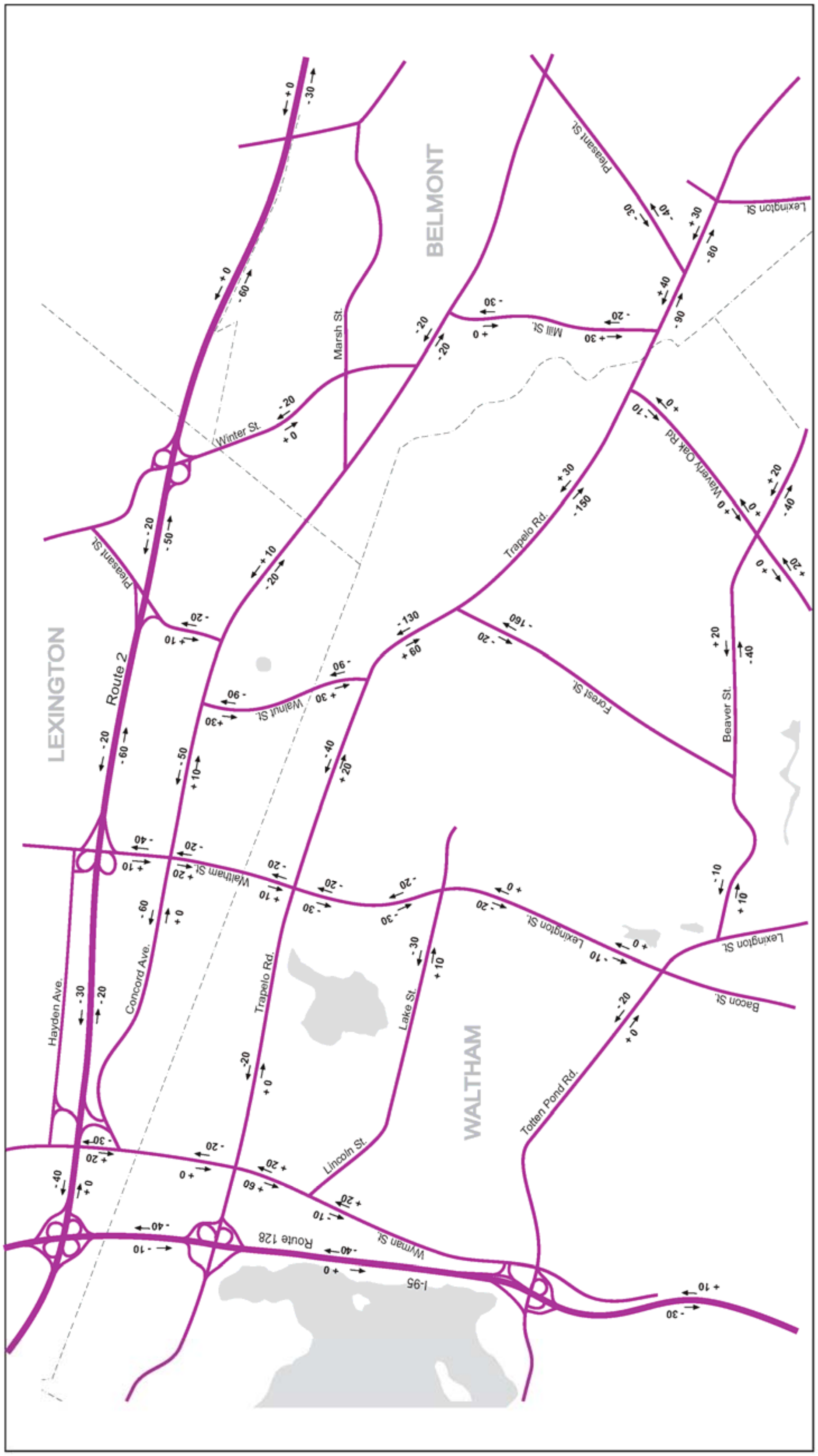
3.3.3 Alternative Growth Scenarios

Figure 12, AM Peak Hour Projected 2030 Traffic Volume Differences – Comparison of Advisory Committee Preferred Scenario with Build-Out Scenario, shows the projected AM peak hour traffic changes between the Future Build-Out and the Advisory Committee Preferred Scenario. Figure 13, AM Peak Hour Projected 2030 Traffic Volume Differences – Comparison of Smart Growth Scenario with Future Build-Out Scenario, shows the projected AM peak hour traffic growth between the Future Build-Out and the Smart Growth Scenarios. Figures 14 and 15 depict the PM traffic growth for the corresponding scenarios.

There is an overall modest reduction in traffic in the study area when the Alternative Growth Scenarios are compared with the Future Build-Out Scenario. Larger reductions occur around the Fernald Development Center site due to less dense development proposals. During the AM peak hour in the Advisory Committee Preferred Scenario, the greatest traffic reductions occur in the peak direction (northbound) on Forest Street (28 percent), eastbound on Trapelo Road between Forest Street and Waverly Oaks Road (18 percent), and northbound on Woburn/Walnut Street (20 percent). The changes on Woburn/Walnut Street are most likely attributable to fewer trips generated in the Fernald traffic analysis zone. Slight volume increases at some locations are partly attributable to route changes due to less congestion. The same patterns appear in the Smart Growth Scenario with smaller decreases in traffic. PM peak hour changes are similar to AM patterns for both alternative scenarios.

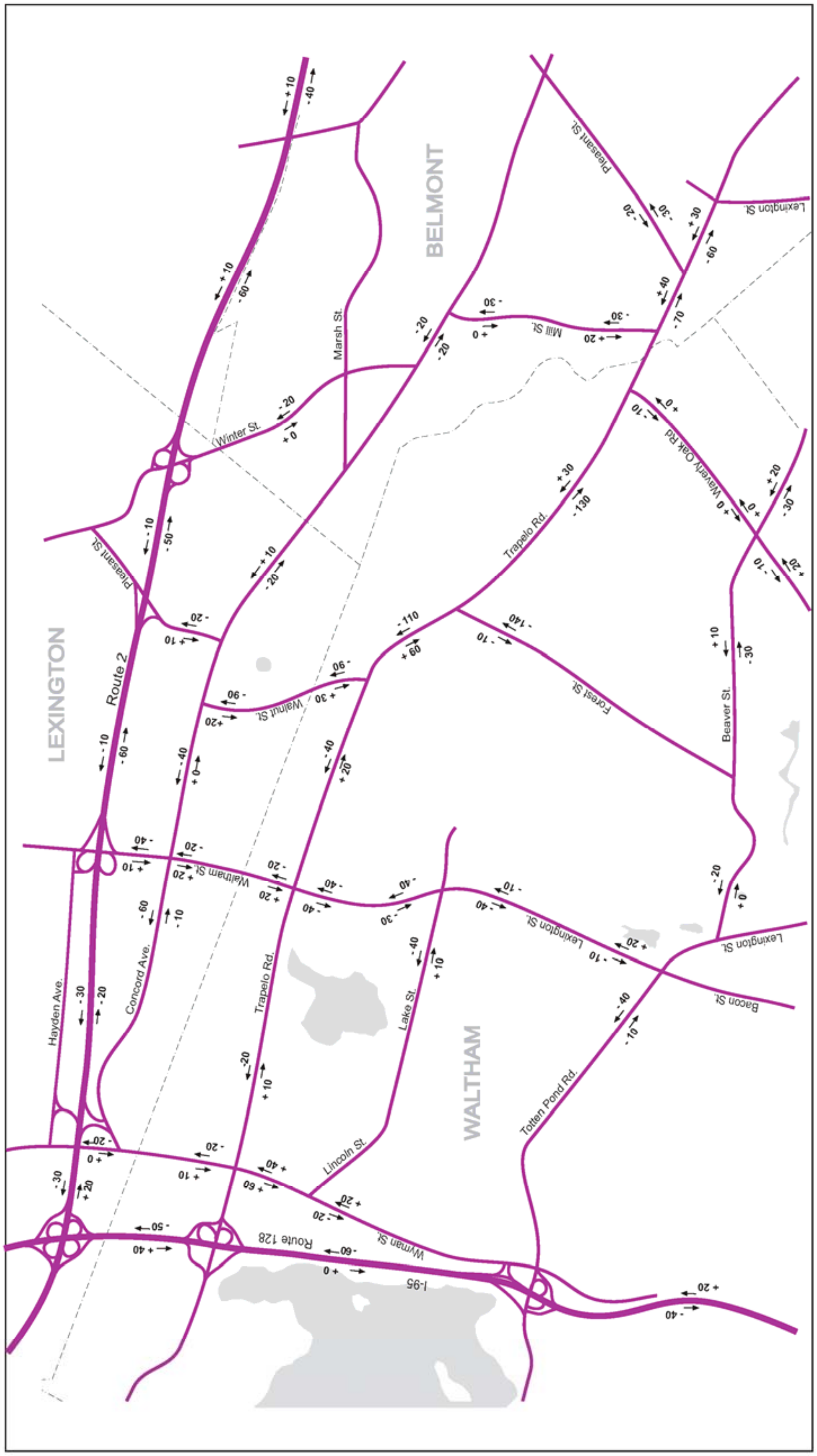
Table 23, 2030 AM Peak Hour Traffic Changes at Select Locations: Future Build-Out vs. Alternative Growth Scenarios, summarizes AM peak hour traffic volume changes for select roadways for the Advisory Committee Preferred and the Smart Growth Scenarios. Table 24, 2030 PM Peak Hour Traffic Changes at Select Locations: Future Build-Out vs. Alternative Growth Scenarios, summarizes the changes in the PM peak hour. Table 25, Alternative Future Scenarios to 2030 - Level of Service Changes, compares growth strategies level of service changes for intersections most impacted for all 2030 Scenarios (Future Build-Out, Advisory Committee Preferred and Smart Growth). These intersections are:

- Trapelo Road at Waverly Oaks Road, Waltham
- Concord Avenue at Walnut Street, Lexington
- Trapelo Road at Woburn Street, Waltham
- Trapelo Road at Forest Street, Waltham.



Belmont, Lexington, Waltham Subarea Study

Figure 12
AM Peak Hour Projected 2030 Traffic Volume Differences
Comparison of Advisory Committee Scenario with Buildout Scenario



Belmont, Lexington, Waltham Subarea Study

Figure 13
AM Peak Hour Projected 2030 Traffic Volume Differences
Comparison of SmartGrowth Scenario with Buildout Scenario

MPO

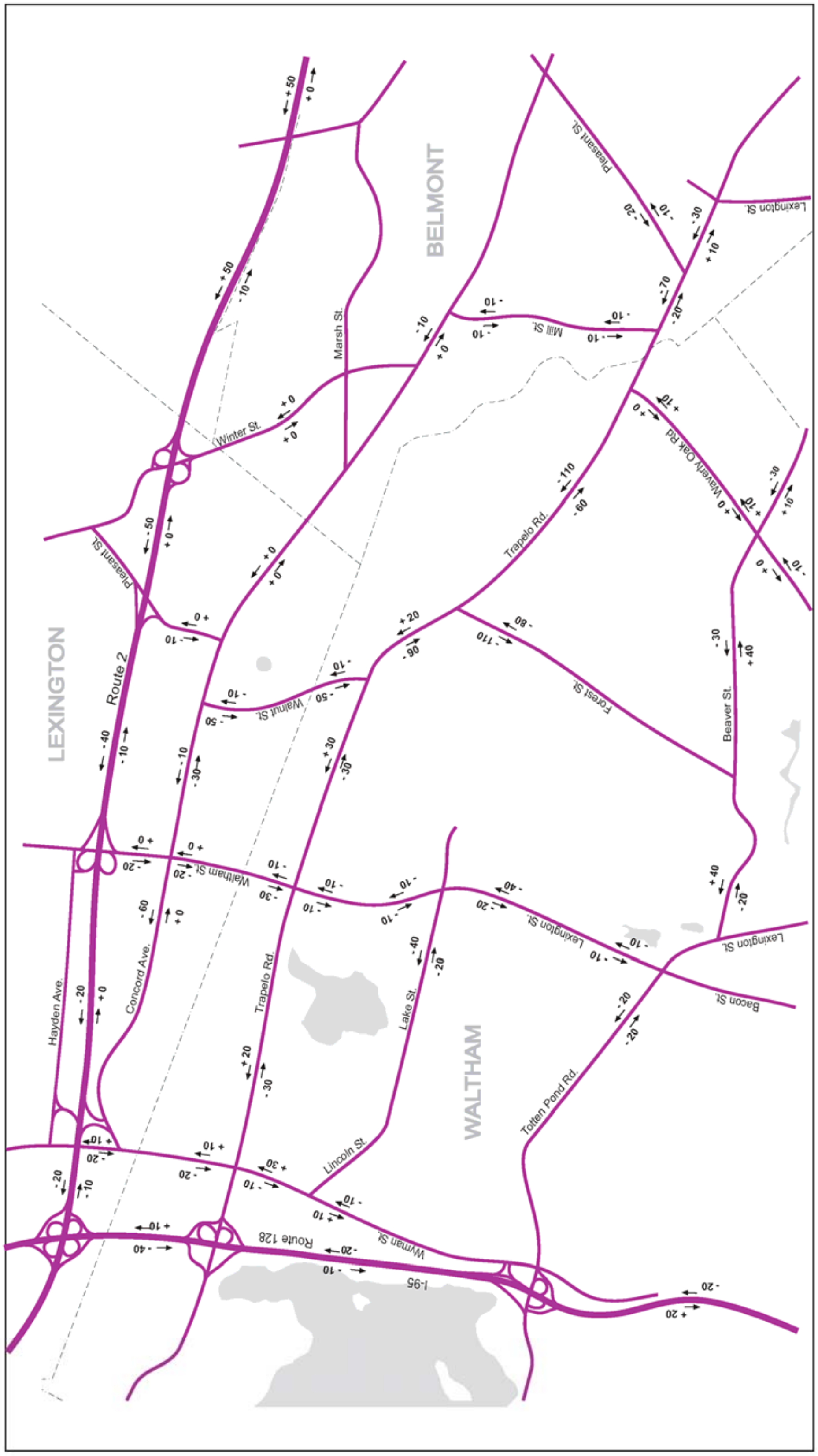


Figure 14
PM Peak Hour Projected 2030 Traffic Volume Differences
Comparison of Advisory Committee Scenario with Buildout Scenario

Belmont, Lexington, Waltham Subarea Study

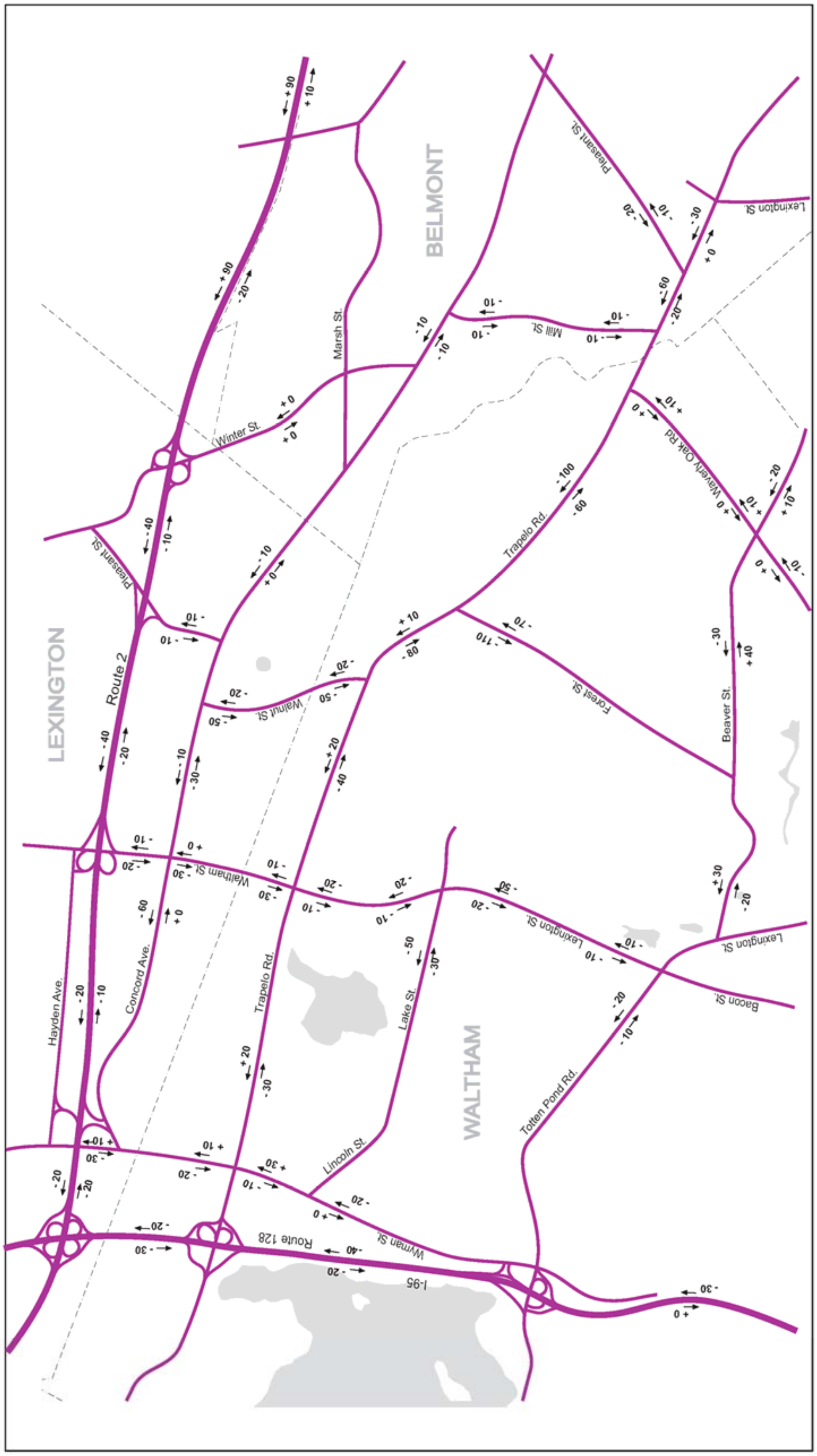


Figure 15
PM Peak Hour Projected 2030 Traffic Volume Differences
Comparison of SmartGrowth Scenario with Buildout Scenario

Belmont, Lexington, Waltham Subarea Study

TABLE 23
2030 AM Peak Hour Traffic Changes at Select Locations:
Build-Out vs. Alternative Growth Scenarios

Major Traffic Corridor	Build-Out Volume	Traffic Volume Changes: Advisory Committee Scenario	Traffic Volume Changes: Smart Growth Scenario
Trapelo Road EB East of Forest Street	850	-150	-130
Trapelo Road WB West of Forest Street	1,070	-130	-110
Trapelo Road WB East of Forest Street	600	+30	+30
Trapelo Road EB East of Mill Street	1,700	-90	-70
Forest Street NB South of Trapelo Road	570	-160	-140
Walnut Street NB South of Concord Road	450	-90	-90

TABLE 24
2030 PM Peak Hour Traffic Changes at Select Locations:
Build-Out vs. Alternative Growth Scenarios

Major Traffic Corridor	Build-Out Volume	Traffic Volume Changes: Advisory Committee Scenario	Traffic Volume Changes: Smart Growth Scenario
Trapelo Road WB East of Forest Street	990	-110	-100
Trapelo Road EB West of Forest Street	1,150	-90	-80
Trapelo Road EB East of Forest Street	750	-60	-60
Trapelo Road WB East of Mill Street	1,470	-70	-60
Forest Street SB South of Trapelo Road	670	-110	-110
Walnut Street SB South of Concord Road	340	-50	-50

TABLE 25
Alternative Future Scenarios to 2030 - Level of Service Changes

S-6 Trapelo Road at Waverly Oaks Road, Waltham

	AM Peak Hour			PM Peak Hour		
2030 Growth Scenarios	**Total Entry Volume**	**Overall LOS**	**Average Delay (sec.)**	**Total Entry Volume**	**Overall LOS**	**Average Delay (sec.)**
Build-Out	2,520	F	110	2,930	E	69
Smart Growth	2,395	E	70	2,783	E	61
Advisory Committee	2,378	E	65	2,756	E	59

U-1 Concord Avenue at Walnut Street, Lexington City/Town

	AM Peak Hour			PM Peak Hour		
2030 Growth Scenarios	**Total Entry Volume**	**Minor Street LOS**	**Minor Street Delay (sec.)**	**Total Entry Volume**	**Minor Street LOS**	**Minor Street Delay (sec.)**
Build-Out	1,410	F	150	1,370	F	78
Smart Growth	1,315	F	82	1,274	E	46
Advisory Committee	1,319	F	82	1,279	E	48

U-6 Trapelo Road at Woburn Street, Waltham

	AM Peak Hour			PM Peak Hour		
2030 Growth Scenarios	**Total Entry Volume**	**Minor Street LOS**	**Minor Street Delay (sec.)**	**Total Entry Volume**	**Minor Street LOS**	**Minor Street Delay (sec.)**
Build-Out	2,280	F	>180	2,445	F	>180
Smart Growth	2,218	F	>180	2,374	F	>180
Advisory Committee	2,202	F	>180	2,379	F	>180

U-7 Trapelo Road at Forrest Street, Waltham

	AM Peak Hour			PM Peak Hour		
2030 Growth Scenarios	**Total Entry Volume**	**Minor Street LOS**	**Minor Street Delay (sec.)**	**Total Entry Volume**	**Minor Street LOS**	**Minor Street Delay (sec.)**
Build-Out	2,250	F	>180	2,445	F	>180
Smart Growth	2,209	F	>180	2,385	F	>180
Advisory Committee	2,196	F	>180	2,396	F	>180

4.0 FINDINGS AND RECOMMENDATIONS

Conditions are forecast to continue deteriorating according to the build-out analysis. Depending on intersection location and volume, proximity to prospective developments, and existing geometry, some locations are impacted more than others. This section discusses proposed transportation improvements (e.g. signal timing, geometric changes and pavement markings) and enhancement to bus service as well as pedestrian and bicycle access for 2010 conditions. The level of service results reflect the impacts of traffic growth but do not reflect mitigation strategies, other than minor traffic signal timing adjustments at signalized intersections. The transportation and land use recommendations were arrived at based upon results of the 2030 Future Build-Out Scenario and the Alternative Growth Scenarios (Advisory Committee Preferred and Smart Growth Scenarios). Appendix C, Traffic Forecasts and Traffic Analysis Results, contains a detailed description of the build-out analysis.

4.1 Transportation

4.1.1 Roadway Improvements

This section describes traffic impacts and potential mitigation by major corridor and by intersection. For ease of analysis, the intersections are arranged in four categories according to where the intersection is located: Trapelo Road Corridor, Waltham/Lexington Streets Corridor, Concord Avenue Corridor, and Other Intersections.

<u>Trapelo Road Corridor</u>

S1 – Trapelo Road at Smith Street

The LOS at this intersection is undesirable under existing conditions and is expected to worsen in the future. However, the city of Waltham has approved funding to reconstruct and upgrade the intersection.

S2 – Trapelo Road at Lexington Street

Future traffic growth will affect this intersection marginally. With traffic signal timing adjustments to somewhat increase intersection capacity, the future level of service is not expected to deteriorate seriously from the present level.

U6 – Trapelo Road at Woburn Street

Woburn Street, the minor approach at this unsignalized intersection, was found to have undesirable LOS under existing conditions and in the future scenarios. Potential improvements include:

- Installation of a traffic signal, including pedestrian phases.
- Geometric changes, pavement markings, and crosswalks.

U7 – Trapelo Road at Forest Street

The LOS of the minor street (Forest Street) approach was found undesirable under existing conditions and in the future scenarios. To improve traffic conditions, the following actions may be considered:

- According to the 2007-2010 Transportation Improvement Program files of the Boston MPO region, the City of Waltham needs to initiate the project development process.
- This intersection may warrant the installation of a traffic signal.
- Intersection improvements should include traffic use of Doty Street.
- Geometric changes should be considered, including a westbound left turn storage lane on Trapelo Road.

S6, S7, U8, and S8 – Trapelo Road at Waverly Oaks Road, Mill Street, Pleasant Street, and Lexington Street

These three signalized and one unsignalized intersections are located close to each other and must be examined as a single system. Future traffic operations are expected to deteriorate at all of the intersections by various degrees.

- At this time, the most recent mitigation plan for these four locations appears to be adequate, given the limited space for right-of-way expansion along Trapelo Road.
- Extending the bicycle lane that is included in this plan westward to Lexington Street would be desirable.

<u>Waltham/Lexington Streets Corridor</u>

S3 – Waltham Street at Concord Avenue

The operation of this signalized intersection is expected to deteriorate gradually in the future, especially during the morning peak hour. Most of the deterioration is attributed to the high southbound left turns and the narrow east-west Concord Avenue approaches. To mitigate traffic growth in the future, the following may be considered:

- Introduce a left-turning storage lane on the Concord Avenue westbound approach.
- Make adjustments to the traffic signal phase design and timing.
- Examine traffic signal phase design and stripe the Waltham Street northbound and southbound approaches accordingly.

S4 – Lexington Street at Lake Street

The LOS at this intersection will maintain acceptable LOS in the future; only minor traffic signal timing adjustments will be required.

S5 – Lexington Street at Totten Pond Road/Bacon Street

The operation of this heavily traveled, multiphased signalized intersection is already deficient under existing conditions and is expected to deteriorate somewhat in the future.

- For the immediate future, overhead traffic lane assignment signs are needed for the southbound approach to help direct drivers to the correct lanes.

- In the near future, the City of Waltham should initiate project development procedures according to the universe of projects files of the 2007-2010 Transportation Improvement Program of the Boston MPO Region.

Concord Avenue Corridor

U1 and U2 – Concord Avenue at Walnut Street and at Pleasant Street
The proximity and function of these two unsignalized intersections dictates that they be examined in tandem. Traffic from Walnut Street and Pleasant Street cannot easily find gaps to enter Concord Avenue, especially during the future AM peak hour.

- The Pleasant Street intersection likely warrants traffic signal control.
- This treatment would benefit Walnut Street traffic as sufficient gaps will be created for it to enter Concord Avenue.
- Both intersections will benefit from geometric improvements, including pavement markings and pedestrian crossings.

U3 and U4 – Concord Avenue at Winter Street and at Mill Street
The proximity and traffic pattern through these two unsignalized intersections require that they be treated as a system. The following should be considered for improved operations and safety:

- Traffic signal installation and coordination.
- Geometric changes and pavement markings.
- Pedestrian sidewalk and crosswalks.

Other Intersections

U5 – Winter Street at Marsh Street
A minor deterioration is expected at this unsignalized intersection. No improvements are recommended at this time.

S9 – Waverly Oaks Road at Beaver Street
Capacity analysis indicates that this intersection has sufficient capacity to handle traffic growth in the future. No improvements are recommended at this time.

4.1.2 Cost Estimates for Transportation Improvements

The cost estimates for the suggested improvements are shown in Table 26, Cost Estimates for Suggested Improvements, and described below. This table also prioritizes the improvements. The cost estimates are intended to provide a general idea of the costs to implement the transportation improvements described in this section. The cost estimates used in this analysis are based upon 2005 dollars.

<u>Overhead and Post-Mounted Signs</u>
The cost of an overhead sign has two components: the sign panel and the support (overhead truss) on which the sign panel is attached. Sign panels cost approximately $20 per square foot, while the support is approximately $600 per linear foot including labor and installation. Based on these estimates the installation of an overhead sign with two 10-foot by 6-foot panels spanning 60 feet will cost about $40,000. Post-mounted signs installed at the side of the roadway typically cost between $200 and $300. Signage improvements are expected to cost about $50,000.

<u>Pavement Markings</u>
Pavement marking involves removing old paint and restriping with new paint. In some cases where the existing pavement has cracks, the pavement is resurfaced before new pavement markings are applied. Typically it costs more to remove old pavement markings than to apply new pavement markings. The estimate for new pavement markings is about $1 per linear foot.

<u>Signal Timing Plans</u>
New signal timing plans for a coordinated signal system cost approximately $50,000. This cost would need to be updated if new signal controllers are purchased.

<u>Turning Movement Signalization</u>
This improvement requires a new signal installation and reconfiguring reconfiguration of the existing intersection to provide for turning lanes. The cost of this improvement which includes installing new signal post and signal head and intersection geometric improvements is expected to be in the range of $75,000.

TABLE 26
Cost Estimates for Suggested Improvements

Priority	Improvement	Estimated Cost
1	Improve signing at Lexington Street at Totten Pond Road/Bacon Street to reduce motorist confusion including overhead lane assignments sign at the southbound approach.	$50,000
2	Improve pavement markings to reduce motorist confusion.	$1/linear foot*
3	Coordinate traffic signals.	$50,000**
4	Turning movement signalization.	$75,000 per intersection

*New pavement markings only. **Includes item 2

4.1.3 Trapelo Road Bus Service

Base service for MBTA Routes 553[22] and 554 combined requires four vehicles, two on each route, to maintain a 60-minute frequency for the separate routes and a 30-minute frequency for the combined segment. Several possible modifications to Route 554 could be initiated to serve all or part of the Trapelo Road corridor:

- Extend all Route 554 service to Trapelo Road and Lexington Street.
- Lengthen headways to accommodate longer running times.
- Operate Route 554 via Forest Street and Trapelo Road in place of Beaver Street Belmont Street, and Lexington Street.
- Operate all Route 554 AM outbound service and PM inbound service via Forest Street and Trapelo Road.
- Reroute morning peak outbound and afternoon peak inbound Route 554 buses via Forest Street, Trapelo Road, Waverly Oaks Road, Beaver Street, Belmont Street, and Lexington Street between Beaver Street at Forest Street and Waverly Square.

Rerouting morning peak outbound and afternoon peak inbound Route 554 buses via Forest Street, Trapelo Road, Waverly Oaks Road, Beaver Street, Belmont Street, and Lexington Street between Beaver Street at Forest Street and Waverly Square provides the least amount of service to Trapelo Road. However, this is the most cost effective method to expand service and would have the least negative impact to existing Route 554 riders. If ridership on the Trapelo Road segment proved to be reasonable, consideration could then be given to rerouting service at additional times via Trapelo Road. Appendix E, Bus Analysis on Trapelo Road, contains the detailed analysis.

As recommended in the 2008 MBTA Service Plan, Route 554 has been recently modified to add three trips in the morning peak and three trips in the evening peak to travel via Forest Street, Trapelo Road, and Waverly Oaks Road in Waltham. MBTA routes are changed, added, or dropped during the service planning period which occurs every two years. The MBTA is currently in the planning process and the next plan will be adopted by the end of 2010.

4.1.4 Pedestrian and Bicycle Access

Future design of the Trapelo Road Corridor needs to integrate all modes of transportation; private vehicle, public transit, walking and bicycle. Enhanced pedestrian and bicycle access is critical to improving the Trapelo Road Corridor. A more connected street network will improve accessibility by providing shorter and more direct routes as well as links to adjacent roadways.

The 2006 Massachusetts Highway's Project Development and Design Guidebook should be utilized as design changes are made along Trapelo Road. The Design Guidebook takes a multimodal and accommodating approach for the construction and design of roadways and encourages and supports safe travel for pedestrians, bicyclists and other modes of travel.

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[22] MBTA Route 553 does not traverse Trapelo Road. MBTA Routes 553 and 554 eventually merge.

A network of bicycle lanes (on and off-road) and pedestrian paths should be provided to accommodate demand along this corridor. Specific pedestrian and bicycle improvements can increase safety and potentially reduce the use of private vehicles. To enhance safety, a variety of roadway design techniques to manage vehicular traffic that include narrowing traffic lanes, changing the street surface, and installing speed tables or raised crosswalks on side streets, and/or curb extensions need to be considered in areas of concentrated pedestrian and bicycle usage.

Design of the Trapelo Road Corridor should focus on widening sidewalks and painting crosswalks to the maximum extent feasible. Intersection improvements such as Continental style crosswalks, curb extensions, and center median refuge areas are needed to improve pedestrian accommodation. Communities should also pursue the acquisition of easements to establish pedestrian and bicycle paths.

Attention must be given to safe and efficient transportation for all user types as well as the provision of alternatives for non-motorized travel along the Trapelo Road Corridor. Network connectivity should be provided that would eliminate critical gaps in the existing network, with a final goal of achieving a fully interconnected system of bicycle lanes and pedestrian paths within the study area.

4.2 Land Use

The identification of an alternative land use scenario to reduce or slow the growth of auto traffic within the sub-area is an important component of this study. Most planners, municipal officials, and the public believe intuitively that the quantity, type and mix of housing, businesses, and services in an area will affect the amount of traffic in that area. Still, understanding exactly how land use influences traffic, and using that knowledge to determine appropriate land uses for a given location is a much more complicated undertaking. A summary of these findings is below and is described in more detail in Appendix F, Literature Review. These findings, which served as a guide for the Advisory Committee and the Study Team in developing the Smart Growth Scenario, can also be employed by the communities as they attempt to coordinate land use and transportation planning.

Increasing development tends to add traffic on local roads, but not all types of development contribute equally. Some types of development make it easier to get around without a car, which can mitigate the traffic burden on adjacent roads. Other developments leave residents, employees, and/or visitors with little choice but to travel by car. Research supports the fact that, generally, people living in neighborhoods where they can safely and conveniently walk, bike, and/or take transit to access goods, services, and jobs tend to drive less than people in more car-dependent neighborhoods. This does not mean that building a certain type of development guarantees that people will drive less; rather, it suggests that in certain types of developments people are able to drive less, and some of them will choose to take advantage of their alternatives. Furthermore, to some degree people tend to choose where to live based on where they need to go and how they prefer to get there. If less car-dependent neighborhoods attract residents who prefer or require other travel options, those new residents can be expected to drive less than the average resident.

Integrating amenities such as restaurants, services, and convenience retail within walking distance of housing and/or jobs means that residents or employees have the option of doing some of their errands on foot. Nationwide, roughly forty percent of social, recreational, and shopping trips under a half mile in length are made on foot or by bike.[23] Exactly how far people are willing to walk, though, will depend on the individual, the purpose of the trip, the other transportation options available and their appeal, as well as the surroundings. A more connected street network provides shorter, more direct routes, and off-road paths. Sidewalks and/or bike lanes can improve safety and enable people to make short trips without a car.

Using land use to influence travel demand is by no means an exact science, but there is compelling evidence that land use impacts transportation and vice versa. Most importantly, land use changes can enable and increase the appeal of non-auto travel. Zoning code and design guidelines cannot control how people choose to travel but they can make some transportation options more appealing than others.

Many of the features that shape transportation outcomes are connected, and are most effective when done together. New development that adheres to principles of Smart Growth - development that is environmentally, fiscally, and economically smart and includes mixed use development (i.e., residential, commercial, institutional) – is strongly encouraged. Public education and outreach are critical accompaniments to a land use plan because of the importance of public perception and individual attitudes in shaping travel decisions. A comprehensive strategy that promotes alternative transportation will have the greatest chance of success.

4.3 Implementation Tools

All recommended projects are on local roads and are generally the responsibility of municipalities. This section describes the processes by which the roadway recommendations may be implemented if proponents desire state and federal funding. The implementation of improvements would follow the standard process that any proponent of a federal-aid eligible roadway improvement is required to follow. The process provides for the participation of the general public, community representatives, and other agencies.

The following description of the implementation process is based on Chapter 2 of the *Massachusetts Highway Department Project Development and Design Guidebook* (2006).

<u>Needs Identification</u>
The proponent leads the effort to define the problem, establish project goals and objectives, and define the scope of the planning needed for implementation for each location an improvement is to be implemented. To that end, the proponent completes a Project Need

[23] Reid Ewing, *Transportation & Land Use Innovations: When you Can't Pave your Way out of Congestion,* Chicago: Planners Press, 1997, p. 61.

Form (PNF), which states in general terms the deficiencies or needs related to the transportation facility or location.

Planning

The purpose of this implementation step is for the project proponent to identify issues, impacts, and approvals that may need to be obtained, so that the subsequent design and permitting processes are understood. The level of planning needed will vary widely, based on the complexity of the project. Typical tasks include: defining the existing context, confirming the project need, and establishing goals and objectives.

Project Initiation

At this point in the process, the proponent fills out, for each improvement, a Project Initiation Form (PIF), which is reviewed by its Project Review Committee and the MPO. The PIF documents the project type and description, summarizes the project planning process, identifies likely funding and project management responsibility, and defines a plan for interagency and public participation.

Environmental, Design, and Right-of-Way Process

This step has four distinct but closely integrated elements: public outreach, environmental documentation and permitting (if required), design, and right-of-way acquisition (if required). The outcome of this step is a fully designed and permitted project ready for construction. However, a project does not have to be fully designed in order for the MPO to program it in the TIP.

Programming

Programming, which typically begins during the design phase, can actually occur at any time during the process, from planning to design. The MPO considers the project in terms of regional needs, evaluation criteria, and compliance with the regional Transportation Plan and decides whether to place it in the draft TIP for public review and then in the final TIP.

Procurement

Following project design and programming, the proponent publishes a request for proposals. It then reviews the bids and awards the contract to the qualified bidder with the lowest bid.

Construction

After a construction contract is awarded, the proponent and the contractor develop a public participation plan and a management plan for the construction process.

Project Assessment

Constituents' comments on the project development process and the project's design elements are received during this step.

Below are tools collected by the study team that the communities can use jointly or individually to address issues of preservation, improved transit provision and/or single occupancy auto trip management. The tools fall into two categories: 1) regulations that control and direct land use development to promote transit and non-single owner auto trips by clustering development; and 2) tools for generating funds to help the communities subsidize provision of transit in the area.

4.3.1 TIP Funding

The Transportation Improvement Program (TIP) is managed by the Boston Region Metropolitan Planning Organization (MPO). The TIP lists all transportation projects programmed to receive federal funds over a four-year horizon and all projects programmed with federal and state highway funds that are expected to be available. Eligible project categories are: bridges, roads, bicycle facilities, transit, as well as pedestrian and streetscape improvements.

The MPO has defined the overall framework for TIP programming and created project selection criteria. Criteria are used on existing conditions, safety, mobility, community, environmental justice, environment, land use and economic development.

An MPO-endorsed TIP is incorporated into the State Transportation Improvement Program (STIP), which is distributed to the Federal Highway Administration, Federal Transit Administration, and Environmental Protection Agency for certification before the end of each federal fiscal year (September 30).

4.3.2 Land Use and Financing (or Value Capture) Tools

The land use tools described below are innovative programs meant to guide growth and types of development. The financing (or value capture) tools assist with purchasing or increasing the economic value of land.

Land Use Tools

<u>Community Preservation Act (CPA) – M.G.L. Chapter 44B</u>
The Community Preservation Act allows Massachusetts municipalities to adopt a 1 to 3 percent surcharge on real estate taxes, and apply the revenue generated to 1) acquire and preserve open space, 2) acquire and preserve historic buildings and landscapes, and 3) create community housing. The CPA stipulates that at least 10 percent of the fund must be directed to each of the three primary uses, and that the remaining 70 percent may be allocated in any variation between the three. Allocation decisions are made by local Community Preservation Committees, established when the act is adopted. Funds may not be used to maintain existing assets. Of potential benefit to the communities within the study area is the fact that CPA funds may be used anywhere in the Commonwealth. One community can use funds to purchase and preserve land in another community, or communities can pool their funds for joint ventures.

Lexington and Waltham voted for the CPA in 2006 and 2005 respectively. Belmont has formed a committee to explore the benefits of implementing CPA which has not been adopted.

More information about the CPA can be found on-line at:
http://www.communitypreservation.org

Transfer of Development Rights – M.G.L. Chapter 40A, Section 9
Transfer of Development Rights (TDR) allows municipalities to direct growth away from priority open space or other areas that it wishes to preserve and towards areas where development would be more beneficial and supported by existing infrastructure. A TDR program is proposed in the 2002 Lexington Comprehensive Plan as a tool to protect specific parcels.

More information about TDRs can be found on-line at:
http://www.mass.gov/envir/smart_growth_toolkit/pages/CS-tdr-falmouth.html

Down Zoning
Down zoning either reduces the allowable uses or increases the lot requirements of land area within a municipality. Down Zoning can be coupled with Transfer of Development Rights within a growth management program to maximize preservation of open space and direct development to areas with infrastructure to sustain it. Down Zoning requires a master planning or growth management program to avoid a regulatory taking challenge.

Down Zoning could be employed to help the three study communities curtail conversion of double sized lots with a single house to two single lots. Currently developed lots that are large enough to accommodate 1 to 5 new units under current zoning make up 612 new units within the study area at build-out, that is 22.7 percent of the housing units projected for the study area by 2030.

Financing (or Value Capture) Tools

District Improvement Financing – M.G.L. Chapter 40Q
The Massachusetts DIF program allows a municipality to identify a district for improvement. They can then access tools to improve that district. One of these tools is the ability to fund improvements by floating bonds based on new tax revenue generated by the future improvements and/or zoning changes within the district. DIF programs could be designated to raise funds for transit capital from increases in value due to new development within corridor.

More information about DIFs can be found on-line at:
http://www.mass.gov/envir/smart_growth_toolkit/pages/mod-diftif.html

Impact Fees
An impact fee is a calculated and consistent charge on new development used by municipalities and other public entities to offset the cost of providing new services. Massachusetts municipalities have the right to impose impact fees through their Home Rule attributed Police Power, but historically local attempts to codify fee programs have been overturned when challenged in court. To be legally defensible, an impact fee must be reasonably related to the infrastructure needs created by the development to which it is

applied, the fee payer must receive some benefit from the additional facility, and the fee must be proportional to the impact of the development.

4.4 Inter-Community Coordination

Increased communication and cooperation among the three communities was identified as a goal of the study process by the Advisory Committee. Each community identified preliminary elements that they would like support for:

- The Towns of Belmont and Lexington agreed to support Waltham's efforts to obtain additional transit service for the Trapelo Road corridor. Lexington further expressed a desire to link any additional bus service provided by the MBTA with the Lexpress local bus service. Belmont noted that improved transit service in Waltham and Lexington would help relieve pressure on Belmont's roads and parking supply from commuters. Belmont suggested that bus routes running to Waverley square could be extended into Waltham along Trapelo Road.

- Belmont is seeking support to redesign their portion of Trapelo Road on the Metropolitan Planning Organization's Transportation Improvement Program for Fiscal Year 2009-2012. This project will provide new traffic signals, sidewalks, landscaping and streetscape items. The roadway will be resurfaced and will provide bicycle accommodations.

- Waltham is working to widen the portion of Trapelo Road around Route 60 and coordinate the signal timing at that intersection with the Belmont traffic signals in order to improve the flow of traffic.

- The Towns of Belmont and Lexington are in support of Waltham's considerations to preserve the Fernald Development Center property, maintain it as a working facility for the remaining residents and develop part of the site as a multi-use museum and recreational complex.[24]

[24] Subsequent to the Advisory Committee meetings, there was an October 2008 decision by the Court of Appeals of the First Circuit which paved the way for the Commonwealth to move forward on its plan to resettle residents of the Fernald Development Center. The State of Massachusetts ordered all residents to move from the Fernald Development Center by June 30, 2010. Attorneys for the families of relatives who live at the Fernald Development Center filed an appeal against the closing order. In April 2009, the US Supreme Court formally declined to hear this appeal.

Appendix A
Advisory Committee List of Representatives

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Advisory Committee List of Representatives

Belmont/Lexington/Waltham Sub-Area Study

Belmont
Angelo Firenze, Selectman
Vincent De Novellis, Belmont Vision 21
Mary Jo Frisoli, Traffic Advisory Board
Andrew McClurg, Planning Board
Jeffrey Wheeler, Planning Coordinator
One Open Position

Lexington
Jeanne Krieger, Selectman
Richard Canale, Planning Board
Nicholas Cannalonga
Eileen Entin, Citizens for Lexington Conservation
Arthur Katz, South Lexington Civic Association
Gail Wagner, Transportation Services Coordinator

Waltham
Frank Ching, Transportation Director
George Darcy, Ward 3 Councilor
Pat DiIeso
Jean P. Foster, Waltham resident
Stewart LaCrosse, CPW Director, or his designee
Kathleen McMenimen, Councilor-at-Large
Ron Vokey, Planning Department Director, or his designee

Executive Office of Transportation (EOT)
Doug Carnahan, Office of Transportation Planning

Appendix B
Intersection Capacity Analysis Characteristics

MEMORANDUM

TO: **Existing Conditions Analysis Files** **March 21, 2006**
Belmont, Lexington, and Waltham Subarea Study

FROM: **Chen-Yuan Wang and Seth Asante**
Traffic Analysis and Design Group

RE: **Intersection Capacity Analysis**

This memorandum summarizes the intersection capacity analyses for major intersections in the study area. Based on the existing (2005) traffic conditions, seventeen intersections were examined. They are nine signalized intersections (numbered as S-1 to S-9) and eight unsignalized intersections (numbered as U-1 to U-8):

S-1 Trapelo Road at Smith Street in Waltham
S-2 Lexington Street at Trapelo Road in Waltham
S-3 Waltham Street at Concord Avenue in Lexington
S-4 Trapelo Road at Lake Street/Bishop's Forest Drive in Waltham
S-5 Lexington Street at Totten Pond Road/Bacon Street in Waltham
S-6 Trapelo Road at Waverly Oaks Road in Waltham
S-7 Trapelo Road at Mill Street in Belmont
S-8 Trapelo Road at Lexington Street in Belmont
S-9 Waverly Oaks Road at Beaver Street in Waltham

U-1 Concord Avenue at Walnut Street in Lexington
U-2 Concord Avenue at Pleasant Street in Lexington
U-3 Concord Avenue at Winter Street in Belmont
U-4 Concord Avenue at Mill Street in Belmont
U-5 Winter Street at Marsh Street in Belmont
U-6 Trapelo Road at Woburn Street in Waltham
U-7 Trapelo Road at Forest Street in Waltham
U-8 Trapelo Road at Pleasant Street in Belmont

Figure 1 shows the AM and PM peak hour turning movement counts at these intersections. The data were obtained from traffic counts performed by CTPS or were derived from recent traffic studies in the area. Among the intersections examined, several have 3,000 or more entering vehicles per peak hour. These intersections—all currently signalized—are Trapelo Road at Smith Street (S-1), Lexington Street at Trapelo Road (S-2), Lexington Street at Totten Pond Road/Bacon Street (S-5), and Trapelo Road at Mill Street (S-7). The intersections of Trapelo Road at Lexington Street (S-8) and at Pleasant Street (U-8) in Belmont each process 2,500 or more vehicles per peak hour. Three intersections, each process nearly 2,000 vehicles per peak hour: Trapelo Road at Forest

Street/Bishop's Forest Drive (S-4), Concord Avenue at Winter Street (U-3), and Concord Avenue at Mill Street (U-4).

The results of intersection capacity analyses are presented using the criterion of level of service (LOS). The criterion defining the six levels of service is based on six ranges of intersection delay, which is estimated from intersection geometry, operational parameters, and approaching traffic volumes. Table 1 shows the LOS criteria for unsignalized and signalized intersections from the Highway Capacity Manual (HCM 2000). LOS A represents the most favorable condition, with minimal traffic delay. LOS F represents the worst condition, with significant traffic delay. LOS D is generally considered acceptable in an urban environment.

Table 1 Level-of-Service Criteria (HCM 2000)

LOS	Unsignalized Intersections	Signalized Intersections
	Control Delay per Vehicle (seconds)	Control Delay per Vehicle (seconds)
A	≤ 10	≤ 10
B	>10 and ≤ 15	>10 and ≤ 20
C	>15 and ≤ 25	>20 and ≤ 35
D	>25 and ≤ 35	>35 and ≤ 55
E	>35 and ≤ 50	>55 and ≤ 80
F	> 50	> 80

Using the peak hour traffic volumes and intersection geometry data collected in field reconnaissance, CTPS analyzed the existing traffic operations through the application of Synchro/SimTraffic,[1] a traffic analysis and simulation software package that contains methodologies based on HCM 2000. The results are summarized in Tables 2 and 3. Table 2 shows the estimated overall LOS and average delay for the signalized intersections. Table 3 shows the estimated LOS and delay for the minor street of the unsignalized intersections. Figures 2 and 3 show the AM and PM peak hour intersection capacity analyses for all the selected intersections.

Table 2 Summary of Overall LOS and Average Delay for Signalized Intersections

Intersection Number and Location		City/Town	AM Peak Hour			PM Peak Hour		
			Total Entry Volume	Overall LOS	Average Delay (sec.)	Total Entry Volume	Overall LOS	Average Delay (sec.)
S-1	Trapelo Rd @ Smith St	Waltham	3,050	F	130	2,850	E	55
S-2	Lexington St @ Trapelo Rd	Waltham	3,650	D	53	3,850	E	59
S-3	Waltham St @ Concord Ave	Lexington	2,350	D	54	2,100	D	38
S-4	Trapelo Rd @ Lake St	Waltham	2,050	C	25	2,300	C	30
S-5	Lexington St @ Totten Pond Rd	Waltham	3,450	E	74	3,750	E	74
S-6	Trapelo Rd @ Waverly Oaks Rd	Waltham	1,950	C	32	2,350	D	35
S-7	Trapelo Rd @ Mill St	Belmont	3,100	D	38	3,300	E	67
S-8	Trapelo Rd @ Lexington St	Belmont	2,750	C	25	2,750	C	27
S-9	Waverly Oaks Rd @ Beaver St	Waltham	2,300	C	34	2,500	C	34

[1] *Synchro/SimTraffic Version 6*, Trafficware Corporation, 2003.

Table 3 Summary of LOS and Delay for the Minor Street of Unsignalized Intersections

Intersection Number and Location		City/Town	Traffic Control/ Total Approaches	AM Peak Hour		PM Peak Hour	
				LOS	Delay (sec.)	LOS	Delay (sec.)
U-1	Concord Ave @ Walnut St	Lexington	2-Way Stop/3 Legs	C	18	C	16
U-2	Concord Ave @ Pleasant St	Lexington	2-Way Stop/3 Legs	F	> 180	F	78
U-3	Concord Ave @ Winter St	Belmont	2-Way Stop/3 Legs	F	> 180	F	124
U-4	Concord Ave @ Mill St	Belmont	2-Way Stop/3 Legs	F	> 180	F	> 180
U-5	Winter St @ Marsh St	Belmont	2-Way Stop/4 Legs	C/F	23/69	C/E	22/35
U-6	Trapelo Rd @ Woburn St	Waltham	2-Way Stop/3 Legs	F	> 180	F	> 180
U-7	Trapelo Rd @ Forest St	Waltham	2-Way Stop/3 Legs	F	> 180	F	> 180
U-8	Trapelo Rd @ Pleasant St	Belmont	2-Way Stop/3 Legs	F	87	F	> 180

The capacity analysis results and the observed traffic conditions at each of the seventeen intersections are discussed below. Detailed capacity analysis reports from Synchro for the signalized and the unsignalized intersections are presented in Appendices A and B, respectively.

S-1 Trapelo Road at Smith Street in Waltham

This signalized intersection is located just east of the interchange of Route 128 and Trapelo Road and about half a mile south of the interchange of Route 2 and Spring Street in Lexington. Trapelo Road is an urban arterial running from Belmont, through Waltham, to Lincoln. Its section in Waltham is mainly a two-lane roadway. Smith Street is a two-lane arterial about half a mile long that continues as Wyman Street to the south in Waltham and as Spring Street to the north in Lexington. All approaches near the intersection are widened from one lane to two lanes, one for exclusive left-turn movements and one for shared through/right-turn movements. Crosswalks and pedestrian signal phases are not provided at this intersection.

The major land uses in the vicinity are residential and office developments. The residential area is mostly located on the east side of the intersection, away from Route 128. Office developments are mostly located on the west side of the intersection, the area between Route 128 and Smith Street. Further south, a number of major office developments are located on both sides of Wyman Street. At the intersection, there is a gas station with convenience store on the northeast corner, a church on the southeast corner, and a condo development on the northwest corner.

Due to the proximity to Route 128 and many office buildings, the intersection carries heavy traffic during peak periods. Traffic patterns are different in the AM and PM periods. In the AM peak period, eastbound and southbound traffic is heavy and experiences extensive delay. The eastbound traffic from Route 128 destined to the office developments on Smith Street and Wyman Street frequently backs up to the Route 128 and Trapelo Road interchange area. The AM peak hour capacity analysis for the intersection indicates LOS F for the eastbound left-turn movement, with extensive delay (see Figure 2). The southbound traffic is mainly from Route 2 and the area north, with a majority heading straight to the office developments south of the intersection (over 55%). The rest is mainly right-turn traffic heading to the Route 128 interchange, with a slim portion of left-turn traffic. The heavy traffic thus backs up extensively on the single through and right-turn shared lane. It is evaluated to have a LOS F with an average delay of over three minutes (see Figure 2).

In the PM peak period, traffic is somewhat lighter than the AM peak period. However, eastbound and northbound traffic is heavy and endures delay. The eastbound traffic mainly heads straight (about 60%), with high portion of left-turning movement (over 25%). The PM peak hour capacity analysis for the intersection indicates LOS F for the eastbound left-turn movement, with an average delay of about one minute (see Figure 3). The northbound traffic from the office developments mainly heads to Route 128 and Route 2. The northbound left-turn movement is evaluated to be LOS F, with an average delay of over four minutes (see Figure 3). As traffic is somewhat lighter in the PM than in the AM peak period, all other movements are estimated to operate at acceptable levels of service.

The turning movement counts performed in December 2005 indicate that the pedestrian traffic is low at this intersection. One pedestrian was observed in the morning from 7:00 to 9:00 and four in the afternoon from 4:00 to 6:00. It should be noted that the day was cold with light snow in the morning. Although the intersection is located near a major highway interchange, it is also close to a residential neighborhood. Pedestrian traffic should be assumed higher other times of the year.

S-2 Lexington Street at Trapelo Road in Waltham

This intersection, currently signalized, is located about one mile east of the intersection of Trapelo Road at Smith Street. Lexington Street (named Waltham Street in Lexington) is an urban arterial running in the north-south direction from downtown Lexington to downtown Waltham. Its section in Waltham is mainly a four-lane roadway with sidewalks on both sides.

The northbound and southbound approaches of Lexington Street each consist of an exclusive left-turn lane, a through-only lane, and a shared through/right-turn lane. On Trapelo Road, the eastbound approach consists of an exclusive left-turn lane, a through-only lane, and a shared through/right-turn lane; the westbound approach consists of an exclusive left-turn lane, a through-only lane, and an exclusive right-turn lane. Crosswalks are provided on all approaches, with an exclusive pedestrian signal phase. The pedestrian signal shows a countdown of remaining time for the pedestrian phase.

The major land uses in the vicinity are commercial and residential developments. A number of commercial developments are located on both sides of Lexington Street just north of the intersection. Further north, there are commercial, office, and condo developments on Waltham Street in Lexington. South of the intersection, a number of condo developments are located on both sides of Lexington Street. Further south, a major shopping plaza (formally be known as the Wal-Lex Recreation Center) is located on the west side of Lexington Street. On Trapelo Road, there are mainly single-family houses and a few condo developments. The Our Lady’s Church and School are located about a quarter mile east of the intersection. At the intersection, there is a Shell gas station on the northeast corner, a Mobil gas station on the northwest corner, a condo development on the southeast corner, and a garage on the southwest corner.

The intersection processes 3,500 or more vehicles per peak hour. Traffic is somewhat heavier in the PM than in the AM peak hour. Traffic volume is higher on Lexington Street than on Trapelo Road.

Observations from the field indicate that the intersection is busy but that usually no serious congestion occurs in the AM peak hour. Traffic queues were observed on the southbound approach in the PM peak hour. The congestion is caused by traffic from the shopping developments just north of the intersection as well as the heavy southbound traffic from Route 2 and the area north. Overall, the intersection is evaluated to operate at LOS D in the AM peak hour and at LOS E in the PM peak hour, with delay mainly occurring in the northbound and southbound left-turn movements (see Figures 2 and 3).

About five to ten pedestrian crossings per peak hour were observed. The intersection's pedestrian signal timing is considered appropriate.

S-3 Waltham Street at Concord Avenue in Lexington

This signalized intersection is located about 1,000 feet south of the interchange of Route 2 and Waltham Street and about half mile north of the intersection of Lexington Street at Trapelo Road. Waltham Street, running in the north-south direction, is a two-lane arterial that reaches downtown Lexington in the north. Concord Avenue, intersecting Waltham Street in the east-west direction, is a two-lane arterial running from Cambridge, through Belmont, to Lexington and ending at Spring Street.

At the intersection, the northbound and southbound approaches of Waltham Street are operated as two lanes, one for exclusive left-turn movements and one for shared through and right-turn movements, although no lane delineation is visible. The eastbound and westbound approaches of Concord Avenue each contain only one lane shared by left-turn, through, and right-turn movements. Crosswalks are provided on all approaches, with an exclusive pedestrian signal phase.

The land uses in the vicinity are mainly residential developments and a few commercial and office developments. The commercial/office developments are mainly located on Waltham Street south of the intersection, along with a major condo development (Brookhaven at Lexington) on the east side of Waltham Street. On Concord Avenue, there are mainly single-family houses. At the intersection, there is a daycare center on the northwest corner and a gas station on the southwest corner.

The intersection processes 2,000 to 2,500 vehicles per peak hour. Traffic is somewhat heavier in the AM than in the PM peak hour. Traffic volume is much higher on Waltham Street than on Concord Avenue. Observations from the field indicate that usually no serious congestion occurs at the intersection in either the AM or PM peak hour. The southbound traffic is the heaviest of all approaches. Its traffic queue sometimes extends to the interchange area around 8:00 AM, but usually dissipates in a short time. Overall, the intersection is evaluated to operate at LOS D in the AM peak hour and in the PM peak hour, with delay mainly occurring on the southbound approach, especially for the left-turn movement (see Figures 2 and 3).

Not many pedestrian crossings (less than five per peak hour) were observed at this intersection. The pedestrian signal timing is considered appropriate.

S-4 Lexington Street at Lake Street/Bishop’s Forest Drive in Waltham

The intersection, currently signalized, is located about half a mile south of the intersection of Lexington Street at Trapelo Road, and less than a mile north of the intersection of Lexington Street at Totten Pond Road. Lexington Street is an urban arterial running in the north-south direction from downtown Lexington to downtown Waltham. Lake Street, intersecting Lexington Street from the west, is a two-lane collector of less than a mile that connects Lexington Street to Lincoln Street. Bishop’s Forest Drive, intersecting the intersection from the east, is a two-lane local street that basically serves as an access road for a number of condo developments east of the intersection.

At the intersection, the northbound and southbound approaches of Lexington Street each consist of an exclusive left-turn lane, a through-only lane, and a shared through and right-turn lane. The Lake Street approach contains only one lane, shared by left-turn, through, and right-turn movements. The Bishop’s Forest Drive approach has a shared left-turn and through lane, and an exclusive right-turn lane. Crosswalks are provided on all approaches with an exclusive pedestrian signal phase. The pedestrian signal shows a countdown of remaining time for the pedestrian phase.

There are varied land uses in the vicinity of the intersection. North of the intersection on Lexington Street, a major shopping/office plaza (Wal-Lex Center) is located on the west side and a condo development on the east side. South of the intersection on Lexington Street, there are JFK Junior High School and Waltham High School on the east side, and some single-family houses on the west side. On Lake Street, there are mainly single-family houses and apartments.

The intersection processes 2,000 to 2,500 vehicles per peak hour, with a majority (nearly 80%) coming from Lexington Street. Traffic is somewhat heavier in the PM than in the AM peak hour. No serious congestion was observed in either peak hour. Overall, the intersection is evaluated as operating at LOS C in both AM and PM peak hours, with no significant delays (see Figures 2 and 3). In part, this intersection operates well during peak hours because it is located between two major intersections, Lexington Street at Trapelo Road and at Totten Pond Road, which meter traffic via their signals and channel a certain portion of traffic to the area near Route 128.

About five pedestrian crossings per peak hour were observed. The pedestrian signal timing is appropriate.

S-5 Lexington Street at Totten Pond Road/Bacon Street in Waltham

This signalized intersection is located about one and a half miles east of Route 128 and about one mile north of downtown Waltham. Lexington Street is a four-lane arterial running in the north-south direction from Lexington to downtown Waltham. Totten Pond Road, intersecting Lexington Street from the west, is a two-lane arterial that connects Lexington Street and Route 128. Bacon Street, intersecting Lexington Street from the southwest, is a two-lane minor arterial that connects Lexington Street and Route 20 (Main Street) in downtown Waltham. At the intersection, there is also a church driveway intersecting Lexington Street from the east.

The northbound approach of Lexington Street contains two exclusive left-turn lanes and a through-only lane. The southbound approach of Lexington Street contains an exclusive left-turn lane and a shared left-turn/through/right-turn lane. The Totten Pond Road approach consists of an exclusive left-turn lane and two exclusive right-turn lanes. The Bacon Street approach consists of a shared left-turn/through lane and a shared through/right-turn lane. The westbound approach (the church's driveway) has only one lane shared by all movements. Crosswalks are provided on all street approaches, with an exclusive pedestrian signal phase. The pedestrian signal shows a countdown of remaining time for the pedestrian phase.

The intersection is somewhat confusing because the three major streets intersect each other unevenly, with the church's driveway and an apartment building's curb cut also located at the intersection. There are lane assignment pavement markings on all street approaches to alert drivers. However, during peak hours the markings are hardly visible due to heavy traffic. Lane assignment signs are posted on the sidewalk curb of the northbound approach to increase awareness for drivers. But no signs are provided on other approaches.

The major land use in the vicinity is residential, mostly single-family houses and some multiple-family houses. The JFK Junior High School and Waltham High School are located on the east side of Lexington Street about half a mile north of the intersection. At the intersection, there is a church on the northwest corner and another church on the southeast corner.

The intersection processes nearly 3,500 vehicles in the AM peak hour and about 3,750 vehicles in the PM peak hour. Traffic on Lexington Street is heavy on both approaches in both the AM and PM peak hours. Traffic on Totten Pond Road is heavier in the PM than in the AM peak hour. Traffic on Bacon Street is somewhat heavier in the PM than in the AM peak hour but is much lighter than other approaches. Observations from the field indicate that the southbound traffic frequently backs up to Winter Street (about 500 feet north of the intersection) and beyond in the AM and PM peak hours. The northbound (Lexington Street) and eastbound (Totten Pond Road) traffic backs up frequently in the PM peak hour. Overall, the intersection is evaluated as operating at LOS E in both the AM and PM peak hours, with delay mainly occurring on the southbound approach and at the northbound and eastbound left-turn movements (see Figures 2 and 3).

About ten pedestrian crossings per peak hour were observed. The pedestrian signal timing is considered appropriate.

S-6 Trapelo Road at Waverly Oaks Road in Waltham

This intersection is located near the Waltham/Belmont border and just about 500 feet west of the intersection of Trapelo Road at Mill Street in Belmont. It is a three-way intersection with signal control. Trapelo Road is a two-lane arterial running in the east-west direction from Belmont to Lincoln. Waverly Oaks Road is a two-lane arterial that runs from this intersection south to Main Street (Route 20) in downtown Waltham. Trapelo Road east of the intersection to Pleasant Street in Belmont and Waverly Oaks Road are part of state Route 60.

The eastbound approach of Trapelo Road contains only one lane, shared by through and right-turn movements. The westbound approach of Trapelo Road contains an exclusive left-turn lane and a though-only lane. The northbound approach of Waverly Oaks Road consists of an exclusive left-turn lane and a channelized exclusive right-turn lane. Crosswalks are provided only on the northbound approach, with an exclusive pedestrian signal phase.

The major land uses in the vicinity include recreational, residential, institutional, and office developments. The area immediately east and north of the intersection is mainly parkland of the Beaver Brook Reservation. Single-family houses are located in the area west of the intersection. Further west, the Fernald State School and its affiliated facilities take up a major area south of Trapelo Road. On Waverly Oaks Road, single-family houses are located on the west side and a couple of major office developments are on the east side south of the Beaver Brook Reservation.

The intersection processes about 2,000 to 2,500 vehicles per peak hour. Traffic is heavier in the PM than in the AM peak hour. Traffic on Trapelo Road westbound is heavy with high left-turn volumes in the AM and PM peak hours. Field observations indicate that sometimes left-turning vehicles have to wait for the next signal cycle in order to pass through the intersection. Traffic queues usually extend to but not beyond the intersection at Mill Street. Traffic on Trapelo Road eastbound in peak hours is not as heavy but still backs up sometimes due to the single-lane operation. On Waverly Oaks Road, vehicles are usually able to clear the intersection within a signal cycle. Overall, the intersection is evaluated as operating at LOS C in the AM peak hour and at LOS D in the PM peak hour, with delay mainly occurring at the westbound left-turn movement (see Figures 2 and 3).

About five or fewer pedestrian crossings per peak hour were observed. The intersection's pedestrian signal timing is considered appropriate.

S-7 Trapelo Road at Mill Street in Belmont

This intersection is located about 500 feet east of the intersection of Trapelo Road at Mill Street and about 1,000 feet west of Waverly Square. It is a three-way intersection with signal control. Trapelo Road, running in the east-west direction, is the major street. It is basically a two-lane arterial with the section in this area widened to three or four lanes. Mill Street is a two-lane minor arterial of less than a mile in length that runs from this intersection to Concord Avenue in the north.

The eastbound approach of Trapelo Road contains a shared left-turn/through lane and a through-only lane. The westbound approach of Trapelo Road contains two though lanes and a channelized exclusive right-turn lane. The southbound approach of Mill Street consists of an exclusive left-turn lane and a channelized exclusive right-turn lane. A crosswalk is provided only on the westbound approach, with an exclusive pedestrian signal phase.

The major land uses in the vicinity include recreational, residential, and institutional developments. The area immediately west and south of the intersection is mainly parkland of the Beaver Brook Reservation. East of the intersection, McLean Hospital and its affiliated facilities take up most of the area north of Trapelo Road. Multiple-family and some single-family houses occupy the area south of Trapelo Road. At the intersection, a neighborhood park owned by the town is located just south of the intersection next to the reservation; a major condominium development is located on the northeast corner; and a popular local diner is located about 300 feet east of the intersection on Trapelo Road.

The intersection processes over 3,000 vehicles per peak hour. Traffic is heavier in the PM than in the AM peak hour. Traffic is heavy on all three approaches in peak hours, as Trapelo Road is a major commuter route that reaches Cambridge and Boston, and Mill Street is frequently used to access Route 2 and the area north via Winter Street in Belmont or via Concord Avenue and Pleasant

Street in Lexington. Field observations indicate that the southbound traffic frequently backs up on Mill Street in the AM and PM peak hours. The southbound left-turn movement is evaluated as operating at LOS F in both the AM and PM peak hours with extensive delay (see Figures 2 and 3). Traffic on Trapelo Road is heavy, but approaching vehicles usually are able to pass through the intersection in a signal cycle. The only major delay on Trapelo Road occurs at the eastbound left-turn movement in the PM peak hour.

About five pedestrian crossings per peak hour were observed. The pedestrian signal timing of about 27 seconds is considered appropriate.

S-8 Trapelo Road at Lexington Street in Belmont

This intersection, currently signalized, is in the Waverly Square area, where many local businesses are located. Trapelo Road is a two-lane arterial running in the east-west direction from Belmont to Lincoln. In this area it is widened from two to four lanes. Lexington Street, intersecting Trapelo Road diagonally from the southeast, is a two-lane collector running in the north-south direction in Belmont from Trapelo Road to Belmont Street. Intersecting Trapelo Road from the north is a driveway for a Shaw's supermarket. The driveway connects Pleasant Street to the north.

The eastbound approach of Trapelo Road contains an exclusive left-turn lane, two though-only lanes, and a channelized exclusive right-turn lane. The westbound approach of Trapelo Road contains a through-only lane and a shared through/right-turn lane, with left-turn movements prohibited. The Lexington Street approach consists of an exclusive left-turn lane and a shared left-turn/through/right-turn lane. The Shaw's driveway consists of a shared left-turn/through lane and an exclusive right-turn lane. Crosswalks are provided on the westbound, northbound, and southbound approaches, with pedestrian signal phases concurrent with traffic flow. On-street parking is allowed on both sides of Lexington Street and on the south side of Trapelo Road east of the intersection.

The major land uses in the vicinity are residential and commercial developments. Multiple-family houses are located in the area south and west of the intersection. Shops and stores are located on Trapelo Road, Lexington Street, and Church Street, which encircle Waverly Square. The MBTA Fitchburg commuter rail line, which has a station at the square, runs through the square under Trapelo Road and Lexington Street. A municipal short-term parking lot for shoppers and others is located next to the station at street level. Waverly Square also is the terminal for MBTA trackless trolley bus Route 73 that runs between the square and Harvard Square. At the intersection, there is a car-wash center on the northeast corner, the Shaw's supermarket on the northwest corner, and an equipment rental store on southwest corner. The commuter rail station and the parking lot take up the southeast corner.

The intersection processes nearly 3,000 vehicles per peak hour. Traffic is somewhat heavier in the PM than in the AM peak hour. As the intersection is located in a major business area, traffic is heavy on all approaches during peak hours. The Route 73 buses also pass through the intersection during peak hours. The signal cycle length is about 110 seconds long, with a split phase in the north-south direction. Although traffic is heavy, no extensive queues were observed on the field during peak hours. All the approaches of the intersection, except the northbound approach, are evaluated as operating at acceptable levels of service in the AM and PM peak hours (see Figures 2 and 3). The northbound approach is estimated to operate at LOS D in the AM peak hour, but at LOS E in the PM peak hour with an average delay of about a minute.

S-9 Waverly Oaks Road at Beaver Street in Waltham

This intersection, currently signalized, is located less than a mile south of the intersection of Trapelo Road at Waverly Oaks Road. Waverly Oaks Road is a two-lane arterial running in the north-south direction from Trapelo Road to Main Street (Route 20) in downtown Waltham. The entire section of Waverly Oaks Road is part of state Route 60. Beaver Street is a minor arterial running in the east-west direction from Belmont Street to Lexington Street.

The northbound approach of Waverly Oaks Road consists of an exclusive left-turn lane, a through-only lane, and an exclusive right-turn lane. The southbound approach of Waverly Oaks Road consists of an exclusive left-turn lane, a through-only lane, and a channelized exclusive right-turn lane. The eastbound approach of Beaver Street contains an exclusive left-turn lane and a shared through/right-turn lane. The westbound approach of Beaver Street contains an exclusive left-turn lane, a though-only lane, and an exclusive right-turn lane. Crosswalks are provided on all the approaches, with pedestrian signal phase concurrent with traffic flow.

The major land uses in the vicinity are residential and office developments. The office developments are located mainly in the area immediately east and north of the intersection. A major development, Waverly Oaks Industrial Park, is located to the east of Waverly Oaks Road about 500 feet north of the intersection. At the intersection, there is a gas station/car wash service center on the northeast corner, an office building on the southeast corner, and a ballpark on the southwest corner. The northwest corner of the intersection is vacant land.

The intersection processes nearly 2,500 vehicles per peak hour. Traffic volume is higher in the PM than in the AM peak hour. No major congestion was observed at this intersection. In the PM peak hour, the westbound traffic is heavy but usually cycles through the intersection without major delay. The capacity analyses indicate that the intersection operates at acceptable levels of service on all approaches (see Figures 2 and 3).

Field observations indicated that the intersection had about five or fewer pedestrian crossings per peak hour and that its pedestrian signal phases worked well with the current traffic conditions.

U-1 Concord Avenue at Walnut Street in Lexington

This intersection, currently unsignalized, is located about half a mile west of Waltham Street and a quarter mile south of Route 2. It is a three-way intersection, with stop control on Walnut Street. The major street, Concord Avenue, is a two-lane arterial running in the east-west direction from Cambridge, through Belmont, to Lexington. The minor street, Walnut Street, is a narrow two-lane collector about half a mile long that continues south as Woburn Street and ends at Trapelo Road in Waltham.

Each of the three approaches has only one lane shared by all movements. No crosswalk is present on any approach. The land use in the vicinity is primarily single-family residential. A condominium development, Potter Pond, is located on the east side of Walnut Street about 1,000 feet from the intersection.

The intersection processes nearly 1,000 vehicles per peak hour. It currently operates at an acceptable level of service. The northbound approach, which is under stop control, is evaluated as operating at LOS C in the AM and PM peak hours with minor delay (see Figures 2 and 3).

U-2 Concord Avenue at Pleasant Street in Lexington

This intersection is located about 300 feet east of the intersection of Concord Avenue at Walnut Street, and about a quarter of a mile south of the interchange of Route 2 and Pleasant Street. It is a three-way intersection, with stop control on Pleasant Street. The major street, Concord Avenue, is a two-lane arterial running in the east-west direction from Cambridge, through Belmont, to Lexington. The minor street, Walnut Street, is a two-lane collector that runs from this intersection north to Massachusetts Avenue in Lexington.

Each of the three approaches has only one lane shared by all movements. No crosswalk is present on any approach. The land use in the vicinity is primarily single-family residential.

The intersection processes somewhat over 1,000 vehicles per peak hour. Total traffic volume is slightly higher in the PM than in the AM peak hour. However, on the stop-control approach of Pleasant Street, traffic volume is higher in the AM than in the PM peak hour. A major portion of the traffic is coming from Route 2 and the area north, and heading to Belmont, Cambridge, and the communities near or in Boston. It was observed that Pleasant Street southbound traffic frequently backed up in the AM peak hour, but backups were not as serious in the PM peak hour. The capacity analyses indicate that the approach operates at LOS F in the AM peak hour with extensive delay, and at LOS F in the PM peak hour with less delay (see Figures 2 and 3).

U-3 Concord Avenue at Winter Street in Belmont

This intersection, currently unsignalized, is located about a mile south of the interchange of Route 2 and Winter Street. It is a three-way intersection, with stop control on Winter Street. The major street, Concord Avenue, is a two-lane arterial running in the east-west direction from Cambridge, through Belmont, to Lexington. The minor street, Winter Street, is a two-lane minor arterial that runs from this intersection north to the interchange and continues as Watertown Street in Lexington.

The eastbound and westbound approaches of Concord Avenue each have only one lane shared by all movements. The Winter Street approach contains an exclusive left-turn lane and a short channelized section of exclusive right-turn lane. A crosswalk is provided on the westbound approach for pedestrians to cross Concord Avenue. The land use in the vicinity is primarily single-family residential.

The intersection processes over 2,000 vehicles in the AM peak hour and nearly 2,000 vehicles in the PM peak hour. On the stop-control approach of Winter Street, traffic is heavy in both the AM and PM peak hours, with somewhat higher volume in the AM peak hour. A major portion of the traffic is coming from Route 2 and the area north and heading to Belmont, Cambridge, and communities near or in Boston, via Concord Avenue or Mill Street. Field observations indicate that Winter Street southbound traffic frequently backs up in the peak hours, sometimes extending to Marsh Street and beyond. The capacity analyses indicate that the approach operates at LOS F in the AM peak hour with extensive delay, and at LOS F in the PM peak hour with less delay (see Figures 2 and 3).

U-4 Concord Avenue at Mill Street in Belmont

This intersection is located about 400 feet east of the intersection of Concord Avenue at Winter Street. It is a three-way intersection, with stop control on Mill Street. Concord Avenue is a two-lane arterial running in the east-west direction. Intersecting Concord Avenue diagonally from the southeast, Mill Street is a two-lane arterial less than a mile long that runs from this intersection south to Trapelo Road. Slightly west of the intersection, connecting to Concord Avenue from the north is a dead-end local street, Audubon Lane, which serves only about ten single-family houses. East of the intersection, there is a short section of roadway connector deviating from Mill Street and connecting to Concord Avenue, where a gas station/car repair garage is located on its east side.

Each of the three approaches has only one lane. As the northbound right-turn and westbound left-turn vehicles mostly use the connector, the northbound and westbound lanes serve mainly through traffic. The eastbound lane of Concord Avenue is wide and operates like two lanes for through and right-turn movements separately.

The land use in the vicinity is predominantly single-family residential. McLean Hospital and its affiliated facilities are located on the east of Mill Street about half a mile south of the intersection.

The intersection processes over 2,000 vehicles in the AM peak hour and nearly 2,000 vehicles in the PM peak hour. On the stop-controlled approach of Mill Street, traffic is heavy in both the AM and PM peak hours, with higher volume in the PM peak hour. A major portion of the traffic is from Belmont, Cambridge, and the area further east near Boston and is heading to Route 2 and the area north. It was observed that Mill Street northbound traffic backed up extensively in the PM peak hour. The capacity analyses indicate that the approach operates at LOS F in both the AM and PM peak hours with extensive delay (see Figures 2 and 3).

U-5 Winter Street at Marsh Street in Belmont

This intersection is located less than a mile south of the interchange of Route 2 and Winter Street and about 1,000 feet north of the intersection of Concord Avenue at Winter Street. It is currently unsignalized, with stop control on Marsh Street. Winter Street is a two-lane minor arterial running in the north-south direction from the Route 2 interchange to Concord Avenue. Marsh Street is a two-lane collector running in the east-west direction from Park Avenue to Concord Avenue.

The land use surrounding the intersection is primarily single-family residential. The area north and west of the residential neighborhood is a golf course and other facilities owned by the Belmont Country Club. All approaches have only one lane shared by all movements. The southbound right-turn movement at the intersection is prohibited in the morning from 7:00 to 10:00. The prohibition is to prevent traffic cutting through the neighborhood to access Concord Avenue when Winter Street southbound is congested. A crosswalk is provided on the westbound approach for pedestrians to cross Concord Avenue.

The intersection processes about 1,250 vehicles per peak hour. Traffic volume is somewhat higher in the AM than in the PM peak hour. Traffic on Winter Street is heavy in peak hours, as it is a major access route to Route 2 and the area north. Traffic on Marsh Street, especially eastbound, therefore encounters delays; acceptable traffic gaps are few. The intersection capacity analyses indicate that the eastbound approach operates at LOS F in the AM peak hour with an average delay of about a minute, and at LOS E in the PM peak hour with much less delay (see Figures 2 and 3).

U-6 Trapelo Road at Woburn Street in Waltham

This intersection, currently unsignalized, is located about half a mile west of Lexington Street. It is a three-way intersection, with stop control on Woburn Street. The major street, Trapelo Road, is a two-lane arterial running in the east-west direction from Belmont, through Waltham, to Lincoln. The minor street, Woburn Street, is a narrow two-lane collector about half a mile long that continues north as Walnut Street and ends at Concord Avenue in Lexington.

Each of the three approaches has only one lane shared by all movements. The land use in the vicinity is primarily single-family residential. A condominium development is located on the east side of Woburn Street about 300 feet from the intersection. The area northwest of the intersection was owned by the County Hospital and is currently being developed into a condominium development of nearly 300 units.

The intersection processes about 1,750 vehicles in the AM peak hour and nearly 2,000 vehicles in the PM peak hour. On the stop-control approach of Woburn Street, traffic backs up frequently in the peak hours, as traffic on Trapelo Road is heavy. The capacity analyses indicate that the approach operates at LOS F in both the AM and PM peak hours with extensive delay (see Figures 2 and 3).

U-7 Trapelo Road at Forest Street in Waltham

This intersection is located about 600 feet east of the intersection of Trapelo Road at Woburn Street. It is a three-way intersection, with stop control on Forest Street. Trapelo Road is a two-lane arterial running in the east-west direction. Forest Street is a two-lane collector slightly over a mile long that runs from this intersection south to Beaver Street.

Each of the three approaches has only one lane shared by all movements. The land use near the intersection is primarily single-family residential. The main campus of Brandeis University is located to the east of Forest Street about a mile south of the intersection.

The intersection processes about 1,750 vehicles in the AM peak hour and nearly 2,000 vehicles in the PM peak hour. On the stop-controlled approach of Forest Street, traffic backs up frequently in the peak hours, especially in the PM peak hour. The capacity analyses indicate that the approach operates at LOS F in both the AM and PM peak hours with extensive delay (see Figures 2 and 3).

U-8 Trapelo Road at Pleasant Street in Belmont

This intersection, currently unsignalized, is located about 400 feet west of Waverly Square in Belmont. It is a three-way intersection, with stop control on Pleasant Street. Trapelo Road is a two-lane arterial running in the east-west direction from Belmont to Lincoln. Pleasant Street is a two-lane arterial that runs from this intersection north to Arlington Center. Trapelo Road west of the intersection to Waverly Oaks Road and the entire section of Pleasant Street are part of state Route 60.

The eastbound approach of Trapelo Road contains a though-only lane and a shared right-turn/through lane. The westbound approach of Trapelo Road contains a shared through/left-turn lane and a through-only lane. The Pleasant Street approach consists of an exclusive left-turn lane and a channelized exclusive right-turn lane. Pedestrian crosswalks are not provided at this intersection.

The major land uses in the vicinity are residential, institutional, and commercial developments. Multiple-family houses are located in the area south of Trapelo Road. McLean Hospital and its affiliated facilities are located in the area northwest of the intersection, with an infrequently used service road located just north of the intersection. A gas station with car-repair service is located on the northeast corner of the intersection.

The intersection processes nearly 3,000 vehicles per peak hour. Traffic is somewhat heavier in the PM than in the AM peak hour. Traffic is heavy on Trapelo Road in peak hours and thus leaves not many gaps for traffic on Pleasant Street to enter the intersection, especially for the left-turn movement. The intersection capacity analyses indicate that the southbound left-turn movement operates at LOS F in both the AM and PM peak hours with extensive delay (see Figures 2 and 3).

Appendix C
Traffic Forecasts and Traffic Analysis Results

MEMORANDUM
(Draft)

TO: **Study Advisory Committee** **December 6, 2006**
Belmont, Lexington, and Waltham Subarea Study

FROM: Efi Pagitsas, Chen-Yuan Wang, and Alicia Wilson
Traffic Analysis and Design

RE: **Traffic Forecasts and Traffic Analysis Results: Scenarios "2010 Proposed Developments" and "2030 Build Out"**

This memorandum summarizes the projected traffic growth on major roadways and the results of traffic analysis that was performed at major intersections in the study area for two future scenarios: the 2010 proposed developments scenario and the 2030 build out scenario.

The 2010 proposed developments scenario includes all the developments, which are proposed in the study area by 2010. The 2030 build out scenario includes all developments in the 2010 scenario and all other land development in the study area that zoning can accommodate.

In addition to these two scenarios, the work program for this study anticipates the evaluation of two 2030 smart growth scenarios. The smart growth scenarios will be defined with input from the Study Advisory Committee based on a number of considerations, including traffic impact results from the two scenarios presented in this memo.

Traffic Forecasts and Traffic Growth Summary

To project traffic growth and estimate impacts from the 2010 and 2030 build out scenarios, the study team developed a transportation planning model. The model was first calibrated to the existing conditions and then was used to forecast 2010 and 2030 conditions. Each scenario was modeled for two peak periods: AM (6:00-9:00) and PM (3:00-6:00). However, the traffic forecasts presented in this memo are for the peak hours.

The 2010 and 2030 traffic forecasts were based on MAPC's population, employment, and household forecasts, which were input to the Boston Region Metropolitan Planning Organization (MPO) transportation planning model, adapted to specifically fulfill the needs of this study. The forecasts were produced through a series of transportation planning analysis procedures. The appendix to this memo contains a brief description of these procedures and key inputs and assumptions used to adapt the regional planning model to the requirements of this study.

Overall, the model projected traffic growth on major roadways in the study area that ranges from 10 to 20 percent in the 2010 proposed developments scenario and from15 to 30 percent in the 2030 build out scenario. Table 1 summarizes ranges of the AM peak hour traffic volume changes on major roadways for the two scenarios. Table 2 summarizes the changes in the PM peak hour.

Table 1 Summary of AM Peak Hour Traffic Growth on Major Roadways

Major Traffic Corridor	Base Year 2005 Traffic Volume Range (Both Directions Total)	Traffic Growth Range	
		2010 Prop. Developments	2030 Build Out
Trapelo Road	1,150 - 2,750	9% - 14%	12% - 27%
Waltham St./Lexington St.	1,650 - 2,200	7% - 25%	12% - 34%
Concord Avenue	750 - 1,900	9% - 29%	17% - 54%
Mill Street	1,400 - 1,650	3% - 16%	10% - 18%
Waverly Oaks Road	700 - 1,150	10% - 22%	18% - 38%
Smith Street	1,250 - 1,350	1% - 13%	12% - 18%

Table 2 Summary of PM Peak Hour Traffic Growth on Major Roadways

Major Traffic Corridor	Base Year 2005 Traffic Volume Range (Both Directions Total)	Traffic Growth Range	
		2010 Prop. Developments	2030 Build Out
Trapelo Road	1,300 - 2,800	6% - 11%	8% - 23%
Waltham St./Lexington St.	1,500 - 2,150	1% - 9%	7% - 20%
Concord Avenue	700 - 1,750	8% - 19%	17% - 48%
Mill Street	1,350 - 1,650	7% - 10%	15% - 16%
Waverly Oaks Road	750 - 1,450	5% - 9%	16% - 22%
Smith Street	1,200 - 1,250	9% - 14%	15% - 30%

Figures 1 to 6 show the existing traffic volumes and projected changes for specific locations on major roadways in the study area. Figure 1 shows the existing AM peak hour traffic volumes on major roadway locations based on available 2005 traffic counts. Figure 2 shows the projected AM peak hour traffic growth between 2005 existing conditions and 2010 proposed developments scenarios. Figure 3 shows the projected AM peak hour traffic growth between 2005 existing conditions and 2030 build out scenarios. Figures 4, 5, and 6 show the PM traffic growth for the corresponding scenarios and locations as in the AM peak hour.

Intersection Capacity Analysis

Future traffic conditions at major intersections were analyzed for the 2010 and 2030 build out scenarios. The analysis was based on projected approach volumes, turning movements, intersection layout, traffic control parameters, and other information. Major intersections in the study area include nine signalized intersections (numbered as S-1 to S-9) and eight unsignalized intersections (numbered as U-1 to U-8):

S-1 Trapelo Road at Smith Street, Waltham
S-2 Trapelo Road at Lexington Street, Waltham
S-3 Waltham Street at Concord Avenue, Lexington

Figure 1 Base Year (2005) AM Peak Hour Traffic Volumes

Belmont, Lexington, Waltham Subarea Study

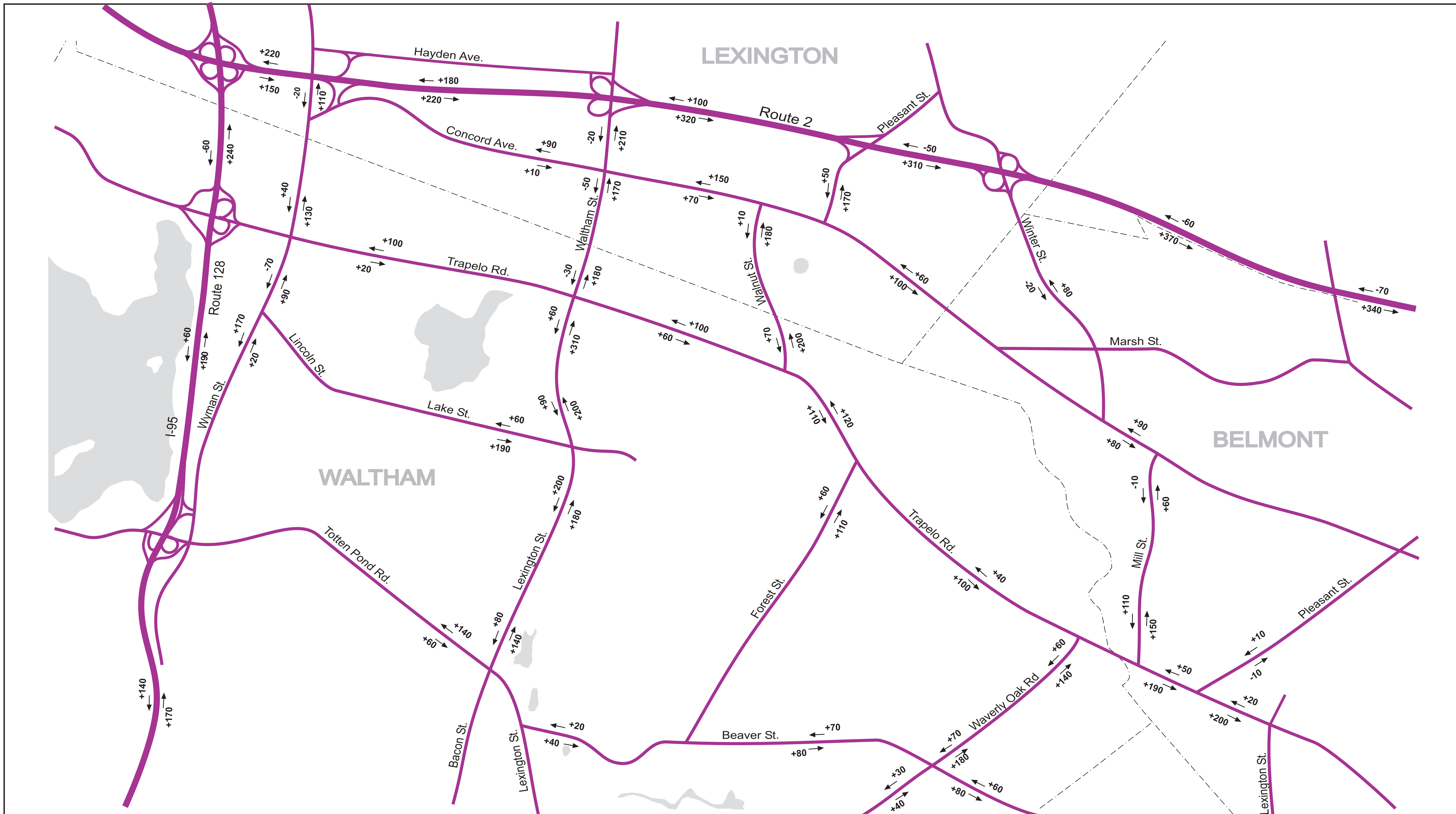


Figure 2 AM Peak Hour Traffic Growth
from 2005 Existing Conditions to 2010 Proposed Developments

Belmont, Lexington, Waltham Subarea Study

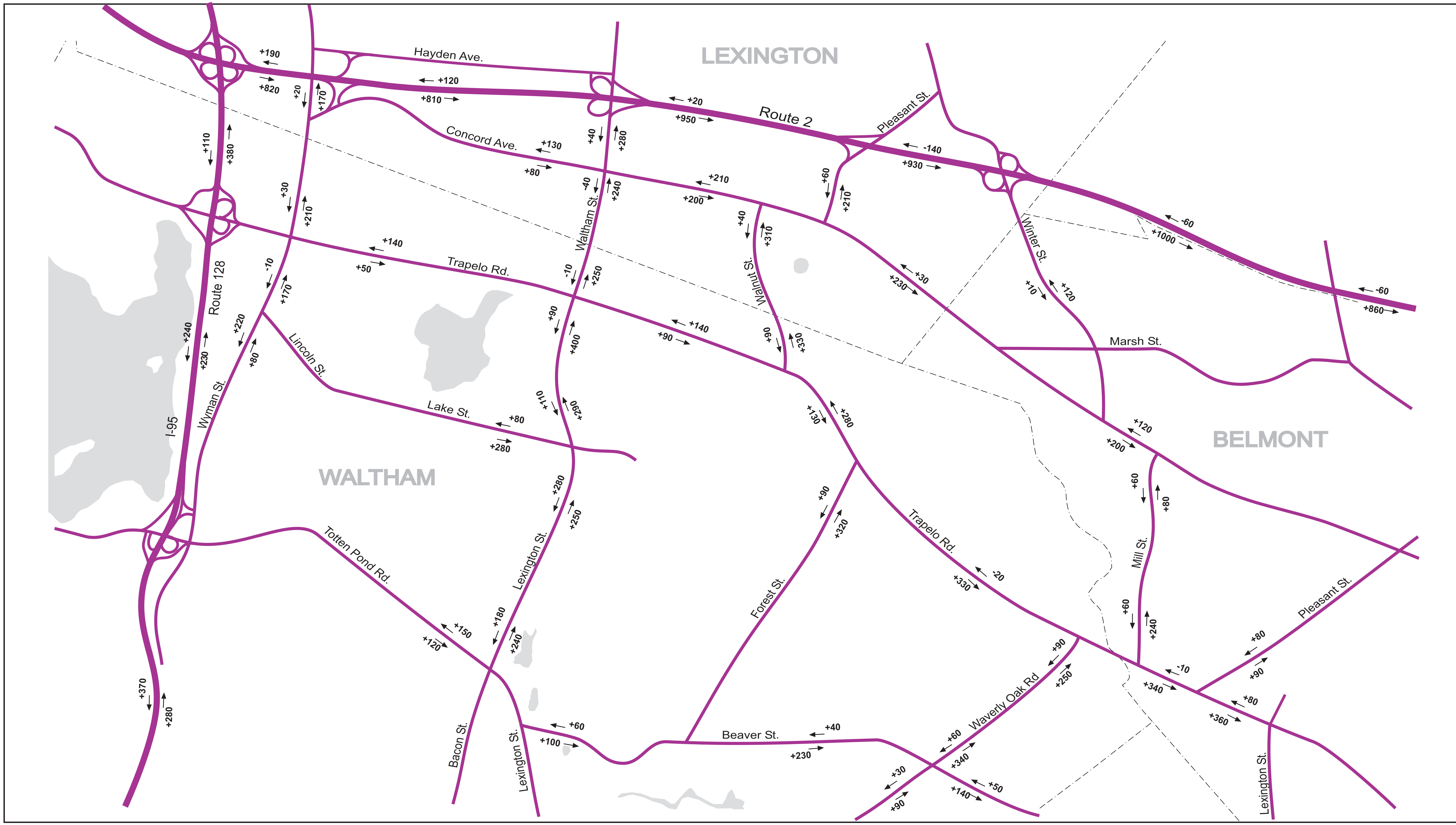


Figure 3 AM Peak Hour Traffic Growth from 2005 Existing Conditions to 2030 Build Out

Belmont, Lexington, Waltham Subarea Study

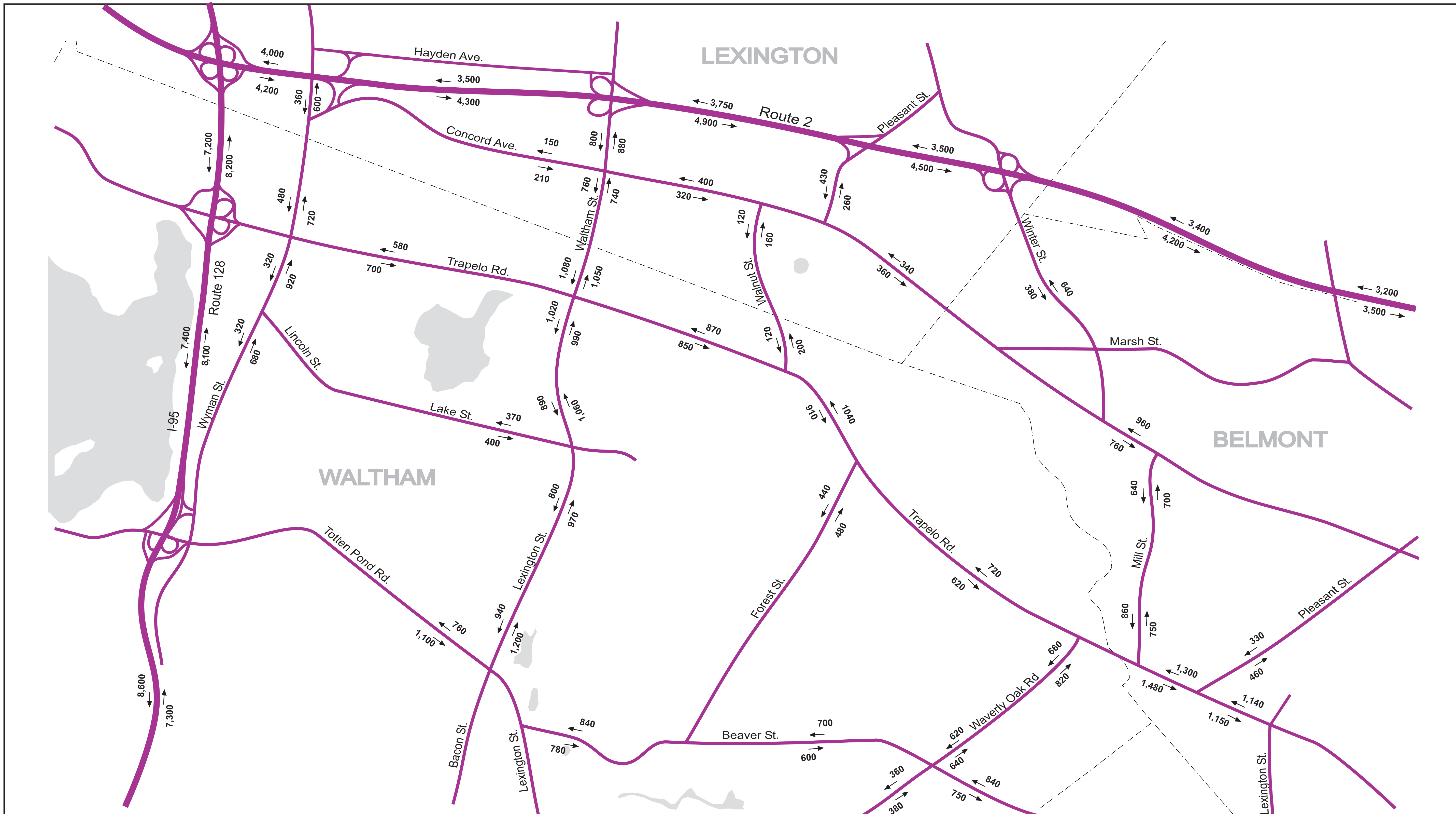


Figure 4 Base Year (2005) PM Peak Hour Traffic Volumes

Belmont, Lexington, Waltham Subarea Study

Figure 5 PM Peak Hour Traffic Growth
from 2005 Existing Conditions to 2010 Proposed Developments

Belmont, Lexington, Waltham Subarea Study

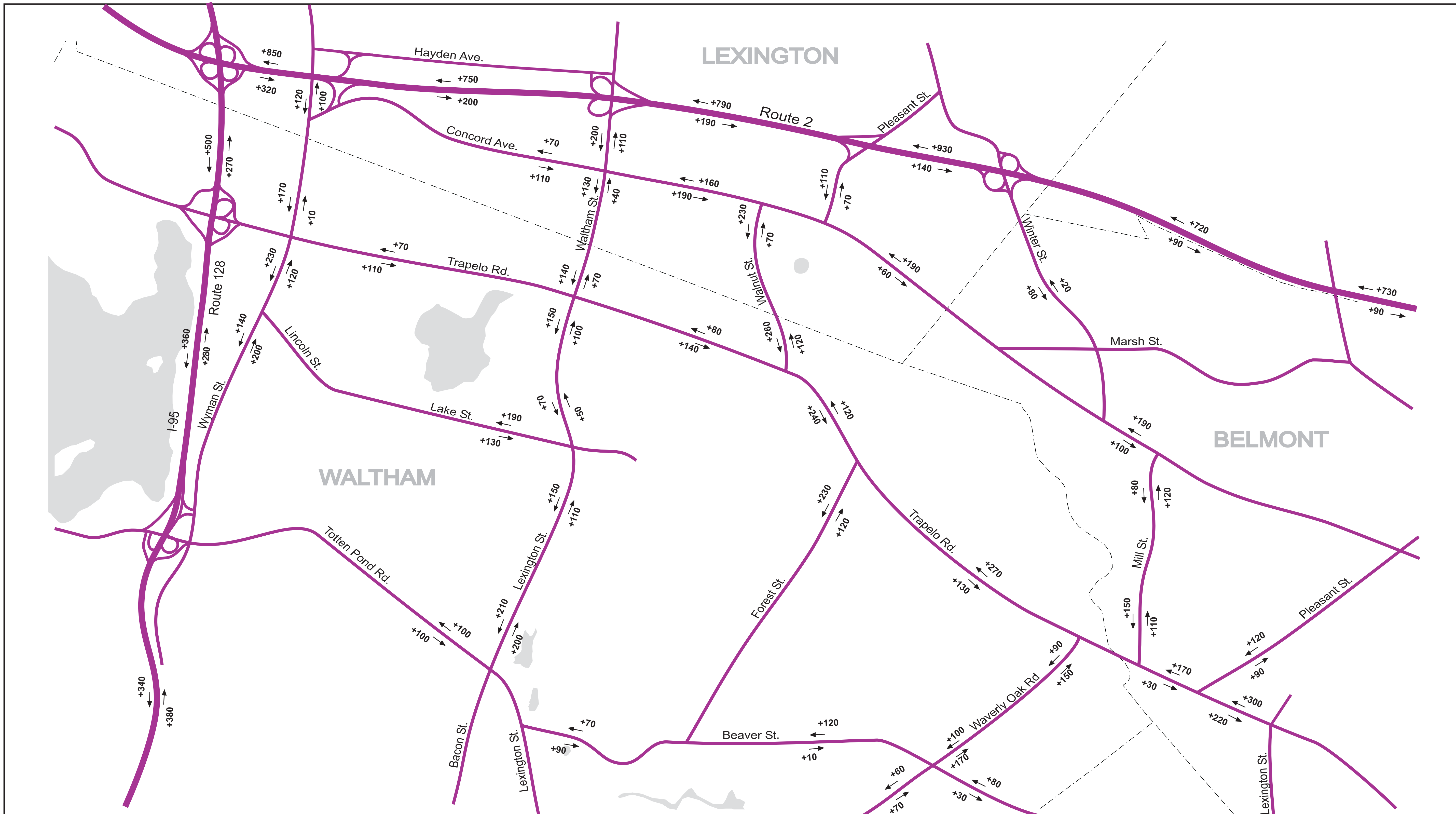


Figure 6 PM Peak Hour Traffic Growth
from 2005 Existing Conditions to 2030 Build Out

Belmont, Lexington, Waltham Subarea Study

S-4 Trapelo Road at Lake Street/Bishop's Forest Drive, Waltham
S-5 Lexington Street at Totten Pond Road/Bacon Street, Waltham
S-6 Trapelo Road at Waverly Oaks Road, Waltham
S-7 Trapelo Road at Mill Street, Belmont
S-8 Trapelo Road at Lexington Street, Belmont
S-9 Waverly Oaks Road at Beaver Street, Waltham

U-1 Concord Avenue at Walnut Street, Lexington
U-2 Concord Avenue at Pleasant Street, Lexington
U-3 Concord Avenue at Winter Street, Belmont
U-4 Concord Avenue at Mill Street, Belmont
U-5 Winter Street at Marsh Street, Belmont
U-6 Trapelo Road at Woburn Street, Waltham
U-7 Trapelo Road at Forest Street, Waltham
U-8 Trapelo Road at Pleasant Street, Belmont

The results of intersection capacity analyses are presented using the criterion of level of service (LOS), an intersection performance grading system ranging from A to F, the best and worst grade, respectively. LOS A implies unimpeded traffic flow through the intersection while E and F indicate undesirable conditions. LOS is estimated based on traffic volumes, geometry and lane allocation to traffic, traffic signal parameters, traffic volume peaking characteristics, percent heavy vehicles, pedestrian volume, traffic signal coordination, control type for unsignalized intersections, and other parameters.

Tables 3 and 4 summarize the AM and PM peak hour capacity analyses for the signalized intersections under existing conditions (2005) and the 2010 and 2030 build out scenarios. For the future scenarios, the intersection layout is assumed to remain the same as in the existing conditions for all the intersections but the signal timing was adjusted according to the projected volumes of all approaches at the intersection. For ease of analysis purposes, the intersections are arranged in four categories according to where the intersection is located: Trapelo Road Corridor, Waltham/Lexington streets Corridor, Concord Avenue Corridor, and other locations.

Tables 5 and 6 summarize the AM and PM peak hour capacity analyses for the unsignalized intersections under existing conditions and the 2010 and 2030 build out scenarios. For the future scenarios, the intersection layout and traffic control are assumed to remain the same as in the existing conditions for all the intersections. The intersections are arranged in three categories: Trapelo Road Corridor, Concord Avenue Corridor, and other locations.

Table 3 Summary of AM Peak Hour Capacity Analysis for Signalized Intersections

Intersection Number and Location		City/ Town	2005 Existing Conditions			2010 Proposed Developments			2030 Build Out		
			Total Entry Volume	Overall LOS	Average Delay (sec.)	Total Entry Volume	Overall LOS	Average Delay (sec.)	Total Entry Volume	Overall LOS	Average Delay (sec.)
S-1	Trapelo Rd @ Smith St	Waltham	3,050	F	130	3,310	F	> 180	3,585	F	> 180
S-2	Trapelo Rd @ Lexington St	Waltham	3,650	D	52	4,035	E	58	4,220	E	64
S-6	Trapelo Rd @ Waverly Oaks Rd	Waltham	1,950	C	32	2,245	D	55	2,520	F	110
S-7	Trapelo Rd @ Mill St	Belmont	3,100	D	38	3,475	E	60	3,665	F	95
S-8	Trapelo Rd @ Lexington St	Belmont	2,750	C	25	2,985	C	28	3,323	D	50
S-3	Waltham St @ Concord Ave	Lexington	2,350	D	54	2,645	E	77	2,910	F	132
S-4	Lexington St @ Lake St	Waltham	2,050	C	25	2,465	D	36	2,695	D	45
S-5	Lexington St @ Totten Pond Rd	Waltham	3,450	E	74	3,820	F	88	4,085	F	94
S-9	Waverly Oaks Rd @ Beaver St	Waltham	2,300	C	34	2,605	D	44	2,795	D	52

Table 4 Summary of PM Peak Hour Capacity Analysis for Signalized Intersections

Intersection Number and Location		City/ Town	2005 Existing Conditions			2010 Proposed Developments			2030 Build Out		
			Total Entry Volume	Overall LOS	Average Delay (sec.)	Total Entry Volume	Overall LOS	Average Delay (sec.)	Total Entry Volume	Overall LOS	Average Delay (sec.)
S-1	Trapelo Rd @ Smith St	Waltham	2,850	E	55	3,140	E	62	3,415	F	94
S-2	Trapelo Rd @ Lexington St	Waltham	3,850	E	58	4,070	E	60	4,260	E	64
S-6	Trapelo Rd @ Waverly Oaks Rd	Waltham	2,350	D	35	2,590	D	44	2,930	E	69
S-7	Trapelo Rd @ Mill St	Belmont	3,300	E	67	3,515	E	72	3,785	E	85
S-8	Trapelo Rd @ Lexington St	Belmont	2,750	C	27	3,080	C	32	3,390	D	45
S-3	Waltham St @ Concord Ave	Lexington	2,100	D	38	2,300	D	48	2,600	F	84
S-4	Lexington St @ Lake St	Waltham	2,300	C	30	2,410	D	35	2,620	D	45
S-5	Lexington St @ Totten Pond Rd	Waltham	3,750	E	74	3,985	F	82	4,265	F	100
S-9	Waverly Oaks Rd @ Beaver St	Waltham	2,500	C	34	2,625	D	37	2,810	D	42

Table 5 Summary of AM Peak Hour Capacity Analyses for Unsignalized Intersections

Intersection Number and Location		City/Town	2005 Existing Conditions			2010 Proposed Developments			2030 Build Out		
			Total Entry Volume	Minor Street LOS	Minor Street Delay (sec.)	Total Entry Volume	Minor Street LOS	Minor Street Delay (sec.)	Total Entry Volume	Minor Street LOS	Minor Street Delay (sec.)
U-6	Trapelo Rd @ Woburn St	Waltham	1,785	F	70	2,085	F	> 180	2,280	F	> 180
U-7	Trapelo Rd @ Forest St	Waltham	1,845	E	38	2,100	F	> 180	2,250	F	> 180
U-8	Trapelo Rd @ Pleasant St	Belmont	2,885	F	150	3,115	F	> 180	3,335	F	> 180
U-1	Concord Ave @ Walnut St	Lexington	920	B	14	1,120	F	80	1,410	F	150
U-2	Concord Ave @ Pleasant St	Lexington	1,120	F	53	1,315	F	170	1,515	F	> 180
U-3	Concord Ave @ Winter St	Belmont	1,935	F	118	2,100	F	150	2,250	F	> 180
U-4	Concord Ave @ Mill St	Belmont	1,980	F	75	2,165	F	118	2,325	F	> 180
U-5	Winter St @ Marsh St	Belmont	1,155	C/D	17/30	1,250	C/E	23/37	1,350	D/E	33/37

Table 6 Summary of PM Peak Hour Capacity Analyses for Unsignalized Intersections

Intersection Number and Location		City/Town	2005 Existing Conditions			2010 Proposed Developments			2030 Build Out		
			Total Entry Volume	Minor Street LOS	Minor Street Delay (sec.)	Total Entry Volume	Minor Street LOS	Minor Street Delay (sec.)	Total Entry Volume	Minor Street LOS	Minor Street Delay (sec.)
U-6	Trapelo Rd @ Woburn St	Waltham	1,985	F	56	2,225	F	> 180	2,445	F	> 180
U-7	Trapelo Rd @ Forest St	Waltham	2,110	F	> 180	2,265	F	> 180	2,445	F	> 180
U-8	Trapelo Rd @ Pleasant St	Belmont	3,005	F	> 180	3,220	F	> 180	3,435	F	> 180
U-1	Concord Ave @ Walnut St	Lexington	900	B	13	1,050	C	22	1,050	F	78
U-2	Concord Ave @ Pleasant St	Lexington	1,075	C	25	1,225	E	36	1,420	F	70
U-3	Concord Ave @ Winter St	Belmont	1,750	D	30	1,890	F	58	2,050	F	116
U-4	Concord Ave @ Mill St	Belmont	1,790	F	66	1,940	F	108	2,105	F	> 180
U-5	Winter St @ Marsh St	Belmont	1,160	C/C	16/20	1,250	C/D	20/30	1,355	D/E	26/45

Traffic Impacts and Potential Mitigation

In general, Tables 3 to 6 show a deterioration of conditions between 2005 and the two future scenarios, 2010 and 2030. Depending on intersection location and importance, proximity to prospective developments, and existing geometry, some locations are impacted more than others. The level of service results reflect the impacts of traffic growth but do not reflect mitigation strategies, other than minor traffic signal timing adjustments at signalized intersections.

Traffic impacts and potential mitigation are described below by intersection and by major corridor, where the intersection is located.

Trapelo Road Corridor

S1 – Trapelo Road at Smith Street
The LOS at this intersection is evaluated as undesirable under the existing conditions and it is expected to become worse in the future. Potential improvements include:

- Geometric changes, including pedestrian crosswalks
- New traffic signal equipment
- Improved traffic signal design, including pedestrian phase and exclusive left turn phases for southbound, eastbound, and westbound traffic

S2 – Trapelo Road at Lexington Street
Future traffic growth will affect this intersection marginally. With traffic signal timing adjustments to increase somewhat intersection capacity, the future level of service is not expected to deteriorate seriously from the present level.

U6 – Trapelo Road at Woburn Street
Woburn Street, the minor approach at this unsignalized intersection, was found to have undesirable LOS under existing conditions and in the future scenarios. Potential improvements include:

- Possibly, the installation of a traffic signal, including pedestrian phases
- Geometric changes, pavement markings, and crosswalks

U7 – Trapelo Road at Forest Street
The LOS of the minor street (Forest Street) approach was found undesirable under existing conditions and in the future scenarios. To improve traffic conditions, the following actions may be considered:

- According to the 2007-2010 Transportation Improvement Program files of the Boston region MPO, the City of Waltham needs to initiate the project development process.
- This intersection may warrant the installation of a traffic signal.
- Intersection improvements should include traffic use of Doty Street.
- Geometric changes should be considered, including a westbound left turn storage lane on Trapelo Road.

S6, S7, U8, and S8 – Trapelo Road at Waverly Oaks Road, Mill Street, Pleasant Street, and Lexington Street

These three signalized and one unsignalized intersections are located close to each other and must be examined as a system. Future traffic operations are expected to deteriorate at all of them by various degrees.

- At this time, the most recent mitigation plan for these four locations appears to be adequate, given the limited space for right-of-way expansion along Trapelo Road.
- Extending the bicycle lane that is included in this plan westward to Lexington Street would be desirable.

<u>Waltham/Lexington Streets Corridor</u>

S3 – Waltham Street at Concord Avenue

The operation of this signalized intersection is expected to deteriorate gradually into the future, especially during the morning peak hour. Most of the deterioration is attributed to the high southbound left turns and the narrow east-west Concord Avenue approaches. To mitigate traffic growth into the future, the following may be considered:

- Introduce a left-turning storage lane on the Concord Avenue westbound approach.
- Make adjustments to the traffic signal phase design and timing.
- Examine traffic signal phase design and stripe the Waltham Street northbound and southbound approaches accordingly.

S4 – Lexington Street at Lake Street

The LOS at this intersection will maintain acceptable LOS into the future; only minor traffic signal timing adjustments will be required.

S5 – Lexington Street at Totten Pond Road/Bacon Street

The operation of this heavily traveled, multiphase signalized intersection is already deficient under existing conditions and is expected to deteriorate somewhat in the future.

- For the immediate future, overhead traffic lane assignment signs are needed for the southbound approach to help direct drivers to the correct lanes.
- In the near future, the City of Waltham should initiate project development procedures according to the universe of projects files of the 2007-2010 Transportation Improvement Program of the Boston Region MPO.

<u>Concord Avenue Corridor</u>

U1 and U2 – Concord Avenue at Walnut Street and at Pleasant Street

The proximity and function of these two unsignalized intersections dictates that they be examined in tandem. Traffic from the Walnut Street and Pleasant Street cannot easily find gaps to enter Concord Avenue, especially during the future AM peak hour.

- The Pleasant Street intersection likely warrants traffic signal control.
- This treatment would benefit the Walnut Street traffic as sufficient gaps will be created for it to enter Concord Avenue.
- Both intersections will benefit from geometric improvements, including pavement markings and pedestrian crossings.

U3 and U4 – Concord Avenue at Winter Street and at Mill Street
The proximity and traffic pattern through these two unsignalized intersections require that they be treated as a system. The following should be considered for improved operations and safety:
- Traffic signal installation and coordination
- Geometric changes and pavement markings
- Pedestrian sidewalk and crosswalks

Other Intersections

U5 – Winter Street at Marsh Street
A minor deterioration is expected at this unsignalized intersection. No improvements are recommended here at this time.

S9 – Waverly Oaks Road at Beaver Street
Capacity analysis indicates that this intersection has sufficient capacity to handle traffic growth in the future. No improvements are recommended at this time.

APPENDIX

Belmont, Lexington, and Waltham Subarea Study: Model Description

Model Set

The model set simulates travel on the entire transit and highway system in Eastern Massachusetts. As such, it contains all MBTA rail and bus lines all MBTA ferry service, and all private express bus carriers. The model contains service frequency (i.e. how often trains and buses arrive at any given transit stop), routing, travel time and fares for all these lines. In the highway system, all express highways and principal arterial roadways and many minor arterial and local roadways are included. The outputs of the model set contain detailed information relating to the transportation system. On the highway side, the model output contains traffic volumes, congested travel speeds, vehicle miles traveled, average travel times on the roadway links etc. On the transit side, the output provides information relating to the average weekday ridership on different transit sub modes (commuter rail, rapid transit, local buses, express buses and private carriers), station boardings, park-n-ride demand, peak load volumes etc.

As mentioned earlier, this model set was modified to specifically meet the requirements of the Belmont, Lexington, and Waltham study. A brief description of some of these modifications follows.

Modeling Scenarios

The transportation model consists of four future land use scenarios. They are:

- 2010 proposed developments
- 2030 build-out
- 2030 smart growth scenario 1
- 2030 smart growth scenario 2

The 2010 proposed developments scenario includes all the proposed land developments in the study area. The 2030 build out scenario includes all the developments in the 2010 scenario and all other land in the study area being developed to its fullest allowable zoning. The study team has completed the preliminary model development for these two scenarios. Each was modeled for two time periods: AM (6:00-9:00) and PM (3:00-6:00). The model for the 2030 smart growth scenarios will be developed after they are defined in coordination with the study advisory committee.

Traffic Analysis Zone System

The transportation model for this study was developed from the most updated regional transportation model, which contains 2727 traffic analysis zones (TAZs) and associated roadway and transit networks. For the area outside the study area, the TAZ delineation remains the same as the regional model. For the area inside the study area, some TAZs remained the same as in the regional model; zones that have potential for future developments were disaggregated into finer zones. This resulted in ten additional zones (see Figure A-1 and Table A-1).

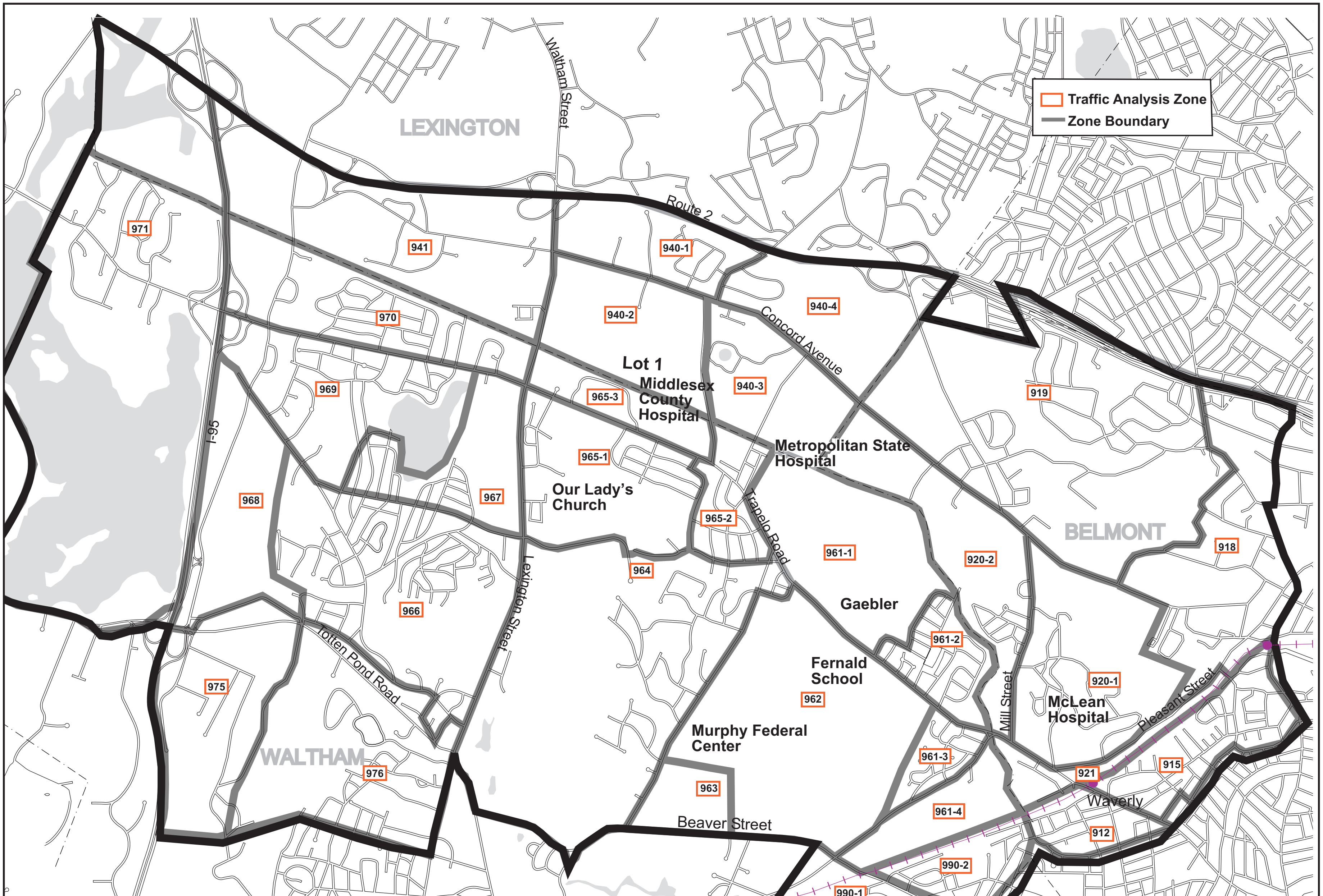


Figure A-1 Traffic Analysis Zones in the Study Area

Belmont, Lexington, Waltham Subarea Study

Table A-1 Dissagregation of Traffic Analysis Zones in the Study Area

City/Town	Original Zone (2727-TAZ System)	Disaggregated Zones	Number of Additional Zones
Belmont	920	920-1, 920-2	1
Lexington	940	940-1, 940-2, 940-3, 940-4	3
Waltham	961	961-1, 961-2, 961-3, 961-4	3
	965	965-1, 965-2, 965-3	2
	990	990-1, 990-2	1
Total number of Additional Zones			10

Future Network Assumptions

In the future, a number of roadway and transit projects are expected to be in operation in the Boston metropolitan region. These projects were coded in the future year roadway and transit networks in order to reflect the anticipated changes in the supply of transportation services. Table A-2 shows transportation projects that were coded in the 2010 and/or 2030 network. The list was derived from the most-recently approved transportation plan of the Boston region MPO. The transportation projects listed for 2030 will be applied to the build out as well as to each of the two smart growth scenarios.

Socio-economic Forecasts

Socio-economic data, such as population and employment, are essential inputs to the transportation model. Based on review of the proposed projects and build out scenario with the study area communities, MAPC produced the population, households, and employment forecasts in the study area for the 2010 proposed developments and 2030 build-out scenarios. These data were used as inputs to the traffic analysis zones within the study area (see Table A-3). For the area outside the study area, the projections are based on the forecasts developed by MAPC for the most recently approved regional transportation plan. A similar procedure will be followed for the analysis of the two 2030 smart growth scenarios.

The Four-Step Process

The regional model sets are based on the traditional four-step, sequential process known as trip generation, trip distribution, mode choice and trip assignment. The model set employs sophisticated and involved techniques in each step of the process. The following paragraphs describe very briefly what each step does.

Trip Generation: This is the most important step of the model chain. In this step, the model estimates the number of trips produced in and attracted to each traffic zone. To do this, the model uses estimates of projected population, employment and other socioeconomic and household characteristics of that zone. Trips are divided into four major categories, home-based work trips, home-based school trips, home-based other trips and non-home based trips.

Table A-2 Transportation Projects in 2010 and/or 2030 Network

Project	2010	2030	Note
Crosby Drive (Bedford)	X	X	Roadway Project
Miiddlesex Turnpike (Bedford & Burlington)	X	X	Roadway Project
Rt. 128 Capacity Improvements (Beverly to Peabody)		X	Roadway Project
East Boston Haul Road/Chelsea Truck Route (Boston)		X	Roadway Project
Arborway Restoration (Boston)	X	X	Transit System
Red Line/Blue Line Connector (Boston)		X	Transit System
Fairmount Line Improvements (Boston)	X	X	Transit System
Route 1A/Boardman Street Grade Separation (Boston)		X	Roadway Project
Russia Wharf Ferry Terminal (Boston)	X	X	Transit System
Rutherford Avenue (Boston)		X	Roadway Project
Silver Line Phase 3 (50/50) (Boston)		X	Transit System
Old Colony/Greenbush Commuter Rail (Boston to Scituate)	X	X	Transit System
Green Line to Medford Hillside (Boston, Medford & Somerville)		X	Transit System
Urban Ring Phases I & 2 (Compact Communities)		X	Transit System
I-93/I-95 interchange (Canton)		X	Roadway Project
I-95 (NB)/Dedham Street Ramp (Canton)		X	Roadway Project
Concord Rotary (Concord)		X	Roadway Project
Route 2/Crosb's Corner (Concord and Lincoln)	X	X	Roadway Project
Route 1/114 Corridor Improvements (Danvers & Peabody)		X	Roadway Project
Telecom City Boulevard (Everett Maiden & Medford)		X	Roadway Project
Revere Beach Parkway (Everett & Medford)		X	Roadway Project
Route 126/135 Grade Separation (Framingham)		X	Roadway Project
Route 9/126 Interchange (Framingham)		X	Roadway Project
Route 53 (Hanover)	X	X	Roadway Project
Route 53/228 (Hingham and Norwell)	X	X	Roadway Project
Rte. 128 Capacity Improvements (Lynnfield to Reading)		X	Roadway Project
Route 1 Improvements (Malden & Revere)		X	Roadway Project
I-495/I-290/Route 85 Interchange (Marlborough)		X	Roadway Project
Needham Street/Highland Avenue (Newton & Needham)		X	Roadway Project
Burgin Parkway (Quincy)	X	X	Roadway Project
Quincy Center Concourse, Phase 2 (Quincy).		X	Roadway Project
1-93/1-95 Initiative (Reading & Woburn)		X	Roadway Project
Mahoney Circle Grade Separation (Revere)		X	Roadway Project
Route 1/Route 16 Interchange (Revere)		X	Roadway Project
Route 1A/Route 16 Connection (Revere)		X	Roadway Project
North Shore Transit Improvements (Revere to Salem)		X	Transit System
Boston Street (Salem)		X	Roadway Project
Bridge Street (Salem)		X	Roadway Project
Assembly Square Orange Line Station (Somerville)		X	Transit System
I-93/Mystic Avenue Interchange (Somerville)		X	Roadway Project
Naval Air Station Access Improvements (Weymouth)		X	Roadway Project
Route 18 (Weymouth)	X	X	Roadway Project
Route 3 South Additional Lanes (Weymouth to Duxbury)		X	Roadway Project
I-93/Ballardvale Street Interchange (Wilmington)		X	Roadway Project
I-93/Route 129 Interchange (Wilmington)		X	Roadway Project
New Boston Street Bridge (Woburn)		X	Roadway Project
Worcester Commuter Rail Full Service with Four New Stations	X	X	Transit System
100 Additional Buses to Improve Service on Existing Routes		X	Transit System
Additional Park & Ride Spaces	X	X	Transit System

Table A-3 Socio-economic forecasts for 2010 and 2030 Build-out Scenarios

TAZ	TOWN	HH 2010	POP 2010	EMP 2010	HH 2030	POP 2030	EMP 2030
912	BELMONT	505	998	308	509	1033	458
915	BELMONT	732	1812	205	820	2064	1237
918	BELMONT	502	1389	577	559	1538	748
919	BELMONT	520	1411	386	503	1387	337
920-1	BELMONT	693	1125	1664	693	1025	3153
920-2	BELMONT	144	422	3	144	379	3
921	BELMONT	142	431	736	316	842	1458
940-1	LEXINGTON	221	559	5	235	592	5
940-2	LEXINGTON	316	604	509	369	727	525
940-3	LEXINGTON	529	1249	35	529	1197	35
940-4	LEXINGTON	62	161	61	69	178	61
941	LEXINGTON	362	909	1427	371	970	2286
961-1	WALTHAM	2	5	7	2	11	7
961-2	WALTHAM	424	954	8	434	1071	8
961-3	WALTHAM	230	518	12	233	948	12
961-4	WALTHAM	4	9	1833	4	12	2633
962	WALTHAM	78	160	1580	1468	3162	1580
963	WALTHAM	1	2409	1131	1	2409	1086
964	WALTHAM	920	2325	678	983	2477	650
965-1	WALTHAM	1035	2329	82	1046	2059	82
965-2	WALTHAM	280	630	161	287	852	161
965-3	WALTHAM	404	880	421	460	977	462
966	WALTHAM	1363	3616	209	1590	4150	241
967	WALTHAM	1367	3205	449	1380	3209	502
968	WALTHAM	8	27	6826	19	50	6878
969	WALTHAM	602	1506	30	738	1820	41
970	WALTHAM	408	1033	1131	410	1050	1262
971	WALTHAM	319	982	2436	313	972	2347
975	WALTHAM	1	1	5370	0	0	6148
976	WALTHAM	398	1004	201	426	1076	213
990-1	WALTHAM	1042	2588	434	1121	2606	419
990-2	WALTHAM	216	486	568	241	583	605

Trip Distribution: In this step, the distribution model links the trip ends estimated from trip generation to form zonal trip interchanges or movements between two zones. The output of this second step is a trip table, which is a matrix containing the number of trips occurring between every origin-destination zone combination. Trip distribution is performed for each trip purpose.

Mode Choice*:* The mode choice model set consists of four models, one for each trip purpose. The model allocates the person trips estimated from the trip distribution step to the two primary competing modes: automobile and transit. This allocation is based on the desirability or utility of each choice a traveler faces, based on the attributes of that choice and the characteristics of the individual. The resulting output of the mode choice model is the percentage of trips that use the automobile and transit for each trip interchange. The transit trips are further divided into two modes of access: walk-access transit trips and drive-access transit trips (park-n-ride trips). The auto trips are further divided into single-occupancy and multiple occupancy trips.

Trip Assignment: In this final step, the model assigns the transit trips to different transit modes such as subway, commuter rail, local bus, express bus etc. To do this, it uses the shortest transit path from one zone to another. This path may involve just one mode such as a local bus or commuter rail or multiple modes such as a local bus and a transfer to the subway line, etc. The highway trips are assigned to the highway network. Thus, the future year traffic volumes on the highways and forecasted transit ridership on different transit lines can be obtained from the model outputs.

Preparing the Model for Application

Before applying the model set to the Belmont, Lexington, and Waltham study, it was adjusted several times until it replicates the existing highway volumes and transit ridership data at an acceptable level of accuracy. This adjustment is called model calibration. It is usually performed by adjusting the highway and transit access links and times from each zone in the study area. Then inputs to the model set for the forecast year are created and the entire model set is run to simulate future year travel.

Appendix D
Population and Employment Projections

Metropolitan Area Planning Council
60 Temple Place, Boston, Massachusetts 02111 617/451-2770 Fax 617/482-7185
MAPC
Serving 101 cities and towns in metropolitan Boston

MEMORANDUM

November 3, 2006

FROM: **Simon van Leeuwen and Rebecca Dann, Metropolitan Area Planning Council**

TO: **The Study Advisory Committee and the Interested Public**

RE: **Belmont-Lexington-Waltham Sub-Area Study –Population and Employment Projections**

As part of the Belmont-Lexington-Waltham Sub-Area Study[*], the Metropolitan Area Planning Council (MAPC) has completed projections of households, population, and employment for the years 2010 and 2030 for the Study Area. These projections are based on a detailed lot-by-lot analysis of: large scale planned or potential projects identified in the study area, current zoning, development restricted land, and input from local planners, the study advisory committee, and community members.

These projections are used to develop a simulation of future transportation conditions in and around the study area. Both the projections and the resulting transportation impacts will be presented and discussed at the 3rd Advisory Committee meeting of the Belmont, Lexington, and Waltham Sub-Area Study. They will inform the development of an alternative land use scenario and potential transportation approaches to mitigate the traffic generated by increasing development.

A summary of the most significant elements of the projections for each community is given below. In addition, projected numbers in the categories of Households, Population, and Employment by Traffic Analysis Zone (TAZ) for the years 2010 and 2030 are provided in Appendix 1, as well as the corresponding numbers for the years 2000 and 2005 for comparison. (A map of the study area's TAZs has been included as Appendix 3.) These projections represent the aggregate of the general build out analysis coupled with the identified planned and potential projects for each TAZ. Detailed information on the "Identified Projects" in each of the three communities and the growth they are expected to generate in population, households, and employment in the years 2010 and 2030 is included in Appendix 2.

[*] Please see the project's website (**http://www.mapc.org/transportation/trapelo.html**) for background information on the study.

Significant elements of Belmont's projections include:

- The Belmont portion of the study area includes almost 2,000 parcels.
- 2030 projections estimate over 1070 new housing units in this area and 3974 new jobs.
- The McLean Hospital redevelopment will include approximately 640 new housing units and 650 new jobs by 2030. All of the housing along with the offices accounting for over 430 of the jobs are already built or permitted.
- The Town of Belmont plans to increase the intensity of commercial use at Waverly Square and Belmont Center.
- McLean Hospital redevelopment, the increased intensity of use in Waverly Square and Bemont Center, and the reconstruction of Pleasant St/Route 60 will lead to the full use of business parcels along Pleasant Street/Route 60, which are currently underutilized. The expected development in these areas accounts for all of Belmont's projected employment growth outside of McLean Hospital.
- The potential air-rights development of a mix of apartments over retail above Waverly Square Station will add 170 housing units and roughly 30 jobs.

Significant elements of Lexington's projections include:

- The Lexington portion of the study area includes almost 500 parcels.
- 2030 projections estimate totals of over 560 new housing units in this area and 940 new jobs.
- Of the new housing units projected for this area of Lexington, nearly 450 of them are already built or permitted. Out of the remaining units projected, 48 are from projected development on Lot One of the former Middlesex County Hospital Site and the rest are from smaller possible developments identified through the buildout analysis.
- The jobs projected include a potential new office development on Spring Street with approximately 880 new jobs. This assumption does not reflect current a development proposal. Rather, it is based on a number of factors, including location, current zoning, ownership, similar developments, and activity on surrounding parcels (see the 'Identified Projects' page for more detail).

Significant elements of Waltham's projections include:

- The Waltham portion of the study area includes approximately 5,300 parcels.
- 2030 projections estimate over 2,700 new housing units in this area and 2,400 new jobs.
- 590 of the projected housing units and just 77 of the projected jobs are accounted for by developments that are already built or permitted.
- The potential by-right redevelopment of the Fernald Center represents almost half of all projected housing development between 2000 and 2030 (1,200 Units).
- The 2,400 new jobs projected for 2030 are clustered in two main areas:
    - Nearly 1,200 jobs are projected in the parts of the study area closest to Route 128. In addition, several other major sites in Waltham along Route 128 south of the study area are expected to see significant increases in commercial development.

- 800 jobs are expected along Pleasant Street, where existing business parcels are currently underutilized. The assumption there is that the redevelopment of McLean Hospital and the reconstruction of Pleasant St/Route 60 in Belmont will spark redevelopment along Pleasant St. in Waltham.

Please direct concerns, suggestions, and/or corrections to the project email address (bel.lex.wal@mapc.org). Comments and input are appreciated throughout the project.

Appendix 1. Growth projections by Transportation Analysis Zone (TAZ)

Tables 1.a Households

BELMONT

Transportation Analysis Zone (TAZ)	2000	2005	2010	2030*	2030**	Net New Households at 2030**
912	491	495	505	509	509	18
915	720	726	732	820	820	100
918	458	480	502	559	559	101
919	467	493	520	503	503	36
920-1	52	52	693	693	693	641
920-2	144	144	144	144	144	0
921	140	141	142	146	316	176
BELMONT Total	2472	2531	3238	3374	3544	1072

LEXINGTON

Transportation Analysis Zone (TAZ)	2000	2005	2010	2030*	2030**	Net New Households at 2030**
940-1	221	221	221	235	235	14
940-2	256	256	316	321	369	113
940-3	143	143	530	530	530	387
940-4	62	62	62	69	69	7
941	330	346	362	371	371	41
LEXINGTON Total	1012	1028	1491	1526	1574	562

WALTHAM

Transportation Analysis Zone (TAZ)	2000	2005	2010	2030*	2030**	Net New Households at 2030**
961-1	2	2	2	2	2	0
961-2	424	424	424	434	434	10
961-3	230	230	230	233	233	3
961-4	4	4	4	4	4	0
962	20	20	78	495	1468	1448
963	1	1	1	1	1	0
964	854	887	920	983	983	129
965-1	1035	1035	1035	1046	1046	11
965-2	280	280	280	287	287	7
965-3	136	136	404	460	460	324
966	1320	1342	1363	1501	1590	270
967	1103	1123	1367	1380	1380	277
968	8	8	8	19	19	11
969	580	591	602	738	738	158
970	394	401	408	410	410	16
971	299	309	319	313	313	14
975	1	1	1	0	0	-1
976	381	390	398	426	426	45
990-2	216	216	216	241	241	25
WALTHAM Total	7288	7399	8061	8973	10035	2747

* 2030 numbers without the "Under Consideration" projects

** 2030 numbers including the "Under Consideration" projects

Tables 1.b Population

BELMONT

Transportation Analysis Zone (TAZ)	2000	2005	2010	2030*	2030**	Net New Population at 2030**
912	991	986	998	1033	1033	42
915	1833	1823	1812	2064	2064	231
918	1304	1347	1389	1538	1538	234
919	1304	1357	1411	1387	1387	83
920-1	173	173	1125	1025	1025	852
920-2	379	379	422	379	379	0
921	435	433	431	449	842	407
BELMONT Total	6419	6497	7588	7874	8266	1847

LEXINGTON

Transportation Analysis Zone (TAZ)	2000	2005	2010	2030*	2030**	Net New Population at 2030**
940-1	559	559	559	592	592	33
940-2	516	516	604	614	727	211
940-3	287	287	1251	1200	1200	913
940-4	161	161	161	178	178	17
941	878	893	909	970	970	92
LEXINGTON Total	2401	2416	3484	3554	3667	1266

WALTHAM

Transportation Analysis Zone (TAZ)	2000	2005	2010	2030*	2030**	Net New Population at 2030**
961-1	11	11	5	11	11	0
961-2	1049	1049	954	1071	1071	22
961-3	942	942	518	948	948	6
961-4	12	12	9	12	12	0
962	44	44	160	1061	3162	3118
963	2409	2409	2409	2409	2409	0
964	2198	2261	2325	2477	2477	279
965-1	2035	2035	2329	2059	2059	24
965-2	837	837	630	852	852	15
965-3	277	277	880	977	977	700
966	3567	3592	3616	3958	4150	583
967	2611	2633	3205	3209	3209	598
968	26	26	27	50	50	24
969	1479	1493	1506	1820	1820	341
970	1015	1024	1033	1050	1050	35
971	942	962	982	972	972	30
975	1	1	1	0	0	-1
976	979	991	1004	1076	1076	97
990-2	529	529	486	583	583	54
WALTHAM Total	20963	21129	22078	24594	26888	5925

* 2030 numbers without the "Under Consideration" projects
** 2030 numbers including the "Under Consideration" projects

Tables 1.c Employment

BELMONT

Transportation Analysis Zone (TAZ)	2000	2005	2010	2030*	2030**	Net New Jobs at 2030**
912	295	302	308	458	458	163
915	226	215	205	1237	1237	1011
918	546	561	577	748	748	202
919	397	392	386	337	337	-60
920-1	1232	1232	1664	2928	3153	1921
920-2	3	3	3	3	3	0
921	721	728	736	1431	1458	737
BELMONT Total	2704	3075	3878	7141	7394	3974

LEXINGTON

Transportation Analysis Zone (TAZ)	2000	2005	2010	2030*	2030**	Net New Jobs at 2030**
940-1	5	5	5	5	5	0
940-2	499	499	509	525	525	26
940-3	35	35	35	35	35	0
940-4	61	61	61	61	61	0
941	1367	1384	1427	1398	2286	919
LEXINGTON Total	1967	1984	2037	2024	2912	946

WALTHAM

Transportation Analysis Zone (TAZ)	2000	2005	2010	2030*	2030**	Net New Jobs at 2030**
961-1	7	7	7	7	7	0
961-2	8	8	8	8	8	0
961-3	12	12	12	12	12	0
961-4	1833	1833	1833	2633	2633	800
962	1503	1503	1580	1580	1580	77
963	1086	1108	1131	1086	1086	0
964	650	664	678	650	650	0
965-1	82	82	82	82	82	0
965-2	161	161	161	161	161	0
965-3	397	409	421	462	462	64
966	203	206	209	241	241	38
967	449	435	449	502	502	53
968	6585	6705	6826	6878	6878	293
969	29	29	30	41	41	12
970	1148	1140	1131	1262	1262	115
971	2347	2392	2436	2347	2347	0
975	5243	5307	5370	6148	6148	904
976	196	199	201	213	213	17
990-2	568	568	568	605	605	37
WALTHAM Total	22506.96	22767	23134	24918	24918	2411

* 2030 numbers without the "Under Consideration" projects
** 2030 numbers including the "Under Consideration" projects

Appendix 2. Specifically Identified Projects*

BELMONT

Group	Project Name	Project Location	Address	Proponent/Owner	Completion	Description	Building Sq ft		Site Size (acres)	Units	Map - Lot	TAZ	Inclusion Year	HH 2010	Pop 2010	Emp 2010	HH 2030	Pop 2030	Emp 2030
Broken Ground in last 2 yrs, Built or Permitted	**The Woodlands at Belmont Hill**	McLean Hospital	115 Mill St	Northlands Residential	First phase complete in 2006. Final phase by 2008	Luxury Townhouses				121 (10 condo units in existing building, 111 new condos 2,300 to 3,100 sq ft)	59-11	920-1	2010	121	355	0	121	280	0
Broken Ground in last 2 yrs, Built or Permitted	**McLean Senior Units**	McLean Hospital	115 Mill St	American Retirement Corporation	2009	Senior living units				480	59-11	920-1	2010	480	480	0	480	480	0
Broken Ground in last 2 yrs, Built or Permitted	**McLean R&D Offices**	McLean Hospital	115 Mill St	Belmont Value Realty Partners LLC	2009	Research and development space	150,000	R and D			59-11	920-1	2010	0	0	432	0	0	432
Broken Ground in last 2 yrs, Built or Permitted	**McLean Affordable Housing**	McLean Hospital	115 Mill St	Town of Belmont	2008	Conveyed to the town of Belmont for affordable housing			1.34	Between 25 and 40 units	59-11	920-1	2010	40	117	0	40	92	0
Broken Ground in last 2 yrs, Built or Permitted	**Waverly Square Fire Station**	Condos at old Waverley Square Fire Station	Trapelo Rd	Town of Belmont	2007	Re-use of old fire station to residential units	Station - 12,000			6	27-76A	912	2010	6	18	0	6	14	0
In Permitting Process	**Wood Lot on Woodfall Rd**	Woodfall Rd		Town of Belmont		Town is selling parcel for residential development			5.37	4 Single Family homes	Part of 67-2	919	2010	4	12	0	4	9	0
Under Consideration	**Waverly Square Air Rights**	Waverley Square Station	Trapelo Rd	Proponents - Town of Belmont and MBTA		Air rights development on top of the commuter rail station - apartments on top of retail			4.95	80 to 170 Residential units, 18,000 sqft of retail	32-11	921	2030				170	393	28
Under Consideration	**McLean Expansion**	McLean Hospital	115 Mill St	McLean Hospital	No Date - Open ended place holder for future Development*	Hospital Expansion	50,000	Medical			59-11	920-1	2030				0	0	225

*Includes projects identified by community, advisory committee, or study team as being relevant to growth within the study area

LEXINGTON

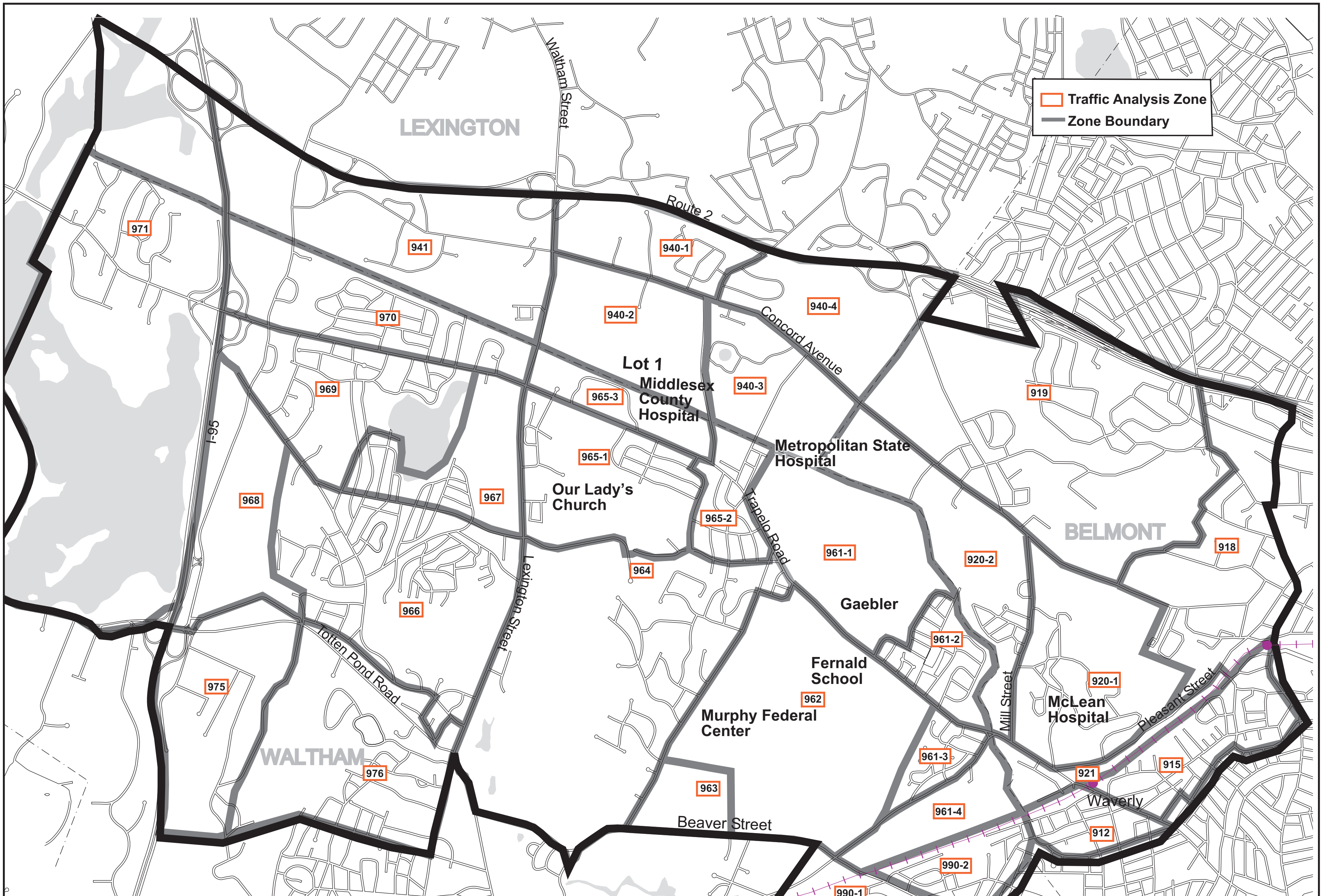
Group	Project Name	Project Location	Address	Proponent/Owner	Completion	Description	Building Sq ft		Site Size (acres)	Units	Map - Lot	TAZ	Inclusion Year	HH 2010	Pop 2010	Emp 2010	HH 2030	Pop 2030	Emp 2030
Broken Ground in last 2 yrs, Built or Permitted	**Commercial Building on Waltham St.**	On Waltham Street on the Border of Waltham (Assessors Map 5, Parcel 11A)	Waltham St.	Rogers and Company	Is still in the Building Permit Phase	Commercial Building (Drive-In Bank and Office Space)	7,552	General Office	0.69		5-11A	941	2010	0	0	26	0	0	26
Broken Ground in last 2 yrs, Built or Permitted	**Brookhaven Expansion**	Brookhaven Life Care Housing	1010 Waltham St.	CHOATE-SYMMES LIFE CARE INC	Complete	Adding managed care independent living units	Current 375,950, Expanded 505,000		26	41 new single units (241 total single units)	5-17	940-2	2010	41	41	10	41	41	10
Broken Ground in last 2 yrs, Built or Permitted	**Avalon at Lexington Hills (Formerly Avalon at Lexington Sq)**	Former Metropolitan State Hospital	Concord Ave. (Metropolitan Parkway North)	AvalonBay	2007	12 Buildings with 387 apartments. Plan includes re-use of some existing structures	Current structure 620,000		23	387 (689 bedrooms)	Lexington Map 1	940-3	2010	387	964	0	387	913	0
In Permitting Process	**Lexington Hills**	Former Middlesex County Hospital	Walnut St. (currently 61 Walnut St. - Lot 6)	Lexington August Realty Trust	has undergone preliminary subdivision review (2/2/06)	The Lot includes the property originally purchased by Walnut Roseland and Lot 6 (6.9 acres).			17.93	18 Unit (Single Family)**	2, 1B (11.03 acres) and 2, 1C (5.26acres)	940-2	2010	18	45	0	18	42	0
Under Consideration	**Spring St Office development**			Possible 191 Spring Street Trust		Merging of lot 12-4 and 12-3, and the development of an office park.***	219194	Office	7.4		12-4 and 12-3	941	2030				0	0	888
Under Consideration	**Lot One**	Former Middlesex County Hospital	Trapelo Rd	DCAM		46 acres in Lexington, 8 Acres in Waltham			54	Proposed between 20-48 single family units (Sasaki report)	Lexington - Map 2, Lot 1A,	940-2	2030				48	113	0

**Adjusted based on input from Lexington Planning Department (8/22/06)

***This assumption was not based on a current development proposal. It was developed during the buildout analysis. As part of the process we identified all vacant parcels and attempted to predict the most likely activity that would take place on them at buildout. These assumptions are based on a number of factors, some of which include current zoning, similar developments, location, and activity on surrounding parcels. Parcel 12-4 is owned by the same trust (part of Boston Properties) that owns the two adjacent office parks (parcels 12-13A and 12-13B). Office park is the dominant land use along this portion of Interstate 95, and parcel 12-3's proximity to Route 2 increases its access and desirability. Given these factors it is likely

WALTHAM

Group	Project Name	Project Location	Address	Proponent/Owner	Completion	Description	Building Sq ft		Site Size (acres)	Units	Map - Lot	TAZ	Inclusion Year	HH 2010	Pop 2010	Emp 2010	HH 2030	Pop 2030	Emp 2030
Broken Ground in last 2 yrs, Built or Permitted	**Waltham Athletic Fields**	Former Frederick C. Murphy Federal Center (424 Trapelo Rd)	Forest St.	City of Waltham	Complete	Municipal Soccer and Athletic Fields			25		R035-007-015C	962	2010	0	0	0	0	0	0
Broken Ground in last 2 yrs, Built or Permitted	**Gann Academy**	Former Frederick C. Murphy Federal Center (424 Trapelo Rd)	333 Forest St.	Gann Academy	Complete	New Jewish High School	115,000	High School	15		R035-007-015B	962	2010	0	0	77	0	0	77
Broken Ground in last 2 yrs, Built or Permitted	**Bentley North Campus Dorms**	Former Frederick C. Murphy Federal Center (424 Trapelo Rd)	Forest St.	Bentley College	Complete	College Dorms			20	2 Dorms (116 students)	R035-007-015A	962	2010	58	116	0	58	116	0
Broken Ground in last 2 yrs, Built or Permitted	**The Ridge**	Lexington Road	55 Ridge Lane	Lincoln Property Company SW, Inc.	Complete	Apartment Complex			22	264 (one and two bedroom, 786-1242 sq ft)	R023-007-032	967	2010	264	594	0	264	570	0
Broken Ground in last 2 yrs, Built or Permitted	**Wellington Crossing (formally part of Lot Four)**	Former Middlesex County Hospital	775 Trapelo Road	Pulte Homes (purchased from JPI)	2006	Existing historic hospital building redeveloped as housing, plus additional units. All Condominium	Current Structure 900,750		25.68	268 (one and two bedroom, 957 - 2270 sq ft)	R015 008 0007	965-3	2010	268	603	0	268	579	0
In Permitting Process	**Future site of Waltham Golf Course**	Former Metropolitan State Hospital	Trapelo Road	City of Waltham		Could be a 9 hole golf course. Terms of the deed prohibit housing. Must be active or passive recreation			32	None		961-1	2030				0	0	0
Under Consideration	**Fernald Center**	Fernald Center	Trapelo Rd	DCAM		Reuse committee was formed in 2002. State was indicated a wish to sell the land for housing			200 +	1219 (identified by city of Waltham buildout)	R045-001-0001, R036-008-0001, R036-008-0002	962	2030				1219	2633	0
Under Consideration	**Stigmatine Fathers of Waltham**		554 Lexington Street	Stigmatine Fathers of Waltham		Waltham is interested in purchasing this land from the seminary			40	89 (identified by city of Waltham buildout)	R033-002-0019	966	2030				89	192	0



Belmont, Lexington, Waltham Subarea Study

Appendix E
Bus Analysis on Trapelo Road

DRAFT MEMORANDUM

TO: **Belmont/Lexington/Waltham Subarea Study Files** **November 14, 2007**

FROM: **Jonathan Belcher, Alicia Wilson, and Efi Pagitsas**

RE: **Analysis for Trapelo Road Bus Service**

Presently, there is no fixed-route transit service on Trapelo Road in Waltham from the Belmont line (just north of Waverley Square) to the intersection of Trapelo Road and Lexington Street, a distance of 2.8 miles. Transit service along this corridor was briefly provided between 2001 and 2003 by the Waltham "Citibus" system. A private carrier bus service also operated along this corridor from the 1920s to 1979. The closest MBTA bus routes are two serving Waverley Square (Route 73 Waverley-Harvard and Route 554 Waverley-Downtown Boston via Central Square Waltham) and another route serving the western end of Trapelo Road and Lexington Street (Route 70A North Waltham-Central Square Cambridge).

The Advisory Committee to the Belmont/Lexington/Waltham Subarea Study is interested in restoring bus service along the Trapelo Road corridor that would connect to the Fitchburg Commuter Rail line and MBTA trackless trolley Route 73 (Waverly-Harvard) at Waverly Square. Following is the analysis of likely transit demand, routing, and cost for such a service.

TRAPELO ROAD TRANSIT MARKET

The largest portion of the likely market for a Trapelo Road feeder service to Waverley Square would be commuters living within walking distance to Trapelo Road and wishing to reach destinations served by the Fitchburg Line, bus Route 73, and the Red Line. Typically these are Cambridge and downtown Boston destinations[1]. Also, from known transit demand statistics in this region, the most concentrated demand for transit services generally occurs during the morning peak period.

One-quarter mile is the generally accepted industry standard for how far a person will walk (five to ten minutes) to a bus route. 2000 Census journey-to-work data indicates that 389 people who work in Boston and Cambridge live within one-quarter mile of Trapelo Road between Lexington Street and the Belmont border. Note that this figure is for the entire day, not just the morning peak period. According to the survey used to calibrate the MPO regional travel model, 76% of work trips are made during the morning peak period.

[1] The Trapelo Road transit market is likely to also include a small proportion of shoppers or workers destined for the Waverly Square area in Belmont.

To confirm the Census estimate, staff preformed a select-link[2] analysis for the 2005 AM peak period at a Trapelo Road location just west of Waverly Oaks Road. That analysis showed that 44% of all vehicles (225) from zones abutting Trapelo Road east of Lexington Street have destinations in Boston or Cambridge during the morning peak period. Assuming that 76% of all home-to-work trips are made during the peak period and vehicle occupancy of 1.25, yields an inbound daily person work trip count of 370 from zones abutting Trapelo Road to Cambridge and downtown Boston.

The two daily person trip estimates, 389 from the Census and 370 from the model are the same order of magnitude, considering the difference in the two methods of estimating the transit market demand to Cambridge and downtown Boston along Trapelo Road. However, for the purposes of this analysis, in the interest of developing an upper bound for transit market demand, the Census estimate is used in this analysis. As indicated earlier, the household survey used to calibrate the travel model indicates that 76 % of the daily trips to work occur during the morning peak period. Also, Census data indicates that 30%[3] of Waltham's commuters to Boston and Cambridge, including those who use commuter rail and express buses, use transit. Applying these percentages to the daily person trip total of 389 from the Census yields a theoretical maximum AM peak period inbound transit ridership of approximately 90 trips under existing conditions. Applying the bus mode-split only, 15% for Waltham, yields 45 bus trips under existing conditions.

The following data is appropriate in comparing the likely demand for a Trapelo Road bus service with historical information and with transit demand from a densely developed site.

Comparison to Historical and Dense Development Information

CTPS has partial data available for morning peak ridership along Waltham Citibus Route 14. This bus route provided service along Trapelo Road between Waverley Square and Lexington Street from August 2001 to July 2003. Route 14 also provided service along Lexington Street between Waltham Center and the Lexington town line. Citibus Route 14 operated every 60 minutes weekdays from 7:00 AM to 8:00 PM. CTPS collected morning ridership by trip for the entire Citibus system as part of a rider survey undertaken at the time. The data from 2003 is not broken down by stop, only by trip. This data showed 18 passengers utilizing Citibus Route 14 over a 4-hour period from 6:40 AM to 10:05 AM, lower than the rough estimate above of 45 under current conditions. 18 passengers during the 4-hour peak period amounts to 4.5 passengers per hour of service for both directions of travel combined. This also includes riders whose entire journey may have been along Lexington Street.

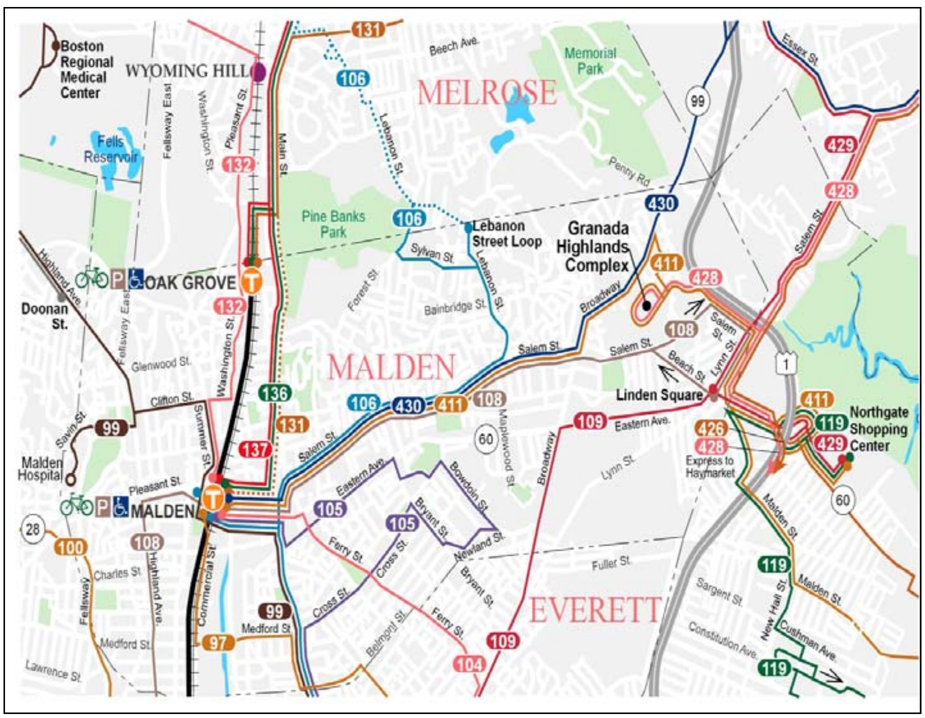
The following information is useful in order to gain perspective into the effect that concentrated development can have on transit demand. The 910-unit apartment complex

[2] A select-link analysis identifies the origin and destination zones of the Boston Region MPO's transportation planning model for those trips that pass a specific link of the model's roadway network during a specified time period.

[3] Waltham's 30% mode-split is the average for the entire City. Most of the City's transit services are closer to the Center of Waltham and away from Trapelo Road. Of the average 30% mode-choice figure, the bus share is 15%, which includes an express bus service portion.

at Granada Highlands in Malden, east of Malden Center is an example of a dense development located on bus lines. This complex, which consists of eight eight- to nine-story buildings and five three-story buildings, is one of the largest apartment properties in the state.[4] Two MBTA bus routes, Route 411 and Route 428, serve the complex (Figure 1). Route 411 provides feeder service to Malden Station on the Orange Line as well as connections to local shopping areas. Route 428 provides express rush hour service to Boston. The bus routes together have 141 inbound boardings and 80 outbound alightings (those who get off at the complex) Seventy-two percent of inbound boardings occur during the AM peak period. Eighty-one percent of outbound alightings occur during the PM peak period. According to the 2000 Census, the census tract where Granada Highlands is located contains 3,199 households of which 910, or 28.5%, are part of the Granada Highlands complex. Applying this proportion to the total transit trips to the Boston peninsula yields 102 transit trips from the complex to the Boston peninsula.

FIGURE 1
Existing MBTA Bus Service at Granada Highlands



NEW BUS SERVICE

Based on the schedules operated by Waltham Citibus prior to 2003, a shuttle route operating between Waverley Square and the intersection of Trapelo Road and Lexington Street would have a travel time of approximately 10 minutes in each direction. With recovery time added in, one vehicle could provide a frequency of every 30 minutes on a shuttle operating along Trapelo Road. Based on present costs for several existing contracted bus services in the Boston region, a contractor would charge between $45 and $70 per hour. A new direct-operated MBTA bus service operating along the same route,

[4] Boston Globe, July 31, 2007.

for the same set of service hours would have costs up to $106 per peak-period hour of service.

A Citibus Route 14 level of ridership on a contracted rush-hour only shuttle, carrying 4.5 passengers per hour for 6 hours of service would generate daily ridership of 27 and annual ridership of 6,800 based on 252 days of service. Based on a fare of $1.75, the potential per passenger subsidy would be $8.20 to $13.60. Providing an additional 6 hours of mid-day service in addition to rush-hour service could double the annual cost, although the subsidy per passenger could remain the same if midday ridership also generated 4.5 passengers per hour. Operating a shuttle service as a direct-operated MBTA service, at approximately $106 for 6 hours per day for 252 days would yield a per passenger subsidy of over $21.00.

The following table shows a range of demand and costs under existing conditions. Only peak period service, a $1.75 fare, 252 annual service days, and 2007 costs are assumed. Hourly ridership ranges from a low of five passengers (Citibus ridership) to a high of 13 based on Census journey-to-work data. The latter was calculated by applying the inbound/outbound ratio observed at Granada highlands to the 45 AM peak period bus trips and dividing by the hours of service.

New Bus Service: Demand and Cost Characteristics

Low Demand Estimate					
Service Type	Service Hours	Hourly Ridership[1]	Annual Ridership	Net Annual Cost[2]	Subsidy per Passenger[3]
Contracted	6/day	5	6,800	$56,100- $93,100	$8.20-$13.60
MBTA	6 /day	5	6,800	$148,365	$21.00

High Demand Estimate					
Service Type	Service Hours	Hourly Ridership	Annual Ridership	Net Annual Cost[1]	Subsidy per Passenger[2]
Contracted	6/day	13	18,900	$56,100-$93,100	$1.21-$3.17
MBTA	6 /day	13	18,900	$148,365	$6.10

[1]Rounded ridership

[2]Minus a per passenger fare of $1.75.

[3] Does not include cost per mile.

Existing and new MBTA bus routes must meet a cost-effectiveness service standard to be deemed viable. This standard is calculated during the biennial service planning process during which all existing MBTA bus routes and their respective net cost per passenger are compared against the bus system average. The net cost per passenger ratio is determined by adding the cost per weekday peak hour, the cost per weekday off peak hour, the cost per mile and subtracting the average fare per passenger. Routes that have a net cost per passenger more than three times the system average are considered deficient and are subject to review for modifications that could improve the performance. Exceptions to the net cost per passenger standard can be made, on a case-by-case basis, due to extenuating circumstances such as geographic isolation.[5] The 2008 process is currently underway. The 2006 bus cost-effectiveness standard is greater than or equal to

[5] MBTA Service Delivery Policy 2006 Update, July 13, 2006.

three times the system average. The average cost at that time was $1.50 per passenger. New routes must also demonstrate viable net cost per passenger ratios. Given this standard, it appears that an MBTA operated route would not be considered viable given estimated ridership.

MODIFYING EXISTING MBTA SERVICE TO SERVE THE TRAPELO ROAD CORRIDOR

Several modifications to existing routes within the same hours of service could be made. These modifications are discussed below.

MBTA Route 73

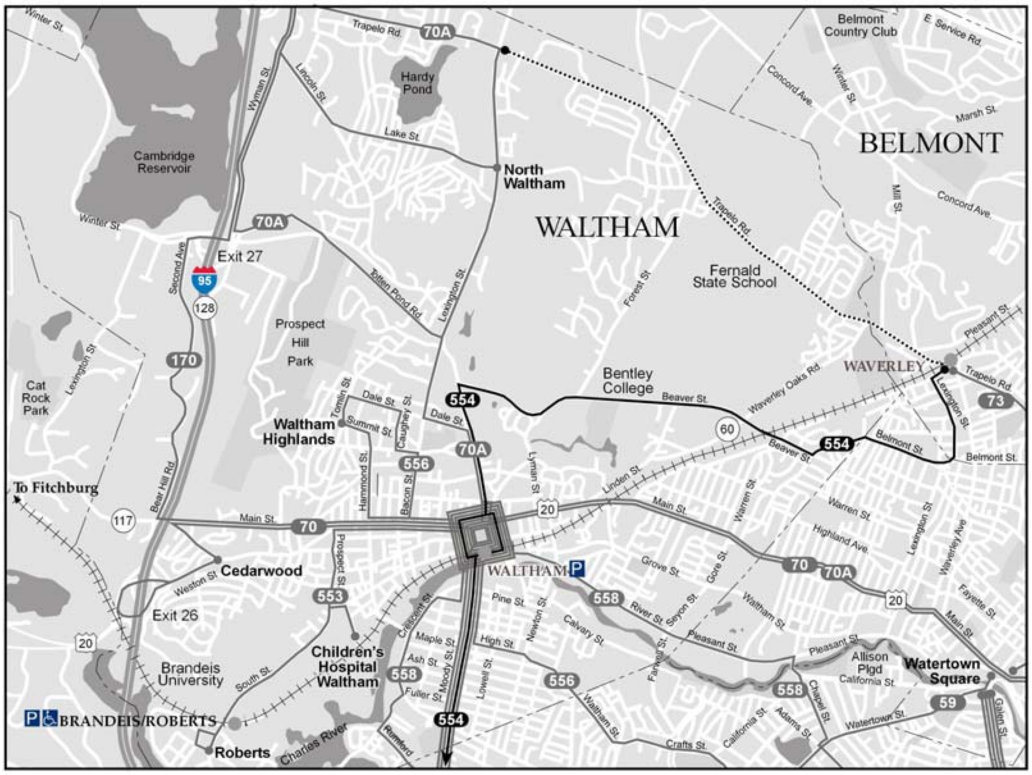
MBTA Route 73 is operated by electric trackless trolleys Monday-Saturday, and operates with diesel buses only on Sundays. Extending Route 73 further north beyond Waverley Square would require substantial capital investment to provide overhead catenary for electric operation. In order to serve Trapelo Road beyond Waverly Square, without installing new overhead catenery, dual-mode vehicles could be operated on Route 73. The MBTA does operate dual-mode vehicles on its Silver Line Waterfront service, capable of operating in an electric mode receiving power from overhead catenary, or in a diesel mode, operating without wires. However, there is a high capital cost to obtain these vehicles, and transferring any existing vehicles from the present Silver Line fleet would not be a viable option, as these buses are not equipped with left-side doors, which would be required to operate in the Harvard bus tunnel.

MBTA Route 554

Route 554 (Waverley-Downtown Boston) operates every 60 to 65 minutes from 7:00 AM to 7:15 PM, with the exception of an extra round-trip at 7:30 AM, which creates a brief headway of every 30-40 minutes for part of the AM peak. Service is coordinated with Route 553 (Roberts-Downtown Boston), with the two routes serving a long common segment between Central Square Waltham and Downtown Boston via Newton Corner (Figure 2).

Much of the total combined ridership for Routes 553 and 554 is within this common segment, the service provided by the two separate routes combined is comparable to a single route with two branches at the outer end. The frequency of service on the combined segment is every 30-35 minutes, with a brief period of approximately every 15-minute service between 7:00 AM and 8:00 AM. Both routes provide local service between their outer terminal points and Newton Corner, and then operate express to Downtown Boston via the Massachusetts Turnpike. The travel time from Waverley to Downtown Boston is scheduled for 50 to 60 minutes in the peak period, and thus is unlikely to attract many through-riders from the outer end of the route traveling direct to Boston, as commuter rail service from Waverley Square or Route 73 service to Harvard connecting to the Red Line would be faster options. Most passengers boarding in the segment between Central Square Waltham and Waverley are presumably local riders traveling just within Waltham or to Newton.

FIGURE 2
Existing MBTA Bus Route 554



Base service for the Routes 553 and 554 combined requires 4 vehicles, two on each route, to maintain a 60-minute frequency for the separate routes and a 30-minute frequency for the combined segment. Several possible modifications to Route 554 could be initiated to serve all or part of the Trapelo Road corridor. These modifications are discussed below and explained more fully in the appendix.

Extend all Route 554 service to Trapelo Road and Lexington Street:

Extending Route 554 service to Trapelo Road and Lexington Street would require adding a bus and approximately 13 additional hours of service resulting in an annual cost of approximately $347,250. This would also result in excessive layovers, uncoordinated headways with Route 553, or longer headways in the common section of Routes 554 and 553.

Lengthen headways to accommodate longer running time:

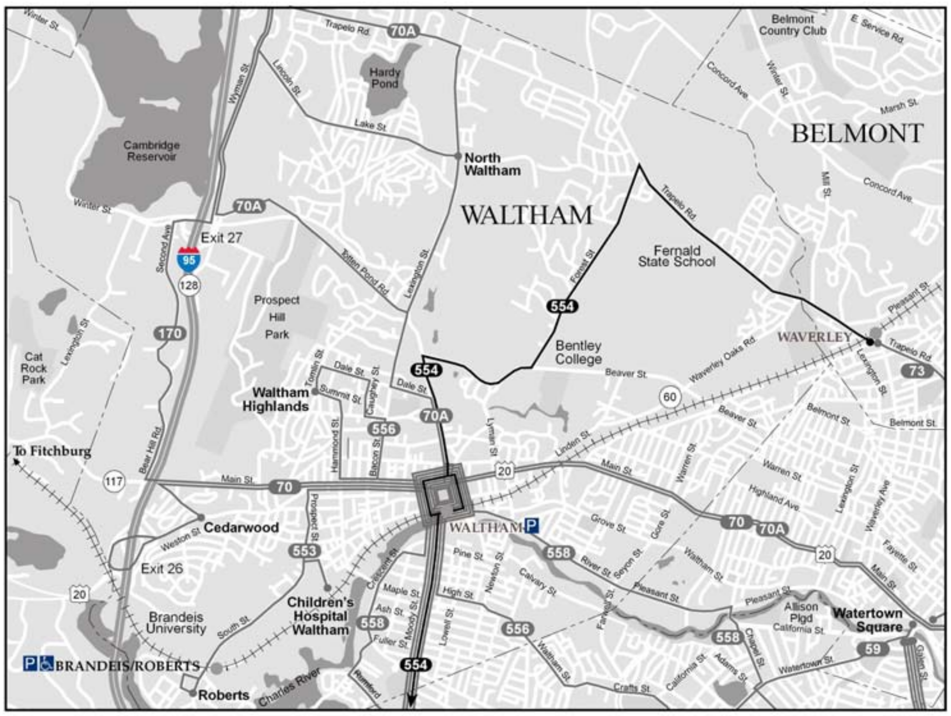
Lengthening headways to accommodate longer running times would have a negative impact on existing riders and increase layover times.

The following modifications would serve a portion of Trapelo Road without the full costs of adding an entire vehicle to the route.

Operate Route 554 via Forest Street and Trapelo Road in place of Beaver Street Belmont Street, and Lexington Street

Operating Route 554 via Forest Street and Trapelo Road in place of Beaver Street Belmont Street, and Lexington Street (Figure 3) would provide new service along Trapelo Road between Forest Street and Waverly Square past the Fernald School at little or no extra cost. It would not provide any service along Trapelo Road between Forest Street and Lexington Street resulting in 27 existing boarding passengers and 22 existing alighting passengers left without service.

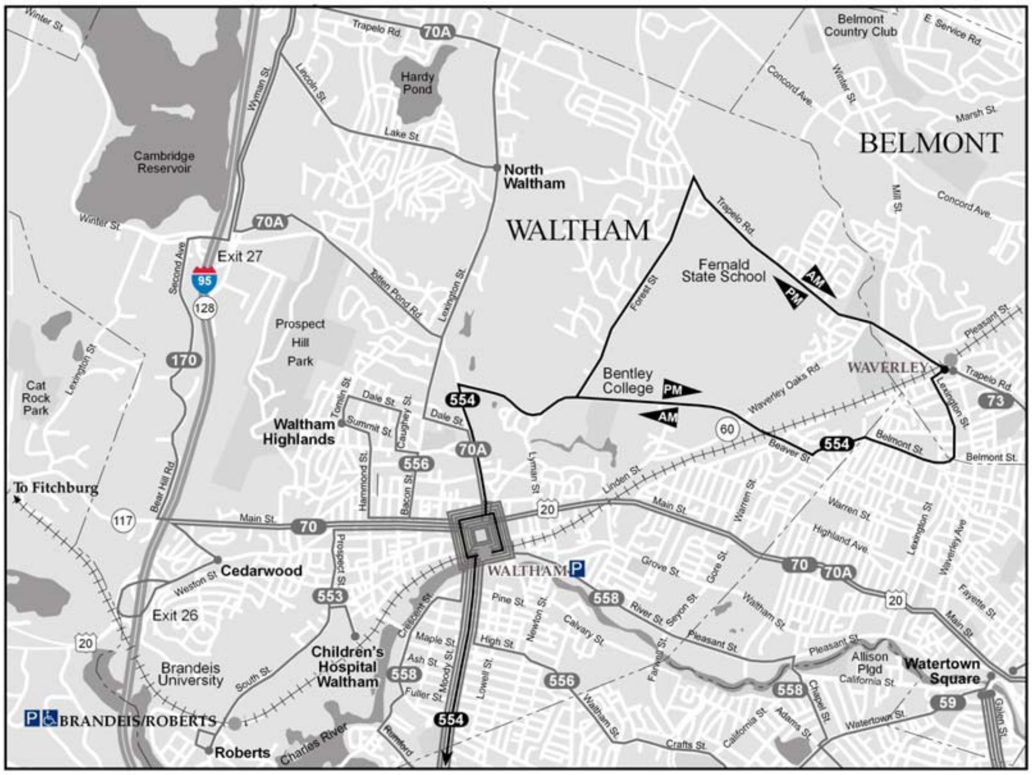
FIGURE 3
Route 554 Via Forest Street and Trapelo Road



Operate all Route 554 AM outbound service and PM inbound service via Forest Street and Trapelo Road

This proposal is a modification of the proposal to reroute all Route 554 service via Forest Street and Trapelo Road and would reroute service in one direction only, creating a one-way loop at the outer end of the route between Beaver Street and Forest Street, and Waverley Square (Figure 4). Buses could operate in a clock-wise pattern in the morning to provide service from Trapelo Road to Waverley Square and a counter clockwise pattern in the afternoon to bring passengers from Waverley Square to Trapelo Road. Service would continue to follow the existing Route 554 routing between Waverley Square and Bentley College traveling toward Waltham in the morning and traveling toward Waverley in the afternoon. This proposal would eliminate some morning outbound service and some afternoon inbound service.

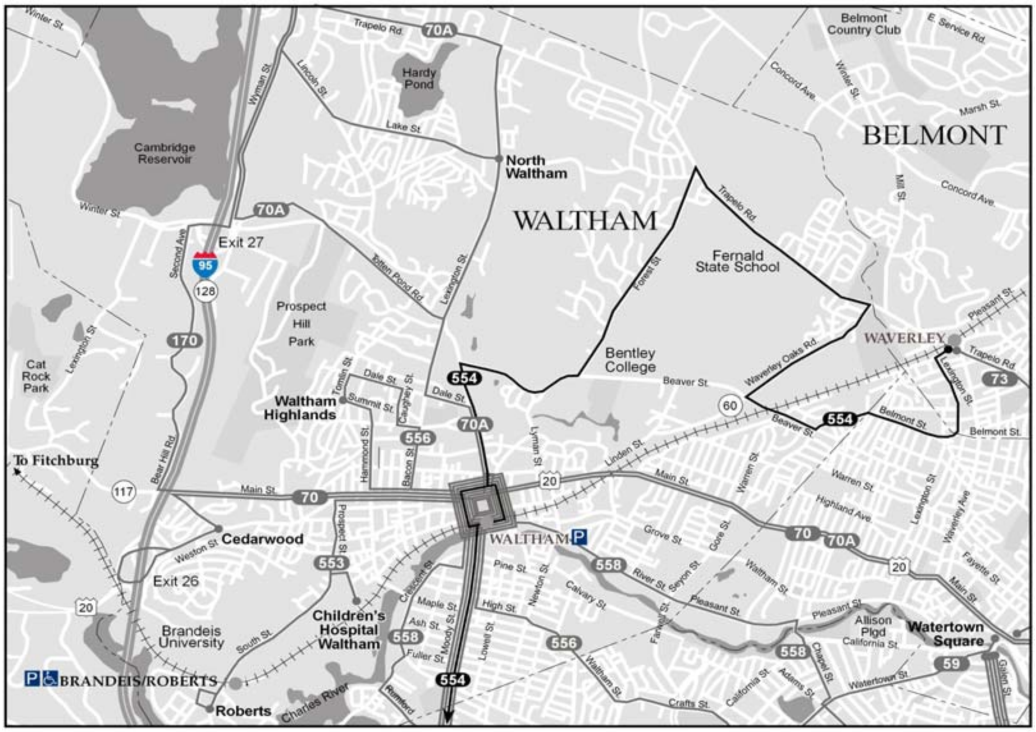
FIGURE 4
Route 554 Via Forest Street and Trapelo Road with a One-way Loop



Reroute morning peak outbound and afternoon peak inbound Route 554 buses via Forest Street, Trapelo Road, Waverley Oaks Road, Beaver Street, Belmont Street, and Lexington Street between Beaver Street at Forest Street and Waverley Square.

This proposal would retain service on a majority of the existing Route 554, but add a reroute via Forest Street, Trapelo Road, and Waverley Oaks Road in order to provide service on Trapelo Road between Forest Street and Waverley Oaks Road (Figure 5) This would add 8 to 10 minutes of running time to each trip rerouted, and add a new 3.1-mile segment via Forest Street, Trapelo Road, and Waverley Oaks Road to replace a 0.8 mile direct segment along Beaver Street between Forest Street and Waverley Oaks Road.

FIGURE 5
Route 554 Via Forest Street Trapelo Road and Waverly Oaks Road



Recent counts showed no passenger activity in this section, except at the stop at Bentley College, near Beaver Street and Forest Street. Because of the added running time, only three outbound trips in the morning and three inbound trips in the afternoon could be altered without having an impact on the remainder of Route 554 or a significant impact on the coordinated service with Route 553. This modification could be implemented with minimal cost

Although this option would provide the least amount of service to the Trapelo Road corridor, it would be the most cost effective method to initiate any service and would have the least negative impact on any existing Route 554 riders. If ridership on the Trapelo Road segment proved to be reasonable, consideration could then be given to rerouting service at additional times via Trapelo Road.

SUMMARY

A private carrier operated bus service along Trapelo Road for approximately fifty years ending in 1979. Waltham's Citibus system operated service in the corridor briefly between 2001 and 2003. The Advisory Committee to the Belmont/Lexington/Waltham Subarea Study is interested in restoring bus service along Trapelo Road.

An analysis of current demand for and the cost of a new peak period bus service along the roadway indicates annual ridership of 6,800 to 18,900 with per passenger subsidies of $1.21 to $21.00 depending upon ridership and the service provider.

Base service for MBTA Routes 553 and 554 combined requires 4 vehicles, two on each route, to maintain a 60-minute frequency for the separate routes and a 30-minute frequency for the combined segment. Several possible modifications to Route 554 could be initiated to serve all or part of the Trapelo Road corridor:

- Extend all Route 554 service to Trapelo Road and Lexington Street
- Lengthen headways to accommodate longer running time
- Operate Route 554 via Forest Street and Trapelo Road in place of Beaver Street Belmont Street, and Lexington Street
- Operate all Route 554 AM outbound service and PM inbound service via Forest Street and Trapelo Road
- Reroute morning peak outbound and afternoon peak inbound Route 554 buses via Forest Street, Trapelo Road, Waverley Oaks Road, Beaver Street, Belmont Street, and Lexington Street between Beaver Street at Forest Street and Waverley Square.

Rerouting morning peak outbound and afternoon peak inbound Route 554 buses via Forest Street, Trapelo Road, Waverley Oaks Road, Beaver Street, Belmont Street, and Lexington Street between Beaver Street at Forest Street and Waverley Square provides the least amount of service to Trapelo Road. However, it would be the most cost effective method to initiate service and would have the least negative impact on existing Route 554 riders. If ridership on the Trapelo Road segment proved to be reasonable, consideration could then be given to rerouting service at additional times via Trapelo Road.

Appendix

Modifications to MBTA Routes 553/554

Extend all Route 554 service to Trapelo Road and Lexington Street:

Extending Route 554 the full distance along Trapelo Road from Waverley Square to Lexington Street, while maintaining existing 60-minute headways along the route, will require adding a bus throughout the day to the vehicle requirement of the route. This would add approximately 13 hours of service. Because the existing round-trip running time between Waverley Square and Lexington Street is only 20 minutes, approximately 40 minutes of additional layover time would be added to each round-trip. As an alternative to providing these excessive layover times, headways could be reduced from every 60 minutes to every 50 minutes. This however would make it impossible to coordinate headways with Route 553, which operates every 60 minutes. The time between buses in the common segment would be greater than the existing 30 minutes during some 60-minute time intervals, and would also be much less than demand justifies during others. As an example, if Route 553 trips departing every 60 minutes left Central Square Waltham at 1:00, 2:00, 3:00, and 4:00; and Route 554 trips departing every 50 minutes left at 1:30, 2:20, 3:10 and 4:00; then the combined schedule over this sample three-hour period would result in a 30-minute wait, followed by a 20-minute wait, followed by a 40-minute wait, followed by a 10-minute wait, followed by two buses departing at the same time.

Because of the additional resources required, there would be little advantage in extending Route 554 while maintaining a 60-minute headway in comparison to simply operating one vehicle every 30-minutes along a new stand-alone route between Waverley Square and Lexington Street via Trapelo Road.

Lengthen headways to accommodate longer running time:

The headways (frequency) of Route 553 and 554 could each be lengthened from 60 minutes to 70 minutes to accommodate the longer running time required by extending Route 554 to Trapelo road and Lexington Street Presently, Route 554 utilizes two vehicles to operate at every 60-minutes, meaning the total round-trip travel time including recovery time is 120 minutes. Lengthening the frequency from 60 minutes to 70 minutes would allow for a total round-trip running time, of 140 minutes, including end-of-line recovery time. This added running time could accommodate the estimated additional 20 minutes required to cover the round-trip distance from Waverley Square to Trapelo Road & Lexington Street Route 553 would also need to have headways lengthened from 60 to 70 minutes to maintain coordination with Route 553. Such a change would however have a negative impact on existing Route 553 and 554 riders. When a simple spreadsheet-based elasticity model, used to calculate the impact of frequency changes in transit service, is applied to existing combined Route 553 and 554 ridership, the results estimate that up to 110 existing route 553 and 554 riders would stop utilizing the service because of the longer wait times. In addition, lengthening Route 553 frequencies to match Route 554 frequencies would result in buses laying over for longer periods of time at the terminal point of Route 553 in Waltham at South Street in the Roberts section of Waltham. This layover location has generated concern in the past from area residents about existing layover times, and an increase in layover times would most likely not be well received by abutters. The MBTA investigated the potential for other layover locations for Route 553, including possible extensions into Weston, but did not find any alternatives that appeared to be acceptable.

There are several potential ways for Route 554 to serve a portion of Trapelo Road, without the full costs of adding an entire vehicle to the route.

Operate Route 554 via Forest Street and Trapelo Road in place of Beaver Street Belmont Street, and Lexington Street

This proposal would reroute all Route 554 service at all times to operate via Forest Street and Trapelo Road in place of Beaver Street, Belmont Street, and Lexington Street in the segment from Beaver Road and Forest Street to Waverley Square. This would provide new service along Trapelo Road between Forest Street and Waverley Square past the Fernald School site, a distance of 1.1 miles. It would not provide any service along Trapelo Road between Forest Street and Lexington Street, a distance of 1.2 miles.

The existing Route 554 segment from Beaver Street and Forest Street to Waverley is 2.4 miles long. The rerouted segment would be 2.7 miles long. It would be possible to maintain existing Route 554 scheduled departure times by reallocating a small amount of time from the bus layover and recovery time at Waverley Square to account for the slightly longer travel distance.

The last weekday ridership count for Route 554 from 2004 showed 36 passengers boarding and 30 passengers alighting at stops that would be by-passed with this service change. That number does include 9 boarding passengers and 8 alighting passengers at the stop near the main entrance of Bentley College. This stop is a short distance from a stop that would remain at Beaver Street and Forest Street. This net result of existing passengers left without service within a short walking distance would be 27 boarding passengers and 22 alighting passengers. The stop with the greatest amount of activity, which would be by-passed, is Beaver Street and Waverley Oaks Road. For both directions of travel combined, there were 12 passengers boarding at this stop and five passengers alighting.

Operate all Route 554 AM outbound service and PM inbound service via Forest Street and Trapelo Road

This proposal would be a modification of the proposal to reroute all Route 554 service via Forest Street and Trapelo Road and would reroute service in one direction only, creating a one-way loop at the outer end of the route between Beaver Street and Forest Street, and Waverley Square. Buses could operate in a clock-wise pattern in the morning to provide service from Trapelo Road to Waverley Square and a counter clockwise pattern in the afternoon to bring passengers from Waverley Square to Trapelo Road. Service would continue to follow the existing Route 554 routing between Waverley Square and Bentley College traveling toward Waltham in the morning and traveling toward Waverley in the afternoon.

If this proposal were implemented, there would be no outbound morning or inbound afternoon bus service on Beaver Street between Forest Street to Belmont Street in Belmont, or along Belmont Street and Lexington Street in Belmont and Watertown to Waverley Square. The last ridership count of Route 554 from Spring 2004 showed 5 passengers departing outbound Route 554 buses in this segment and 2 passengers boarding before noon. After noon, 10 passengers boarded and 4 passengers departed inbound buses in this segment. The most significant stop activity in the segment that would be by-passed is the stop at Beaver Street and Waverley Oaks Road. There were four passengers departing outbound buses at this stop prior to noon and 8 passengers boarding inbound buses at this stop after noon. If buses during this time period were rerouted via Forest Street and Trapelo Road, these passengers would either have to walk from a new stop located at Trapelo Road and Waverley Oaks Road (a distance of .8 miles along Waverley Oaks Road), or wait on-board the bus through the layover at Waverley Square, and continue to Waverley Oaks Road on the inbound trip in the morning, or from Waverley Oaks Road on an outbound trip in the afternoon. This would add 11 to 14 minutes to the existing travel time for these passengers. Those 2 morning passengers and 4 afternoon passengers whose entire journey is within the Beaver Street and Belmont Street to Waverley Square segment would still be left without any reasonable transit alternative.

Reroute morning peak outbound and afternoon peak inbound Route 554 buses via Forest Street, Trapelo Road, Waverley Oaks Road, Beaver Street, Belmont Street, and Lexington Street between Beaver Street at Forest Street and Waverley Square.

This proposal would retain service on a majority of the existing Route 554, but add a reroute via Forest Street, Trapelo Road, and Waverley Oaks Road in order to provide service on Trapelo Road between Forest Street and Waverley Oaks Road. This would add 8 to 10 minutes of running time to each trip rerouted, and add a new 3.1-mile segment via Forest Street, Trapelo Road, and Waverley Oaks Road to replace a 0.8-mile direct segment along Beaver Street between Forest Street and Waverley Oaks Road. The 2004 ridechecks showed no passenger activity in this section, except at the stop at Bentley College, near Beaver Street and Forest Street.

Because of the added running time, only three outbound trips in the morning to Waverley Square and three inbound trips from Waverley Square in the afternoon could be altered without having an impact on the remainder of Route 554 or a significant impact on the coordinated service with Route 553.

Although this option would provide the least amount of service to the Trapelo Road corridor, it would be the most cost effective method to initiate any service and would have the least negative impact on any existing Route 554 riders. If ridership on the Trapelo Road segment proved to be reasonable, consideration could then be given to rerouting service at additional times via Trapelo Road.

jb/aw/ep

Appendix F
Literature Review

Metropolitan Area Planning Council
60 Temple Place, Boston, Massachusetts 02111 617/451-2770 Fax 617/482-7185
MAPC
Serving 101 cities and towns in metropolitan Boston

DATE: 11/15/06

TO: THE BELMONT-LEXINGTON-WALTHAM SUB-AREA STUDY ADVISORY COMMITTEE

FROM: BELMONT-LEXINGTON-WALTHAM SUB-AREA STUDY TEAM

RE: A SUMMARY OF LITERATURE ON "SMART GROWTH" LAND USE AND TRAVEL BEHAVIOR

An important element of the Belmont-Lexington-Waltham sub-area study is the identification an alternative land use scenario to reduce or slow the growth of auto traffic within the sub-area. To identify land use patterns that have the potential to reduce auto use, MAPC has undertaken a review of current academic and practical planning literature. Most planners, municipal officials, and the public believe intuitively that the quantity, type and mix of housing, businesses, and services in an area will affect the amount of traffic in that area. Still, understanding exactly how land use influences traffic, and using that knowledge to determine appropriate land uses for a given location is a much more complicated undertaking. This report summarizes the findings of current literature on the subject, to serve as a guide for the Advisory Committee and the Study Team in developing alternative land use scenarios for the study area.

Increasing development tends to increase traffic on local roads, but not all types of development contribute equally. Some types of development make it easier to get around without a car, which can mitigate the traffic burden on roads nearby. Others leave residents, employees, and/or visitors with little choice but to travel by car. Research supports the fact that, generally, people living in neighborhoods where they can safely and conveniently walk, bike, and/or take transit to access goods, services, and jobs tend to drive less than people in more car-dependent neighborhoods. This does not mean that building a certain type of development guarantees that people will drive less; rather, it suggests that in certain types of developments people are able to drive less, and some of them will choose to take advantage of their alternatives. Furthermore, to some degree people tend to choose where to live based on where they need to go and how they prefer to get there. If less car-dependent neighborhoods attract residents who prefer or require other travel options, those new residents can be expected to drive less than the average resident.

Integrating amenities such as restaurants, services, and convenience retail within walking distance of housing and/or jobs means that residents or employees have the option of doing some of their errands on foot. Nationwide, roughly 40% of social, recreational, and shopping trips under a half mile in length are made on foot or by bike.[1] Exactly how far people are willing to walk, though, will depend on the individual, the purpose of the trip, the other transportation options available and how appealing they are, and the surroundings. A more connected street network provides shorter, more direct routes, and off-road paths, sidewalks and/or bike lanes can make it safer and more pleasant to make short trips without a car.

Several studies illustrate the difference in travel patterns between different types of neighborhoods. For example, one study found that the share of trips made on foot or by bike is higher in areas with substantial mixed use or nearby convenience services.[2] Another study found that residents of neighborhoods with more access to convenience retail[*] made fewer trips by car than those in neighborhoods with less access to conveniences.[3] A study of mixed use neighborhoods in the Seattle area found that walk trips as a share of all trips were roughly double in the mixed use neighborhoods compared to their surrounding area.[4] Several studies found that in areas with higher-quality pedestrian environments (with characteristics such as sidewalks, streetlights, shorter blocks, planting strips, and flat terrain) people were more likely to make their non-work trips without a car, and made fewer vehicle trips.[5]

One study that produced a number of interesting statistics compared residents in single family homes in a neo-traditional development (i.e. with higher density, a mix of uses, and a network of sidewalks and paths) in North Carolina with residents (described as demographically similar by the authors) of conventional subdivisions in the same area. The authors found that residents in the neo-traditional development (NTD) made more walk trips and 20% fewer car trips per household than the conventional subdivision residents.[†] NTD residents made 78.4% of all their trips by car and 17.2% on foot, compared with 89.9% by car and 7.3% on foot in the conventional subdivisions. Trips by residents of the NTD were also more likely to remain within the neighborhood – 20.2% of NTD resident trips were internal to the development, compared with just 5.5% of trips by conventional subdivision residents.[6] These factors together mean that residents of single-family homes in the NTD made only 71.8% of all their trips by car to destinations outside the development, while in the conventional subdivisions, 88.8% of all residents' trips were by car to destinations outside the development. These statistics indicate that in the neighborhood with walkable shopping opportunities, residents are choosing to walk more and shop within the development more, resulting in less vehicle traffic leaving the development.

Similarly, at worksites, mixing retail, restaurants, and services with office buildings can allow workers to complete errands from the office on foot. This in turn can make it easier for people to commute to work without their own car, especially if there are transit or ridesharing options available. In theory, mixing residences with offices can enable people to walk to work, but in suburban mixed-use developments only about 2% of commute trips remain within the development.[7] On the other hand, mixing offices and homes can help support retail and restaurants by creating a base of potential customers at more hours of the day.

Other important factors include the size and density of the development. For mixed use developments to succeed, there must be a sufficient customer base to support the commercial functions. One author offered estimates of the population needed to sustain various types of neighborhood services. These include one supermarket for every 6,500 people; a neighborhood park for every 5,000 people; 5,700 people per dry cleaner and 5,800 per

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[*] Access to convenience retail in the study cited was defined by the amount of residential land within a quarter mile of convenience retail uses.
[†] Residents of the NTD also made 8.6% fewer total trips per household.

laundromat; and 3,700 per beauty salon.[8] Housing a sufficient pool of potential customers within walking distance of stores and services requires combining mixed uses with higher density housing or employment. For example, accommodating 6,500 people (enough to support one of each of the services listed above) within a half mile of a small commercial center would require a gross density of roughly 13 people per acre or 5 to 6 housing units per acre[‡] over that area. In denser mixed-use areas, more residents and/or employees can shop within the development, and more of the businesses' customers can come from within the development, which can reduce traffic on surrounding roads. In primarily residential developments, a larger population can also provide more of a community, so that more of residents' social trips may also stay within the neighborhood. All of this does not ensure that all neighborhood residents will walk or that no one will drive from outside the community but it maximizes the potential for pedestrian patronage of neighborhood commercial areas.

It is important to note, though, that the commercial uses integrated into a primarily residential area should be appropriate to a neighborhood setting. A study of six traditional shopping districts in the San Francisco Bay Area surrounded by medium density housing in middle-class neighborhoods illustrates the potential problems that can arise when the retail uses are out of proportion to the neighborhood. The report found that one of the shopping areas, with 34 stores, many of which sold "comparison goods" (things that people comparison shop for), generated significant auto traffic despite extensive use of alternative modes. That shopping area also drew more of its patrons from outside the neighborhood than any other shopping center surveyed.[9] This highlights the importance of developing retail uses at an appropriate scale to provide neighborhood residents with local shopping opportunities without drawing large numbers of customers from outside the neighborhood.

Another benefit of developing at higher densities (for all types of development) is that it tends to make transit service more feasible, because more potential riders can be served with each stop. As density increases, it becomes viable to provide transit service more frequently. The better the transit service, the more likely it is that people will choose transit over driving. The relationship between density and the cost-effectiveness of providing transit has led the Boston Region Metropolitan Planning Organization to include certain density thresholds as criteria in prioritizing transportation projects for funding. In suburban areas, the thresholds are 7 housing units per acre or 50 jobs per acre; in urban areas the density must exceed 50 housing units per acre or 150 employees per acre. These densities must be achieved on average for all the residentially- or commercially-zoned land within a half mile of the proposed project.[10]

The practicality of providing transit service to a new development will depend on a number of factors in addition to density, including the total population and/or employment of the development, its distance from the downtown or central business district, how far it is from existing routes and main roads, and the service provider's willingness to expand. Layout and design of new developments will also affect the ease of providing transit service: a development laid out with transit accessibility in mind will be easier to serve than one with cul-de-sacs and long set-backs from the road. There are several reports offering design guidelines for transit compatibility[§], and these, along with consultation with the service

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[‡] Assuming an average household size of 2.3 persons per household.

[§] See, for example, Reid Ewing, *Pedestrian and Transit Friendly Design,* prepared for the Public Transit Office, Florida Department of Transportation, 1996; and Skidmore, Owings & Merrill, et. al., *Planning for Transit-Friendly Land Use: A Handbook for New Jersey Communities*, prepared for New Jersey Transit, June 1994.

provider and a transportation professional, are an important part of planning for the transportation needs of a new development.

Using land use to influence travel demand in new suburban developments is by no means an exact science, but there is compelling evidence that land use impacts transportation and vice versa. Zoning code and design guidelines can't control how people choose to travel but they can make some transportation options more appealing than others. Most importantly, land use changes can enable and increase the appeal of non-auto travel. It is important to note that many of the features that shape transportation outcomes are connected, and are most effective when done together. Public education and outreach are also important complements to a land use plan because of the importance of public perception and individual attitudes in shaping travel decisions. A comprehensive strategy to promote alternative transportation will have the greatest chance of success.

RSD

ENDNOTES

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[1] Reid Ewing, *Transportation & Land Use Innovations: When you can't pave your way out of congestion*, Chicago: Planners Press, 1997, p. 61.
[2] Reid Ewing and Robert Cervero, "Travel and the Built Environment: A Synthesis", *Transportation Research Record 1780* (2001), p. 93.
[3] Ibid., p. 110.
[4] Edward McCormack, G. Scott Rutherford, and Martina G. Wilkinson, "Travel Impacts of Mixed Land Use Neighborhoods in Seattle, Washington", *Transportation Research Record 1780* (2001), p. 29.
[5] Reid Ewing and Robert Cervero, "Travel and the Built Environment: A Synthesis", *Transportation Research Record 1780* (2001), pp. 108-110.
[6] Asad J. Khattak and Daniel Rodriguez, "Travel behavior in neo-traditional neighborhood developments: A case study in USA", *Transportation Research Part A* 39 (2005), p. 488.
[7] Institute of Transportation Engineers, *Trip Generation Handbook: An ITE Proposed Recommended Practice*, 7th Edition, Washington, D.C.: Institute of Transportation Engineers, 2003. Chapter 7.
[8] Reid Ewing, *Best Development Practices: Doing the Right Thing and Making Money at the Same Time*, Chicago: American Planning Association (1996).
[9] Ruth L. Steiner, "Trip Generation and Parking Requirements in Traditional Shopping Districts," *Transportation Research Record*, 1617 (1998), pp. 29-31.
[10] The Boston Region Metropolitan Planning Organization, *The Transportation Improvement Program (TIP) Process at the Boston Region Metropolitan Planning Organization: An Instructional Handbook for Project Proponents* (2006), p. 17.
<http://www.bostonmpo.org/bostonmpo/resources/tip/2006TIPHandbook.pdf>