July 19, 2024

Ref: NEX-2200392.07

Mr. Lee Newman
Director, Planning and Community Development
Town of Needham
500 Dedham Avenue
Needham, MA 02492

Attention: Kate Fitzpatrick
Town Manager

Reference: MBTA Communities Traffic Impact Analysis
Contract No. 24GEN298M
Project Manager: John W. Diaz, P.E.

Dear Mr. Newman:

Greenman-Pedersen, Inc. (GPI) has prepared this technical memo providing a comprehensive summary of the traffic analysis conducted to evaluate the potential impacts of the rezoning proposed in the *Town of Needham, MA – MBTA Communities Summary Report, April 2024* prepared by RKG Associates and Innes Associates, Ltd. The rezoning aims to facilitate the development of additional housing units in compliance with the MBTA Communities Act. The analysis encompasses current traffic conditions, projected traffic volumes, and the anticipated effects on local transportation infrastructure. Our goal is to present data-driven insights to inform decision-making processes, ensuring that the rezoning aligns with community goals while mitigating adverse traffic impacts.

Summary of Findings

To present a worst-case scenario, the traffic operations analysis conducted was conservative and likely overestimates future traffic levels. This approach included a higher-than-expected future growth rate, a larger-than-expected trip generation rate for the proposed development, and a higher-than-expected auto mode share for a transit-oriented development.

Due to this conservative approach, many study area intersections are anticipated to experience high delays in future conditions, primarily due to background traffic growth rather than traffic generated by the proposed projects. Scenario A (Base Compliance) is expected to have little to no impact, while Scenario B (Neighborhood Housing Plan) is expected to cause localized impacts at key intersections.

Potential mitigation measures identified include signal timing optimizations, roadway restriping, adjustments to pedestrian timings, and new signalization. The mitigation analysis shows improvements in the Level of Service (LOS) and decreased delays across the network of intersections when comparing the No-Build scenario to Build Scenarios A and B. During the AM peak hour, many intersections that would operate at an unacceptable LOS F in the No-Build scenario improve to LOS D or better in the Build Mitigated Scenarios. Similarly, during the PM peak hour, the network sees LOS improvements with the implementation of Build Mitigated Scenarios A and B.

Overall, the Build Scenarios A and B with mitigation demonstrate a positive impact on traffic performance, reducing delays and improving LOS across the network of intersections during peak hours despite the increase in vehicle trips from the developments.

Data Collection

Traffic data for the study area intersections and roadways, as illustrated in Figure 1, was compiled from a combination of past studies and new traffic counts. In line with MassDOT guidelines, traffic data collected before the COVID-19 pandemic were seasonally adjusted, projected to 2019 using the DOT's growth rate, and then adjusted to 2024 based on a nearby continuous count station. Post-pandemic data, collected after March 2022, were increased by 1.00% per year to estimate 2024 traffic levels. Data collected in 2024 required only seasonal adjustments, if necessary. All traffic-count and MassDOT adjustment data is provided in detail in the Appendix. Figures 2A and 2B display the existing traffic volumes in the morning and evening peak hours, respectively.

Table 1 provides a detailed overview of the intersections analyzed in this study, describing each intersection within the study area, the source of the traffic count data, and the date when the data was collected.

Intersection Location	Data Source	Date Collected
1. Highland Ave at Webster St	Highland Ave Corridor Study	May, 2022
2. Highland Ave at Hunnewell St	Highland Ave Corridor Study	May, 2022
3. Highland Ave at West St	Highland Ave Corridor Study	May, 2022
4. Highland Ave at Rosemary St	Highland Ave Corridor Study	May, 2022
5. Highland Ave at Chapel St & May St	Turning Movement Counts	May, 2024
6. Highland Ave at Great Plain Ave & Dedham Ave	Highland Ave Corridor Study	May, 2022
7. Chestnut St at Oak St	433 Chestnut Study	November, 2018
8. Chestnut St at School St	433 Chestnut Study	November, 2018
9. Great Plain Ave at Garden St	Downtown Signal Retiming	January, 2024
10. Great Plain Ave at Chapel St & Chestnut St	Turning Movement Counts	May, 2024
11. Webster St at May St	Turning Movement Counts	May, 2024
12. Garden St at May St	Turning Movement Counts	May, 2024
13. Rosemary St at Hillside Ave	Turning Movement Counts	May, 2024
14. Hillside Ave at West St	100 West Street Study	April, 2024
15. Hillside Ave at Hunnewell St	Turning Movement Counts	May, 2024

Traffic Growth

To develop the 2034 No-Build (ten-year) forecast volumes, an annual growth percentage was applied. Based on discussions with the Town of Needham, a conservative (higher than expected) 1.0 percent compounded annual growth rate was assumed for the project area. This approach ensures that the forecasted traffic volumes account for potential increases in traffic demand over the next decade, providing a basis for comparison with the proposed rezoning scenarios. Figures 3A and 3B display the 2034 No-Build traffic volumes in the morning and evening peak hours, respectively.

Trip Generation Methodology

To estimate the potential traffic impact of the proposed rezoning, two scenarios were analyzed. Scenario A, Base Compliance, projects a build-out of 222 multifamily units, while Scenario B, Neighborhood Housing Plan, projects a build-out of 1,099 multifamily units. The trip generation rates from the Institute of Transportation Engineers (ITE) Trip Generation Manual for Land Use Code (LUC) 220 (Multi-Family Housing, Low-Rise) and LUC 221 (Multi-Family Housing, Mid-Rise) were used to estimate the volume of traffic generated by each scenario. Due to the limited number of studies for settings adjacent to rail transit, the trip generation rates were calculated using the "Not Close to Rail Transit" subcategory and "General Urban/Suburban" location to provide a conservative (worst-case) analysis scenario.

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FIGURE 1
PROJECT LOCATION MAP

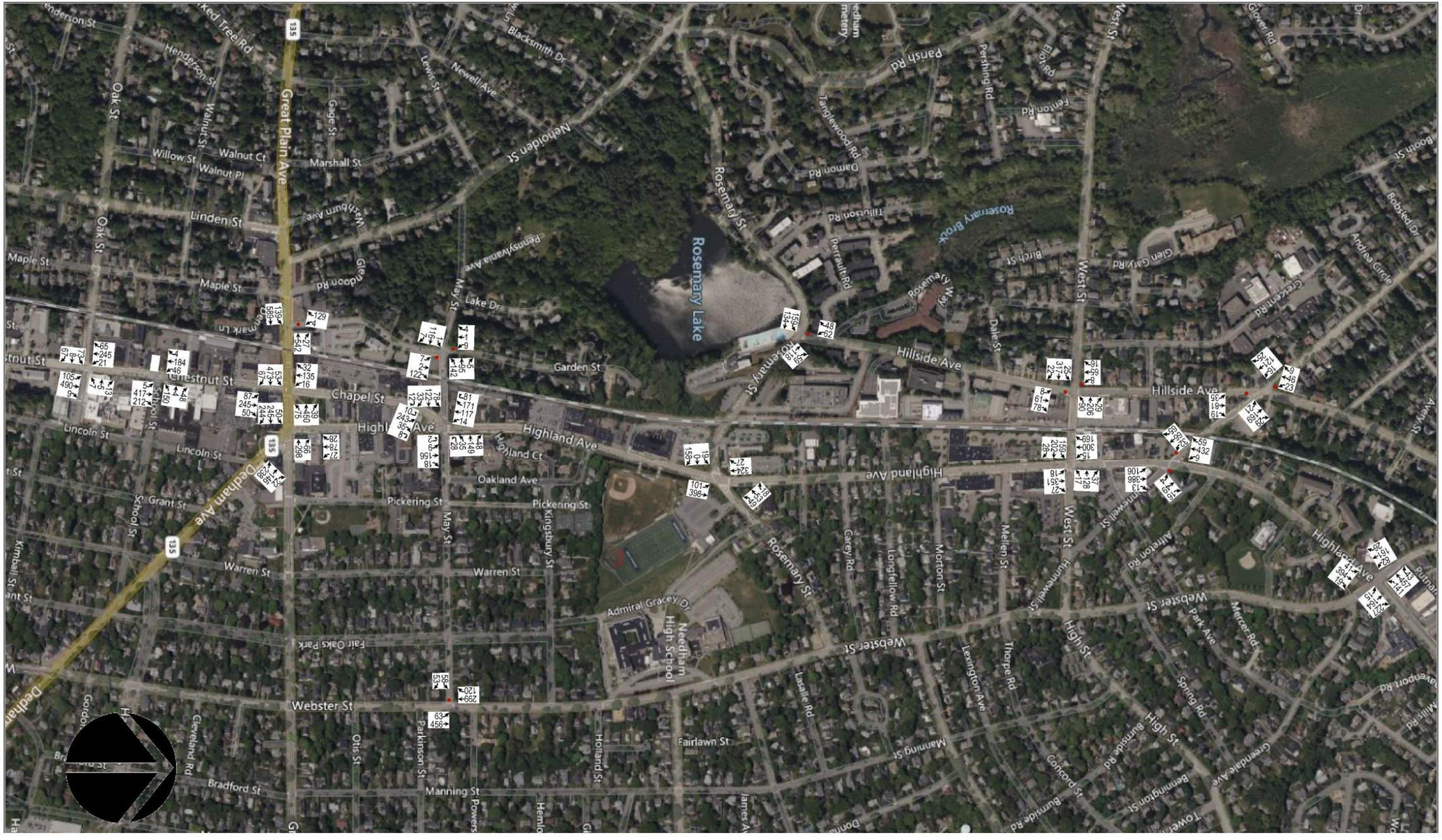

FIGURE 2A

2024 EXISTING CONDITIONS MORNING PEAK HOUR VOLUMES

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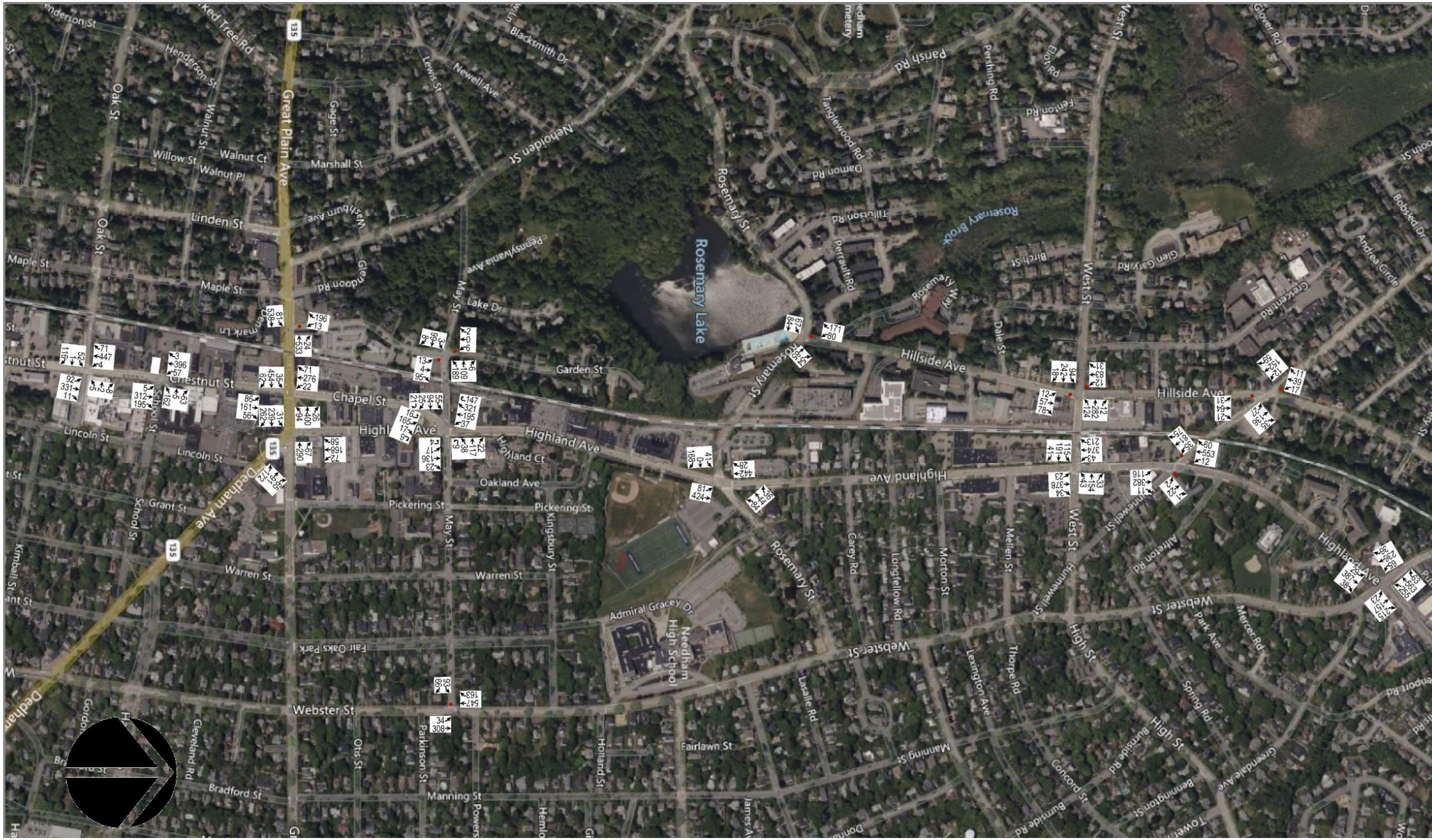

FIGURE 2B

2024 EXISTING CONDITIONS
EVENING PEAK HOUR VOLUMES

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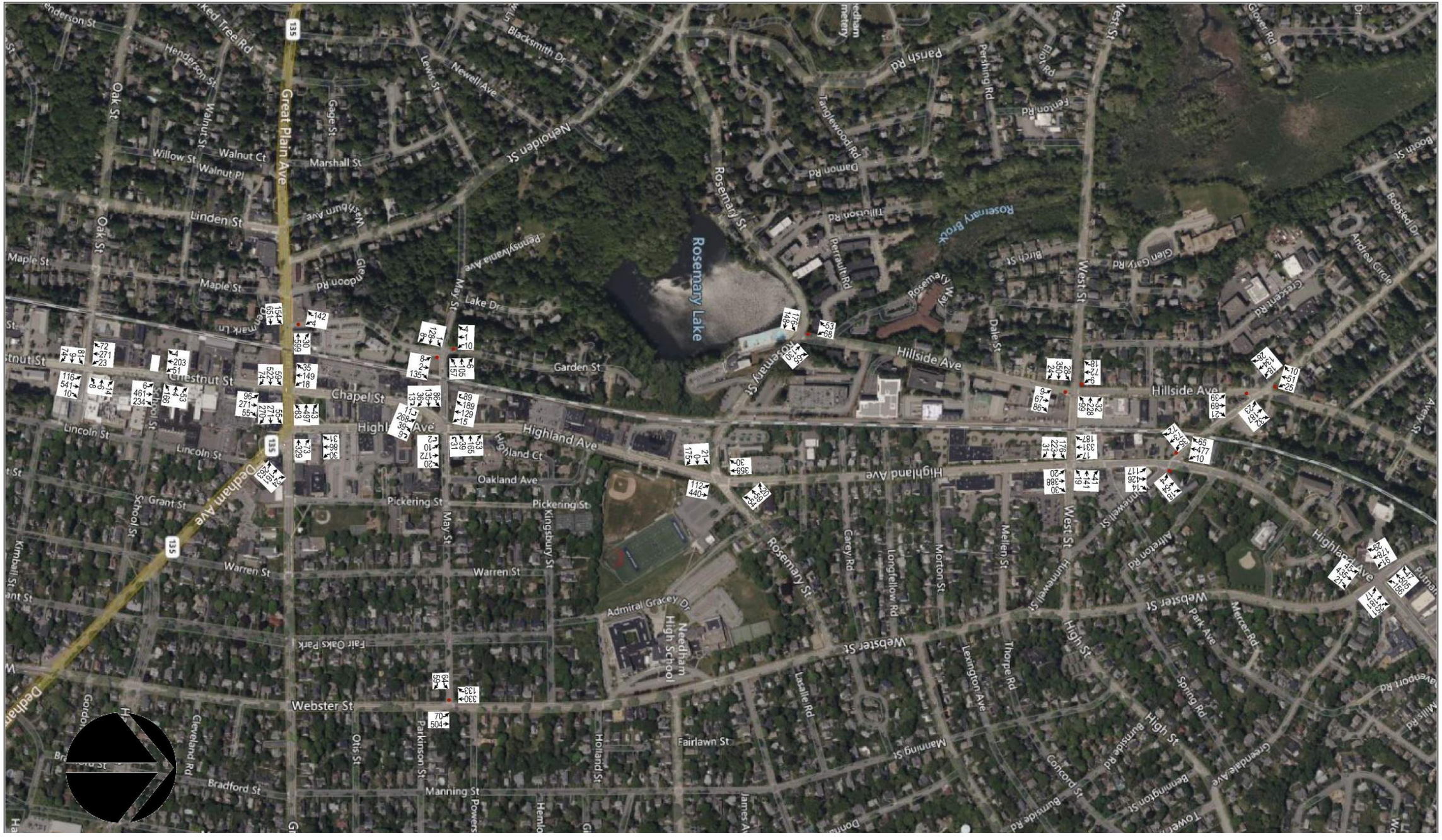

FIGURE 3A

2024 NO-BUILD CONDITIONS
MORNING PEAK HOUR VOLUMES

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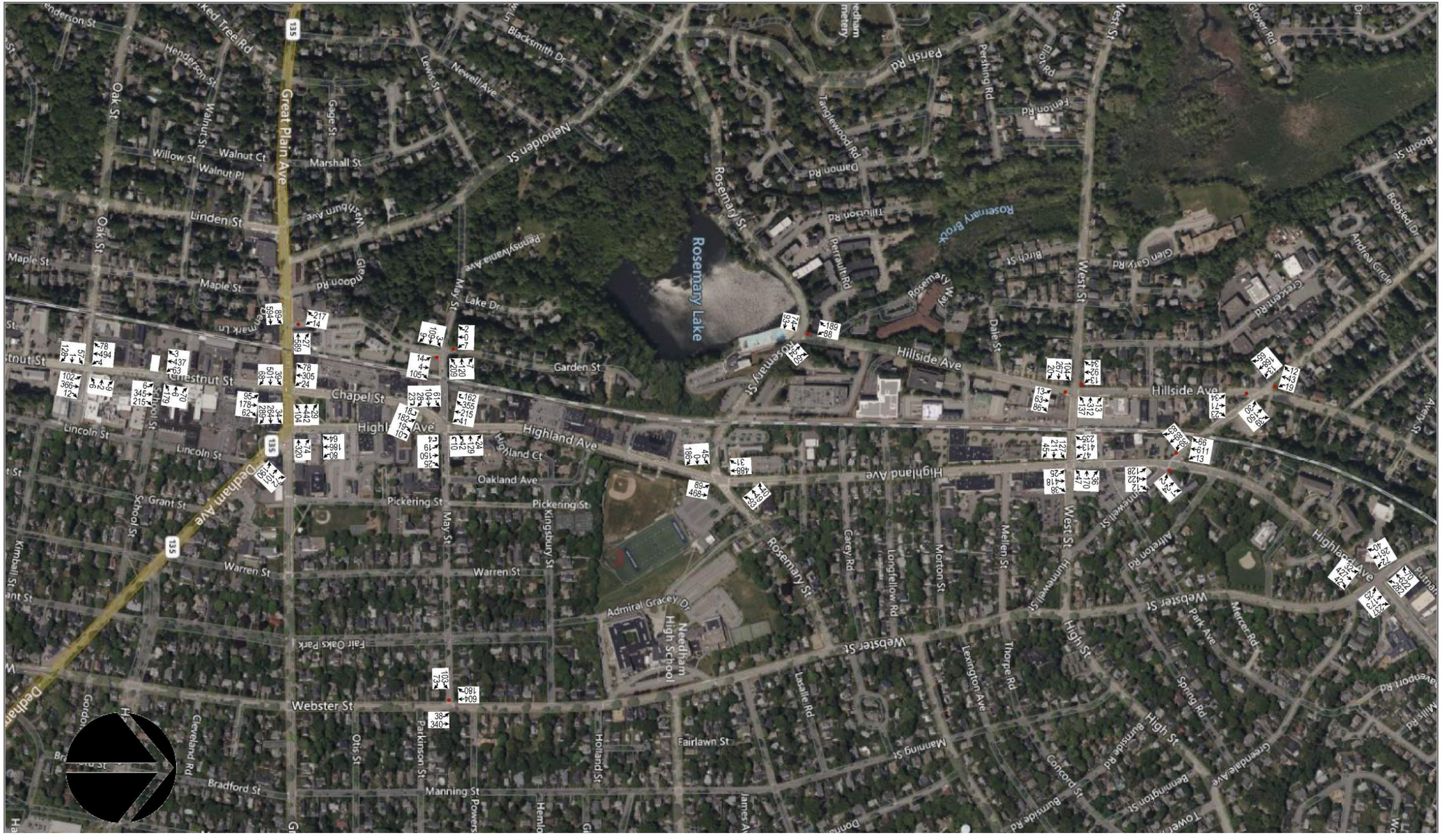

FIGURE 3B

2024 NO-BUILD CONDITIONS
EVENING PEAK HOUR VOLUMES

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Person Trips

The vehicle trips estimated using the ITE data were subsequently converted into person trips by applying average vehicle occupancy rates (VOR) based on national data. The national average VOR applied was 1.67 persons per vehicle, which is representative of general, all-purpose trips. This conversion allows for the application of the mode share credits discussed in the following section, providing a more accurate representation of the total number of trips generated by the proposed rezoning scenarios.

Mode Shares

The MBTA provides service within the proposed rezoning districts, with two commuter rail stations offering access to Boston and bus services connecting to Watertown. Additionally, the districts are in close proximity to various retail, restaurant, and commercial developments. A robust sidewalk network on surrounding roadways further enhances pedestrian connections to these establishments. The availability of public transportation and pedestrian connections is expected to reduce the number of passenger vehicle trips to and from the site. After reviewing multi-modal trip share information from U.S. Census Data and Replica Traffic Data Set for the Town of Needham, a 19 percent reduction in residential vehicle trips to and from the sites is anticipated for the proposed scenarios.

Trip Generation by Mode

As detailed in Table 5, Scenario A is projected to generate 75 new vehicle trips (18 entering and 57 exiting) during the weekday AM peak hour, and 94 new vehicle trips (59 entering and 35 exiting) during the weekday PM peak hour. In contrast, Scenario B is expected to generate 324 new vehicle trips (77 entering and 247 exiting) during the weekday AM peak hour, and 388 new vehicle trips (242 entering and 146 exiting) during the weekday PM peak hour.

Comprehensive trip generation calculations and supporting information are provided in the Appendix. Table 2 summarizes the resulting trip generation estimates.

Table 2
PROPOSED TRIP-GENERATION SUMMARY

Time Period/Direction	Scenario A: Base Compliance				Scenario B: Neighborhood Housing Plan			
	Residential Trips[a]	Person Trips[b]	Other Trips[c]	**Vehicle Trips[d]**	Residential Trips[e]	Person Trips	Other Trips[c]	**Vehicle Trips**
Weekday Daily	1,498	2,502	476	**1,214**	6,474	10,812	2,056	**5,244**
Weekday AM Peak Hour:								
Enter	22	37	7	**18**	94	157	30	**77**
Exit	70	117	23	**57**	305	509	98	**247**
Total	92	154	30	**75**	399	666	128	**324**
Weekday PM Peak Hour:								
Enter	73	122	24	**59**	299	499	95	**242**
Exit	43	72	14	**35**	180	301	57	**146**
Total	116	194	38	**94**	479	800	152	**388**

[a] Based on ITE LUC 220 (Multi-Family Housing, Low-Rise) for 222 units.
[b] Based on a Vehicle Occupancy Rate (VOR) of 1.67. Residential Trips multiplied by VOR.
[c] Based on a 19% transit and walk credit.
[d] Person Trips minus Other Trips divided by VOR.
[e] Based on ITE LUC 220 (Multi-Family Housing, Low-Rise) for 733 units and ITE LUC 221 (Multi-Family Housing, Mid-Rise) for 366 units.

Trip Distribution

The estimated project-generated vehicle trips were distributed across the local roadway network based on U.S. Census Journey-to-Work data for residents of the Town of Needham, reflecting typical commuter travel patterns. Table 3 illustrates the primary trip distribution for both future build scenarios.

Table 3
TRIP-DISTRIBUTION SUMMARY

Direction	Residential Distribution (%)
I-95 Ramps, to/from North	61
West Street, to/from East	8
RT-135, to/from Southeast	12
Chestnut Street, to/from South	6
RT-135, to/from West	10
Hunnewell Street, to/from Northwest	3
Total	**100**

Build Traffic Volumes

Based on the traffic generation and distribution estimates for this project, the traffic volumes associated with the proposed scenarios were assigned to the roadway network. These site-generated traffic volumes were then combined with the 2034 No-Build traffic volumes to develop the 2034 Build peak-hour traffic-volume networks. The Scenario A traffic volumes are depicted in Figures 4A and 4B for the weekday AM and weekday PM peak hours, respectively. Similarly, the Scenario B traffic volumes are shown in Figures 5A and 5B for the weekday AM and weekday PM peak hours. Table 4 shows the increase of vehicle trips traveling through each study area intersection expressed in vehicles per minute when compared to the No-Build Condition. Figure 6A and 6B provide a graphical representation of the data displayed in Table 4.

Table 4
INTERSECTION TRIP INCREASE SUMMARY

Intersection	Morning Peak Hour		Evening Peak Hour	
	Scenario A	Scenario B	Scenario A	Scenario B
Highland Ave at Webster St	0.7[a] (%2)	3.3 (%10)	1.0 (%2)	4.0 (%10)
Highland Ave at Hunnewell St	0.9 (%4)	3.6 (%16)	1.1 (%4)	4.3 (%17)
Highland Ave at West St	0.8 (%3)	3.7 (%14)	0.9 (%3)	4.5 (%15)
Highland Ave at Rosemary St	0.7 (%3)	3.4 (%16)	0.7 (%3)	4.0 (%16)
Highland Ave at Chapel St & May St	0.6 (%2)	3.0 (%12)	0.6 (%2)	3.6 (%13)
Highland Ave at Great Plain Ave & Dedham Ave	0.1 (%1)	0.7 (%2)	0.2 (%1)	0.8 (%3)
Chestnut St at Oak St	0.3 (%2)	3.4 (%16)	0.4 (%2)	4.0 (%19)
Chestnut St at School St	0.3 (%2)	3.4 (%17)	0.4 (%2)	4.0 (%18)
Great Plain Ave at Garden St	0.2 (%1)	0.6 (%2)	0.2 (%1)	0.6 (%2)
Great Plain Ave at Chapel St & Chestnut St	0.5 (%2)	3.6 (%11)	0.6 (%2)	4.2 (%13)
Webster St at May St	0.0 (%0)	0.0 (%0)	0.0 (%0)	0.0 (%0)
Garden St at May St	0.0 (%0)	0.0 (%0)	0.0 (%0)	0.0 (%0)
Rosemary St at Hillside Ave	0.1 (%1)	0.2 (%2)	0.1 (%1)	0.3 (%3)
Hillside Ave at West St	0.3 (%1)	0.6 (%4)	0.3 (%2)	0.7 (%4)
Hillside Ave at Hunnewell St	0.4 (%3)	0.6 (%5)	0.5 (%4)	0.7 (%6)

[a] Number of additional vehicles per minute

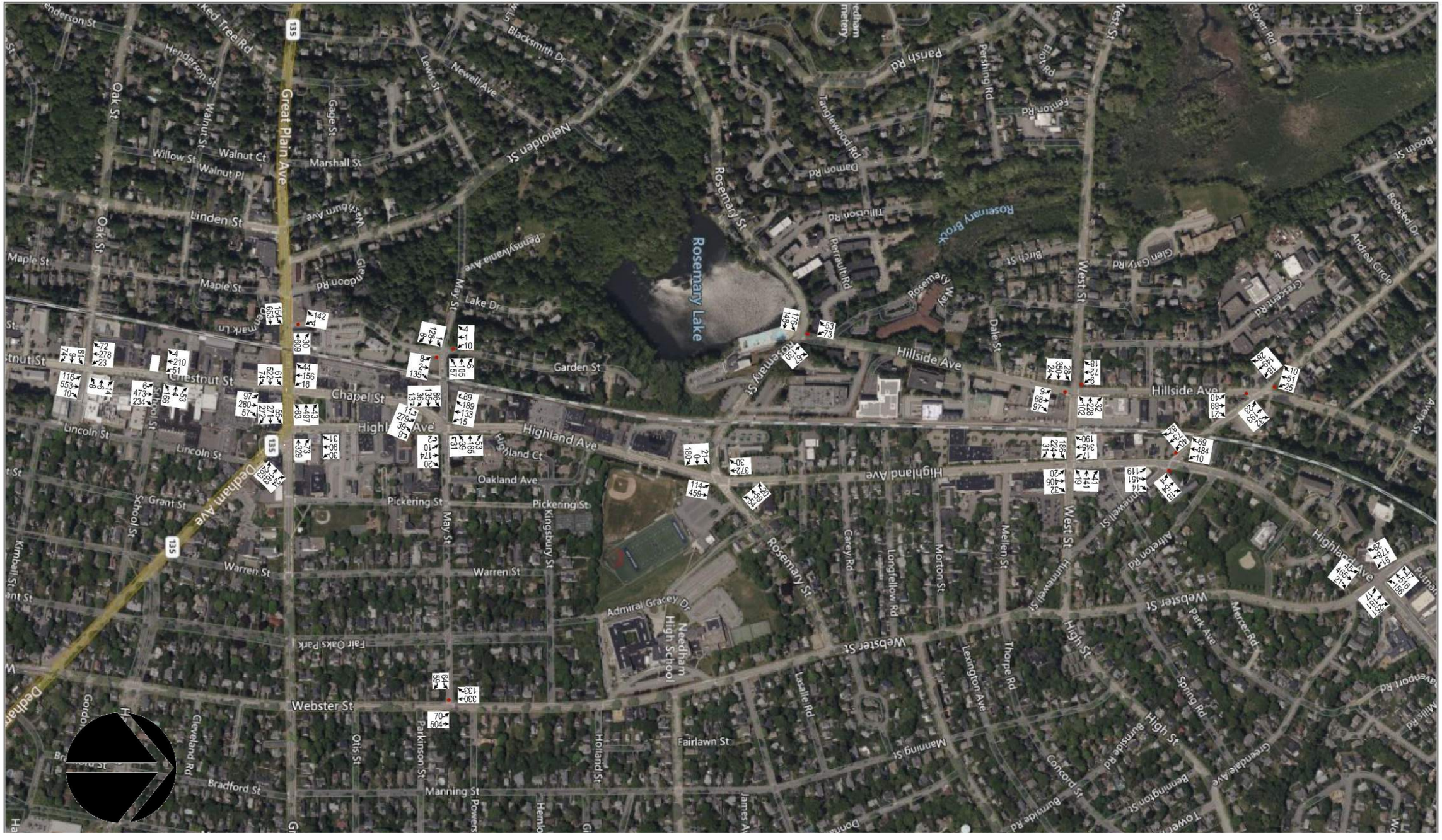

FIGURE 4A

2024 BUILD SCENARIO A
MORNING PEAK HOUR VOLUMES

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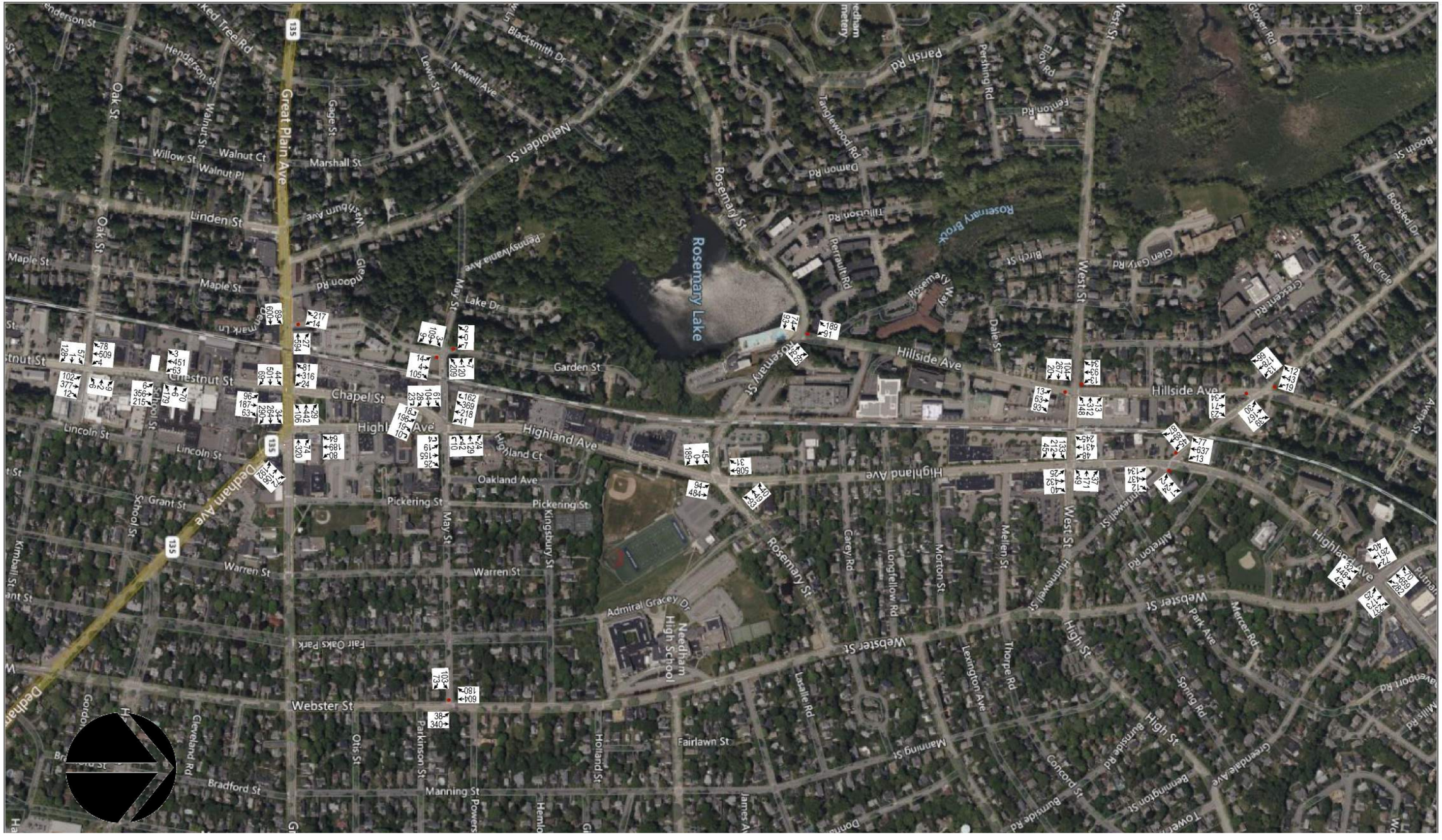

FIGURE 4B

2024 BUILD SCENARIO A
EVENING PEAK HOUR VOLUMES

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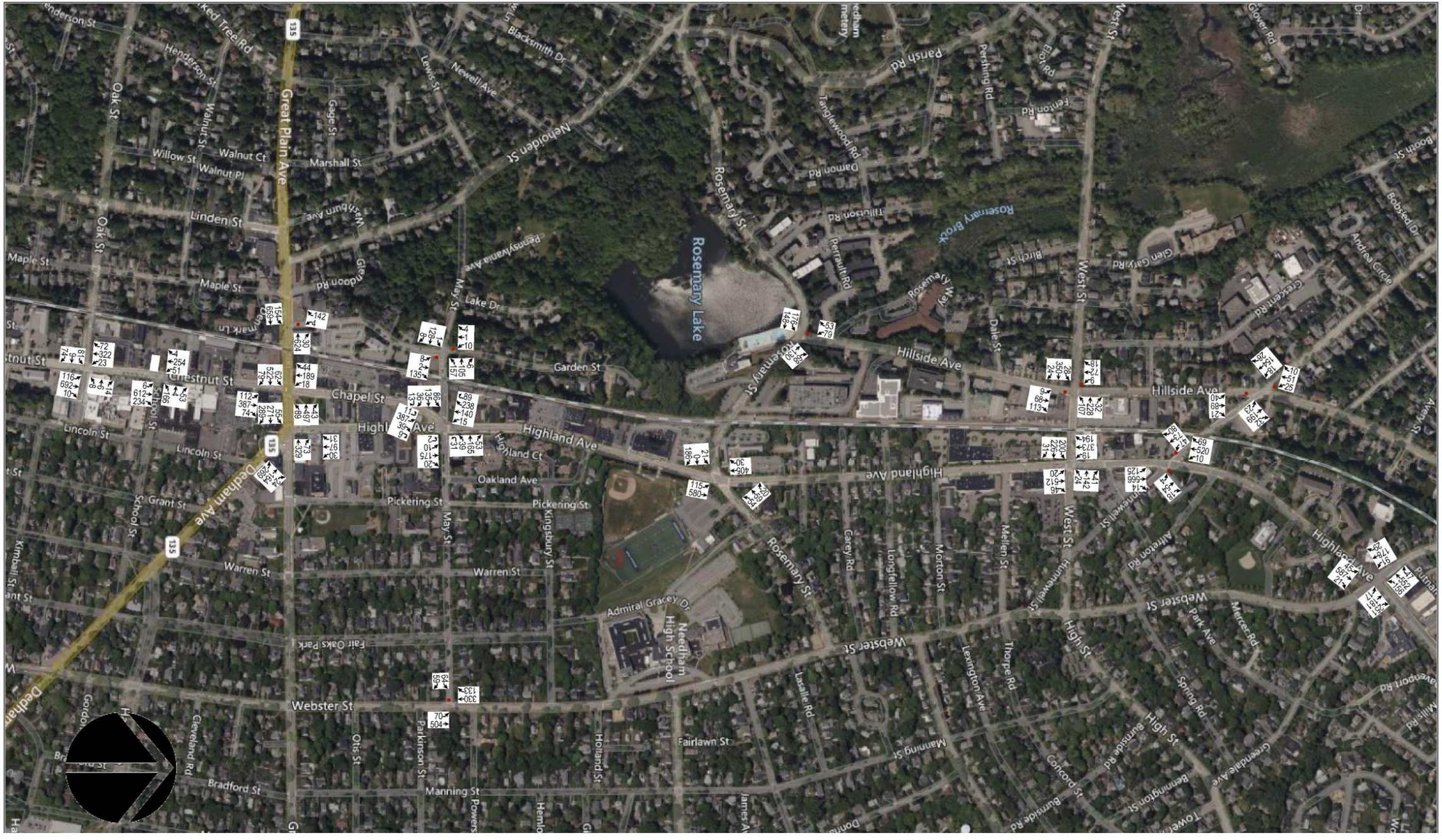

FIGURE 5A

2024 BUILD SCENARIO B
MORNING PEAK HOUR VOLUMES

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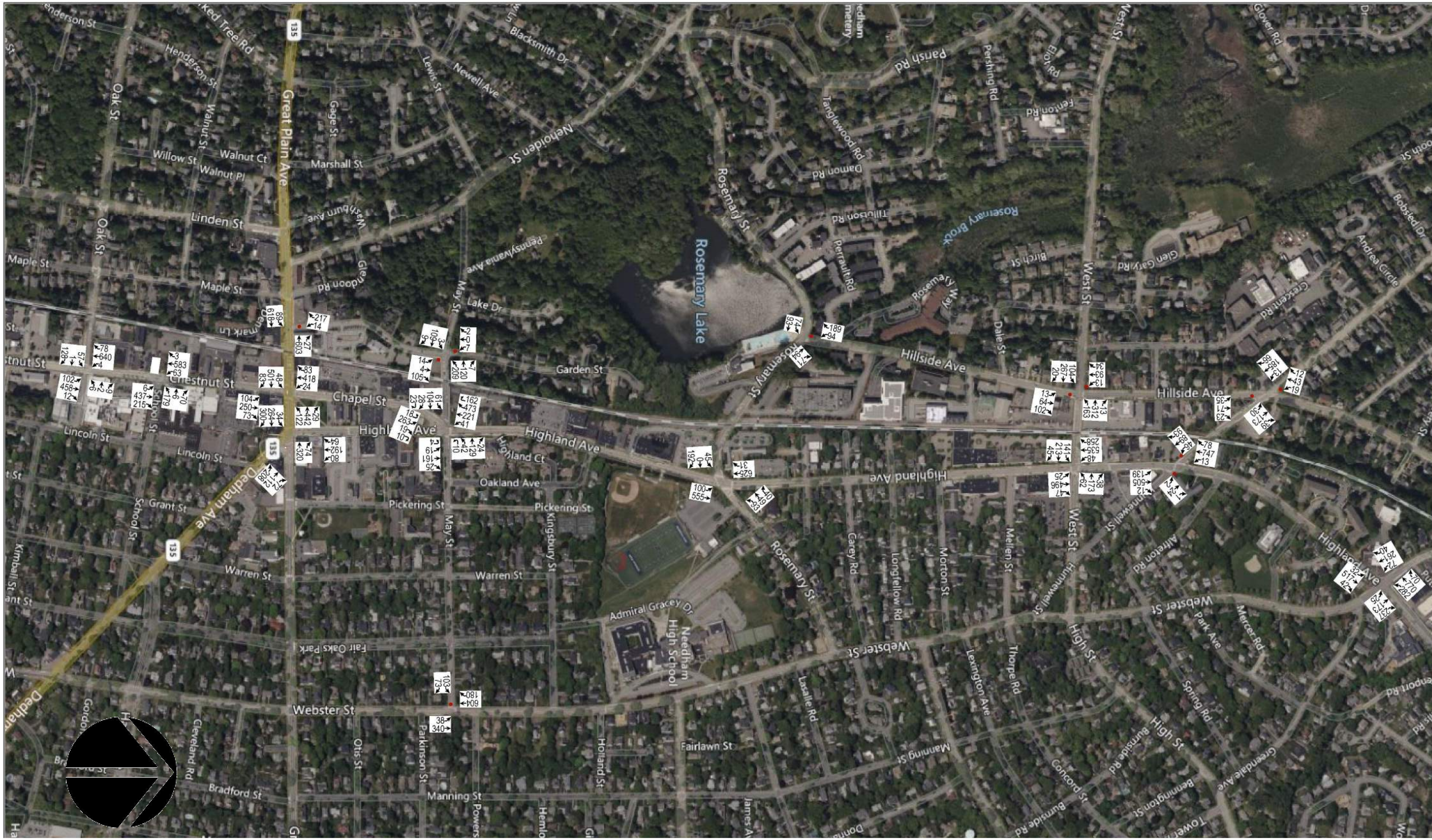

FIGURE 5B

2024 BUILD SCENARIO B

EVENING PEAK HOUR VOLUMES

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FIGURE 6A
2034 BUILD SCENARIO A
ADDITIONAL VEHICLES PER MINUTE

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FIGURE 6B
2034 BUILD SCENARIO B
ADDITIONAL VEHICLES PER MINUTE

Capacity and Queue Analysis Methodology

Capacity and queue analyses were conducted at all study area locations under 2024 Existing, 2034 No-Build, and 2034 Build traffic-volume conditions (for both Scenario A and Scenario B). The impact of site-generated traffic was measured by comparing 2034 No-Build conditions to 2034 Build conditions.

Capacity and queue analyses at the study area intersections were conducted using Synchro software. The analysis utilizes the HCM 2000 methodology for signalized intersections, as the HCM 6th Edition does not effectively analyze exclusive pedestrian signal phasing provided at the signalized study area intersections. MassDOT has acknowledged these inefficiencies with the HCM 6th Edition method and still accepts the HCM 2000 results as the most recently approved method. For study area intersections with STOP sign control, the HCM 6th Edition methodology was applied.

Capacity analyses provide an indication of how well the intersection accommodates the traffic demand placed upon it. A primary result of capacity analysis is the assignment of levels of service to traffic facilities under various traffic flow conditions. The concept of level of service (LOS) is defined as a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. A level-of-service definition provides an index to the quality of traffic flow in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

Six levels of service are defined for each type of facility. They are given letter designations from A to F, with LOS A representing the optimal operating conditions and LOS F the least desirable operating conditions. Since the level of service of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of levels of service, depending on the time of day, day of week, or period of year. A description of the operating condition under each level of service is provided below:

- LOS A: Indicates excellent conditions with minimal delay. Traffic flows smoothly with very short stops.
- LOS B: Represents very good conditions with slightly more delay. Traffic remains stable, and stops are brief.
- LOS C: Conditions are still manageable, with minor delays. While the flow of traffic remains stable, the frequency of stops increases slightly.
- LOS D: In an urban setting, LOS D is often typical and indicates reasonable traffic conditions given the higher density. Traffic flow is still manageable, though there are some delays.
- LOS E: reflects conditions where delays are more noticeable and traffic flow is less stable, but is common in busy urban areas. In such contexts, LOS E can still represent a functional intersection, albeit with higher levels of congestion.
- LOS F: The most congested conditions, where delays are substantial and traffic flow is heavily disrupted. The average delay exceeds 80 seconds per vehicle, often requiring further analysis or improvements.

Thresholds for vehicular LOS criteria for unsignalized and signalized intersections are shown in **Table 5**.

Table 5
LEVEL-OF-SERVICE CRITERIA FOR INTERSECTIONS

Level of Service	Unsignalized Intersection Control Delay Ranges (Seconds)	Signalized Intersection Control Delay Ranges (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, 6th Edition*, Transportation Research Board; Washington, D.C.; 2016.

For signalized intersections, the maximum back of queue during a typical (average) and 95th percentile signal cycle was calculated for each lane group during peak periods. The back of queue measures the vehicle backup length from the stop line to the last vehicle required to stop. This length depends on signal timing, vehicle arrival patterns, and saturation flow rate. For unsignalized intersections, the 95th percentile queue represents the queue length of the critical minor-street movement that is not expected to be exceeded 95 percent of the time during the analysis period, typically one hour. This queue length is determined by the capacity and saturation level of the movement.

Signalized Intersections Analysis Results

The results of the level-of-service (LOS) and queue analyses are shown in Table 6 and are discussed below. Figures 7A and 7B display the intersection LOS in the morning and evening peak hours, respectively.

Highland Avenue at Webster Street

In the AM peak hour, the overall LOS declines from E in 2024 to F in 2034 under the No-Build scenario and remains at LOS F in both Build Scenarios A and B. Notably, the northbound through (NBT) movement deteriorates significantly, with the delay increasing from 86 seconds in 2024 to up to 315 seconds in Build Scenario B. Additionally, the southbound left (SBL) movement also shows substantial worsening, with delays increasing from 132 seconds in 2024 to 198 seconds in all 2034 scenarios, maintaining LOS F.

In the PM peak hour, the intersection's overall LOS is F in 2024 and further deteriorates in all 2034 scenarios. The NBT movement shows an increase in delay from 104 seconds in 2024 to up to 265 seconds in Build Scenario B while the southbound through (SBT) movements also significantly worsens, with LOS dropping from C in 2024 to F in Build Scenario B and delays increasing from 34 seconds to 139 seconds. In addition, the SBL movement experiences LOS F across all four scenarios.

Highland Avenue at West Street

In the AM peak hour, the overall LOS degrades from C in 2024 to D in 2034 under the No-Build scenario, and further to LOS E in Build Scenario B. Notably, the eastbound left (EBL) movement deteriorates significantly, worsening from LOS D in 2024 to LOS F in all 2034 scenarios, with delays increasing from 40 seconds to 148 seconds. Additionally, the westbound through (WBT) movement shows increased congestion, moving from LOS D in 2024 to LOS E in both future build scenarios.

In the PM peak hour, the overall LOS is D in 2024 and deteriorates to E and F in the 2034 Build Scenarios. The EBL movement, which operates at LOS E in 2024, worsens to LOS F in all 2034 scenarios, with delays increasing from 71 seconds to 148 seconds. The southbound through (SBT) movement shows significant deterioration, moving from LOS D in 2024 to LOS F in Build Scenario B, with delays increasing from 39 seconds to 147 seconds.

Highland Avenue at Chapel Street & May Street

In the AM peak hour, the overall level of service (LOS) degrades from E in 2024 to F in 2034 under the No-Build and Build scenarios. Notably, the eastbound through (EBT) and westbound through (WBT) movements experience significant deterioration, with delays increasing from 94 and 145 seconds in 2024 to 161 and 225 seconds, respectively, in Build Scenario B. Additionally, the northeastbound left (NEL) movement worsens from LOS C to F, with delays increasing from 34 to 81 seconds.

In the PM peak hour, the intersection's overall LOS declines from E in 2024 to F in all 2034 scenarios. The northbound through (NBT) movement shows a dramatic increase in delay from 59 seconds in 2024 to 242 seconds in Build Scenario B, resulting in LOS F. Similarly, the southbound through (SBT) movement experiences severe deterioration, with delays increasing from 81 seconds in 2024 to 335 seconds in Build Scenario B, also resulting in LOS F. The southbound right (SBR) movement further deteriorates from LOS C to F, with delays increasing from 34 seconds to 123 seconds.

Highland Avenue at Great Plain Avenue & Dedham Avenue

In the AM peak hour at the intersection of Highland at Great Plain Ave & Dedham Ave, the overall level of service (LOS) declines from D in 2024 to F in all 2034 scenarios. Specifically, the eastbound through (EBT) movement exhibits a notable deterioration, with delays escalating from 95 seconds in 2024 to 291 seconds in Build Scenario B, maintaining LOS F consistently across scenarios.

In the PM peak hour, the intersection's overall LOS decreases from D in 2024 to E in all 2034 scenarios. The eastbound through (EBT) movement shows significant delays, degrading from LOS C in 2024 to LOS F across all future scenarios. The northbound left movement (NBL) experiences significant delays and LOS F across all four study scenarios. Similarly, the southbound through (SBT) movement experiences delays rising from 77 seconds to 79 seconds in all 2034 scenarios, maintaining LOS E.

Chestnut Street at School Street

In the AM peak hour at the intersection of Chestnut Street at School Street, the overall level of service (LOS) degrades from C in 2024 to D in 2034 No-Build and E in 2034 Build Scenario B. The westbound through (WBT) movement experiences significant delays across all analysis scenarios, maintaining LOS F. The northbound through (NBT) movement worsens notably, with delays rising from 28 seconds in 2024 to 83 seconds in Build Scenario B, shifting from LOS C to F.

In the PM peak hour, the intersection maintains an overall LOS C from 2024 through 2034 scenarios, but the westbound through (WBT) movement's delay increases from 71 seconds in 2024 to 98 seconds in all 2034 scenarios, shifting from LOS E to F.

Great Plain Avenue at Chapel Street & Chestnut Street

In the AM peak hour, the overall LOS degrades from C in 2024 to D in 2034 under the No-Build scenario, with further deterioration to LOS D in Build Scenario A and LOS F in Build Scenario B. Specifically, the eastbound through (EBT) movement deteriorates significantly, moving from LOS C in 2024 to LOS D in the No-Build scenario, LOS E in Build Scenario A, and LOS F in Build Scenario B. Similarly, the westbound through (WBT) movement deteriorates from LOS B to LOS D in the No-Build, and LOS F in Build Scenario B.

In the PM peak hour, the intersection's overall LOS worsens from D in 2024 to E in 2034 under the No-Build scenario and further declines to LOS E in Build Scenario A and LOS F in Build Scenario B. Notably, the southbound through (SBT) movement shows a dramatic decline, with LOS dropping from E in 2024 to F in all 2034 scenarios, and delay increasing substantially, indicating severe congestion issues. The westbound through (WBT) movement deteriorates from LOS D to LOS E in the No-Build, and LOS F in Build Scenario B.

All other signalized intersections in the study area maintain an acceptable level of service (LOS D or better) across all analysis scenarios.

Table 6
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2024 Existing					2034 No-Build					2034 Build: Scenario A					2034 Build: Scenario B				
Intersection/Peak Hour/Lane Group	V/C [a]	Delay [b]	LOS [c]	50Q [d]	95Q [d]	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q
Highland at Webster Street																				
Weekday AM:																				
EBT	0.64	28	C	54	#159	0.68	29	C	61	#188	0.68	29	C	61	#188	0.68	29	C	61	#188
WBT	0.69	32	C	80	#186	0.72	33	C	90	#217	0.72	33	C	90	#217	0.72	33	C	90	#217
WBR	0.83	60	E	116	172	0.88	74	E	135	192	0.88	74	E	135	192	0.88	74	E	135	192
NBL	0.24	17	B	16	47	0.35	19	B	18	53	0.38	19	B	18	54	0.46	20	B	18	57
NBT	1.04	86	F	~233	#448	1.18	141	F	~310	#512	1.25	175	F	~348	#556	1.56	315	F	~501	#731
SBL	1.08	132	F	~71	#97	1.23	198	F	~97	#119	1.23	198	F	~97	#119	1.23	198	F	~97	#119
SBT	0.7	17	B	155	#467	0.79	23	C	181	#541	0.81	24	C	187	#557	0.86	30	C	207	#609
	1.10	**57**	**E**			**1.22**	**82**	**F**			**1.22**	**92**	**F**			**1.28**	**139**	**F**		
Weekday PM:																				
EBT	0.77	41	D	112	#176	0.82	45	D	127	#211	0.82	45	D	127	#211	0.82	45	D	127	#211
WBT	0.73	41	D	126	#195	0.77	44	D	141	#236	0.77	44	D	141	#236	0.77	44	D	141	#236
WBR	0.62	29	C	162	167	0.67	31	C	183	185	0.67	31	C	183	185	0.67	31	C	183	185
NBL	0.27	24	C	19	44	0.51	28	C	22	#64	0.51	28	C	22	#64	0.51	28	C	22	#64
NBT	1.10	104	F	~447	#530	1.24	162	F	~522	#599	1.30	185	F	~559	#635	1.48	265	F	~678	#746
SBL	1.33	220	F	~395	#235	1.50	298	F	~464	#277	1.50	298	F	~464	#277	1.50	298	F	~464	#277
SBT	0.89	34	C	~504	#699	1.00	61	E	~602	#801	1.05	77	E	~655	#855	1.21	139	F	~820	#1025
	0.90	**83**	**F**			**0.99**	**117**	**F**			**1.01**	**126**	**F**			**1.08**	**162**	**F**		

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 50th/95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 6 (continued)
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2024 Existing					2034 No-Build					2034 Build: Scenario A					2034 Build: Scenario B				
Intersection/Peak Hour/Lane Group	V/C [a]	Delay [b]	LOS [c]	50Q [d]	95Q [d]	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q
Highland at West Street																				
Weekday AM:																				
EBL	0.70	40	D	112	#216	0.92	85	F	126	#278	1.02	120	F	~142	#309	1.10	148	F	~170	#346
EBT	0.55	29	C	181	276	0.65	36	D	206	310	0.67	39	D	207	311	0.68	39	D	208	313
WBL	0.24	34	C	21	30	0.30	38	D	24	33	0.31	40	D	24	33	0.40	42	D	31	39
WBT	0.69	42	D	152	201	0.78	53	D	171	222	0.79	58	E	171	222	0.80	58	E	172	224
NBT	0.74	25	C	336	355	0.76	26	C	401	408	0.77	26	C	429	434	0.97	52	D	~694	#664
SBT	0.87	34	C	421	#617	0.89	37	D	510	#727	0.90	38	D	~549	#761	0.96	50	D	~646	#834
	0.72	**32**	**C**			**0.81**	**40**	**D**			**0.85**	**45**	**D**			**0.92**	**59**	**E**		
Weekday PM:																				
EBL	0.84	71	E	104	124	0.97	109	F	~117	#161	1.03	124	F	~133	#177	1.10	148	F	~153	#196
EBT	0.59	36	D	171	263	0.64	37	D	192	292	0.64	37	D	193	293	0.64	37	D	195	295
WBL	0.37	40	D	44	63	0.41	41	D	48	68	0.43	41	D	51	71	0.54	44	D	66	86
WBT	0.77	55	D	167	238	0.81	59	E	188	#278	0.83	60	E	191	#285	0.83	61	E	194	#292
NBT	0.57	19	B	281	403	0.64	21	C	324	462	0.67	22	C	342	488	0.76	26	C	422	#644
SBT	0.91	39	D	~600	#803	1.02	65	E	~722	#929	1.06	81	F	~777	#985	1.23	147	F	~993	#1205
	0.80	**39**	**D**			**0.91**	**53**	**D**			**0.95**	**60**	**E**			**1.07**	**90**	**F**		

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 50th/95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 6 (continued)
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2024 Existing					2034 No-Build					2034 Build: Scenario A					2034 Build: Scenario B				
Intersection/Peak Hour/Lane Group	V/C [a]	Delay [b]	LOS [c]	50Q [d]	95Q [d]	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q
Highland at Rosemary Street																				
Weekday AM:																				
EBT	0.66	27	C	12	83	0.67	27	C	14	92	0.68	27	C	14	93	0.69	27	C	14	94
WBL	0.65	40	D	39	53	0.73	50	D	44	58	0.74	51	D	45	58	0.76	53	D	45	59
WBT	0.43	28	C	46	55	0.45	28	C	52	61	0.45	27	C	52	61	0.44	27	C	52	61
NBL	0.42	17	B	49	95	0.53	21	C	60	112	0.57	23	C	63	#119	0.65	28	C	67	#142
NBT	0.60	18	B	195	320	0.67	20	B	234	#395	0.70	21	C	250	#422	0.89	33	C	~401	#597
SBT	0.51	16	B	172	262	0.58	17	B	205	296	0.60	18	B	216	310	0.65	19	B	244	342
	0.52	**21**	**C**			**0.58**	**23**	**C**			**0.60**	**23**	**C**			**0.72**	**28**	**C**		
Weekday PM:																				
EBT	0.67	26	C	15	98	0.69	26	C	16	109	0.69	26	C	16	110	0.69	26	C	16	110
WBL	0.63	35	D	29	93	0.70	41	D	33	#109	0.70	42	D	33	#114	0.71	43	D	33	#115
WBT	0.32	24	C	15	62	0.33	24	C	16	67	0.33	24	C	16	67	0.33	24	C	16	67
NBL	0.35	14	B	17	82	0.47	18	B	22	98	0.52	21	C	24	#118	0.93	80	F	35	#170
NBT	0.53	14	B	88	342	0.59	16	B	108	#423	0.61	17	B	114	#447	0.71	19	B	140	#550
SBT	0.57	15	B	104	376	0.64	17	B	129	#470	0.66	17	B	138	#499	0.81	23	C	188	#667
	0.53	**18**	**B**			**0.59**	**20**	**C**			**0.61**	**21**	**C**			**0.78**	**27**	**C**		

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 50th/95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 6 (continued)
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Intersection/Peak Hour/Lane Group	2024 Existing					2034 No-Build					2034 Build: Scenario A					2034 Build: Scenario B				
	V/C [a]	Delay [b]	LOS [c]	50Q [d]	95Q [d]	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q
Highland at Chapel Street & May Street																				
Weekday AM:																				
EBT	1.05	94	F	~216	#283	1.22	156	F	~284	#338	1.22	158	F	~284	#338	1.23	161	F	~284	#338
WBT	1.19	145	F	~287	#367	1.38	221	F	~351	#427	1.38	223	F	~351	#427	1.38	225	F	~351	#427
NBT	0.83	51	D	168	214	0.91	64	E	190	#242	0.92	66	E	192	#252	0.93	68	E	192	#252
SBT	0.61	39	D	89	166	0.69	43	D	100	#196	0.71	45	D	103	#203	0.74	47	D	109	#218
SBR	0.51	21	C	115	258	0.55	22	C	130	291	0.58	23	C	139	310	0.64	25	C	161	355
NEL2	0.13	42	D	9	23	0.14	42	D	9	25	0.14	42	D	9	25	0.14	43	D	9	25
NEL	0.62	34	C	107	258	0.71	37	D	129	#327	0.73	39	D	137	#347	1.01	81	F	225	#546
	0.93	**71**	**E**			**1.06**	**104**	**F**			**1.07**	**104**	**F**			**1.17**	**110**	**F**		
Weekday PM:																				
EBT	0.71	39	D	125	232	0.73	39	D	142	#263	0.73	39	D	142	#264	0.73	39	D	142	#264
WBT	0.76	43	D	118	#249	0.79	45	D	136	#298	0.79	45	D	136	#298	0.79	45	D	136	#298
NBT	0.85	59	E	131	#261	1.24	183	F	~184	#333	1.32	214	F	~196	#347	1.39	242	F	~209	#362
SBT	1.20	81	F	~203	#405	1.51	293	F	~264	#467	1.56	313	F	~271	#475	1.61	335	F	~278	#483
SBR	0.83	34	C	235	#582	0.96	55	C	292	#667	0.98	62	E	304	#691	1.17	123	F	~454	#867
NEL2	0.27	44	D	17	30	0.31	46	D	20	33	0.30	45	D	20	33	0.30	45	D	20	33
NEL	0.36	28	C	51	131	0.43	31	C	65	152	0.47	31	C	74	166	0.65	36	D	121	243
	0.85	**59**	**E**			**0.97**	**104**	**F**			**1.00**	**113**	**F**			**1.07**	**135**	**F**		

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 50th/95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 6 (continued)
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Intersection/Peak Hour/Lane Group	2024 Existing					2034 No-Build					2034 Build: Scenario A					2034 Build: Scenario B				
	V/C [a]	Delay [b]	LOS [c]	50Q [d]	95Q [d]	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q
Highland at Great Plain Ave & Dedham Ave																				
Weekday AM:																				
EBT	1.06	95	F	340	#371	1.48	272	F	~498	#464	1.49	276	F	~499	#465	1.54	291	F	~502	m#399
EBR	0.35	5	A	24	65	0.39	5	A	27	m74	0.40	6	A	28	m72	0.43	6	A	50	m61
WBT	0.43	33	C	114	198	0.53	38	D	138	221	0.53	38	D	139	221	0.54	38	D	142	221
NBL	0.68	42	D	184	#407	0.69	41	D	198	#472	0.69	41	D	198	#476	0.71	42	D	202	#493
NBT	0.41	36	D	111	191	0.42	34	C	119	#242	0.43	34	C	120	#249	0.43	34	C	119	#257
NBR	0.07	32	C	0	0	0.08	30	C	0	0	0.08	30	C	0	0	0.08	30	C	0	0
SBT	0.73	61	E	112	137	0.76	62	E	124	147	0.76	62	E	127	150	0.77	63	E	135	158
SBR	0.20	45	D	0	0	0.22	44	D	0	0	0.21	44	D	0	0	0.21	43	D	0	0
	0.79	**48**	**D**			**0.94**	**92**	**F**			**0.94**	**93**	**F**			**0.96**	**96**	**F**		
Weekday PM:																				
EBT	0.76	28	C	92	#345	1.05	83	F	~315	#444	1.08	93	F	~320	#448	1.15	122	F	~329	m#450
EBR	0.39	11	B	49	97	0.45	15	B	56	m136	0.45	16	B	65	m140	0.47	17	B	80	m135
WBT	0.45	34	C	144	184	0.55	39	D	162	204	0.56	40	D	162	204	0.58	41	D	162	204
NBL	0.95	99	F	156	#288	0.96	97	F	~192	#327	0.96	95	F	~195	#332	0.98	102	F	~225	#366
NBT	0.52	49	D	86	126	0.53	48	D	97	137	0.55	48	D	102	144	0.55	47	D	108	151
NBR	0.30	45	D	0	24	0.31	43	D	0	32	0.31	43	D	0	32	0.30	42	D	0	32
SBT	0.92	77	E	226	#345	0.94	79	E	256	#399	0.94	79	E	~262	#405	0.94	78	E	~270	#413
SBR	0.18	38	D	0	16	0.19	37	D	0	22	0.19	36	D	0	22	0.19	36	D	0	22
	0.68	**45**	**D**			**0.80**	**57**	**E**			**0.81**	**59**	**E**			**0.83**	**66**	**E**		

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 50th/95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 6 (continued)
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Intersection/Peak Hour/Lane Group	2024 Existing					2034 No-Build					2034 Build: Scenario A					2034 Build: Scenario B				
	V/C [a]	Delay [b]	LOS [c]	50Q [d]	95Q [d]	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q
Chestnut Street at Oak Street																				
Weekday AM:																				
EBT	0.52	32	C	73	136	0.58	35	C	82	151	0.58	35	C	82	151	0.58	35	C	82	151
WBT	0.07	23	C	11	31	0.08	24	C	12	34	0.08	24	C	12	34	0.08	24	C	12	34
NBL	0.28	14	B	25	93	0.32	15	B	28	106	0.33	16	B	28	106	0.36	16	B	29	111
NBT	0.71	23	C	159	#508	0.78	27	C	186	#580	0.80	28	C	193	#596	1.00	61	E	290	#784
SBT	0.40	15	B	68	206	0.45	16	B	78	233	0.45	16	B	80	239	0.66	23	C	106	#367
SBR	0.10	11	B	0	27	0.11	11	B	0	28	0.11	11	B	0	28	0.11	11	B	0	28
	0.58	**21**	**C**			**0.65**	**23**	**C**			**0.66**	**24**	**C**			**0.77**	**42**	**D**		
Weekday PM:																				
EBT	0.66	41	D	89	#176	0.73	45	D	100	#202	0.73	45	D	100	#202	0.73	45	D	100	#202
WBT	0.05	25	C	7	23	0.06	26	C	8	25	0.06	26	C	8	25	0.06	26	C	8	25
NBL	0.32	14	B	20	88	0.40	17	B	24	#112	0.42	17	B	24	#120	0.63	31	C	28	#156
NBT	0.46	15	B	82	253	0.50	15	B	94	288	0.52	16	B	98	300	0.63	18	B	129	#436
SBT	0.60	23	C	73	m#366	0.66	24	C	80	m#413	0.68	24	C	83	m#435	0.86	33	C	112	m#619
SBR	0.11	28	C	0	m44	0.12	26	C	0	m54	0.12	25	C	0	m54	0.12	23	C	1	m42
	0.56	**23**	**C**			**0.62**	**24**	**C**			**0.63**	**24**	**C**			**0.74**	**29**	**C**		

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 50th/95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 6 (continued)
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Intersection/Peak Hour/Lane Group	2024 Existing					2034 No-Build					2034 Build: Scenario A					2034 Build: Scenario B				
	V/C [a]	Delay [b]	LOS [c]	50Q [d]	95Q [d]	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q
Chestnut Street at School Street																				
Weekday AM:																				
WBT	0.92	86	F	101	#224	1.02	113	F	~115	#251	1.02	113	F	~115	#251	1.02	113	F	~115	#251
WBR	0.14	32	C	0	29	0.15	32	C	0	30	0.15	32	C	0	30	0.15	32	C	0	30
NBL	0.01	11	B	1	10	0.01	11	B	1	13	0.01	11	B	1	13	0.01	11	B	1	13
NBT	0.78	28	C	225	#723	0.86	36	D	271	#822	0.88	38	D	281	#841	1.04	83	F	412	#1049
SBL	0.17	20	C	6	38	0.22	24	C	7	40	0.22	25	C	7	40	0.35	38	D	7	43
SBT	0.19	8	A	28	122	0.21	8	A	32	134	0.22	8	A	33	138	0.26	9	A	41	168
	0.69	**33**	**C**			**0.76**	**41**	**D**			**0.77**	**42**	**D**			**0.89**	**69**	**E**		
Weekday PM:																				
WBT	0.89	71	E	96	#216	1.00	98	F	109	#245	1.00	98	F	109	#245	1.00	98	F	109	#245
WBR	0.16	27	C	0	29	0.17	28	C	0	30	0.17	28	C	0	30	0.17	28	C	0	30
NBL	0.02	7	A	1	m3	0.02	7	A	1	m5	0.02	7	A	1	m4	0.04	7	A	1	m3
NBT	0.70	18	B	183	#561	0.77	22	C	212	#615	0.79	23	C	219	#632	0.90	34	C	270	#740
SBL	0.18	17	B	8	46	0.22	20	B	9	49	0.23	20	C	9	49	0.28	25	C	9	49
SBT	0.44	12	B	71	288	0.48	12	B	82	328	0.50	13	B	85	343	0.64	16	B	126	#548
	0.64	**24**	**C**			**0.71**	**30**	**C**			**0.72**	**30**	**C**			**0.81**	**34**	**C**		

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 50th/95th percentile queue length in feet per lane (assuming 25 feet per vehicle).

Table 6 (continued)
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Intersection/Peak Hour/Lane Group	2024 Existing					2034 No-Build					2034 Build: Scenario A					2034 Build: Scenario B				
	V/C [a]	Delay [b]	LOS [c]	50Q [d]	95Q [d]	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q	V/C	Delay	LOS	50Q	95Q
Great Plain Ave at Chapel Street & Chestnut Street																				
Weekday AM:																				
EBT	0.68	27	C	228	312	0.90	52	D	309	#413	0.95	66	E	324	#422	1.32	243	F	~467	#460
WBT	0.69	13	B	152	#356	0.91	36	D	308	#441	0.95	49	D	313	#445	.38dl	229	F	~418	#482
NBL	0.38	28	C	53	96	0.38	24	C	56	105	0.38	23	C	56	106	0.35	17	B	51	120
NBT	0.77	47	D	232	#456	0.73	41	D	251	#519	0.73	39	D	257	#540	0.78	35	C	331	#783
SBL	0.15	33	C	15	23	0.15	29	C	16	24	0.15	28	C	16	24	0.14	22	C	12	24
SBT	0.61	42	D	135	234	0.57	38	D	145	#278	0.60	38	D	160	#324	0.53	29	C	163	#389
	0.72	**27**	**C**			**0.85**	**42**	**D**			**0.86**	**51**	**D**			**1.04**	**160**	**F**		
Weekday PM:																				
EBT	0.69	40	D	195	262	0.75	42	D	227	303	0.78	44	D	234	313	0.84	50	D	250	#356
WBT	0.90	43	D	250	m302	0.98	59	E	287	m#370	0.99	61	E	288	m#372	1.05	82	F	~314	m#391
NBL	0.55	29	C	61	95	0.70	40	D	68	#127	0.71	40	D	68	#128	0.74	42	D	75	#146
NBT	0.51	34	C	185	#284	0.60	38	D	209	#329	0.62	39	D	221	#351	0.80	48	D	~333	#495
SBL	0.10	28	C	17	31	0.13	30	C	19	33	0.13	30	C	19	33	0.16	31	C	19	33
SBT	1.00	71	E	~409	#580	1.19	124	F	~478	#652	1.23	139	F	~504	#679	1.55	264	F	~695	#879
	0.76	**46**	**D**			**0.86**	**63**	**E**			**0.88**	**68**	**E**			**1.00**	**108**	**F**		

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 50th/95th percentile queue length in feet per lane (assuming 25 feet per vehicle)

Unsignalized Intersections Analysis Results

The results of the level-of-service (LOS) and queue analyses are shown in Table 7 and are discussed below. Figures 7A and 7B display the intersection LOS in the morning and evening peak hours, respectively.

Highland Avenue at Hunnewell Street

In the AM peak hour, both the eastbound (EB) and westbound (WB) directions at the Highland Avenue and Hunnewell Street intersection experience severe congestion with a volume-to-capacity (V/C) ratio greater than 1.50 and delays exceeding 200 seconds, resulting in a Level of Service (LOS) F. The 95th percentile queue lengths are substantial, with the EB direction experiencing a queue of 20.4 units in 2024, and both directions expected to have queues exceeding 25 units in all 2034 scenarios.

Similarly, during the PM peak hour, both the EB and WB directions face extreme congestion with V/C ratios exceeding 1.50 and delays greater than 200 seconds, maintaining a LOS F across all scenarios. The 95th percentile queue lengths for the EB direction are 20.4 units in 2024, while the queues for both directions are expected to surpass 25 units in the 2034 No-Build and Build scenarios.

Great Plain Avenue at Garden Street

In the AM peak hour, the southbound (SB) direction at the Great Plain Avenue and Garden Street intersection operates at an acceptable level of service (LOS C) across all scenarios.

During the PM peak hour, the SB direction experiences more significant congestion. The LOS deteriorates from D in 2024 to E in all 2034 scenarios, with the V/C ratio increasing from 0.61 to 0.78 in Build Scenario B. Delays rise from 26 to 42 seconds, and the 95th percentile queue length grows from 4 to 6.6 units.

Hillside Avenue at West Street

During the AM peak hour, the northbound (NB) and southbound (SB) directions at the Hillside Avenue and West Street intersection operate at LOS F across all scenarios. For the NB direction, the V/C ratio increases from 0.79 in 2024 to 1.21 in the 2034 Build Scenario B, with delays rising significantly from 53 to 167 seconds and the 95th percentile queue length increasing from 6.2 to 14 units. Similarly, the SB direction sees its V/C ratio rise from 0.74 to 1.15, with delays increasing from 63 to 187 seconds and the 95th percentile queue length growing from 4.8 to 9.2 units.

In the PM peak hour, both the NB and SB directions experience severe congestion, with the V/C ratio exceeding 1.50 and delays surpassing 200 seconds in all scenarios, resulting in LOS F. The 95th percentile queue lengths are consistently greater than 25 units, indicating substantial queuing and delays.

Webster Street at May Street

In the AM peak hour, the eastbound (EB) direction at the Webster Street and May Street intersection experiences a degradation in LOS from E in 2024 to F in the 2034 No-Build and Build scenarios. The V/C ratio increases from 0.61 to 0.83, with delays rising from 43 to 80 seconds and the 95th percentile queue length growing from 3.6 to 5.9 units.

During the PM peak hour, the EB direction also deteriorates, with the LOS dropping from F to even worse conditions. The V/C ratio escalates from 0.97 in 2024 to 1.29 in 2034 scenarios, and delays increase from 100 to 218 seconds, with the 95th percentile queue length extending from 8.4 to 13.1 units.

All other unsignalized intersections in the study area maintain an acceptable level of service (LOS D or better) across all analysis scenarios.

Table 7
UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Intersection/Peak Hour/Lane Group	2024 Existing				2034 No-Build				2034 Build: Scenario A				2034 Build: Scenario B			
	V/C [a]	Delay [b]	LOS [c]	95Q [d]	V/C	Delay	LOS	95Q	V/C	Delay	LOS	95Q	V/C	Delay	LOS	95Q
Highland Avenue at Hunnewell Street																
Weekday AM:																
EB	>1.50	>200	F	20.4	>1.50	>200	F	>25	>1.50	>200	F	>25	>1.50	>200	F	>25
WB	1.07	188	F	6.9	>1.50	>200	F	>25	>1.50	>200	F	>25	>1.50	>200	F	>25
Weekday PM:																
EB	>1.50	>200	F	20.4	>1.50	>200	F	>25	>1.50	>200	F	>25	>1.50	>200	F	>25
WB	1.07	188	F	6.9	>1.50	>200	F	>25	>1.50	>200	F	>25	>1.50	>200	F	>25
Great Plain Avenue at Garden Street																
Weekday AM:																
SB	0.38	17	C	1.7	0.47	22	C	2.4	0.48	22	C	2.5	0.50	23	C	2.6
Weekday PM:																
SB	0.61	26	D	4	0.76	38	E	6.2	0.77	39	E	6.3	0.78	42	E	6.6
Garden Street at May Street																
Weekday AM:																
NB	0.25	12	B	1	0.29	13	B	1.2	0.29	13	B	1.2	0.29	13	B	1.2
SB	0.10	19	C	0.3	0.12	22	C	0.4	0.12	22	C	0.4	0.12	22	C	0.4
Weekday AM:																
NB	0.29	14	B	1.2	0.34	16	C	1.5	0.34	16	C	1.5	0.34	16	C	1.5
SB	0.11	21	C	0.4	0.14	26	D	0.5	0.14	26	D	0.5	0.14	26	D	0.5

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 95th percentile queue length in vehicles per lane (assuming 25 feet per vehicle)

Table 7 (continued)
UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Intersection/Peak Hour/Lane Group	2024 Existing				2034 No-Build				2034 Build: Scenario A				2034 Build: Scenario B			
	V/C [a]	Delay [b]	LOS [c]	95Q [d]	V/C	Delay	LOS	95Q	V/C	Delay	LOS	95Q	V/C	Delay	LOS	95Q
Rosemary Street at Hillside Avenue																
Weekday AM:																
SB	0.38	20	C	1.7	0.47	24	C	2.4	0.50	26	D	2.7	0.53	28	D	3
Weekday PM:																
SB	0.54	17	C	3.3	0.63	20	C	4.5	0.65	21	C	4.8	0.67	22	C	5
Hillside Avenue at West Street																
Weekday AM:																
NB	0.79	53	F	6.2	1.07	123	F	10.6	1.13	143	F	12.1	1.21	167	F	14
SB	0.74	63	F	4.8	1.03	141	F	8.1	1.08	159	F	8.5	1.15	187	F	9.2
Weekday PM:																
NB	>1.50	>200	F	>25	>1.50	>200	F	>25	>1.50	>200	F	>25	>1.50	>200	F	>25
SB	>1.50	>200	F	>25	>1.50	>200	F	>25	>1.50	>200	F	>25	>1.50	>200	F	>25
Hillside Avenue at Hunnewell Street																
Weekday AM																
NB	0.45	19	C	2.3	0.54	23	C	3.1	0.57	25	C	3.4	0.58	26	D	3.5
SB	0.28	17	C	1.1	0.35	20	C	1.5	0.36	21	C	1.6	0.37	21	C	1.7
Weekday PM:																
NB	0.48	23	C	2.5	0.58	29	D	3.5	0.62	32	D	3.9	0.64	34	D	4.1
SB	0.29	19	C	1.2	0.36	23	C	1.6	0.38	24	C	1.7	0.39	25	D	1.8
Webster Street at May Street																
Weekday AM:																
EB	0.61	43	E	3.6	0.83	80	F	5.9	0.83	80	F	5.9	0.83	80	F	5.9
Weekday PM:																
EB	0.97	100	F	8.4	1.29	218	F	13.1	1.29	218	F	13.1	1.29	218	F	13.1

[a] Volume-to-capacity ratio.
[b] Average control delay in seconds per vehicle.
[c] Level of service.
[d] 95th percentile queue length in vehicles per lane (assuming 25 feet per vehicle)

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FIGURE 7A
WEEKDAY AM LOS

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FIGURE 7B
WEEKDAY PM LOS

Potential Mitigation Measures

The intersection capacity analysis indicates that several intersections in the study area experience a Level of Service (LOS) of F under the No-Build Scenario. Additionally, two more intersections—Highland Ave at West St and Great Plain Ave at Chapel St & Chestnut St—are projected to experience a LOS of F under Scenario B Build Condition. To mitigate the impact of site traffic at these intersections, several potential measures have been identified. These include signal timing optimizations, roadway restriping, adjustments to pedestrian timings, and signalization, as detailed below:

Highland Avenue at Webster Street

- Signal timing optimization
- Addition of a southbound left-turn (SBL) lane, potentially requiring the widening of the Highland Avenue southbound approach. Webster Street has two receiving lanes.

Highland Avenue at West Street *(required under Build Scenario B)*

- Signal timing optimization
- Roadway restriping: removal of parking spaces and restriping as a southbound right-turn (SBR) lane, which may necessitate roadway widening or intersection reconstruction. Alternatively, Avery Square can be utilized as a southbound right turn bypass.

Great Plain Avenue at Chapel Street & Chestnut Street *(required under Build Scenario B)*

- Signal timing optimization
- Removal of exclusive pedestrian phase in favor of concurrent pedestrian crossings. Pedestrians would cross along with through traffic outside of left turning phases.
    - Pedestrian safety will need to be evaluated for this change to be implemented.

Highland Avenue at Hunnewell Street

- Signalization
- Roadway restriping: removal of parking spaces and restriping as a northbound left-turn (NBL) lane, which may necessitate roadway widening or intersection reconstruction.

Additionally, the following intersections were improved through signal timing optimization or signalization, without requiring any changes to intersection geometry:

- Hillside Avenue at West Street *(signalization)*
- Webster Street at May Street *(signalization)*
- Highland Avenue at Chapel Street & May Street *(signal timing optimization)*
- Highland Avenue at Great Plain Avenue & Dedham Avenue *(signal timing optimization)*
- Chestnut Street at School Street *(signal timing optimization)*

Intersections Analysis Results, with Mitigation

An analysis incorporating potential mitigation measures was conducted, yielding preliminary results that may vary with a more in-depth examination. The overall intersection level-of-service (LOS) outcomes are detailed in Table 8 and discussed below. Figures 8A and 8B display the intersection with mitigation LOS in the morning and evening peak hours, respectively.

In the mitigation analysis, the Level of Service (LOS) across the network of intersections shows improvements when comparing the No-Build scenario (unmitigated) to the Build Scenarios A and B (mitigated). In the AM peak hour, many intersections that operate at an unacceptable LOS F in the unmitigated future scenarios experience significant improvements to LOS D or better in the mitigated scenarios. For example, intersections such as Highland Avenue at Hunnewell Street and Hillside Avenue at West Street, which perform poorly with LOS F in the No-Build unmitigated scenario, improve to LOS B or C under the Build mitigated scenarios.

Similarly, during the PM peak hour, the network sees improvements in LOS with the implementation of mitigation. Intersections such as Highland Ave at Webster Street and Great Plain Ave at Chapel / Chestnut Street, which face severe delays and poor LOS in the No-Build unmitigated scenario, improve to more acceptable LOS C or D in the Build mitigated scenarios. Overall, the Build Scenarios A and B with mitigation demonstrate a positive impact on the overall traffic performance, reducing delays and improving the LOS across the network of intersections during peak hours despite the increase in vehicle trips due to the respective development programs.

Conclusion

A capacity analysis was conducted to assess the impacts of the proposed rezoning in the Town of Needham, which aims to support the development of additional housing units in alignment with the MBTA Communities Act. The analysis considered current traffic conditions, projected traffic volumes, and the anticipated effects on the local transportation infrastructure.

The analysis was conducted under three main conditions: existing conditions, future no build condition, and two build scenarios—Scenario A and Scenario B. Both build scenarios reflect the proposed rezoning, with Scenario A representing moderate housing development and Scenario B representing a higher density of housing units.

The analysis demonstrates that, with the implementation of recommended mitigation measures, the traffic system will maintain an acceptable Level of Service (LOS) under both Scenario A and Scenario B. Despite the increased traffic volumes associated with the proposed rezoning, the intersections will continue to operate within acceptable urban LOS thresholds, ensuring efficient traffic flow and supporting the planned development.

Table 8
MITIGATED INTERSECTION CAPACITY ANALYSIS SUMMARY

Intersection/Peak Hour/Lane Group	2034 No-Build Mitigated V/C [a]	Delay [b]	LOS [c]	2034 Build: Scenario A Mitigated V/C	Delay	LOS	2034 Build: Scenario B Mitigated V/C	Delay	LOS
Highland Ave at Webster Street									
Weekday AM:	0.92	44	D	0.95	48	D	1.09	76	E
Weekday PM:	0.81	46	D	0.84	53	D	0.97	78	E
Highland Ave at West Street									
Weekday AM:	0.73	31	C	0.75	33	C	0.88	49	D
Weekday PM:	0.70	27	C	0.72	28	C	0.84	38	D
Highland Ave at Chapel Street / May Street									
Weekday AM	1.00	60	E	1.02	62	E	1.11	87	F
Weekday PM:	0.92	45	D	0.94	47	D	1.09	76	E
Highland Ave at Great Plain / Dedham Ave									
Weekday AM:	0.89	63	E	0.90	65	E	0.91	64	E
Weekday PM:	0.80	57	E	0.80	60	E	0.82	74	E
Chestnut Street at School Street									
Weekday AM:	0.74	40	D	0.75	41	D	0.86	55	D
Weekday PM:	0.71	30	C	0.72	30	C	0.81	34	C
Great Plain Ave at Chapel / Chestnut Street									
Weekday AM:	0.80	27	C	0.81	30	C	0.95	42	D
Weekday PM:	0.80	28	C	0.82	29	C	0.95	35	C
Highland Ave at Hunnewell Street									
Weekday AM:	0.64	20	C	0.68	20	B	0.74	25	C
Weekday PM:	0.72	25	C	0.76	25	C	0.85	34	C
Hillside Ave at West Street									
Weekday AM:	0.60	11	B	0.61	11	B	0.63	12	B
Weekday PM:	1.09	59	E	1.10	61	E	1.11	64	E
Webster Street at May Street									
Weekday AM:	0.80	19	B	0.80	19	B	0.80	19	B
Weekday PM:	0.83	22	C	0.83	22	C	0.83	22	C

[a] Volume-to-capacity ratio. [b] Average control delay in seconds per vehicle.
[c] Level of service.

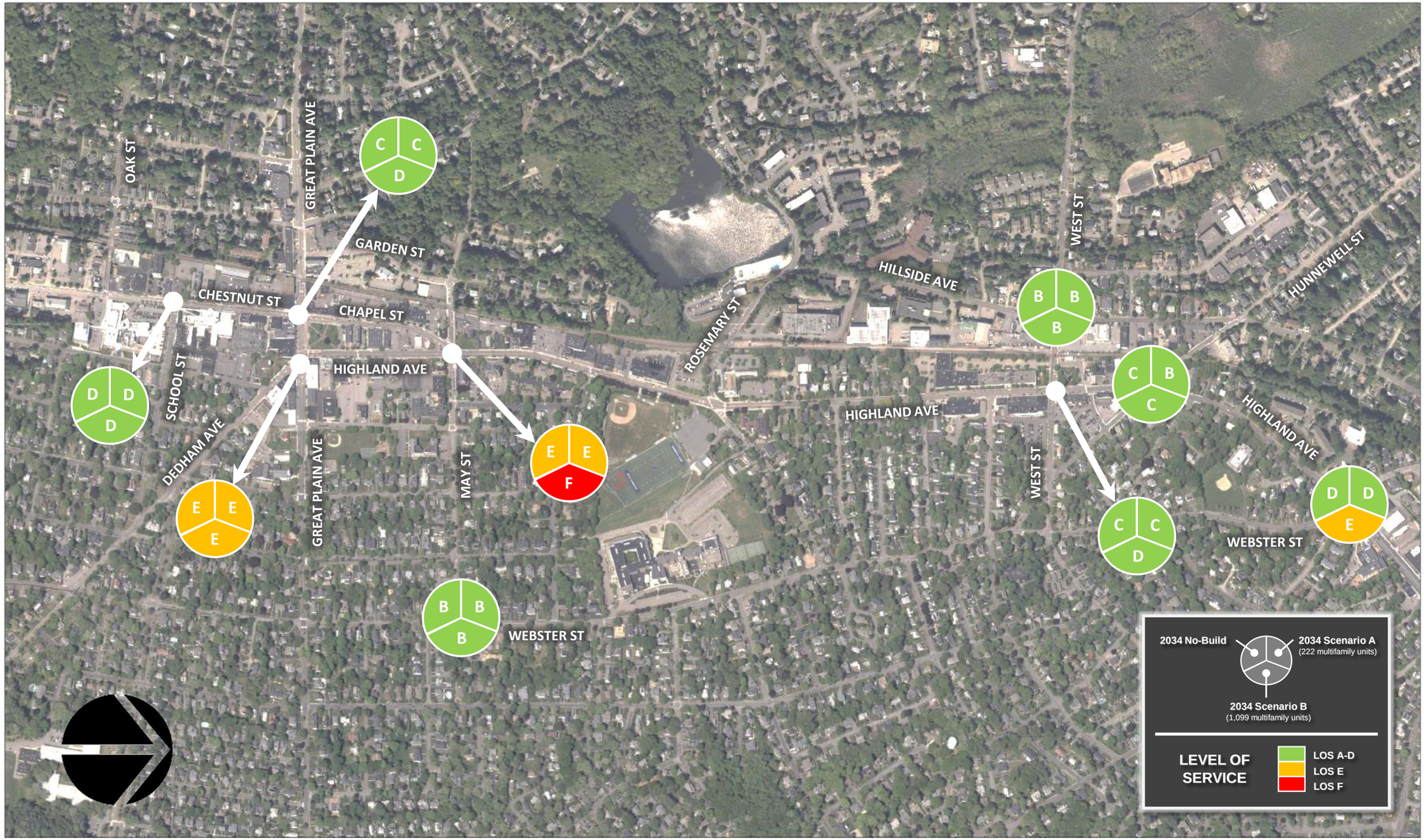

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FIGURE 8A
WEEKDAY AM LOS - MITIGATED

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NEEDHAM, MASSACHUSETTS

FIGURE 8B
WEEKDAY PM LOS - MITIGATED