TRAFFIC IMPACT AND ACCESS STUDY

MUGAR PARCEL 40B RESIDENTIAL DEVELOPMENT

Arlington, Massachusetts

Prepared for:
Oaktree Development LLC

April 2014

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

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Cambridge, Massachusetts

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April 2014

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EXECUTIVE SUMMARY

MDM Transportation Consultants, Inc. (MDM) has prepared this Traffic Impact and Access Study (TIAS) for the proposed Mugar 40B residential development (the Site) to be located along Route 2 proximate to the Lake Street interchange in Arlington, Massachusetts. This report documents existing operational and safety-related characteristics of roadways serving the development Site, estimates future year operating characteristics of these roadways independent of the development, estimates development-related trip generation, and identifies incremental impacts of Site-related traffic. Access and off-site intersection improvements are identified for the development to meet operational needs of the Site and the adjacent roadways as required.

This TIAS has been prepared in accordance with requirements and standards for the preparation of traffic studies as jointly issued by the Commonwealth of Massachusetts Executive Office of Energy & Environmental Affairs/ Massachusetts Department of Transportation (EEA/MassDOT).

E.1 PROJECT DESCRIPTION

The Site comprises approximately 17 acres bounded by Route 2, Dorothy Road, Burch Street and Thorndike Field in Arlington, Massachusetts. The Site currently contains undeveloped land. The proximity of the Site in relation to the regional transportation system is shown in **Figure 1**.

Historical MEPA Review

In September 2000 an Environmental Notification Form (ENF) for the Mugar parcel was submitted through the Massachusetts Environmental Policy Act (MEPA) on behalf of Finard and Company, Inc. At that time, the project included a proposal for the construction of two 150,000 square foot (sf) office buildings on the Site with approximately 1,145 parking spaces. Site access/egress was proposed exclusively via a connection to Route 2 westbound. On

October 26, 2000 the MEPA secretary determined that an EIR was required[1], however, the project never moved forward and the Site remains undeveloped.

Proposed Conditions

The proposed Site programming consists of developing the Site as a 207-unit residential development consisting of 193± rental apartment units and 14± townhouse/ condominium units. On-Site parking is planned for 171 garage spaces and 138 surface spaces for a total of approximately 309 parking spaces. The townhouse apartment units are proposed to have individual driveways directly onto Dorothy Road. Planned Site access/egress for the apartment units includes three unsignalized driveways including a full-access driveway connection to Dorothy Road, a full-access driveway along Burch Street, and a gated emergency-only driveway connection to Parker Street. An additional access/egress driveway that would be restricted to right-in/right-out movements along the Route 2/Lake Street westbound off-ramp is also evaluated as a potential alternative. The preliminary Site layout plan prepared by Oaktree Development LLC is presented in **Figure 2**.

E.2 STUDY AREA

This TIAS evaluates transportation characteristics of roadways and intersections that provide a primary means of access to the Site, and that are likely to sustain a measurable level of traffic impact from the development. The study area includes the following intersections:

- Route 2 at Route 16
- Route 2 at Lake Street EB on/off ramps
- Route 2 at Lake Street WB on/off ramps
- Lake Street at Littlejohn Street
- Lake Street at Burch Street
- Massachusetts Avenue at Lake Street
- Burch Street at Site Driveway
- Dorothy Road at Site Driveway

E.3 SUMMARY OF ANALYSIS AND FINDINGS

Capacity analyses were conducted for each study area intersection to quantify existing and future year traffic operations with and without the development for the weekday morning and weekday evening peak hours. These time periods represent the highest activity periods of the proposed project and the adjacent roadway system.

[1] *Certificate of the Secretary of Environmental Affairs on the ENF; EOEA 12307*, Mugar Parcel dated October 26, 2000.

The Route 2 intersection with Route 16 currently operates with long delays during both the morning and evening peak hours, specifically for the northbound approach. Under future No-Build conditions, with planned roadway improvements, the intersection will operate at an overall LOS C during the morning peak hour while the intersection will continue to operate with long delays during the evening peak hour, specifically for the northbound approach. The signalized study intersections along Lake Street currently operate at LOS C or better during the peak hours. The unsignalized exiting movements from Burch Street onto Lake Street operate below capacity at LOS C operations during peak hours. Unsignalized left turn exit movements from Littlejohn Street onto Lake Street currently operate with long delays while right turn movements currently operate with minimal delay during the weekday morning peak hour; however, field observations indicate that that the calculated delay for the left turn movements onto Lake Street are somewhat overstated and, in fact, operate below capacity during both the weekday morning and weekday evening peak hours.

The Build analyses presented in this TIAS are based on industry-standard trip rates published by the Institute of Transportation Engineers (ITE) and are applied to the total number of residential units. The Site is also immediately adjacent to the Minuteman Bike Path which provides a direct connection to the nearby Alewife MBTA station. On this basis, when adjusted to reflect a documented local transit use mode share of 28%, the proposed residential development is estimated to generate approximately 75 vehicle trips during the weekday morning peak hour (15 entering and 60 exiting) and 82 vehicle trips during the weekday evening peak hour (60 entering and 22 exiting). On a daily basis, the development is estimated to generate approximately 984 vehicle trips on a weekday.

A number of area transportation improvement initiatives have either been implemented or are soon to be implemented that address auto mobility constraints at area intersections. Within the study area these include lane assignment and signal timing improvements at the Lake Street/ Route 2 westbound off-ramp intersection, Route 2 at Route 16 (Alewife Brook Parkway) geometric and signal improvements, and the Massachusetts Avenue Reconstruction project.

Adequate capacity is available under future Build conditions along Lake Street and at the study intersections to accommodate the modest traffic increases for the proposed residential development. Under Build conditions, incremental traffic increases at the study intersections due to the proposed development do not generally result in any material change in overall intersection operations compared to No-Build conditions. Access improvements as outlined in the Conclusions and Recommendations section of this report will enhance safety and operations at the proposed site driveways. Likewise, the project will be designed as a transit-oriented development that provides an integrated system of sidewalks and a path connection to the nearby Minuteman Bike Path to facilitate bicycle use and accessibility and use of public transportation at the nearby Alewife MBTA station.

E.4 ACCESS IMPROVEMENTS

MDM recommends access-related improvements aimed at enhancing traffic operations and/or travel safety including the following:

- STOP signs (R1-1) and STOP line pavement markings are recommended on driveway approaches to Littlejohn Street and Burch Street. The signs and pavement markings shall be compliant with the Manual on Uniform Traffic Control Devices (MUTCD).

- Plantings (shrubs, bushes) and structures (walls, fences, etc.) should be maintained at a height of 2 feet or less within the sight lines in vicinity of the Site driveways to provide unobstructed sight lines. Furthermore, the existing vegetation and structures within the sight lines should be selectively cleared when the Site driveways are constructed and the terrain shall be graded as required to ensure minimum recommended sight line requirements are met or exceeded.

- Final driveway alignment, widths and curb radii should be designed as required to accommodate standard Single Unit (SU) design vehicles and emergency (fire apparatus) design vehicles.

- The alternative driveway connection to the Route 2 westbound off-ramp to Lake Street is being considered as a more direct access to/from Route 2, thereby reducing dependence on local roadways. The Proponent is in consultation with MassDOT to identify land acquisition requirements that involve re-designation of access lines along the Route 2 property frontage and transfer of property to MassDOT that would mutually benefit both parties.

E.5 CONCLUSIONS

The proposed 40B residential project is a modest traffic generator that is being designed to leverage its proximity to a major bike path and nearby public transportation facilities to encourage multi-modal travel. Census data for the neighborhoods surrounding the Site indicate that approximately 28% of the residents utilize public transportation (bus and/or subway) as their primary travel mode to/from work; this trend is expected to apply equally to the Site residents, whom will be served by a system of sidewalks and a path connection to the Minuteman Bike Path that directly connects to the nearby Alewife MBTA Station. Planned intersection improvements at the Route 2/Route 16 intersections and the Massachusetts Avenue at Lake Street intersection will further enhance capacity and safety to accommodate modest traffic increases for the project.

Site-generated traffic increases at the study intersections do not result in any material change in overall intersection operations compared to No-Build conditions. Adequate capacity is available under future Build conditions along Lake Street and at the study intersections to accommodate projected Site traffic increases.

While only modest traffic increases are projected for area neighborhood streets at full build out, an alternative driveway connection to the Route 2 westbound off-ramp to Lake Street is being considered as a more direct access to/from Route 2. This ramp driveway would reduce dependence on local roadways. The Proponent is in consultation with MassDOT to identify land acquisition requirements that involve re-designation of access lines along the Route 2 property frontage and transfer of property to MassDOT that would mutually benefit both parties.

1.0 INTRODUCTION

MDM Transportation Consultants, Inc. (MDM) has prepared this Traffic Impact and Access Study (TIAS) for the proposed Mugar 40B residential development (the Site) to be located off of Lake Street in Arlington, Massachusetts. This report documents existing operational and safety-related characteristics of roadways serving the development Site, estimates future year operating characteristics of these roadways independent of the development, estimates development-related trip generation, and identifies incremental impacts of Site-related traffic. Access and off-site intersection improvements are identified for the development to meet operational needs of the Site and the adjacent roadways as required.

This TIAS has been prepared in accordance with requirements and standards for the preparation of traffic studies as jointly issued by the Commonwealth of Massachusetts Executive Office of Energy & Environmental Affairs/ Massachusetts Department of Transportation (EEA/MassDOT).

1.1 PROPOSED DEVELOPMENT

The Site comprises approximately 17 acres bounded by Route 2, Dorothy Road, Burch Street and Thorndike Field in Arlington, Massachusetts. The Site currently contains undeveloped land. The proximity of the Site in relation to the regional transportation system is shown in **Figure 1**.

Historical MEPA Review

In September 2000 an Environmental Notification Form (ENF) for the Mugar parcel was submitted through the Massachusetts Environmental Policy Act (MEPA) on behalf of Finard and Company, Inc. At that time, the project included a proposal for the construction of two 150,000 square foot (sf) office buildings on the Site with approximately 1,145 parking spaces. Site access/egress was proposed exclusively via a connection to Route 2 westbound. On October 26, 2000 the MEPA secretary determined that an EIR was required[2], however, the project never moved forward and the Site remains undeveloped.

[2] *Certificate of the Secretary of Environmental Affairs on the ENF; EOEA 12307*, Mugar Parcel dated October 26, 2000.

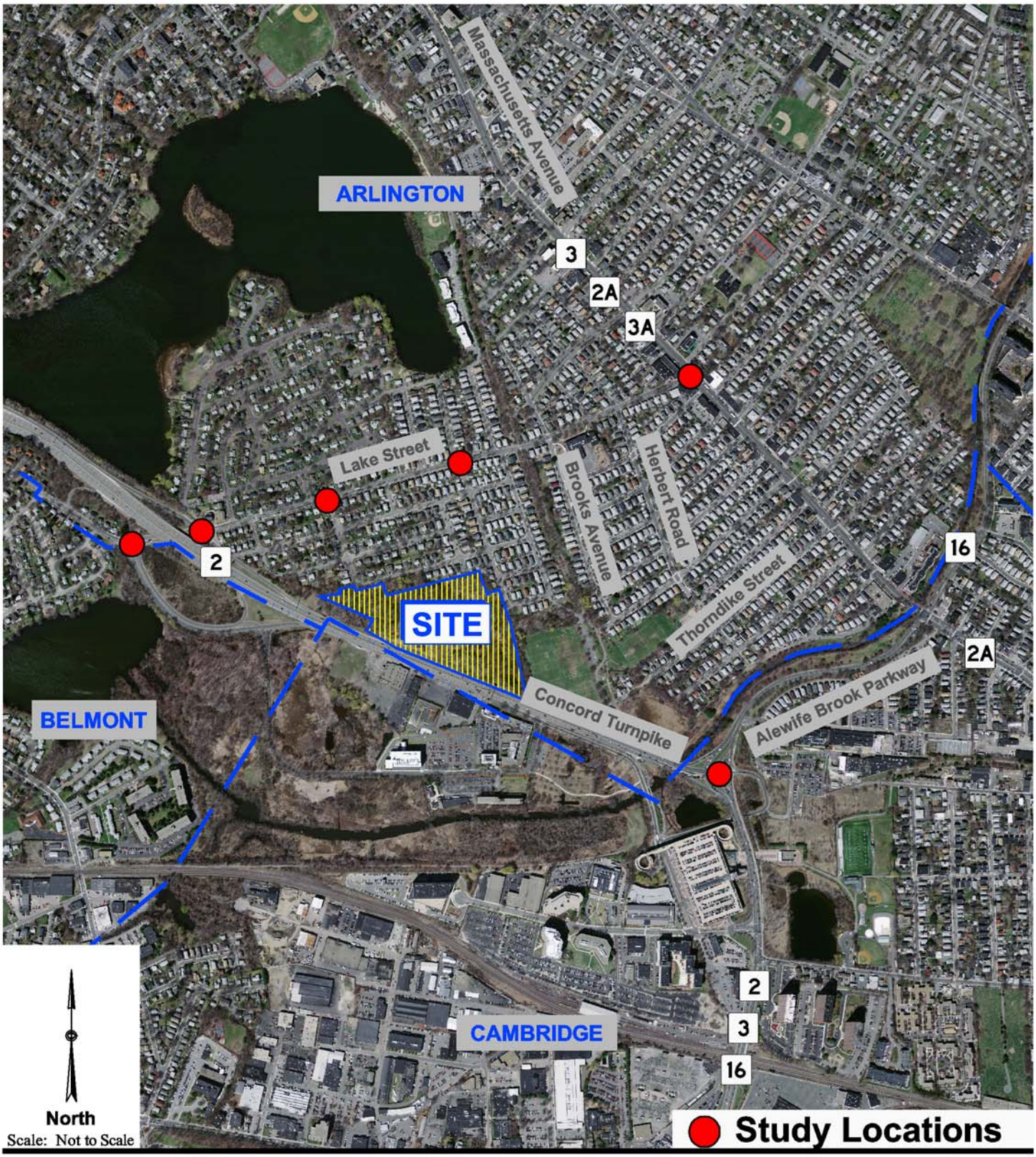


Figure 1

Site Location

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

Date: April 2014
Dwg No. 754 TIAS.dwg

Proposed Conditions

The proposed Site programming consists of developing the Site as a 207-unit residential development consisting of 193± rental apartment units and 14± townhouse/ condominium units. On-Site parking is planned for 171 garage spaces and 138 surface spaces for a total of approximately 309 parking spaces. The townhouse apartment units are proposed to have individual driveways directly onto Dorothy Road. Planned Site access/egress for the apartment units includes three unsignalized driveways including a full-access driveway connection to Dorothy Road, a full-access driveway along Burch Street, and a gated emergency-only driveway connection to Parker Street. An additional access/egress driveway that would be restricted to right-in/right-out movements along the Route 2/Lake Street westbound off-ramp is also be evaluated as an alternative. The preliminary Site layout plan prepared by Oaktree Development LLC is presented in **Figure 2**.

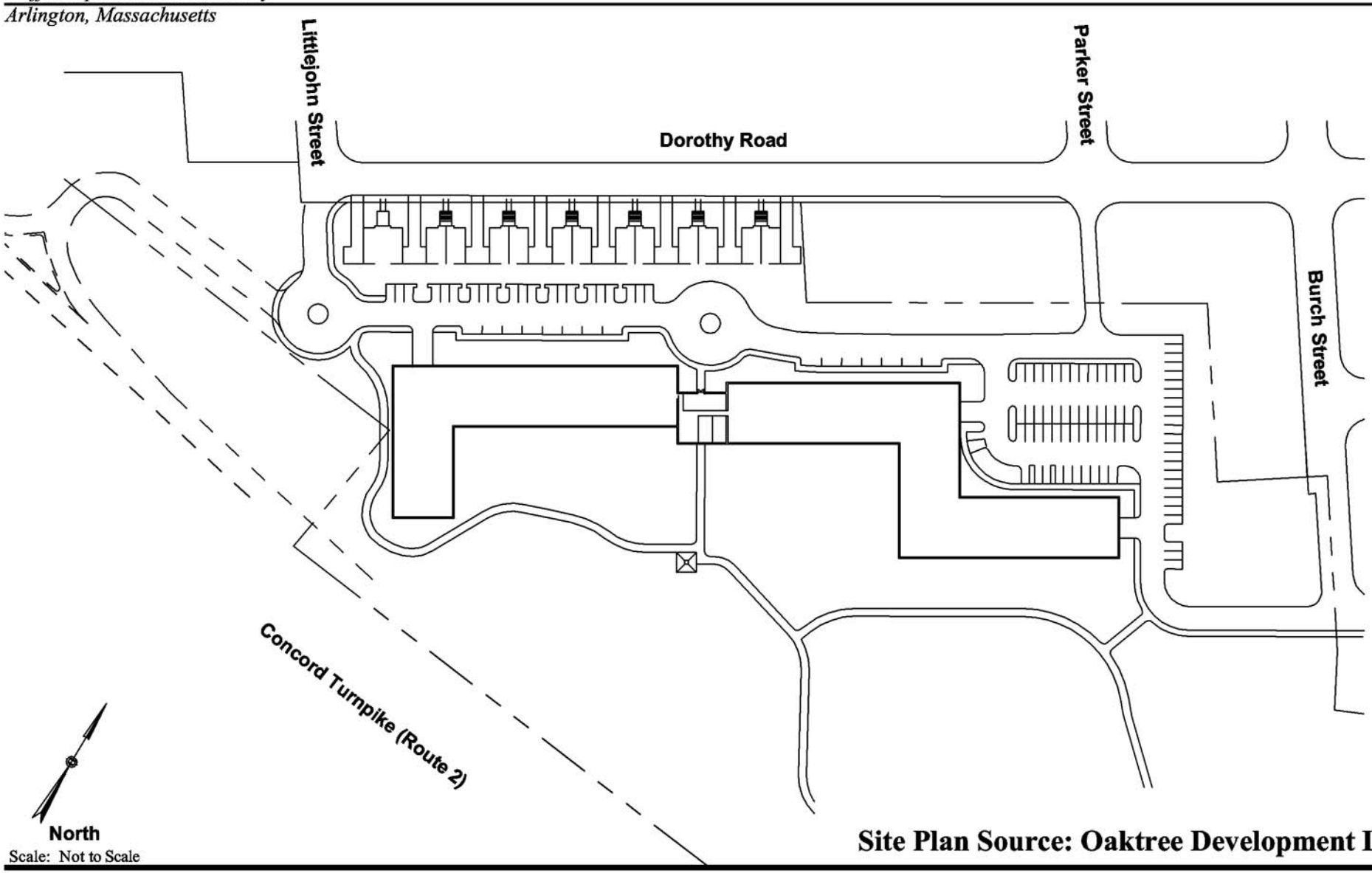
1.2 STUDY METHODOLOGY

This transportation impact and access evaluation is conducted in accordance with EEA/MassDOT guidelines, and consists of several steps. The first step documents existing conditions in the transportation study area including an inventory of roadway geometry, observed traffic volumes, public transportation, and safety characteristics. Next, future year traffic conditions are forecast that account for other planned area developments, normal area growth, and development-related traffic increases. The third step quantifies operating characteristics of the study intersections. Specific attention is given to the incremental impacts of the proposed development. Finally, improvements are identified to address specific development-related requirements as needed.

1.3 STUDY AREA

This TIAS evaluates transportation characteristics of roadways and intersections that provide a primary means of access to the Site, and that are likely to sustain a measurable level of traffic impact from the development. The study area includes the following intersections:

- Route 2 at Route 16
- Route 2 at Lake Street EB on/off ramps
- Route 2 at Lake Street WB on/off ramps
- Lake Street at Littlejohn Street
- Lake Street at Burch Street
- Massachusetts Avenue at Lake Street
- Burch Street at Site Driveway
- Dorothy Road at Site Driveway



Site Plan Source: Oaktree Development LLC

Figure 2

Preliminary Site Layout

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

Date: April 2014
Dwg No. 754 Figure 2 (4-15-2014).dwg

2.0 EXISTING CONDITIONS

In order to provide a basis for quantifying the transportation impacts of the development, the existing roadway system and the existing traffic operations of study area roadways were reviewed. This section describes the existing traffic characteristics and operations of roadways and intersections within the study area. Specifically, this section presents an overview of the traffic data collection program, existing traffic volumes, safety issues and public transportation systems serving the area.

2.1 STUDY AREA ROADWAY NETWORK

The study area roadways and intersections are described briefly in this section. A general description of the physical roadway and intersection features is provided. The study area includes roadways under local (City/Town), State (MassDOT) and Department of Conservation and Recreation (DCR) jurisdiction. The study area and intersection are depicted in **Figure 1**.

2.1.1 Roadways

Lake Street

Lake Street is classified by the Massachusetts Department of Transportation (MassDOT) as an Urban Minor Arterial roadway and is under Local (Town) jurisdiction within the study area. Lake Street is generally a north-south roadway in the Site vicinity and provides a connection between Route 60 to the south in Belmont and Massachusetts Avenue (Routes 3/3A) to the north. Within the study area, the roadway provides a single travel lane in each direction with additional turn lanes at its intersections with the Route 2 ramps. Sidewalks are provided along both sides of Lake Street throughout the study area. The regulatory (posted) speed limit along Lake Street is 30 mph. Land uses along Lake Street within the project area primarily include single family residential homes with commercial uses near its intersection with Massachusetts Avenue. The Hardy Elementary School and Minuteman Commuter Bikeway are also located along Lake Street within the study area.

Concord Turnpike (Route 2)

Route 2 is classified by the MassDOT as a Principal Arterial under MassDOT (State) jurisdiction. This roadway generally runs in an east-west direction and provides a connection among various towns and major highways along the northern portion of Massachusetts between the New York state line and Boston. On a local basis, Route 2 is also known as Concord Turnpike and provides a connection between I-95/ Route 128 to the west with Route 16 to the east primarily as a limited access highway. Within the study area, the roadway provides between 2 and 4 travel lanes in each direction. There are no sidewalks along this section of Route 2; however, a pedestrian overpass is provided between the Lake Street exit and Route 16. Within the study area, the regulatory (posted) speed limit along Route 2 ranges between 45 mph and 55 mph. Land uses with direct access/egress Concord Turnpike (Route 2) are generally restricted within the study area, however, a residential apartment complex and commercial uses have access/egress to Route 2 eastbound between Lake Street and Route 16 near Acorn Park.

Alewife Brook Parkway (Routes 3/ 16)

Alewife Brook Parkway (Routes 3/ 16) is classified by MassDOT as an Urban Other Principal Arterial roadway and is under Department of Conservation and Recreation (DCR) jurisdiction. Within the study area, Alewife Brook Parkway is generally a north-south roadway that connects Concord Avenue to the south and Mystic Valley Parkway to the north. Within the study area, the roadway provides two travel lanes in each direction with additional turn lanes at its major intersections. The Parkway has a heavy vehicle restriction. The regulatory (posted) speed limit along Alewife Brook Parkway is 30 mph. Land uses along Alewife Brook Parkway within the project area include a mix of commercial and residential uses. The Alewife "T" station is also located along Alewife Brook Parkway providing Red Line subway service and parking.

Massachusetts Avenue (Routes 2A/ 3A/ 3)

Massachusetts Avenue (Routes 2A/ 3A/ 3) is classified by MassDOT as a Principal Arterial roadway and is under Local (Town) jurisdiction within the study area. Massachusetts Avenue is generally an east-west roadway that connects the Town of Arlington to the Town of Lexington to the west and the City of Cambridge to the east. Within the study area, the roadway provides a single travel lane in each direction with additional turn lanes at its major intersections. Sidewalks are provided along both sides of Massachusetts Avenue throughout the study area and on-street parking is allowed on both sides of the street. The regulatory (posted) speed limit along Massachusetts Avenue is 30 mph. Land uses along Massachusetts Avenue within the project area include a mix of residential and commercial uses.

2.1.2 Intersections

Route 2 at Route 16

Route 2 meets Route 16/ Alewife Station driveway to form a four-legged, series of 4 signalized intersections under the control of the Department of Conservation and Recreation. The eastbound Route 2 approach provides dual left turn lanes and dual right turn lanes. The westbound Alewife Station egress driveway provides a through travel lane and a channelized right turn lane. The Route 16 northbound approach to the intersection provides dual left turn lanes and dual through travel lanes. The Route 16 southbound approach to the intersection provides dual through travel lanes and a single right turn lane. Land uses at the intersection include The Alewife T Station, a multi-use path, an office building and drainage areas.

Lake Street at Route 2 EB Ramps

Lake Street meets the Route 2 EB Ramp to form a three-legged, signalized intersection. The westbound Route 2 EB Ramp approach provides a left turn lane and a channelized right turn lane which is under "Yield" sign control. The Lake Street northbound approach to the intersection provides a through travel lane and a channelized right turn lane. The Lake Street southbound approach to the intersection provides an exclusive left turn lane and dual through travel lanes. Land uses at the intersection include residential homes and land under the control of MassDOT as part of the Route 2 highway system.

Lake Street at Route 2 WB Ramps

Lake Street meets the Route 2 WB Ramps to form a four-legged, signalized intersection. The westbound Route 2 WB Ramp approach provides a left turn lane, a shared left/ through travel lane and a channelized right turn lane which is under "STOP" sign control. The Lake Street northbound approach to the intersection provides an exclusive left turn lane and a through travel lane. The Lake Street southbound approach to the intersection provides a through travel lane and a shared through/ right turn lane. Land uses at the intersection include residential homes and land under the control of MassDOT as part of the Route 2 highway system.

Lake Street at Littlejohn Street

Lake Street meets Littlejohn Street to form a three-legged, unsignalized intersection. All approaches are single lane approaches with the westbound Littlejohn Street approach under "STOP" sign control. Land uses at the intersection include residential homes.

Lake Street at Burch Street

Lake Street meets Burch Street to form a three-legged, unsignalized intersection. All approaches are single lane approaches with the westbound Burch Street approach under "STOP" sign control. Land uses at the intersection include residential homes.

Massachusetts Avenue (Routes 2A, 3, & 3A) at Lake Street/ Winter Street

Massachusetts Avenue meets Lake Street/ Winter Street to form a four-legged, signalized intersection in an urbanized commercial environment. The eastbound Massachusetts Avenue approach provides a shared left/ through travel lane, a through travel lane and a right turn lane. The westbound Massachusetts Avenue approach provides a shared left/ through travel lane and shared through/ right turn lane. The Lake Street northbound approach to the intersection provides a shared left/through travel lane and an exclusive right turn lane. Winter Street is a one-way street providing egress away from the intersection. Land uses at the intersection include a mix of commercial, retail, and restaurant uses.

2.2 EXISTING TRAFFIC VOLUMES

Traffic-volume data used in this study were obtained by mechanical and manual methods in March 2014. Automatic traffic recorder counts (ATRs) were conducted along Lake Street and the Route 2 westbound off-ramp to Lake Street while manual turning movement counts (TMCs) were conducted at the existing study intersections. Traffic data were collected during the weekday morning (7:00 to 9:00 AM) and weekday evening (4:00 to 6:00 PM) peak periods. These hours represent the combination of busiest activity periods of the Site and adjacent roadway network.

2.2.1 Daily Traffic

Daily traffic volumes along Lake Street and the Route 2 westbound off-ramp east of Lake Street are summarized in **Table 1** and included in the **Appendix**.

TABLE 1
EXISTING TRAFFIC VOLUME SUMMARY

Time Period	Daily Volume (vpd)[1]	Percent Daily Traffic[2]	Peak Hour Volume (vph)[3]	Peak Flow Direction[4]	Peak Hour Directional Volume (vph)
Lake Street west of Burch Street					
Weekday Morning Peak Hour	11,265	12%	1,296	73% WB	946
Weekday Evening Peak Hour	11,265	9%	976	64% EB	628
Route 2 WB off-ramp east of Lake Street					
Weekday Morning Peak Hour	1,425	5%	74	100% WB	74
Weekday Evening Peak Hour	1,425	7%	102	100% WB	102

[1]Two-way daily traffic expressed in vehicles per day without seasonal adjustment.
[2]The percent of daily traffic that occurs during the peak hour.
[3]Two-way peak-hour volume expressed in vehicles per hour.
[4]NB = Northbound, SB = Southbound, EB = Eastbound, WB = Westbound

As summarized in **Table 1**:

- The weekday daily traffic volume on Lake Street to the west of Burch Street is approximately 11,265 vehicles per day (vpd) during a typical weekday. Peak hour traffic flow on Lake Street ranges from approximately 976 vehicles per hour (vph) to 1,296 vph in the immediate project area which represents 9 to 12 percent of daily traffic flow. The traffic flow on Lake Street is significantly higher in the westbound direction during the weekday morning peak hour and is significantly higher in the eastbound travel direction during the weekday evening peak hour consistent with commuter-related travel patterns.

- The weekday daily traffic volume on the Route 2 westbound off-ramp to Lake Street is approximately 1,425 vpd during a typical weekday. Peak hour traffic flow on the westbound off-ramp ranges from approximately 74 vph to 102 vph adjacent to the Site which represents 9 to 12 percent of daily traffic flow.

2.2.2 Peak-Hour Traffic

Manual turning movement counts (TMCs) were conducted along study area roadways and intersections in March 2014. These traffic data were collected during the weekday morning (7:00 to 9:00 AM) and weekday evening (4:00 to 6:00 PM) peak periods.

Review of MassDOT permanent count station data indicates that March is a slightly below-average traffic month. Therefore, an adjustment of 1 percent (increase) was made to the March traffic volume data to represent average conditions. Permanent count station data is provided in the **Appendix**. The resulting existing weekday morning and weekday evening peak hour traffic volumes for the study intersection are depicted in **Figure 3** and **Figure 4**.

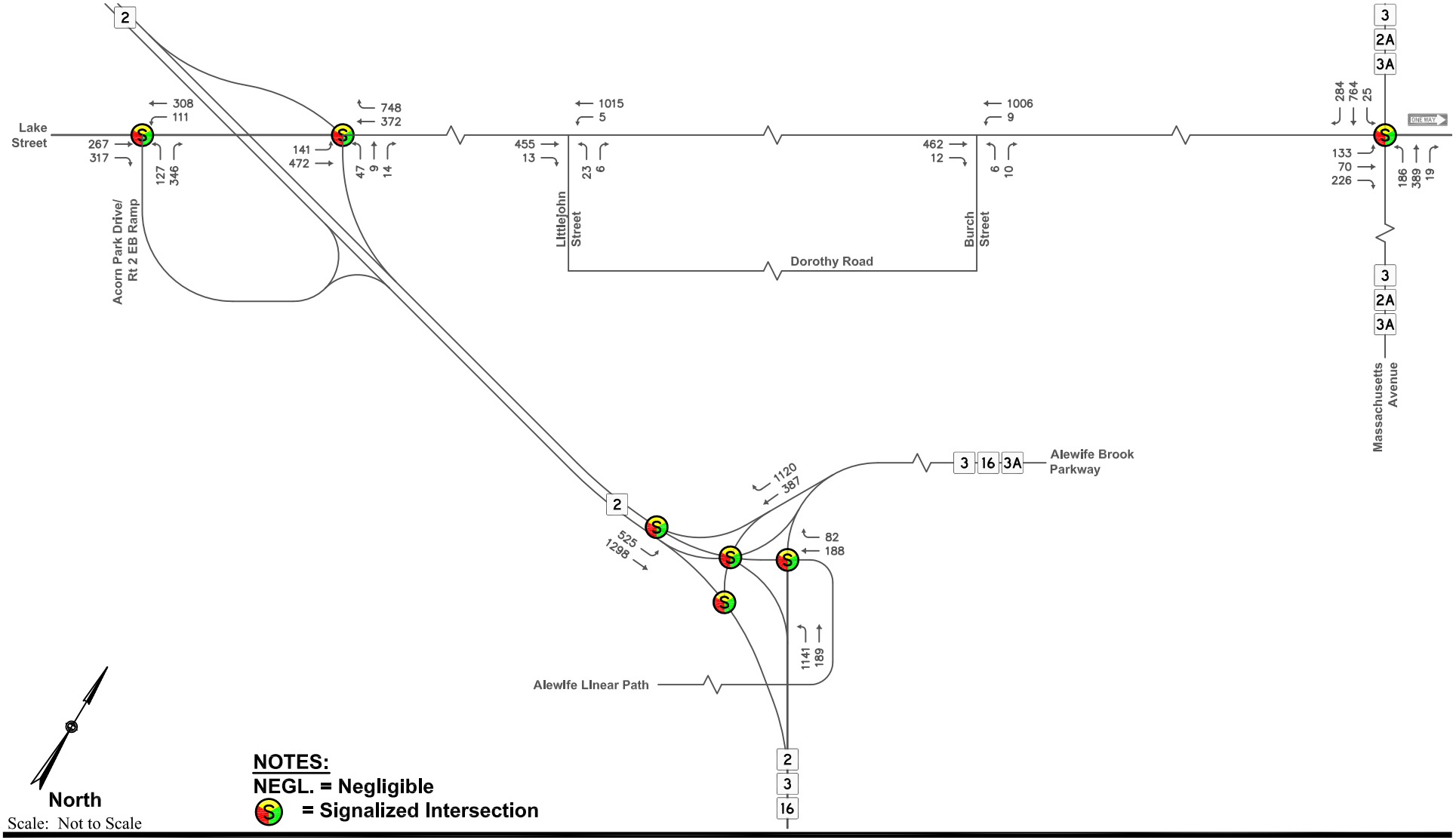


Figure 3

MDM TRANSPORTATION CONSULTANTS, INC.
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2014 Existing Conditions
Weekday Morning Peak Hour Traffic Volumes

Date: February 2014
Dwg No. 754 TIAS.dwg

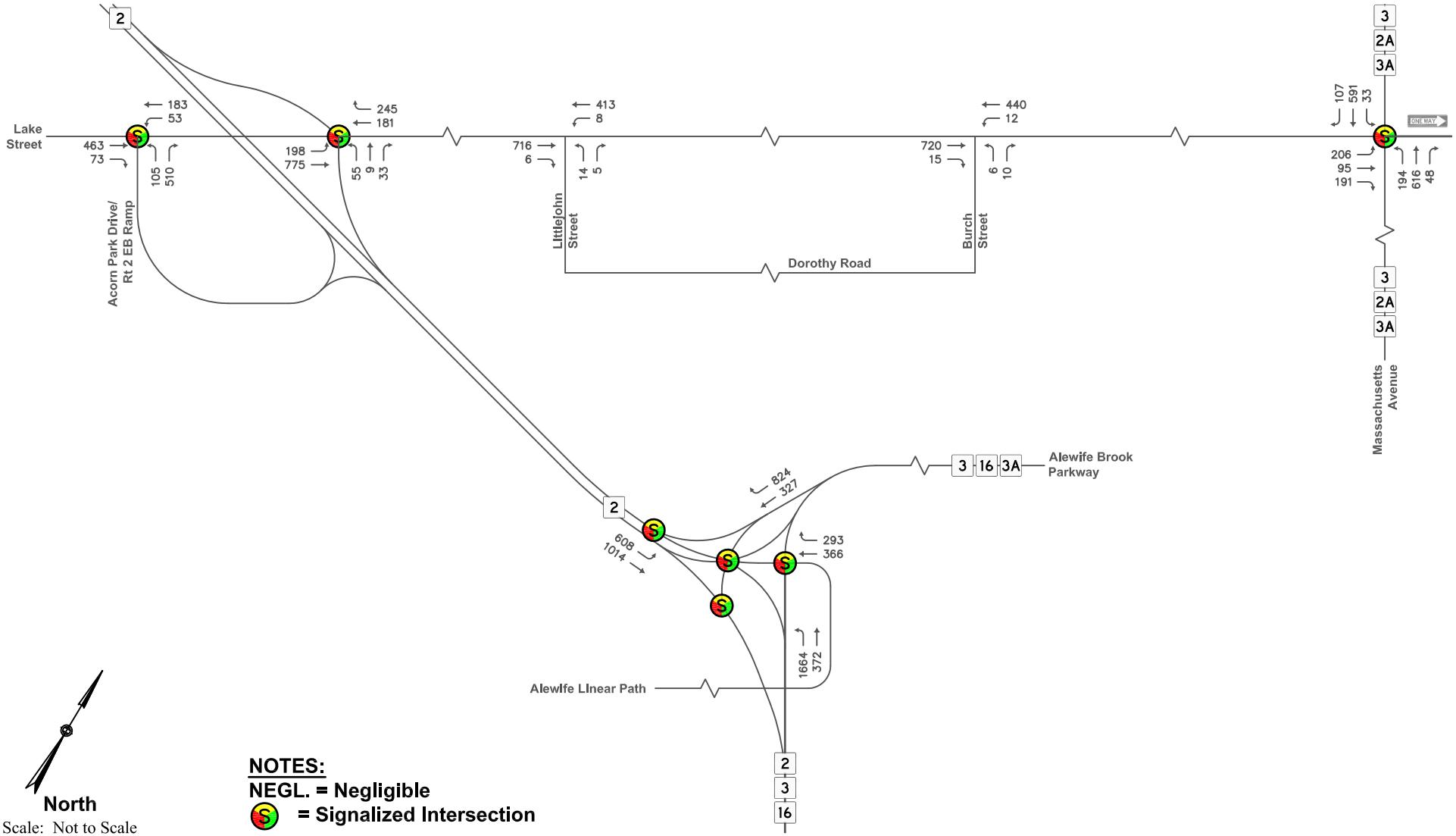

Figure 4

MDM TRANSPORTATION CONSULTANTS, INC.
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2014 Existing Conditions
Weekday Evening Peak Hour Traffic Volumes

Date: February 2014
Dwg No. 754 TIAS.dwg

2.3 SAFETY

In order to identify accident trends and safety characteristics for study area intersections, crash data were obtained from MassDOT for the Town of Arlington for the three-year period covering 2009 through 2011 (the most recent data currently available). A summary of the crash data with crash rates for each study area intersection is detailed in **Table 2**. The **Appendix** contains a tabulation of cash data.

A crash rate was determined for the study intersection. This rate quantifies the number of crashes per million entering vehicles. MassDOT has determined the crash rates within the District 4 area (which includes the Towns of Arlington and Belmont) to be 0.77 for signalized intersections and 0.58 for unsignalized intersections. Likewise, MassDOT has determined the crash rates within the District 6 area (which includes City of Cambridge) to be 0.76 for signalized intersections and 0.58 for unsignalized intersections. These rates represent MassDOT's "average" crash experience for communities within the Districts and serves as a basis for comparing reported crash rates for the study area intersections located within the districts.

As summarized in **Table 2**, the study intersections experience crash rates below the District-wide averages. The exception is the Route 2/ Route 16 intersection which is described in more detail below:

- *Route 2/ Route 16.* A total of sixty-four (64) crashes were reported for the Route 2/ Route 16 signalized intersection – approximately 21 per year – resulting in a crash rate of 1.03 –which is above the District-wide average of 0.76 for signalized intersections. The majority of reported crashes at the intersection were rear-end/ sideswipe type collisions (73%) resulting in property-damage only (73%) and occurring under dry pavement conditions (78%). The majority (72%) of crashes occurred outside of the peak commuting periods. As described in more detail under *Section 3.1 Planned Roadway Improvements*, intersection improvements by MassDOT aimed at enhancing safety and operations are planned for 2014 which include minor widening, elimination of a merge condition between Route 2 eastbound left turns and Route 16 northbound through movements, to improve capacity and vehicle storage at the intersection. The project will include updated traffic signal equipment, traffic signal phasing, curb widening and pavement marking improvements.

TABLE 2
INTERSECTION CRASH SUMMARY – 2009 THROUGH 2011[1]

	INTERSECTION				
Data Category	**Route 2 at Route 16**	**Lake St at Route 2 EB**	**Lake St at Route 2 WB**	**Lake St at Littlejohn St**	**Mass. Ave at Lake St**
Traffic Control	Signalized	Signalized	Signalized	Unsignalized	Signalized
Crash Rate[2]	**1.03**	**0.34**	**011**	**0.14**	**0.34**
District Average[3]	0.76	0.77	0.58	0.77	0.77
Year:					
2009	27	2	0	1	1
2010	14	3	1	1	5
2011	23	1	1	0	3
Total	64	6	2	2	9
Type:					
Angle	12	2	0	0	3
Rear-End	37	2	1	0	0
Head-On	1	0	0	0	1
Sideswipe	10	1	0	1	3
Single Vehicle	3	1	1	1	2
Unknown/Other	1	0	0	0	0
Severity:					
P. Damage Only	47	3	2	2	7
Personal Injury	17	3	0	0	2
Fatality	0	0	0	0	0
Unknown	0	0	0	0	0
Conditions:					
Dry	50	3	2	1	9
Wet	14	3	0	1	0
Snow	0	0	0	0	0
Other/Unknown	0	0	0	0	0
Time:					
7:00 to 9:00 AM	8	0	1	1	3
4:00 to 6:00 PM	10	0	0	0	1
Rest of Day	46	6	1	1	5

[1]Source: MassDOT Crash Database
[2]Crashes per million entering vehicles (MEV).
[3]District 4 or District 6 Average Crash Rates

2.4 PUBLIC TRANSPORTATION FACILITIES

The Massachusetts Bay Transit Authority (MBTA) operates the Alewife "T" Station which is located approximately 2/3 of a mile from the Site. This "T" station services the Red Line subway system and also services several bus routes including:

- Route 62 - Bedford V.A. Hospital - Alewife Station via Lexington Center & Arlington Heights
- Route 67 - Turkey Hill - Alewife Station via Arlington Center
- Route 76 - Hanscom/Lincoln Labs - Alewife Station via Lexington Center & Civil Air Terminal
- Route 79 - Arlington Heights - Alewife Station via Massachusetts Ave.
- Route 84 - Arlmont Village - Alewife Station
- Route 350 - North Burlington - Alewife Station via Burlington Mall
- Route 351 - Oak Park/Bedford Woods - Alewife Station via Middlesex Turnpike

Census 2010 Journey to Work data indicates that approximately 28% of the residents in Census Tract 3561 (which includes the Site) utilized public transportation (bus and/or subway) as their primary travel mode to/from work. Specific route and schedule information is provided in the **Appendix**.

3.0 FUTURE CONDITIONS

Evaluation of the proposed development impacts requires the establishment of a future baseline analysis condition. This section estimates future roadway and traffic conditions with and without the proposed development. To be consistent with EEA/MassDOT guidelines, a seven-year planning horizon was selected.

To determine the impact of Site-generated traffic volumes on the roadway network under future conditions, baseline traffic volumes in the study area were projected to a future year condition. Traffic volumes on the roadway network at that time, in the absence of the development (that is, the No-Build condition), would include existing traffic, new traffic due to general background traffic growth, and traffic related to specific development by others that is currently under review at the local and/or state level. Consideration of these factors resulted in the development of No-Build traffic volumes. Anticipated Site-generated traffic volumes were then superimposed upon these No-Build traffic-flow networks to develop future Build conditions.

The following sections provide an overview of planned area roadway improvements, future No-Build traffic volumes and projected Build traffic volumes.

3.1 PLANNED AREA ROADWAY IMPROVEMENTS

Route 2 at Route 16 (Alewife Brook Parkway)

MassDOT is planning transportation improvements to the Route 2 and Route 16 intersection (Project 605637). The project (construction to begin in 2014) will include minor widening, elimination of a merge condition between Route 2 eastbound left turns and Route 16 northbound through movements to improve capacity and vehicle storage at the intersection. The project will include updated traffic signal equipment, traffic signal phasing, curb widening and pavement marking improvements. Highlights of the project are presented in the **Appendix.**

Massachusetts Avenue Reconstruction

MassDOT is planning to fund transportation improvements to Massachusetts Avenue (Project 604687). A construction contract was expected in March 2014 with construction expected to start in late Spring 2014. The project is expected to be completed in two construction seasons. Specifically, Massachusetts Avenue will be reconstructed in the Town of Arlington from Pond Lane to the Cambridge City line. The work includes the reconstruction of existing pavement, lane reconfiguration, and traffic signal and access improvements. The construction will improve the vehicular, bicycle and pedestrian movement, enhance streetscape, and also improve safety within the project area by improving the roadway crossings thereby creating a more orderly traffic flow. Highlights of the project as they relate to the Massachusetts Avenue signalized intersection with Lake Street are presented in the **Appendix.**

The two improvement projects have been assumed to be complete under future No-Build and Build conditions. Therefore, the future capacity analysis is reflective of the improvements.

3.2 BACKGROUND TRAFFIC GROWTH

Background traffic includes demand generated by other planned developments in the area as well as demand increases caused by external factors. External factors are general increases in traffic not attributable to a specific development and are determined using historical data.

3.2.1 Historical Area Growth

Nearby permanent count station data published by MassDOT indicates a negative (-0.5 percent per year) growth rate. For purposes of this evaluation, a conservative half-percent percent (0.5%) annual traffic growth rate was assumed for the area roadways. This growth rate is higher than historic rates, and, as such, is also expected to account for any small fluctuation in hourly traffic as may occur from time to time in the study area and traffic associated with other potential vacancies or small developments in the area. MassDOT permanent count station data and background growth calculations are provided in the **Appendix**.

3.2.2 Background Development-Related Growth

Development of future No-Build traffic volumes also considers traffic generated through the study area from other specific area developments. Review of Massachusetts Environmental Policy Act (MEPA) files and review of Town files indicates that there are two site-specific development projects in the area that may increase traffic at the study intersections as follows:

- ***The Residences at Alewife (Vox on Two)***: This development includes approximately 228 residential apartment units with a vacancy of approximately 40 units. The project is located at 223 Concord Turnpike (Route 2) in Cambridge with a right-in/ right-out driveway provided along Route 2 eastbound. Traffic associated with the remaining vacancy was estimated based on the Transportation Impact Study (TIS) prepared for the project[3].

- ***The Residences at 160 Cambridgepark Drive***: This development is proposed to include approximately 398 residential apartment units. The project will be located at 160 Cambridgepark Drive in Cambridge. Traffic associated with this development was estimated based on the Transportation Impact Study (TIS) prepared for the project[4].

- ***The Residences at Fresh Pond***: This development is proposed to include approximately 429 residential apartment units. The project will be located at 70 Fawcett Street in Cambridge. Traffic associated with this development was estimated based on the Transportation Impact Study (TIS) prepared for a nearby project[5].

- ***603 Concord at Fresh Pond***: This development is proposed to include approximately 61 residential units and 7,184 sf of retail. The project will be located at 603 Concord Avenue. Traffic associated with this development was estimated based on the Transportation Impact Study (TIS) prepared for a nearby project[6].

- ***Tyler Green Residential Development***: This development is proposed to include approximately 398 residential apartment units. The project will be located at 1 Tyler Court in Cambridge. Traffic associated with this development was estimated based on the Transportation Impact Study (TIS) prepared for the project[7].

- ***Discovery Park***: This development is allowed for a total development of approximately 820,000 rsf of office, research & development, and laboratory space. The project is located between Concord Turnpike (Route 2) eastbound and Acorn Park Drive in Cambridge. Currently, buildings 100, 200, and 300 have been completed and are occupied at the Park. Lots 400, 500 and 600 results in approximately 344,000 sf that remains to be built-out with no known tenants at this time. Consistent with other recent traffic studies in the immediate area trips associated with this development will be accounted for in the general background growth rate.

[3] *TIS, Proposed Residences at Alewife, Cambridge, Massachusetts*, prepared by Vanasse & Associates, Inc., dated December 2010.
[4] *TIS, The Residences at 160 Cambridgepark Drive, Cambridge, Massachusetts*, prepared by VHB, Inc., dated March 2012.
[5] *Ibid 4*
[6] *Ibid 4*
[7] *TIS, Tyler Green Residential Development, Cambridge, Massachusetts*, prepared by Vanasse & Associates, Inc., dated August 2011.

Traffic associated with the aforementioned projects was incorporated into the future year 2021 No-Build traffic networks. Site trips and trip generation estimates for the background developments are provided in the **Appendix.**

3.3 NO-BUILD TRAFFIC VOLUMES

To account for future traffic growth in the study area, a half-percent annual growth rate was applied to existing traffic volumes over a seven-year period (3.6 percent increase over baseline levels) as well as traffic associated with specific area developments. Future No-Build traffic volumes are displayed in **Figure 5** and **Figure 6**.

3.4 SITE-GENERATED TRAFFIC

Future Build condition traffic volumes were developed by estimating the number of peak-hour trips expected to be generated by the proposed development and distributing this additional traffic onto the local roadway network. These future development-related trips were added to future No-Build traffic volumes to evaluate future traffic operations with the proposed Mugar 40B residential development in place. The methodology utilized to estimate the future trip-generation characteristics of the proposed development is summarized below. In accordance with EEA/MassDOT guidelines, the traffic generated by the proposed development was estimated using trip rates published in ITE's *Trip Generation*[8] for the Land Use Codes (LUCs) based on trip rates for Apartment (LUC 220) and for Residential Condominium/ Townhouse (LUC 230). Trip generation calculations are provided in the **Appendix**.

Census data for the neighborhoods surrounding the Site indicate that approximately 28% of the residents utilize public transportation (bus and/or subway) as their primary travel mode to/from work; this trend is expected to apply equally to the Site residents, whom will be served by a system of sidewalks and a path connection to the Minuteman Bike Path that directly connects to the nearby Alewife MBTA Station. US Census data is provided in the **Appendix.**

Table 3 presents the trip-generation estimates for the proposed development based on ITE methodology and EEA/MassDOT guidelines.

[8]*Trip Generation,* Ninth Edition; Institute of Transportation Engineers; Washington, DC; 2012.

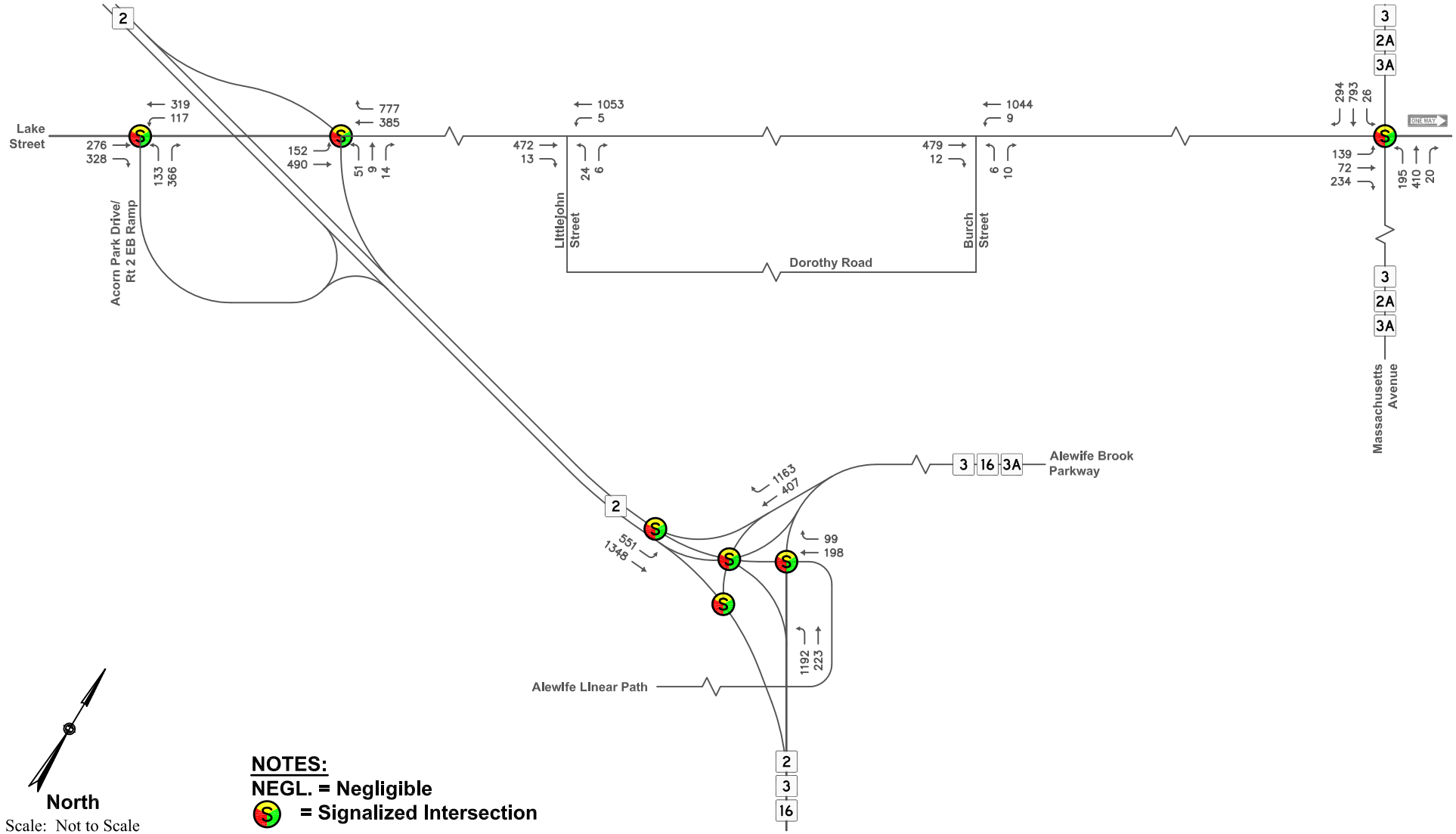

Figure 5

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

2021 No-Build Conditions
Weekday Morning Peak Hour Traffic Volumes

Date: February 2014
Dwg No. 754 TIAS.dwg

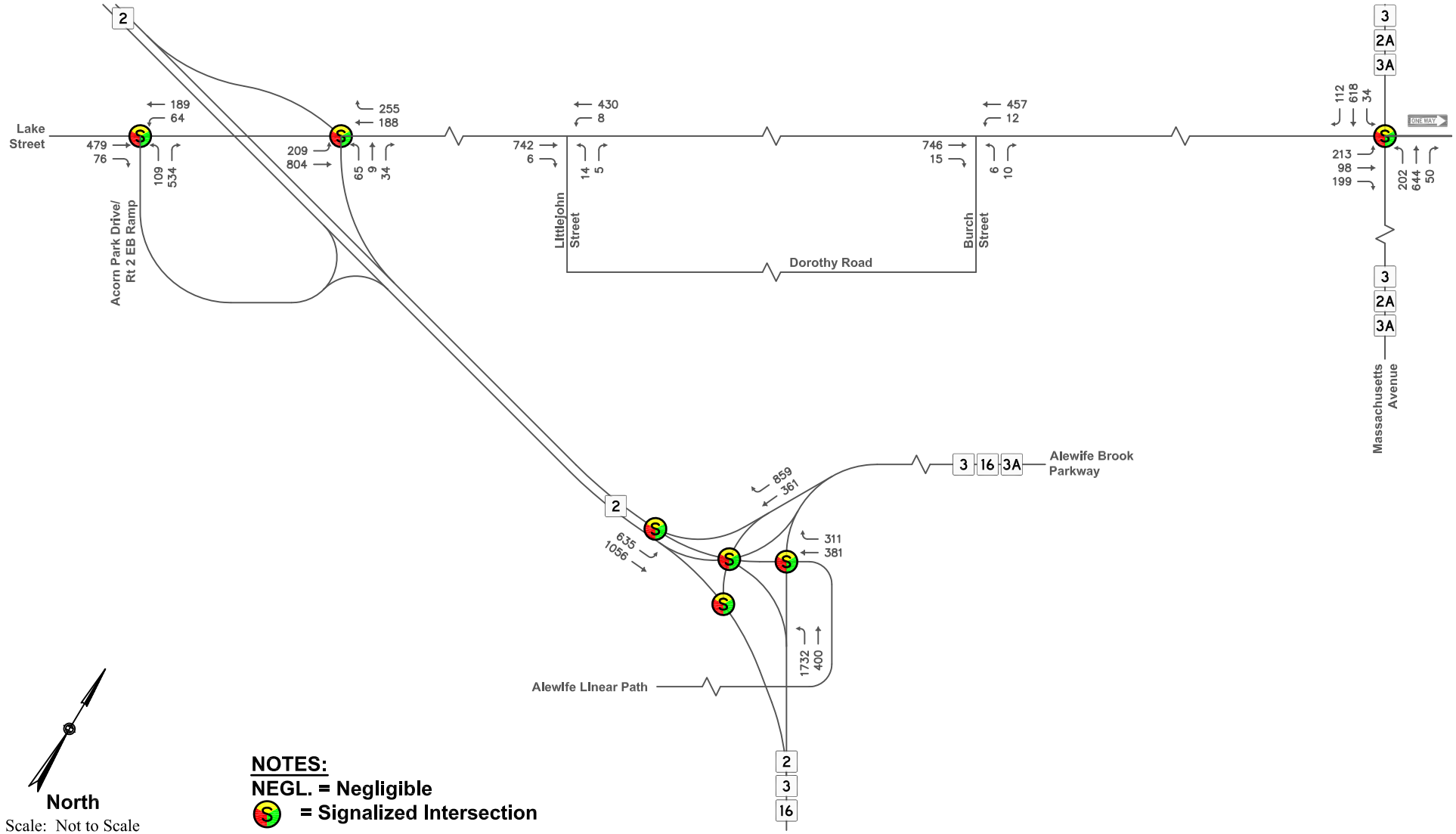

Figure 6

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

2021 No-Build Conditions
Weekday Evening Peak Hour Traffic Volumes

Date: February 2014
Dwg No. 754 TIAS.dwg

TABLE 3
TRIP-GENERATION SUMMARY[1]

Peak Hour/Direction	Apartments[2] (193 Units)	Townhomes[3] (14 Units)	Site Trips Total Trips	Transit Trips[4]	Vehicular Trips[5]
Weekday Morning Peak Hour:					
Entering	20	1	21	-6	**15**
Exiting	78	5	83	-23	**60**
Total	98	6	104	-29	**75**
Weekday Evening Peak Hour:					
Entering	78	5	83	-23	**60**
Exiting	42	2	44	-12	**22**
Total	120	7	127	-35	**82**
Weekday Daily (24 hours)	1,284	82	1,366	-382	**984**

[1]Source: ITE *Trip Generation*, Ninth Edition; 2012.
[2]ITE LUC 220 – Apartment applied to 193 units.
[3]ITE LUC 230 – Residential Condominium/ Townhouse applied to 14 units.
[4]Transit ridership was estimated at 28% per Census 2010 Journey to Work data.
[5]Vehicular Trips = Total Trips + Transit Trip reduction

Based on industry-standard trip rates adjusted for transit ridership, the proposed residential development is estimated to generate approximately 75 vehicle trips during the weekday morning peak hour (15 entering and 60 exiting) and 82 vehicle trips during the weekday evening peak hour (60 entering and 22 exiting). On a daily basis, the development is estimated to generate approximately 984 vehicle trips on a weekday.

3.5 EMPIRICAL TRIP GENERATION DATA

Trip generation estimates for the project are estimated based on well-established trip rates and methodology as published by the ITE for individual land uses. As a point of reference and comparison, empirically-derived trip generation characteristics for residential apartments are provided based on surveys of similar operating facilities in Massachusetts. Detailed empirically based trip generation worksheets are provided in the **Appendix**.

Table 4 present a summary of empirically-derived trip generation rates for similarly-sized residential apartment complex facilities located in Burlington, Waltham and Braintree Massachusetts applied to the proposed 193-unit component of the Site. In summary, comparison of ITE-based trip estimates for the residential component of the Site to observed/empirical characteristics of similar facilities in Massachusetts indicates that the ITE-based estimates are conservatively high (approximately 20 percent higher than empirical data).

TABLE 4
TRIP-GENERATION COMPARISON – APARTMENTS

Peak Hour/ Direction of Travel	*Trip Generation (ITE)*[1]	*Trip Generation (Empirical)*[2]	*Difference (ITE vs Empirical)*
Weekday Morning Peak Hour:			
Entering	20	12	**+8**
Exiting	78	67	**+11**
Total	98	79	**+19**
Weekday Evening Peak Hour:			
Entering	78	66	**+12**
Exiting	42	32	**+10**
Total	120	98	**+22**

[1]Based on ITE LUC 220 (Apartment) trip rates applied to 193 units with no transit reduction.
[2]Based on observed empirical trip generation rates for existing rental apartment complexes with similar unit counts located in Burlington and Braintree Massachusetts; no transit reduction applied. See Appendices.

3.6 TRIP DISTRIBUTION AND ASSIGNMENT

The directional distribution of development-generated trips on the roadway network is a function of a number of variables including local area populations and the efficiency of the roadways leading to the Site. Journey to work census data served as the primary basis for determining the trip distribution pattern for the proposed development. The distribution of the Site generated trips is displayed in **Figure 7**. Trip distribution calculations are provided in the **Appendix.**

Development-related trips for the Site were assigned to the roadway network using the conservative ITE trip-generation estimates shown in **Table 3** and the distribution patterns presented in **Figure 7**. New development-related trips at each intersection for the weekday morning and weekday evening peak hours are quantified in **Figure 8** and **Figure 9**.

3.7 BUILD TRAFFIC VOLUMES

Future Build condition traffic volumes were arrived at by adding development-specific traffic volumes to the 2021 No-Build conditions. The 2021 Build condition traffic-volume networks for the weekday morning and weekday evening peak hours are displayed in **Figure 10** and **Figure 11**.

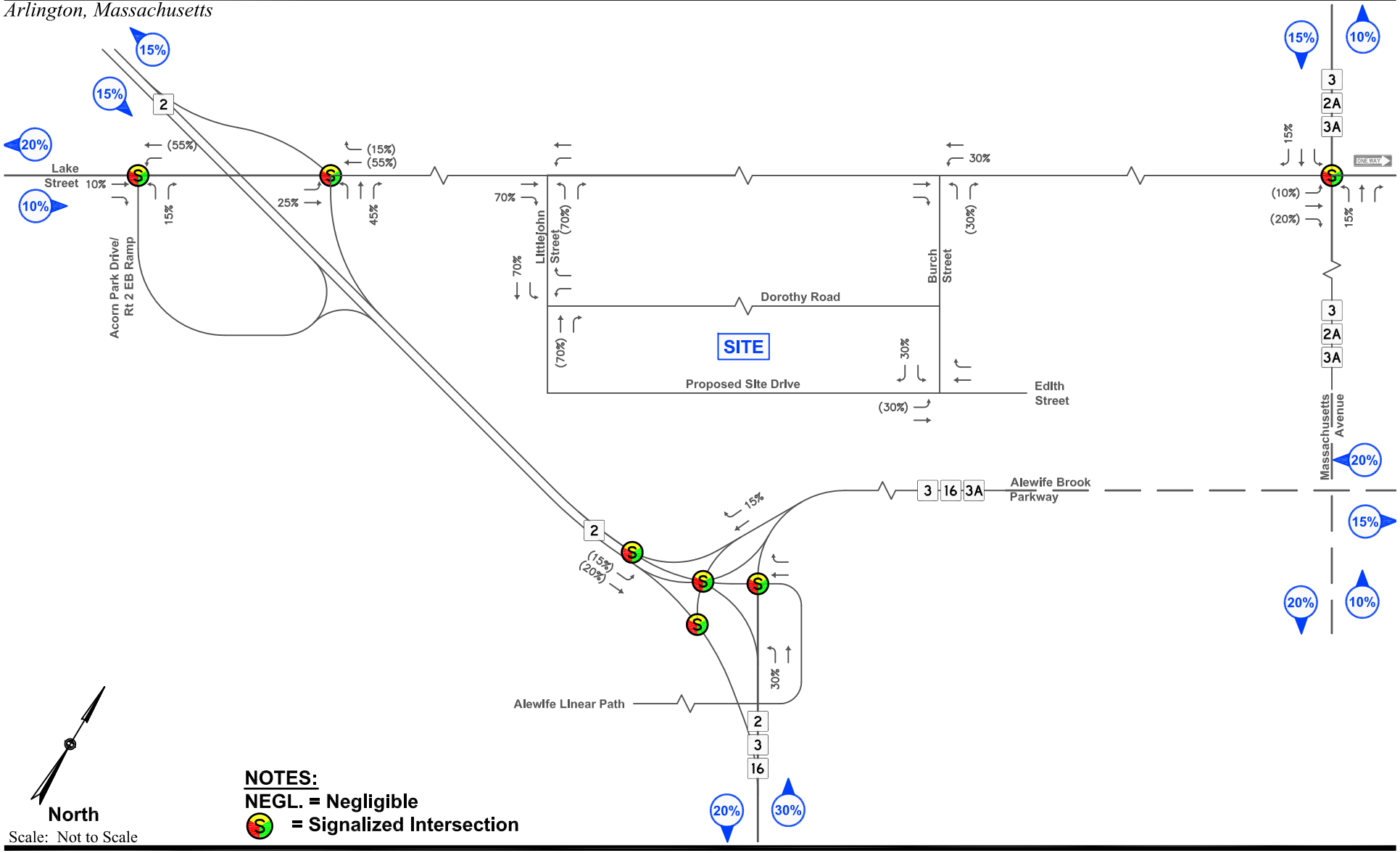

Figure 7

Trip Distribution

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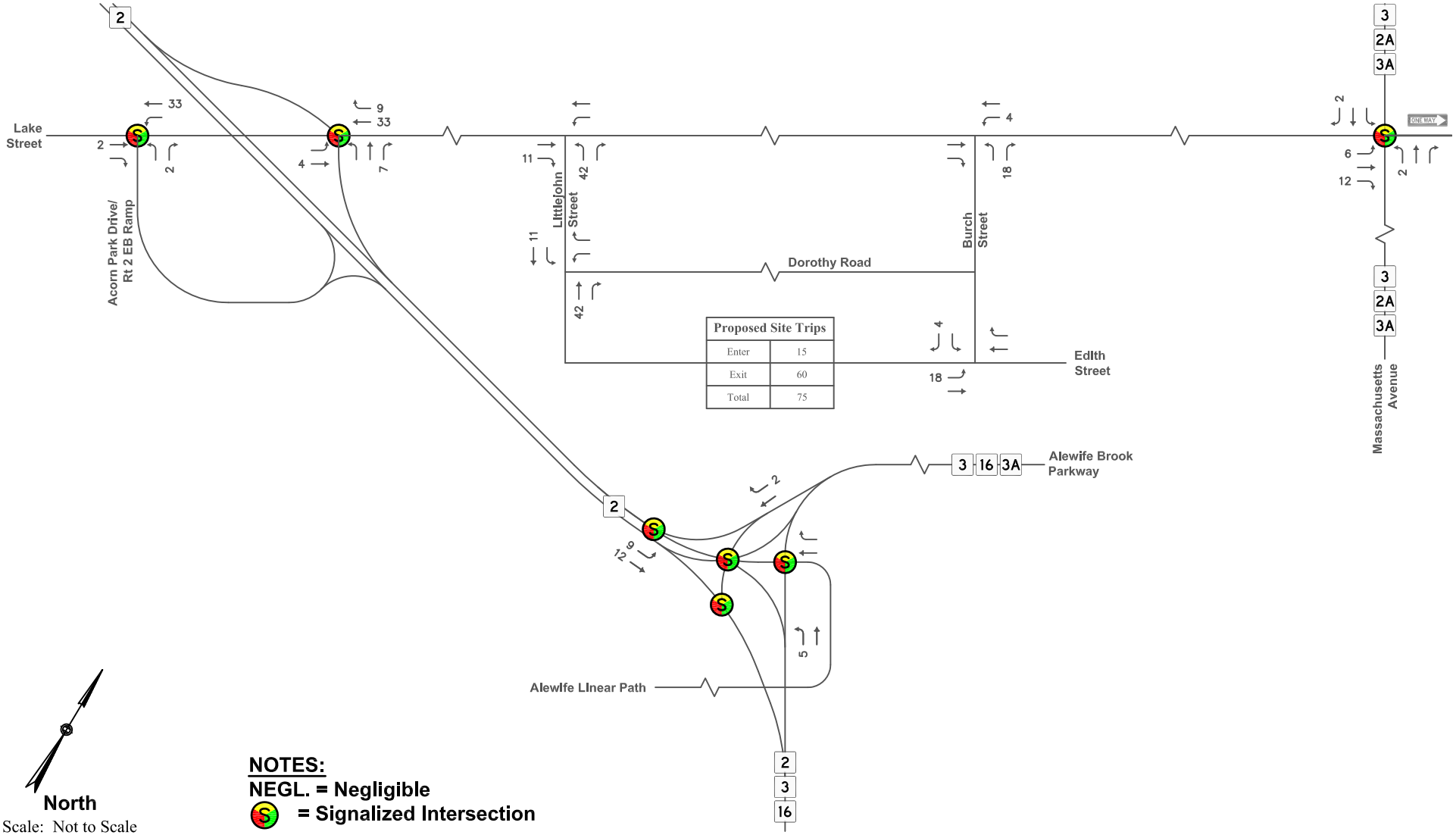

Figure 8

Site-Generated Trips
Weekday Morning Peak Hour Traffic Volumes

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Date: February 2014
Dwg No. 754 TIAS.dwg

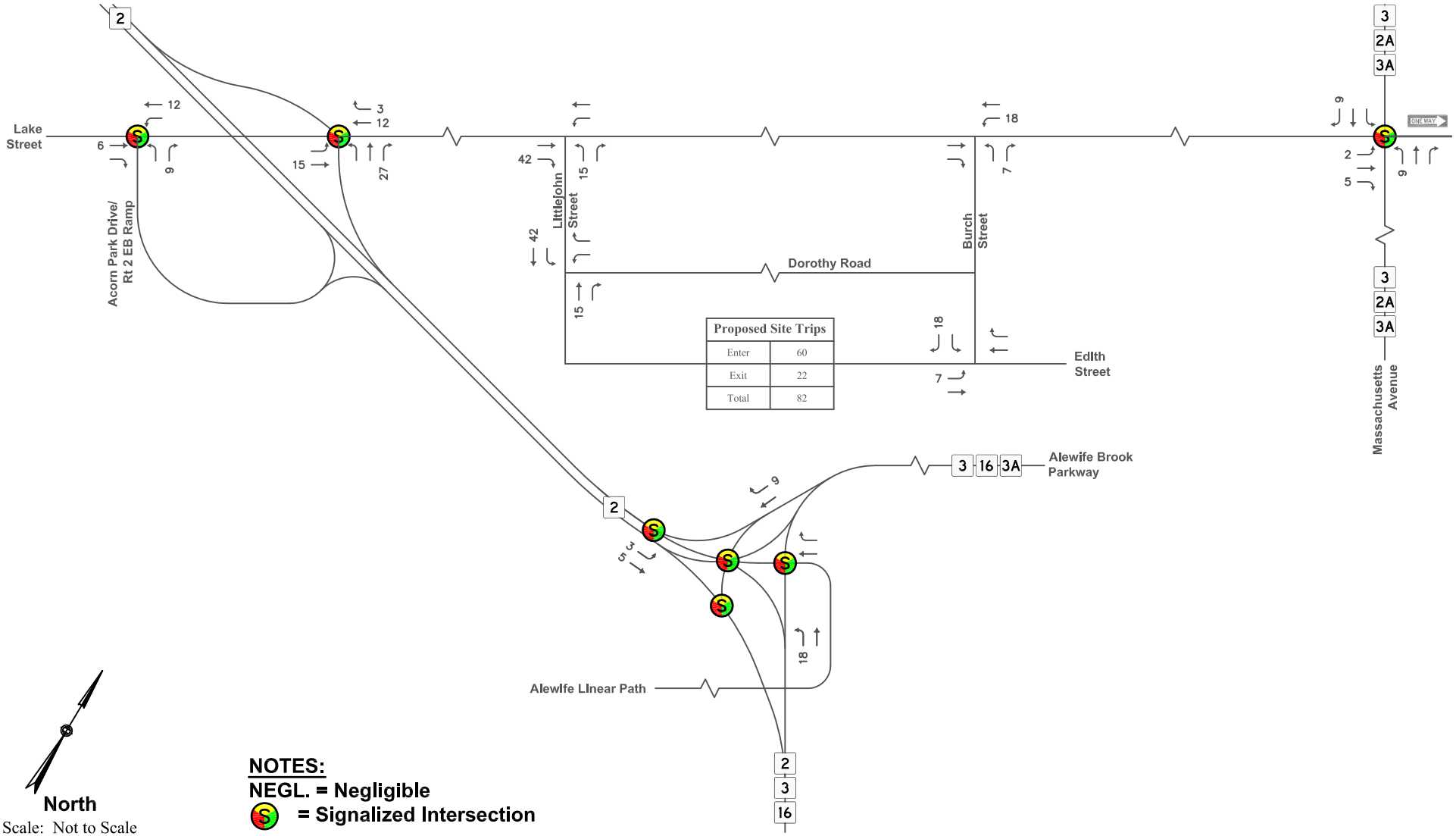

Figure 9

Site-Generated Trips
Weekday Evening Peak Hour Traffic Volumes

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Date: February 2014
Dwg No. 754 TIAS.dwg

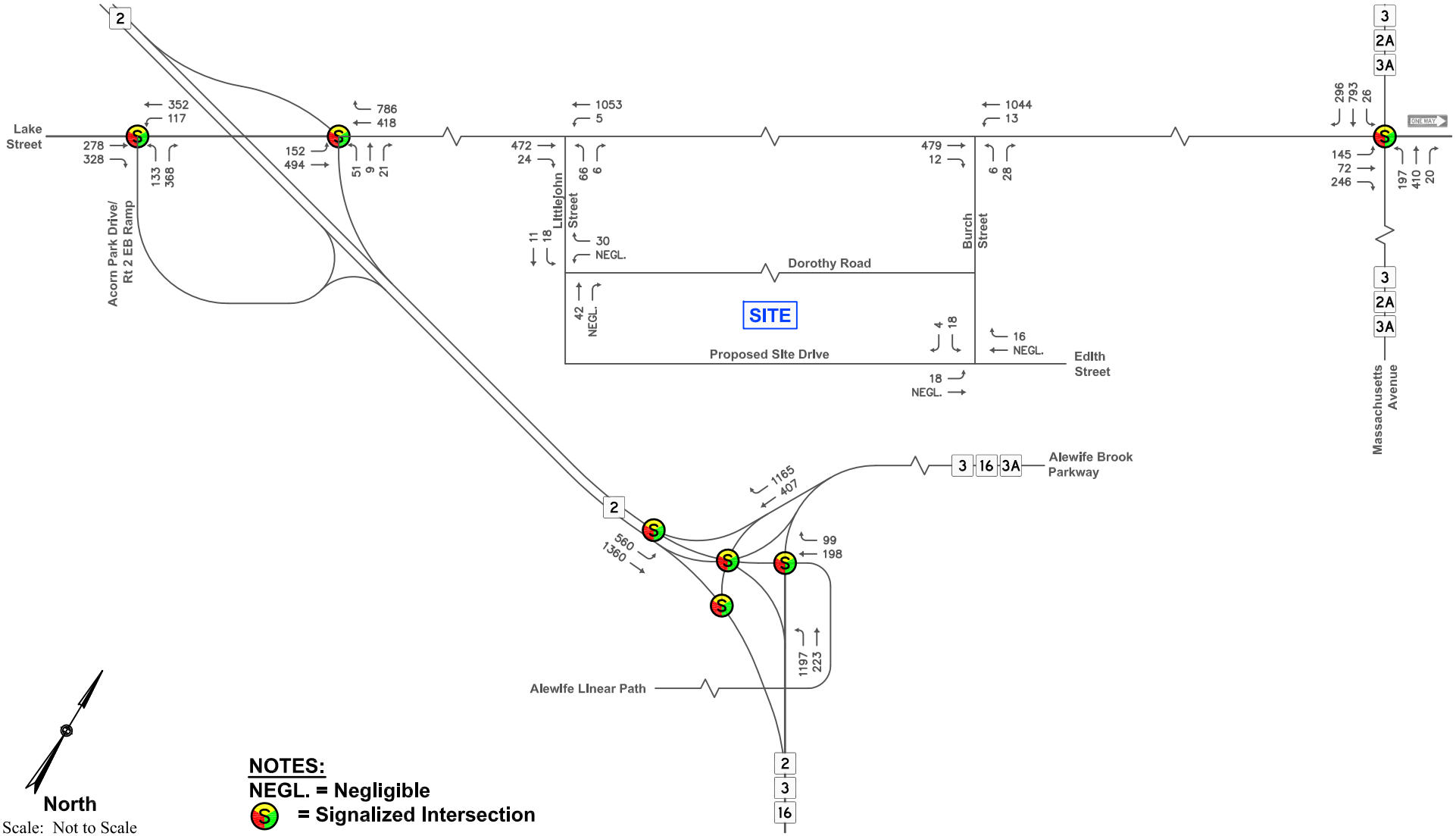


Figure 10

2021 Build Conditions
Weekday Morning Peak Hour Traffic Volumes

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

Date: February 2014
Dwg No. 754 TIAS.dwg

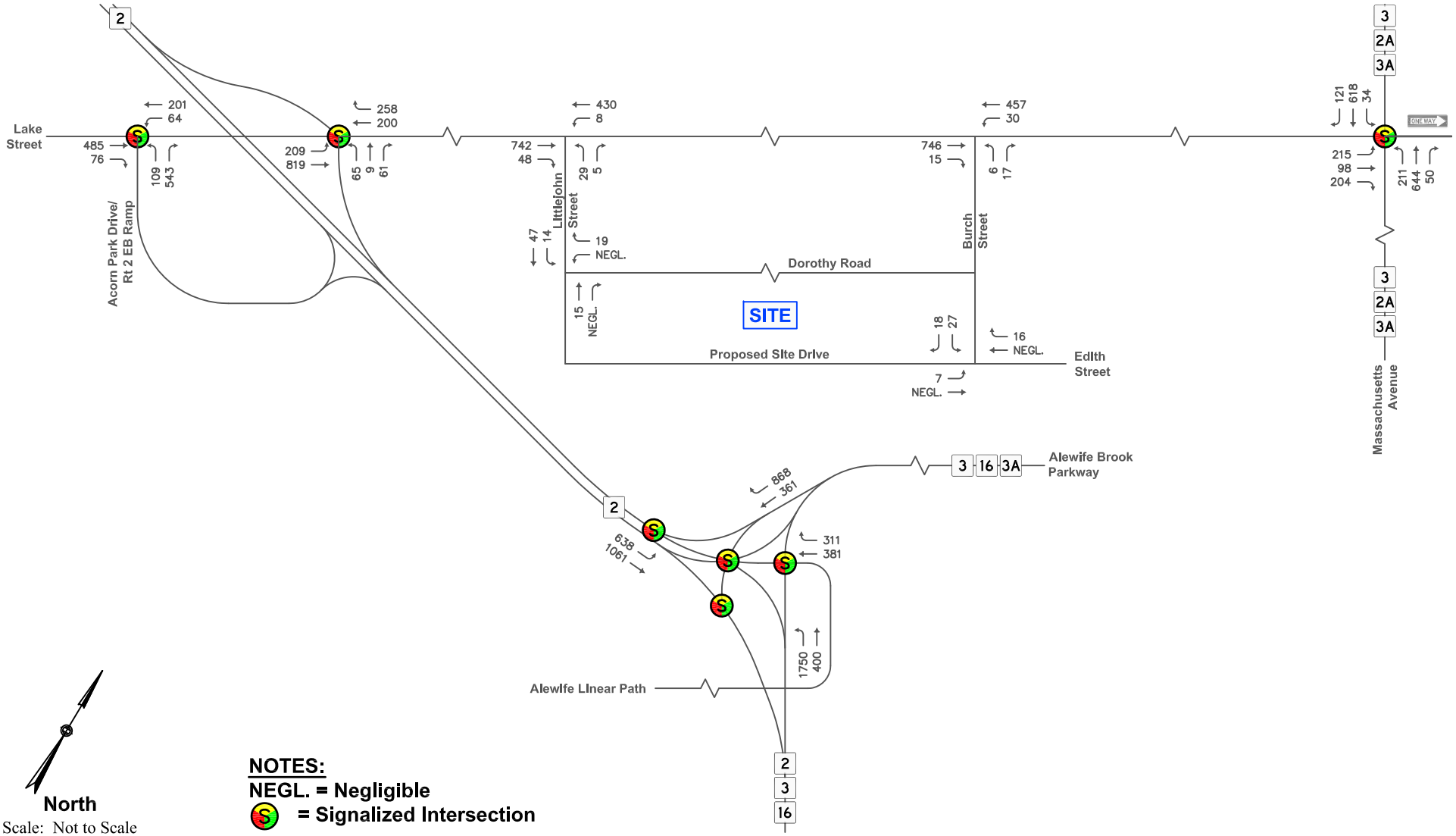


Figure 11

2021 Build Conditions
Weekday Evening Peak Hour Traffic Volumes

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

Date: February 2014
Dwg No. 754 TIAS.dwg

4.0 TRAFFIC OPERATIONS ANALYSIS

Intersection capacity analyses for the study intersections are presented in this section for the Existing, No-Build, and Build traffic-volume conditions. Capacity analyses, conducted in accordance with EEA/MassDOT guidelines, provide an index of how well the roadway facilities serve the traffic demands placed upon them. The operational results provide the basis for recommended access and roadway improvements in the following section.

4.1 CAPACITY ANALYSIS PROCEDURES

Capacity analysis of intersections is developed using the Synchro® computer software, which implements the methods of the 2010 Highway Capacity Manual (HCM). The resulting analysis presents a level-of-service (LOS) designation for individual intersection movements. The LOS is a letter designation that provides a qualitative measure of operating conditions based on several factors including roadway geometry, speeds, ambient traffic volumes, traffic controls, and driver characteristics. Since the LOS of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of LOS, depending on the time of day, day of week, or period of year. A range of six levels of service are defined on the basis of average delay, ranging from LOS A (the least delay) to LOS F (delays greater than 50 seconds for unsignalized movements and 80 seconds for signalized movements). The specific control delays and associated LOS designations are presented in the **Appendix**.

4.2 INTERSECTION CAPACITY ANALYSIS RESULTS

Capacity analysis results for the weekday morning and weekday evening peak hour capacity analysis results for the study intersections are described below, with detailed analysis results presented in the **Appendix**.

4.2.1 Level of Service Analysis

The capacity analysis results for the intersections in the study area are summarized in **Table 5** and **Table 6** for the weekday morning and weekday evening peak hours, respectively. Detailed analysis results are presented in the **Appendix**.

TABLE 5
INTERSECTION CAPACITY ANALYSIS RESULTS
WEEKDAY MORNING PEAK HOUR

		2014 Existing			2021 No-Build			2021 Build		
Intersection	Approach	v/c[1]	Delay[2]	LOS[3]	v/c	Delay	LOS	v/c	Delay	LOS
Route 2 at Route 16	Eastbound	0.69	31	C	0.71	20	B	0.71	20	B
	Westbound	0.47	24	C	0.31	19	B	0.31	19	B
	Northbound	>1.0	>80	F	0.99	53	D	0.99	53	D
	Southbound	0.95	32	C	0.68	22	C	0.68	22	C
	OVERALL	**>1.0**	**77**	**E**	**0.99**	**29**	**C**	**0.99**	**30**	**C**
Lake Street at Route 2 EB Ramps	Westbound	0.35	6	A	0.36	6	A	0.36	6	A
	Northbound	0.37	9	A	0.37	9	A	0.37	9	A
	Southbound	0.37	9	A	0.38	10	A	0.38	10	A
	OVERALL	**0.37**	**8**	**A**	**0.38**	**8**	**A**	**0.38**	**8**	**A**
Lake Street at Route 2 WB Ramps	Westbound	0.27	26	C	0.29	28	C	0.30	28	C
	Northbound	0.45	11	B	0.47	12	B	0.48	12	B
	Southbound	0.65	9	A	0.67	10	A	0.68	12	B
	OVERALL	**0.65**	**11**	**B**	**0.67**	**11**	**B**	**0.68**	**11**	**B**
Lake Street at Littlejohn Street	WB L/R Exit	0.22	38	E	0.25	42	E	0.67	>50	F
	Southbound	0.01	8	A	0.01	8	A	0.01	8	A
Lake Street at Burch Street	WB L/R Exit	0.07	21	C	0.07	22	C	0.10	22	C
	Southbound	0.01	9	A	0.01	9	A	0.01	9	A
Massachusetts Ave at. Lake Street	Eastbound	0.59	21	C	0.76	34	C	0.77	34	C
	Westbound	0.63	23	C	0.67	23	C	0.68	23	C
	Northbound	0.56	22	C	0.71	30	C	0.72	30	C
	OVERALL	**0.63**	**22**	**C**	**0.76**	**30**	**C**	**0.77**	**30**	**C**
Littlejohn Street at Dorothy Road/ Site Driveway	Site Drive Exit	n/a[4]	n/a	n/a	n/a	n/a	n/a	0.05	9	A
Burch Street at Edith Street/ Site Driveway	Site Drive Exit	n/a[4]	n/a	n/a	n/a	n/a	n/a	0.02	9	A

[1]Volume-to-capacity ratio
[2]Average control delay per vehicle (in seconds)
[3]Level of service
[4]n/a = not applicable

TABLE 6
INTERSECTION CAPACITY ANALYSIS RESULTS
WEEKDAY EVENING PEAK HOUR

		2014 Existing			2021 No-Build			2021 Build		
Intersection	Approach	v/c[1]	Delay[2]	LOS[3]	v/c	Delay	LOS	v/c	Delay	LOS
Route 2 at Route 16	Eastbound	0.64	32	C	0.72	19	B	0.73	20	B
	Westbound	0.84	32	C	0.55	26	C	0.55	26	C
	Northbound	>1.0	>80	F	>1.0	>80	F	>1.0	>80	F
	Southbound	0.69	19	B	0.50	20	C	0.51	20	C
	OVERALL	**>1.0**	**>80**	**F**	**>1.0**	**>80**	**F**	**>1.0**	**>80**	**F**
Lake Street at Route 2 EB Ramps	Westbound	0.30	4	A	0.31	4	A	0.32	4	A
	Northbound	0.41	12	B	0.43	12	B	0.43	12	B
	Southbound	0.22	8	A	0.26	9	A	0.26	9	A
	OVERALL	**0.41**	**8**	**A**	**0.43**	**8**	**A**	**0.43**	**8**	**A**
Lake Street at Route 2 WB Ramps	Westbound	0.26	16	B	0.30	18	B	0.31	18	B
	Northbound	0.48	11	B	0.50	12	B	0.53	12	B
	Southbound	0.35	9	A	0.36	8	A	0.37	8	A
	OVERALL	**0.48**	**11**	**B**	**0.50**	**11**	**B**	**0.53**	**11**	**B**
Lake Street at Littlejohn Street	WB L/R Exit	0.09	23	C	0.09	23	C	0.19	29	D
	Southbound	0.01	9	A	0.01	9	A	0.01	10	A
Lake Street at Burch Street	WB L/R Exit	0.06	19	C	0.06	19	C	0.08	19	C
	Southbound	0.02	9	A	0.02	10	A	0.04	10	A
Massachusetts Ave at. Lake Street	Eastbound	0.48	21	C	0.78	37	D	0.79	37	D
	Westbound	0.78	28	C	0.68	32	C	0.80	33	C
	Northbound	0.81	36	D	0.82	37	D	0.82	37	D
	OVERALL	**0.81**	**27**	**C**	**0.82**	**35**	**C**	**0.82**	**35**	**C**
Littlejohn Street at Dorothy Road/ Site Driveway	Westbound Northbound Southbound	Site Drive Exit	n/a[4]	n/a	n/a	n/a	n/a	0.02	9	A
Burch Street at Edith Street/ Site Driveway	Westbound Northbound Southbound	Site Drive Exit	n/a[4]	n/a	n/a	n/a	n/a	0.01	9	A

[1]Volume-to-capacity ratio
[2]Average control delay per vehicle (in seconds)
[3]Level of service
[4]n/a = not applicable

As summarized in **Table 5** and **Table 6**:

- *Route 2 at Route 16:* The Route 2 intersection with Route 16 currently operates with long delays during both the morning and evening peak hours, specifically for the northbound approach. Under future No-Build conditions, with planned roadway improvements, the intersection will operate at an overall LOS C during the morning peak hour while the intersection will continue to operate with long delays during the evening peak hour, specifically for the northbound approach. Under Build conditions, the intersection will incur only minor increases in delay compared to No-Build conditions. The project is anticipated to have no discernable increase in traffic or delays on any of the intersection approaches.

- *Lake Street at Route 2 EB Ramps:* Under future Build conditions, the intersection of Lake Street at Route 2 EB Ramps will continue to operate at an overall LOS A or better during the peak hours.

- *Lake Street at Route 2 WB Ramps:* Under future Build conditions, the intersection of Lake Street at Route 2 WB Ramps will continue to operate at an overall LOS B or better during the peak hours.

- *Massachusetts Avenue at Lake Street:* Under future Build conditions, the intersection of Massachusetts Avenue at Lake Street will continue to operate at an overall LOS C or better during the peak hours.

- *Lake Street at Littlejohn Street:* Left turn exit movements from Littlejohn Street onto Lake Street currently operate with long delays while right turn movements currently operate with minimal delay during the weekday morning peak hour. The exit movements from Littlejohn onto Lake Street will continue to operate with moderate delay during the evening peak hour. Field observations indicate that that the calculated delay for the left turn movements onto Lake Street are somewhat overstated and, in fact, operate below capacity during both the weekday morning and weekday evening peak hours.

- *Lake Street at Burch Street:* Under Build conditions, exit movements from Burch Street onto Lake Street will continue to operate below capacity at LOS C operations.

- *Site Driveways:* Under Build conditions, exit movements from the site driveways onto Littlejohn Street and Burch Street will operate at LOS A with minimal delay.

In summary, incremental traffic increases at the study intersections due to the proposed development do not generally result in any material change in overall intersection operations compared to No-Build conditions.

4.2.2 Vehicle Queue Analysis

Vehicle queue results are presented for the signalized study intersections. These vehicle queues are compared to available storage lengths, which are defined as lengths of exclusive turn lanes or the distance to the nearest major intersection for through lanes. Vehicle queue results from the capacity analysis are summarized in **Table 7** through **Table 10**. Detailed worksheets of the queuing analysis are provided in the **Appendix**.

TABLE 7
VEHICLE QUEUE ANALYSIS SUMMARY
ROUTE 2 AT ROUTE 16

		2014 Existing		2021 No-Build		2021 Build	
Approach	Storage Length (feet)	Average Queue Length[1]	95th Percentile Queue Length[1]	Average Queue Length	95th Percentile Queue Length	Average Queue Length	95th Percentile Queue Length
Weekday Morning Peak Hour							
Eastbound LT	>5000	135	187	167	224	170	228
Eastbound RT	450±	206	285	250	334	254	340
Westbound TH	>1000	96	162	94	153	94	153
Westbound RT	600±	<25	<25	<25	34	<25	34
Northbound LT	275±	481	607	396	548	399	551
Northbound TH	1100±	26	43	62	95	62	95
Southbound TH	2000±	106	152	119	166	119	166
Southbound RT	300±	518	895	289	370	290	371
Weekday Evening Peak Hour							
Eastbound LT	>5000	159	216	195	258	196	260
Eastbound RT	450±	110	157	135	188	136	189
Westbound TH	>1000	204	351	198	292	198	292
Westbound RT	600±	<25	66	114	194	114	195
Northbound LT	275±	801	934	784	919	796	932
Northbound TH	1100±	54	78	115	162	115	162
Southbound TH	2000±	87	128	103	146	103	146
Southbound RT	300±	253	386	180	235	189	246

[1] Average and 95th percentile queue lengths are reported in feet per lane.

TABLE 8
VEHICLE QUEUE ANALYSIS SUMMARY
LAKE STREET AT ROUTE 2 EASTBOUND RAMPS

Approach	Storage Length (feet)	2014 Existing		2021 No-Build		2021 Build	
		Average Queue Length[1]	95th Percentile Queue Length[1]	Average Queue Length	95th Percentile Queue Length	Average Queue Length	95th Percentile Queue Length
Weekday Morning Peak Hour							
Westbound LT	>1000	35	93	38	99	38	99
Westbound RT	>1000	<25	<25	<25	<25	<25	<25
Northbound TH	>2000	68	150	73	159	73	160
Northbound RT	250±	<25	46	<25	47	<25	47
Southbound LT	200±	31	85	34	91	34	91
Southbound TH	450±	<25	38	<20	41	22	45
Weekday Evening Peak Hour							
Westbound LT	>1000	28	80	30	85	30	86
Westbound RT	>1000	<25	<25	<25	<25	<25	<25
Northbound TH	>2000	111	223	120	239	122	242
Northbound RT	250±	<25	<25	<25	<25	<25	<25
Southbound LT	200±	<25	49	<25	58	<25	59
Southbound TH	450±	<25	<25	<25	<25	<25	<25

[1] Average and 95th percentile queue lengths are reported in feet per lane.

TABLE 9
VEHICLE QUEUE ANALYSIS SUMMARY
LAKE STREET AT ROUTE 2 WESTBOUND RAMPS

Approach	Storage Length (feet)	2014 Existing		2021 No-Build		2021 Build	
		Average Queue Length[1]	95th Percentile Queue Length[1]	Average Queue Length	95th Percentile Queue Length	Average Queue Length	95th Percentile Queue Length
Weekday Morning Peak Hour							
Westbound LT	1000±	<25	42	<25	44	<25	44
Westbound LT/TH	1000±	<25	43	25	45	26	45
Westbound RT	150±	<25	<25	<25	<25	<25	<25
Northbound LT	275±	40	145	47	155	50	155
Northbound TH	450±	<25	184	<25	193	<25	195
Southbound TH/ RT	2600±/200±	47	232	54	258	65	297
Weekday Evening Peak Hour							
Westbound LT	1000±	<25	37	<25	44	<25	45
Westbound LT/TH	1000±	<25	40	<25	45	<25	46
Westbound RT	150±	<25	<25	<25	<25	<25	<25
Northbound LT	275±	35	159	39	175	41	180
Northbound TH	450±	<25	387	<25	409	<25	421
Southbound TH/ RT	2600±/200±	<25	76	<25	78	<25	81

[1] Average and 95th percentile queue lengths are reported in feet per lane.

TABLE 10
VEHICLE QUEUE ANALYSIS SUMMARY
MASSACHUSETTS AVENUE AT LAKE STREET

		2014 Existing		2021 No-Build		2021 Build	
Approach	Storage Length (feet)	Average Queue Length[1]	95th Percentile Queue Length[1]	Average Queue Length	95th Percentile Queue Length	Average Queue Length	95th Percentile Queue Length
Weekday Morning Peak Hour							
Eastbound LT	200±	n/a	n/a	<25	39	<25	39
Eastbound TH	>1500	228	297	300	383	302	383
Eastbound RT	100±	63	135	110	210	113	213
Westbound LT	200±	n/a	n/a	90	191	93	198
Westbound TH/RT	>1500	140	186	224	322	226	322
Northbound LT/TH	1100±	120	203	153	241	158	259
Northbound RT	125±	<25	63	<25	70	<25	72
Weekday Evening Peak Hour							
Eastbound LT	200±	n/a	n/a	<25	61	<25	61
Eastbound TH	>1500	168	225	213	308	213	308
Eastbound RT	100±	<25	53	<25	27	<25	33
Westbound LT	200±	n/a	n/a	93	184	97	200
Westbound TH/RT	>1500	216	334	429	657	429	657
Northbound LT/TH	1100±	189	356	205	368	207	371
Northbound RT	125±	<25	71	<25	82	<25	85

[1] Average and 95th percentile queue lengths are reported in feet per lane.

As presented in **Table 7** through **Table 10,** average and 95th percentile vehicle queues at the signalized study intersections are generally contained within available storage lanes during weekday morning and weekday evening peak hours under No-Build and Build conditions. Field observations indicated a queue spillback problem, specifically, during the weekday evening peak hour, from the intersection of Route 16 and Massachusetts Avenue into the Route 2/Route 16 intersection which causes eastbound queue lengths well beyond those calculated by Synchro. This phenomenon appears to result in additional vehicles using Lake Street to by-pass the Route 2/Route 16 intersection. However, the residential development generally results in vehicle queues within 1 vehicle length or less compared to No-Build conditions and will have a nominal effect on queuing at the study intersections.

5.0 ALTERNATIVE ACCESS PLAN

For planning purposes, alternative 2021 Build traffic volume networks and capacity analyses have been provided for a potential right-in/right-out driveway on the Route 2 westbound off-ramp to Lake Street. Under the alternative access plan, the proposed site driveways along Littlejohn Street and Burch Street would be retained and a site driveway restricted to right-in/right out movements would be constructed along the Lake Street westbound ramp. The conceptual alternative access plan is presented in **Figure 12**.

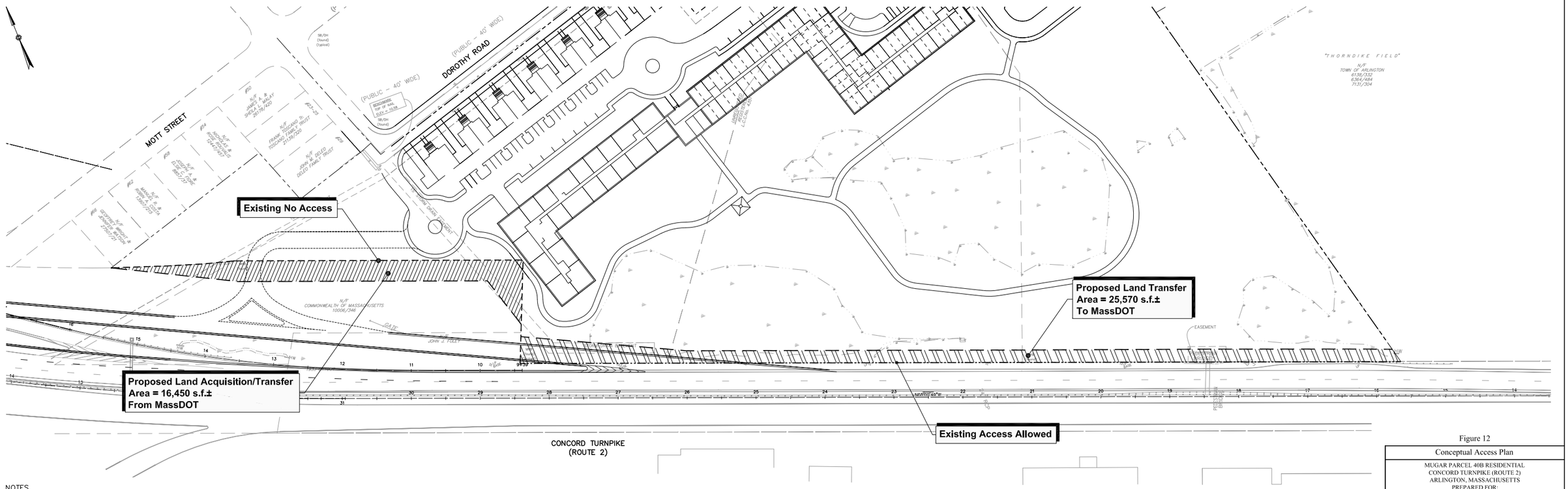
5.1 ALTERNATIVE BUILD TRAFFIC VOLUMES

Development-related trips for the Site were assigned to the roadway network using the conservative ITE trip-generation estimates previously shown in **Table 3** and an updated distribution pattern presented in **Figure 13**. New development-related trips at each intersection for the weekday morning and weekday evening peak hours are quantified in **Figure 14** and **Figure 15**.

Future Alternative Build condition traffic volumes were arrived at by adding development-specific traffic volumes to the 2021 No-Build conditions. The 2021 Alternative Build condition traffic-volume networks for the weekday morning and weekday evening peak hours are displayed in **Figure 16** and **Figure 17**.

5.2 ALTERNATIVE ACCESS CAPACITY ANALYSIS RESULTS

LOS analyses were conducted for Alternative Build conditions for the intersections in the study area. The results of the intersection capacity analyses are summarized in **Table 11** and **Table 12** for the weekday morning and weekday evening hours, respectively. Detailed capacity and queue analysis results are presented in the **Appendix.**



NOTES

1. THIS PLAN INTENDED FOR DISCUSSION PURPOSES ONLY; IT IS NOT FOR CONSTRUCTION.
2. FINAL DESIGN IS SUBJECT TO ADDITIONAL FIELD SURVEY BY OTHERS.
3. PROPERTY LINES AND ACCESS LINE LOCATIONS ARE APPROXIMATE ONLY.
4. BASE PLAN SOURCE: "SITE & BUILDING LAYOUT" PREPARED BY OAK TREE DEVELOPMENT LLC, DATED 2-27-2014.

Figure 12

Conceptual Access Plan

MUGAR PARCEL 40B RESIDENTIAL
CONCORD TURNPIKE (ROUTE 2)
ARLINGTON, MASSACHUSETTS
PREPARED FOR:
OAKTREE DEVELOPMENT
84 SHERMAN STREET
CAMBRIDGE, MASSACHUSETTS 02140

MDM TRANSPORTATION CONSULTANTS, INC.
PLANNERS & ENGINEERS
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Marlborough, MA 01752
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Date: March 19, 2014	Scale: As Noted	
Project No.: 754	File: 754 Concept Plan A (3-19-2014).dwg	Sheet 1 of 1

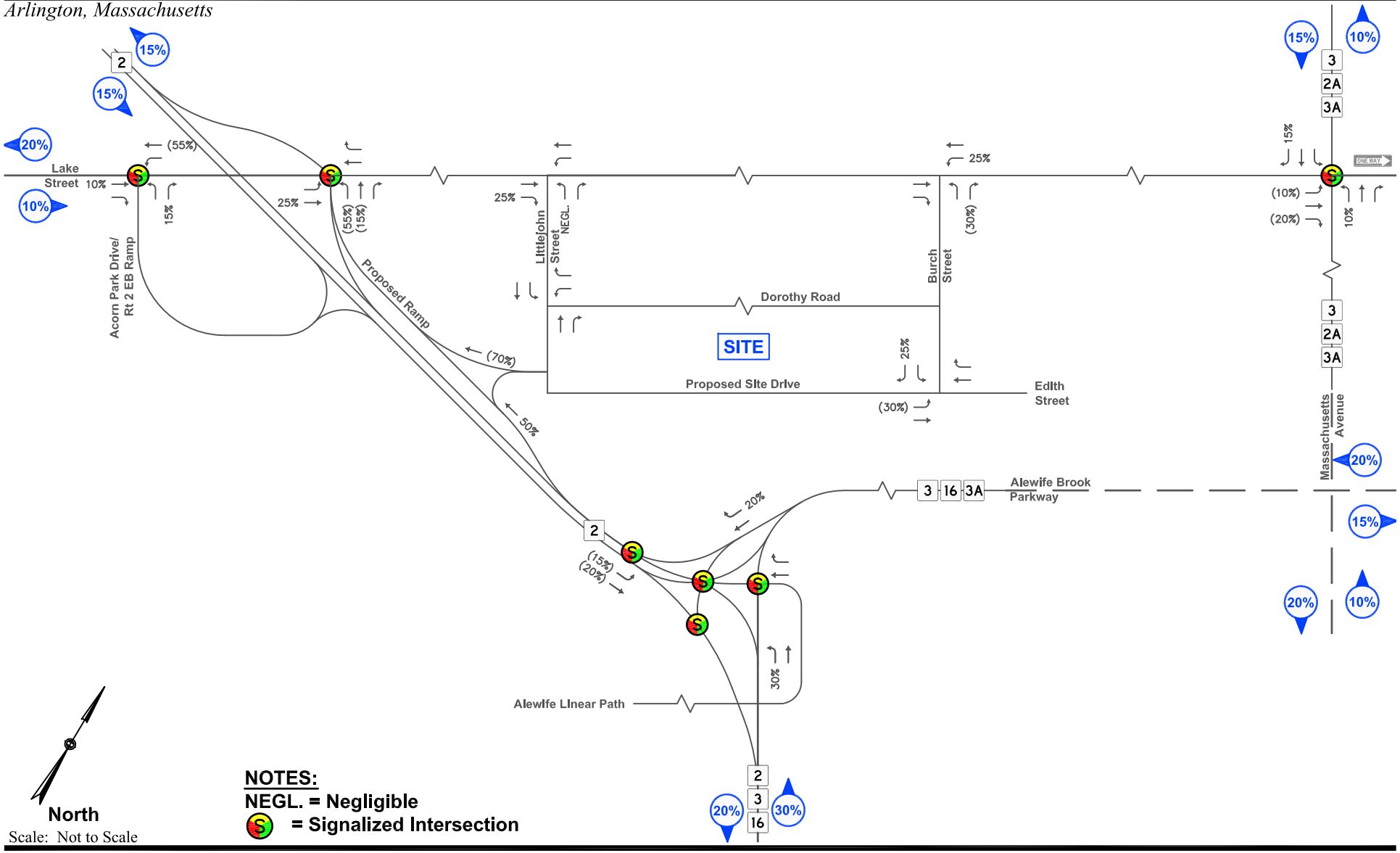

Figure 13

Alternative Trip Distribution

MDM TRANSPORTATION CONSULTANTS, INC.
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Date: February 2014
Dwg No. 754 TIAS.dwg

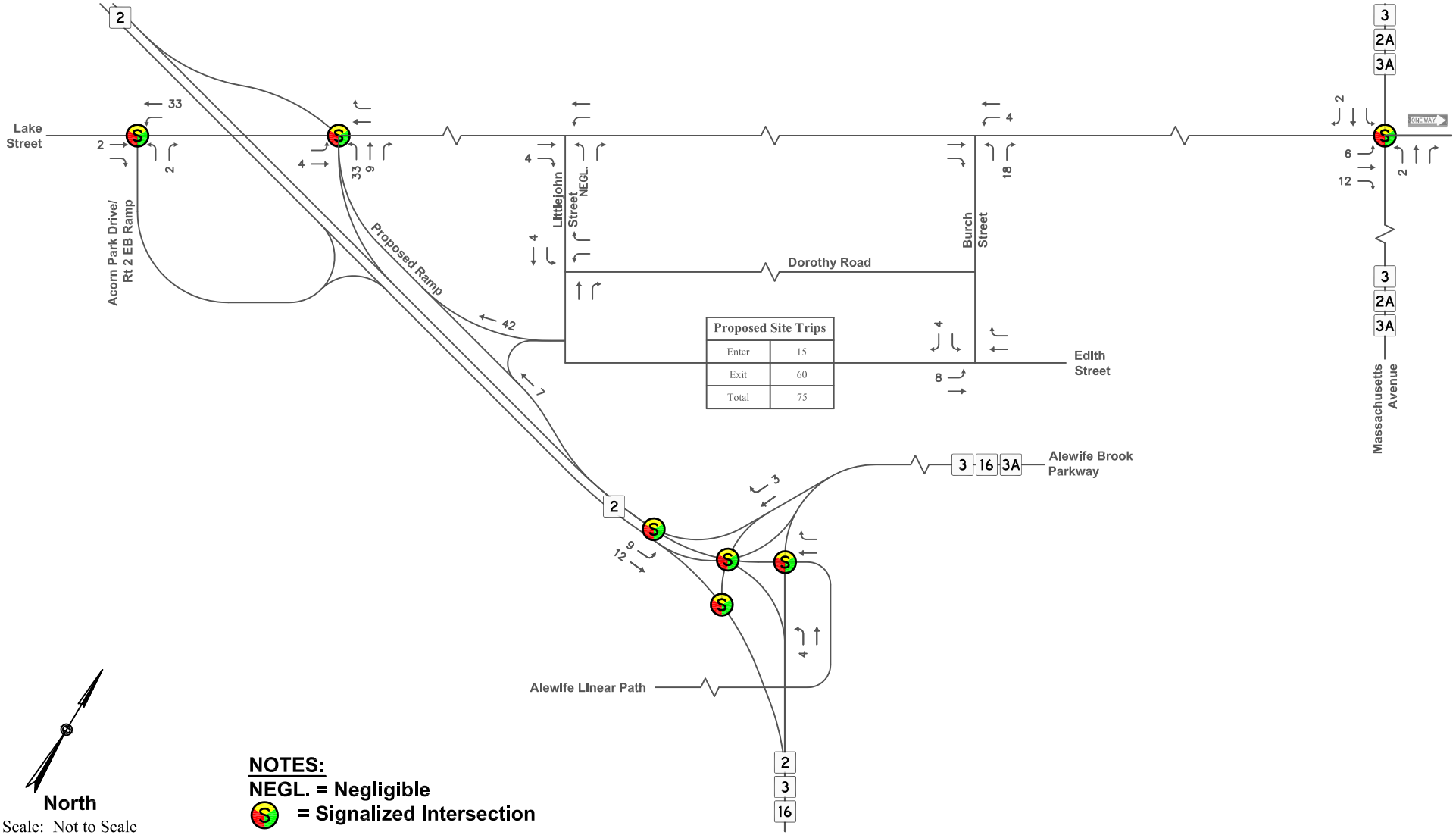

Figure 14

Alternative Site-Generated Trips
Weekday Morning Peak Hour Traffic Volumes

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

Date: February 2014
Dwg No. 754 TIAS.dwg

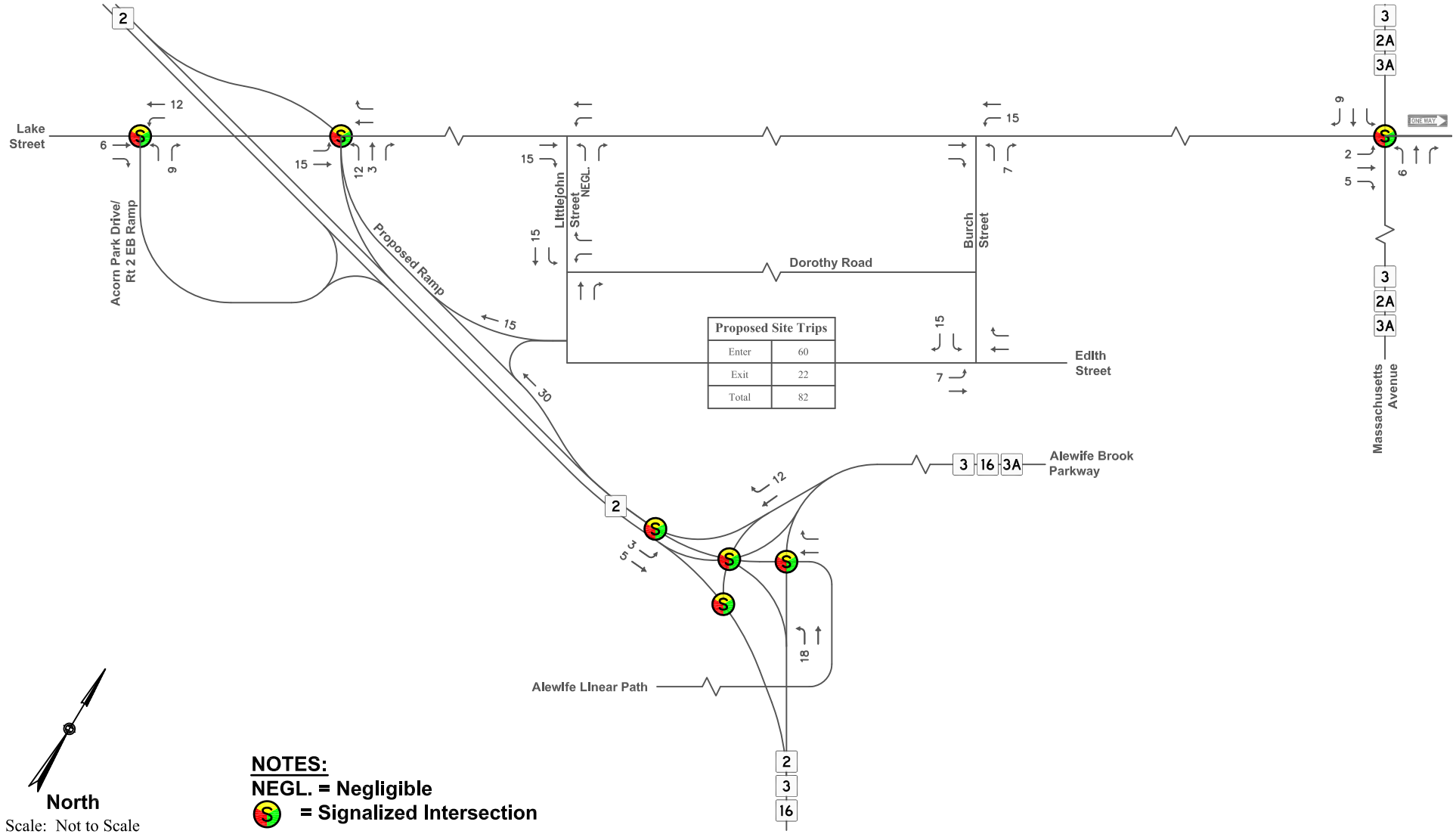

Figure 15

Alternative Site-Generated Trips
Weekday Evening Peak Hour Traffic Volumes

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

Date: February 2014
Dwg No. 754 TIAS.dwg

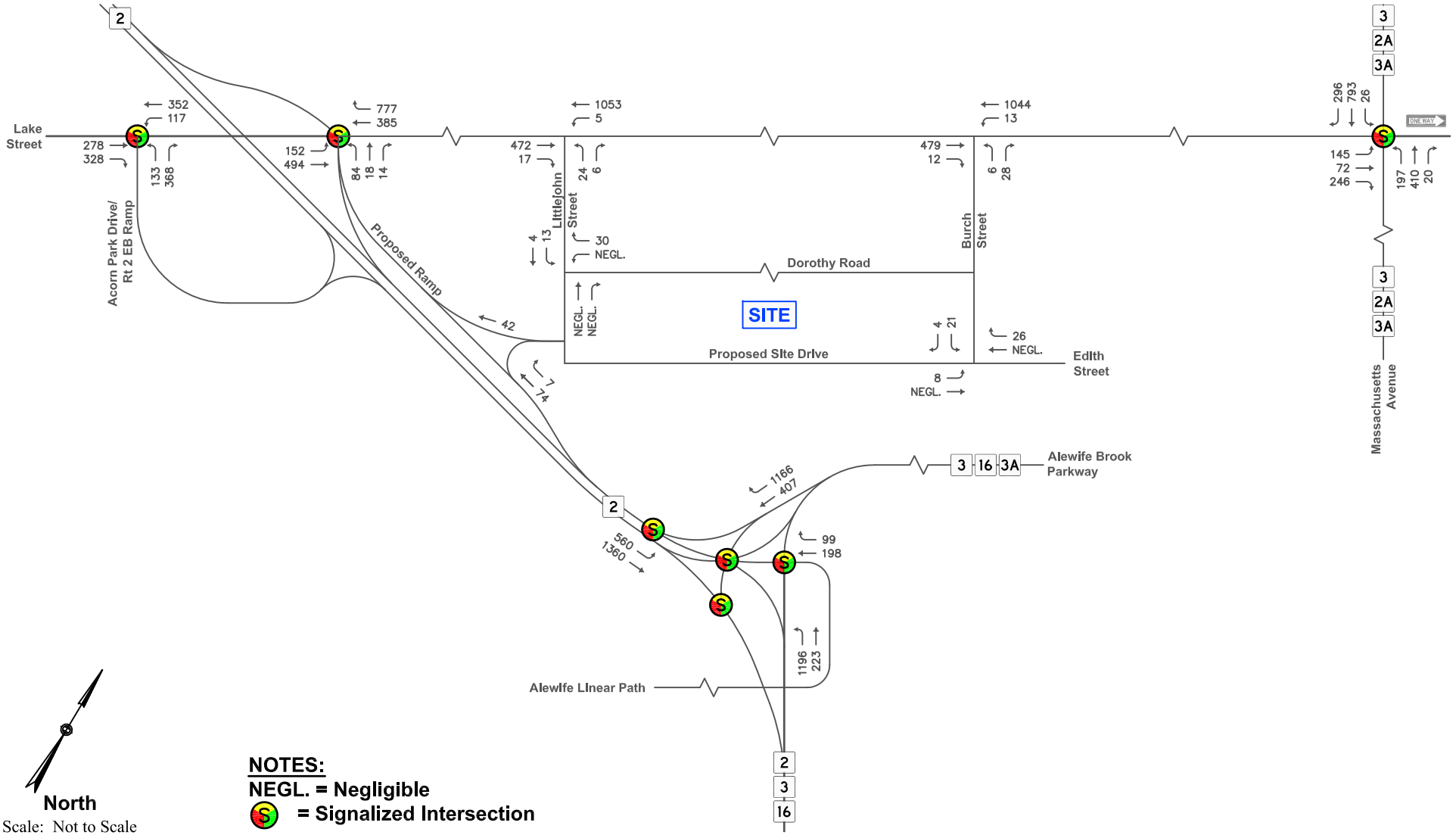

Figure 16

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

2021 Alternative Build Conditions
Weekday Morning Peak Hour Traffic Volumes

Date: February 2014
Dwg No. 754 TIAS.dwg

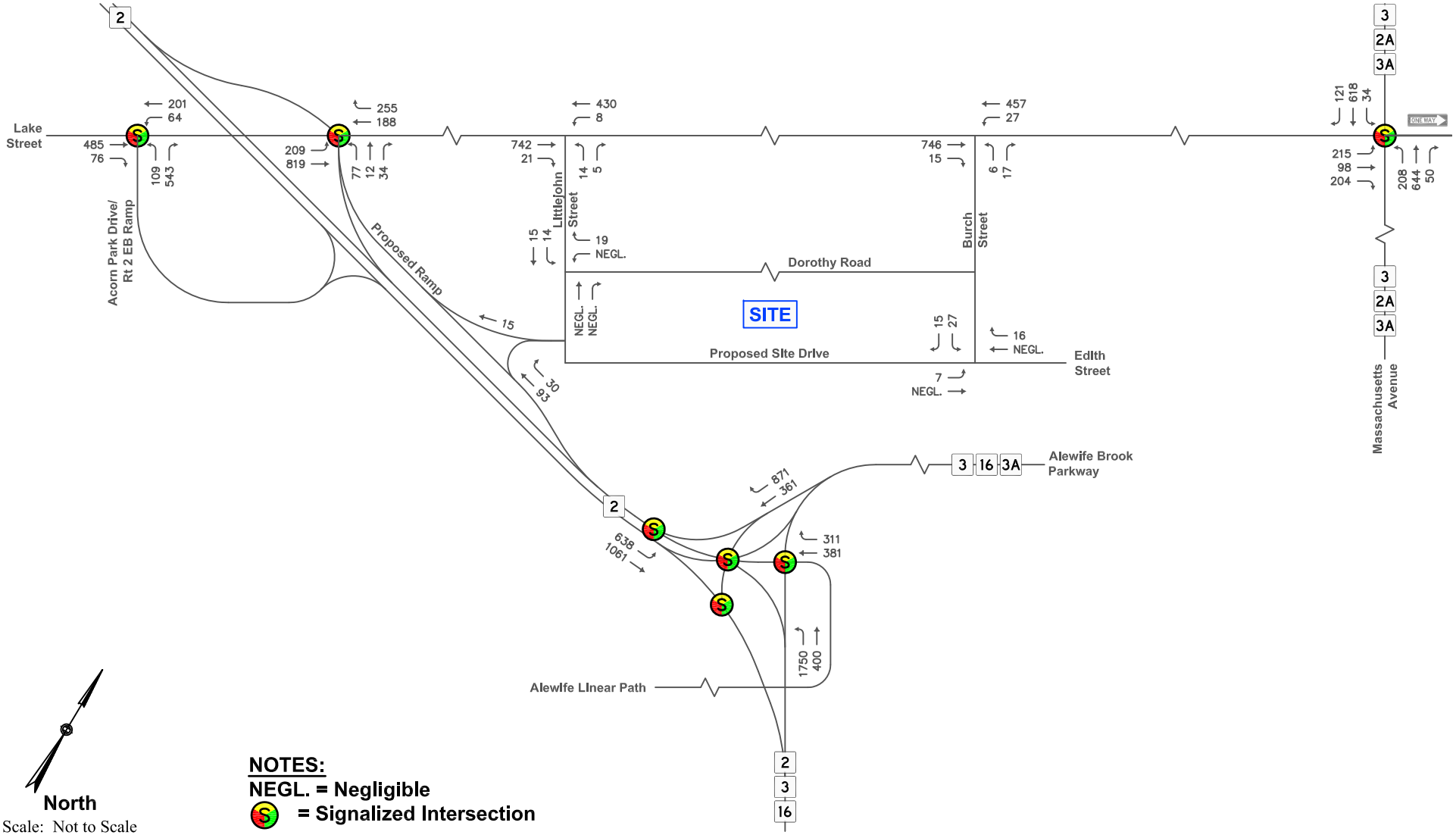

Figure 17

MDM TRANSPORTATION CONSULTANTS, INC.
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2021 Alternative Build Conditions
Weekday Evening Peak Hour Traffic Volumes

Date: February 2014
Dwg No. 754 TIAS.dwg

TABLE 11
INTERSECTION CAPACITY ANALYSIS RESULTS – ALTERNATIVE ACCESS
WEEKDAY MORNING PEAK HOUR

		2021 No-Build			2021 Build			2021 Build (Alternative Access)		
Intersection	Approach	v/c[1]	Delay[2]	LOS[3]	v/c	Delay	LOS	v/c	Delay	LOS
Route 2 at	Eastbound	0.71	20	B	0.71	20	B	0.71	20	B
Route 16	Westbound	0.31	19	B	0.31	19	B	0.31	19	B
	Northbound	0.99	53	D	0.99	53	D	0.99	53	D
	Southbound	0.68	22	C	0.68	22	C	0.68	22	C
	OVERALL	**0.99**	**29**	**C**	**0.99**	**30**	**C**	**0.99**	**30**	**C**
Lake Street at	Westbound	0.36	6	A	0.36	6	A	0.36	6	A
Route 2 EB Ramps	Northbound	0.37	9	A	0.37	9	A	0.37	9	A
	Southbound	0.38	10	A	0.38	10	A	0.38	10	A
	OVERALL	**0.38**	**8**	**A**	**0.38**	**8**	**A**	**0.38**	**8**	**A**
Lake Street at	Westbound	0.29	28	C	0.30	28	C	0.33	29	C
Route 2 WB Ramps	Northbound	0.47	12	B	0.48	12	B	0.51	14	B
	Southbound	0.67	10	A	0.68	12	B	0.69	12	B
	OVERALL	**0.67**	**11**	**B**	**0.68**	**11**	**B**	**0.69**	**13**	**B**
Lake Street at	WB L/R Exit	0.25	42	E	0.67	>50	F	0.25	42	E
Littlejohn Street	Southbound	0.01	8	A	0.01	8	A	0.01	8	A
Lake Street at	WB L/R Exit	0.07	22	C	0.10	22	C	0.11	22	C
Burch Street	Southbound	0.01	9	A	0.01	9	A	0.01	9	A
Massachusetts Ave at.	Eastbound	0.76	34	C	0.77	34	C	0.77	34	C
Lake Street	Westbound	0.67	23	C	0.68	23	C	0.68	23	C
	Northbound	0.71	30	C	0.72	30	C	0.72	30	C
	OVERALL	**0.76**	**30**	**C**	**0.77**	**30**	**C**	**0.77**	**30**	**C**
Littlejohn Street at Dorothy Road/ Site Driveway	Site Drive Exit	n/a[4]	n/a	n/a	0.05	9	A	0.00	Negl.[5]	A
Burch Street at Edith Street/ Site Driveway	Site Drive Exit	n/a[4]	n/a	n/a	0.02	9	A	0.02	9	A
Route 2 WB off-ramp at Alternative Site Driveway	SB R Exit	n/a	n/a	n/a	n/a	n/a	n/a	0.05	9	A

[1]Volume-to-capacity ratio
[2]Average control delay per vehicle (in seconds)
[3]Level of service
[4]n/a = not applicable
[5]Negl. = Negligible

TABLE 12
INTERSECTION CAPACITY ANALYSIS RESULTS – ALTERNATIVE ACCESS
WEEKDAY EVENING PEAK HOUR

		2021 No-Build			2021 Build			2021 Build (Alternative Access)		
Intersection	Approach	v/c[1]	Delay[2]	LOS[3]	v/c	Delay	LOS	v/c	Delay	LOS
Route 2 at Route 16	Eastbound	0.72	19	B	0.73	20	B	0.73	20	B
	Westbound	0.55	26	C	0.55	26	C	0.55	26	C
	Northbound	>1.0	>80	F	>1.0	>80	F	>1.0	>80	F
	Southbound	0.50	20	C	0.51	20	C	0.50	20	C
	OVERALL	**>1.0**	**>80**	**F**	**>1.0**	**>80**	**F**	**>1.0**	**>80**	**F**
Lake Street at Route 2 EB Ramps	Westbound	0.31	4	A	0.32	4	A	0.32	4	A
	Northbound	0.43	12	B	0.43	12	B	0.43	12	B
	Southbound	0.26	9	A	0.26	9	A	0.26	9	A
	OVERALL	**0.43**	**8**	**A**	**0.43**	**8**	**A**	**0.43**	**8**	**A**
Lake Street at Route 2 WB Ramps	Westbound	0.30	18	B	0.31	16	B	0.37	20	B
	Northbound	0.50	12	B	0.53	12	B	0.53	12	B
	Southbound	0.36	8	A	0.37	8	A	0.35	8	A
	OVERALL	**0.50**	**11**	**B**	**0.53**	**11**	**B**	**0.53**	**11**	**B**
Lake Street at Littlejohn Street	WB L/R Exit	0.09	23	C	0.19	29	D	0.10	24	C
	Southbound	0.01	9	A	0.01	10	A	0.01	9	A
Lake Street at Burch Street	WB L/R Exit	0.06	19	C	0.08	19	C	0.08	19	C
	Southbound	0.02	10	A	0.04	10	A	0.04	10	A
Massachusetts Ave at. Lake Street	Eastbound	0.78	37	D	0.79	37	D	0.78	37	D
	Westbound	0.68	32	C	0.80	33	C	0.80	33	C
	Northbound	0.82	37	D	0.82	37	D	0.82	37	D
	OVERALL	**0.82**	**35**	**C**	**0.82**	**35**	**C**	**0.82**	**35**	**C**
Littlejohn Street at Dorothy Road/ Site Driveway	Site Drive Exit	n/a[4]	n/a	n/a	0.02	9	A	0.00	Negl.[5]	A
Burch Street at Edith Street/ Site Driveway	Site Drive Exit	n/a[4]	n/a	n/a	0.01	9	A	0.01	9	A
Route 2 WB off-ramp at Alternative Site Driveway	SB R Exit	n/a	n/a	n/a	n/a	n/a	n/a	0.02	9	A

[1]Volume-to-capacity ratio
[2]Average control delay per vehicle (in seconds)
[3]Level of service
[4]n/a = not applicable
[5]Negl. = Negligible

As summarized in **Table 11** and **Table 12**, incremental traffic increases at the study intersections due to the proposed development under the alternative access plan generally do not result in any significant change in overall intersection operations compared to No-Build conditions. The alternative access plan will provide a direct benefit by reducing traffic impacts of the project along Lake Street, specifically at the Lake Street intersection with Littlejohn Street which was projected to incur the majority of the left-turn movements onto Lake Street under the proposed Site access plan. The Route 2 westbound off-ramp intersection with the Site Driveway will operate at LOS A with minimal delay.

A review of the queue analysis results under the alternative access plan indicates that the residential development generally results in vehicle queues at the signalized study intersections that are within 1 vehicle length or less compared to No-Build conditions and will have a nominal effect on queuing at the study intersections.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Trip generation for the development is estimated at approximately 75 new vehicle-trips during the weekday morning peak hour and 82 new vehicle-trips during the weekday evening peak hour. MDM finds that incremental traffic associated with the proposed development is not expected to materially impact operating conditions at the study intersections.

Access improvements that support the proposed residential development is identified that aim to address access/egress needs for the Site. Recommended improvements include access-related improvements are described below.

6.1 ACCESS IMPROVEMENTS

MDM recommends access-related improvements aimed at enhancing traffic operations and/or travel safety including the following:

- STOP signs (R1-1) and STOP line pavement markings are recommended on driveway approaches to Littlejohn Street and Burch Street. The signs and pavement markings shall be compliant with the Manual on Uniform Traffic Control Devices (MUTCD).

- Plantings (shrubs, bushes) and structures (walls, fences, etc.) should be maintained at a height of 2 feet or less within the sight lines in vicinity of the Site driveways to provide unobstructed sight lines. Furthermore, the existing vegetation and structures within the sight lines should be selectively cleared when the Site driveways are constructed and the terrain shall be graded as required to ensure minimum recommended sight line requirements are met or exceeded.

- Final driveway alignment, widths and curb radii should be designed as required to accommodate standard Single Unit (SU) design vehicles and emergency (fire apparatus) design vehicles.

- The alternative driveway connection to the Route 2 westbound off-ramp to Lake Street is being considered as a more direct access to/from Route 2, thereby reducing dependence on local roadways. The Proponent is in consultation with MassDOT to identify land acquisition requirements that involve re-designation of access lines along the Route 2 property frontage and transfer of property to MassDOT that would mutually benefit both parties.

6.2 CONCLUSIONS

The proposed 40B residential project is a modest traffic generator that is being designed to leverage its proximity to a major bike path and nearby public transportation facilities to encourage multi-modal travel. Census data for the neighborhoods surrounding the Site indicate that approximately 28% of the residents utilize public transportation (bus and/or subway) as their primary travel mode to/from work; this trend is expected to apply equally to the Site residents, whom will be served by a system of sidewalks and a path connection to the Minuteman Bike Path that directly connects to the nearby Alewife MBTA Station. Planned intersection improvements at Route 2/Route 16 intersections and Massachusetts Avenue at Lake Street intersection will further enhance capacity and safety to accommodate modest traffic increases for the project.

Site-generated traffic increases at the study intersections do not generally result in any material change in overall intersection operations compared to No-Build conditions. Adequate capacity is available under future Build conditions along Lake Street and at the study intersections to accommodate projected Site traffic increases.

While only modest traffic increases are projected for area neighborhood streets at full build out, an alternative driveway connection to the Route 2 westbound off-ramp to Lake Street is being considered as a more direct access to/from Route 2. This ramp driveway would reduce dependence on local roadways. The Proponent is in consultation with MassDOT to identify land acquisition requirements that involve re-designation of access lines along the Route 2 property frontage and transfer of property to MassDOT that would mutually benefit both parties.