

TRAFFIC IMPACT REPORT

PROPOSED RESIDENTIAL DEVELOPMENT NASHUA, NEW HAMPSHIRE

Prepared for:

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Nashua, New Hampshire

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EXECUTIVE SUMMARY

Description of Project

Vanasse & Associates, Inc. (VAI) has conducted a Traffic Impact Report (TIR) in order to determine the traffic impacts associated with a proposed residential development to be located off Baldwin Street in the City of Nashua, New Hampshire. The purpose of this TIR is to review existing and future traffic conditions in the vicinity of the site, determine the traffic impact from the proposed project at key intersections expected to experience increased traffic levels from the Project, and review the need for improvements to mitigate the Project's traffic impact.

Proposed Development

The site currently is undeveloped wooded and open area located south of Broad Street parkway and west of Baldwin Street. The proposed project will consist of constructing approximately 181 units in four 4-story apartment buildings. A total of 336 surface parking spaces will be provided. Access to the site will be provided via a new full access driveway intersecting the west side of Baldwin Street with emergency access provided via a connection to Warsaw Avenue.

Existing Conditions

A comprehensive field inventory was conducted to collect existing roadway geometrics, traffic volumes, operating characteristics, speed limits, and sight distances, as well as land use information. Traffic volumes were collected during September 2018 at the intersections expected to receive the major impact from the Project:

- Baldwin Street at Amherst Street (Route 101A)
- Baldwin Street at Prescott Street
- Baldwin Street at Fairmount Street and North Intervale Street

Future Conditions

Traffic volumes within the study area were projected to 2028 Future Year conditions, to reflect a ten-year planning horizon consistent with State traffic study guidelines. These conditions incorporate traffic growth due to general background traffic increases, as well as incorporation of development projects currently under construction but expected to generate traffic in the future.

Project-Generated Traffic

The Project is expected to generate approximately 984 vehicle trips on an average weekday (two-way, 24-hour volume), with approximately 61 vehicle trips (16 vehicle entering and 45 exiting) expected during the weekday morning peak-hour. During the weekday evening peak hour the Project is expected to generate approximately 78 vehicle trips (48 vehicles entering and 30 exiting).

The projected vehicle trips were distributed onto area roadways based on existing travel patterns and U.S. Census Journey to Work data. Traffic-volume increases due to the Project were shown to be between 1.2 and 3.0 percent during the peak hours of the facility, and are expected to be less during other hours of the day.

Traffic Operations Analysis

In future conditions, operations are generally preserved with minor but manageable increases to delay on the various approaches. The Project presents negligible impacts to intersection LOS, and Project-related traffic increases are expected to be no greater than 1.2 to 3.0 percent during the peak hours at any of the locations studied. The Project did not result in the degradation of LOS below LOS D for any locations studied; therefore mitigation is not required.

Recommendations and Conclusions

The site driveway should be placed under STOP-sign control where it intersects Baldwin Street, with a painted STOP-bar on the driveway at the STOP-sign location. Any landscaping or building features should not exceed 24 inches in height or should be placed out of the lines of sight for motorists exiting the site and those approaching the driveway on Baldwin Street.

The roadways and intersections in the vicinity of the Project can accommodate the projected traffic increases without significant impact to motorist delays. Based on the above, VAI has concluded that the Project can be safely accommodated with minimal impact on the area road network.

INTRODUCTION

Vanasse & Associates, Inc. (VAI) has conducted a Traffic Impact Report (TIR) in order to determine the traffic impacts associated with a proposed residential development to be located off Baldwin Street in the City of Nashua, New Hampshire. This study reviews site access requirements, safety considerations, and identifies and analyzes existing traffic conditions and future traffic conditions with and without the proposed project.

STUDY METHODOLOGY

This study was performed in consultation with the City of Nashua and the New Hampshire Department of Transportation (NHDOT); was performed in accordance with the City of Nashua guidelines for the preparation of Traffic Impact Reports and Traffic Management Plans (TIRs); and was conducted in three distinct stages. The first stage involved an assessment of existing conditions in the study area and included an inventory of roadway geometrics, observations of traffic flow, and collection of daily and peak-period traffic counts.

In the second stage of the study, future traffic conditions were projected and analyzed. Specific travel demand forecasts for the project were assessed along with future traffic demands due to expected traffic growth independent of the project. Two future conditions were analyzed: a 2028 No-Build condition (ten-year projection) without the proposed development; and a 2028 Build condition with the proposed development. The traffic analysis conducted in stage two identifies existing or projected future roadway capacity and traffic safety issues.

The third stage of the study presents and evaluates measures to address traffic and safety issues, if any, identified in stage two of the study.

EXISTING CONDITIONS

A comprehensive field inventory of traffic conditions on the study area roadways was conducted in September 2018. The field investigation consisted of an inventory of existing roadway geometrics, traffic volumes, and operating characteristics, as well as posted speed limits and land use information within the study area. The study area for the project was confirmed with the Nashua Senior Traffic Engineer, and contains the major roadways which provide access to the project, as well as the intersections which are expected to accommodate the majority of project-related traffic. The study area is listed below and graphically depicted in Figure 1.

- Baldwin Street at Amherst Street (Route 101A)
- Baldwin Street at Prescott Street
- Baldwin Street at Fairmount Street and North Intervale Street

The following describes the study area roadways and intersections which are also shown in Figure 2 which summarizes existing lane use, travel lane widths, and sidewalk and crosswalks locations at the study area intersections.

GEOMETRY

Roadways

Amherst Street (Route 101A)

Amherst Street in the vicinity of the site is a three-lane principal arterial roadway under the City of Nashua jurisdiction that traverses the study area in a general east-west alignment and provides access to Route 3 to the west of the project site. Within the study area, Amherst Street generally provides two general purpose travel lanes westbound and one general purpose travel lane eastbound. Direction of travel on Amherst Street is separated by a double-yellow centerline. In the vicinity of the site, the posted speed limit along Amherst Street is 30 miles per hour (mph). The Amherst Street Elementary School is located on the north side of Amherst Street across from Baldwin Street. Speed limit signs that implement a temporary speed limit of 20 miles per hour when lights are flashing (flashing occurs when students are being dropped off or picked up from school) are located on Amherst Street approximately 800 feet east of Baldwin Street and 650 feet west of Baldwin Street. Illumination is provided by street lights mounted on wooden utility poles. Land use along Amherst Street, in the vicinity of the project site consists of the Amherst Street Elementary School, residential homes, and a cemetery.

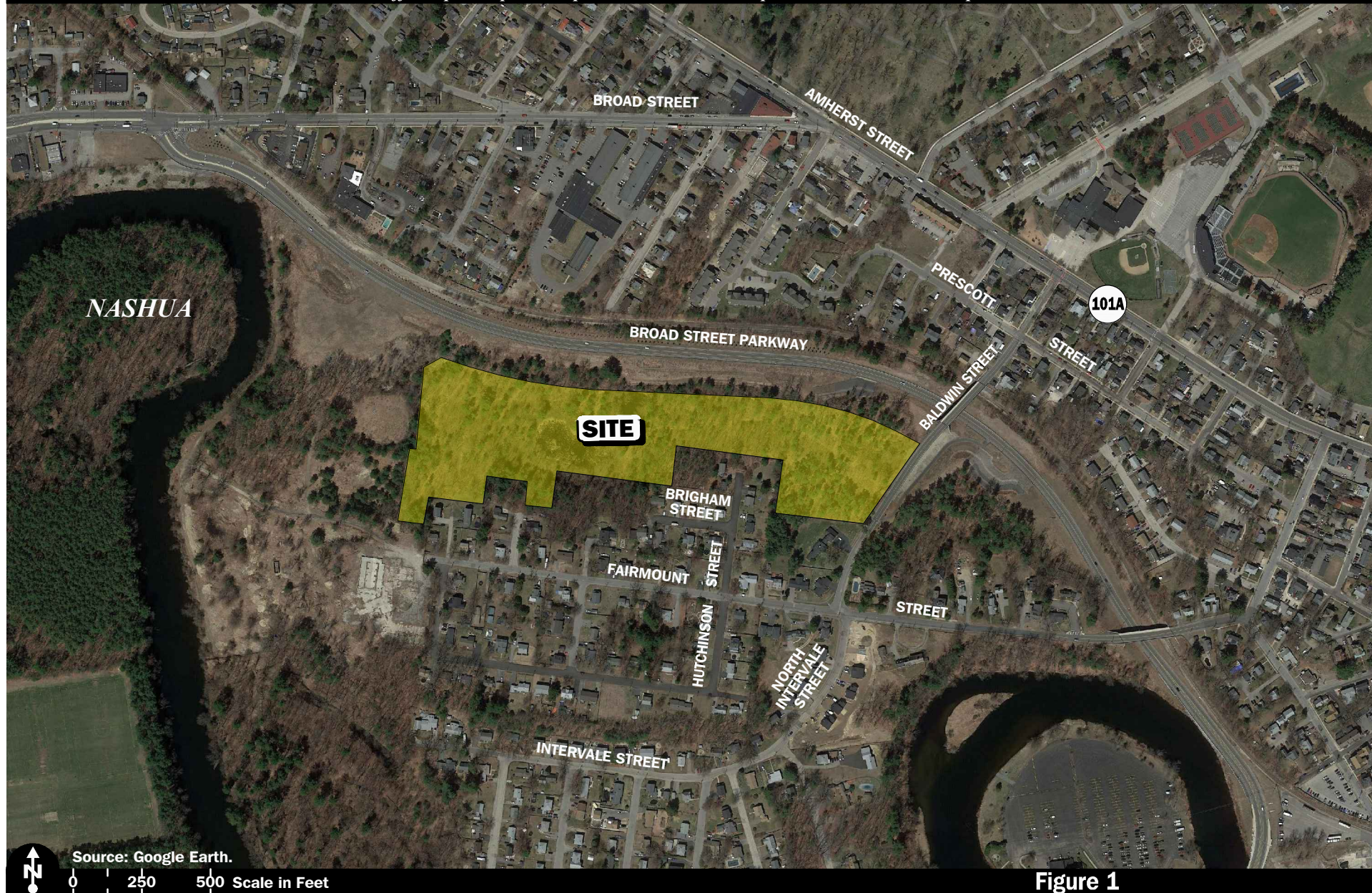


Figure 1

Site Location Map

Legend:

- Ⓢ Signalized Intersection
- Ⓤ Unsignalized Intersection
- Ⓑ Bus Stop Location
- Sidewalk
- Crosswalk
- xx' → Lane Use and Travel Lane Width

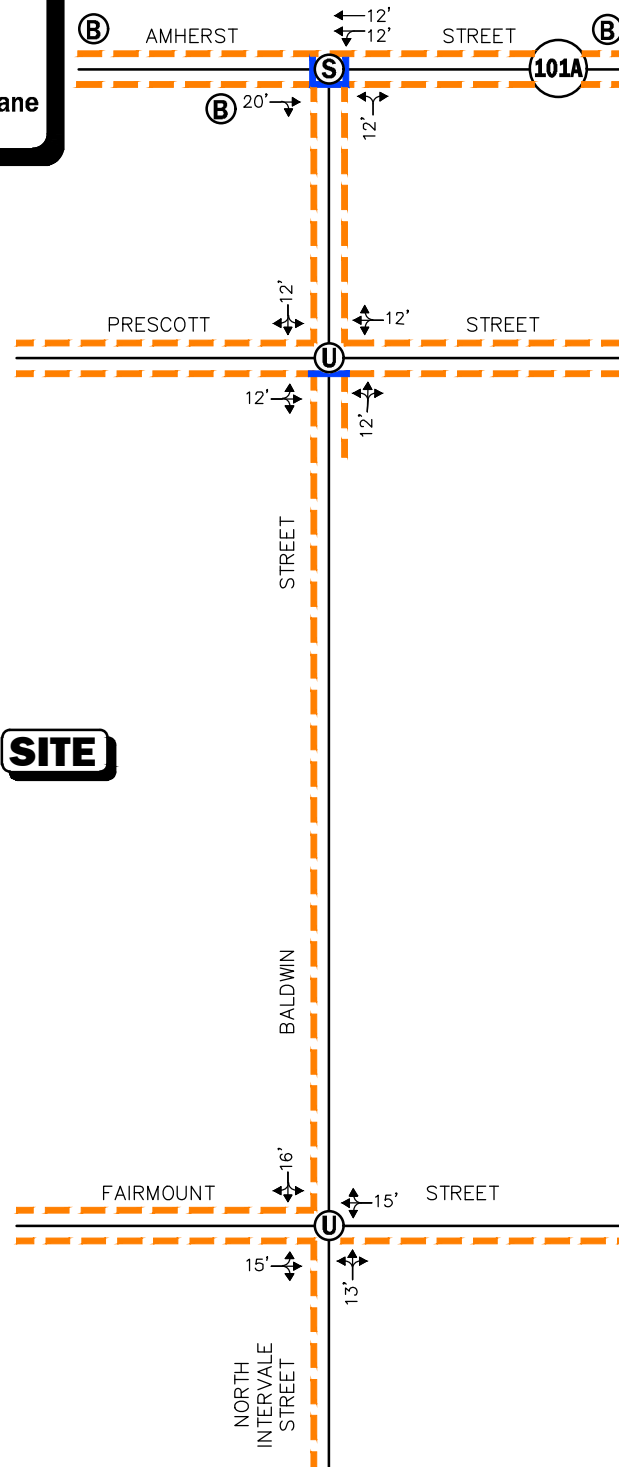


Figure 2

Baldwin Street

Baldwin Street is a two-lane local roadway under the City of Nashua jurisdiction that traverses the study area in a general north-south direction and provides access to Amherst Street to the north. Within the study area, Baldwin Street generally provides two travel lanes separated by a double-yellow centerline. The posted speed limit along Baldwin Street is 25 miles per hour (mph). Illumination is provided via lights mounted on wooded utility poles. Land use along Baldwin Street consists of residential homes wooded areas.

Intersections

Amherst Street (Route 101A) at Baldwin Street

Baldwin Street intersects Amherst Street from the south to form this three-way signalized intersection. Direction of travel on Amherst Street is separated by a double yellow centerline. Direction of travel of Baldwin Street is separated by a double yellow centerline. Lighting is provided by way of lights mounted on wooden utility poles. Land uses at this intersection consists of the Amherst Street Elementary School and residential homes.

Prescott Street at Baldwin Street

Prescott Street intersects Baldwin Street from the east and the west to form this four-way intersection under 4-way STOP sign control. Direction of travel of Baldwin Street is separated by a double yellow centerline. Lighting is provided by way of lights mounted on wooden utility poles. Land uses at this intersection consists of residential homes.

Fairmount Street at Baldwin Street and North Intervale Street

Baldwin Street intersects Fairmount Street from the north and North Intervale Street intersects Fairmount Street from the south to form this offset three-way intersection under 3-way Stop sign control. North Intervale Street has the right-of-way at the intersection. Lighting is provided by way of lights mounted on wooden utility poles. Land uses at this intersection consists of residential homes.

EXISTING TRAFFIC VOLUMES

In order to determine existing traffic-volume demands and flow patterns within the study area, manual turning movement counts (TMCs), and vehicle classification counts were completed in September 2018 while public schools were in session. As directed by the Nashua Traffic Engineer, counts of the weekday morning (7:00 to 9:00 AM) and weekday evening (4:00 to 6:00 PM) peak periods were performed at the study area intersections.

Seasonal Adjustments

In order to evaluate the potential for seasonal fluctuation of traffic volumes within the study area, peak hour traffic count data by the NH permanent count station No. 62315281 on the Frederick E. Everett Turnpike northbound at milepost 5.6 were reviewed. It was determined that June was the peak-month and that September volumes were approximately 4 percent lower than the peak month conditions. Therefore, the September counts were adjusted upwards by 4 percent to peak

month conditions. The 2018 Existing weekday morning and weekday evening peak-month peak-hour traffic volumes are depicted on Figure 3 and summarized in Table 1.

As can be seen in Table 1, Amherst Street was found to accommodate approximately 21,900 vehicles per day (vpd) on an average weekday with 1,506 vehicles per hour (vph) during the weekday morning peak hour and 1,752 vph during the weekday evening peak hour. Baldwin Street was found to accommodate approximately 1,880 vehicles per day (vpd) on an average weekday with 111 vehicles per hour (vph) during the weekday morning peak hour and 206 vph during the weekday evening peak hour.

Table 1
2018 EXISTING PEAK-MONTH TRAFFIC VOLUMES

Location	Daily ^a	Weekday Morning Peak Hour			Weekday Evening Peak Hour		
		VPH ^b	K Factor ^c	Directional Distribution ^d	VPH	K Factor	Directional Distribution
Amherst Street, west of Baldwin Street	21,900	1,506	6.9	52% WB	1,752	8.0 ^e	58% WB
Baldwin Street, at proposed Site Drive	1,880	111	5.9	72% NB	206	11.0 ^f	51% NB

^aAverage daily traffic in vehicles per day.

^bVehicles per hour.

^cPercent of daily traffic in the peak hour noted.

^dPercent traveling in the peak direction.

^eFrom New Hampshire count station 82315120 located on Amherst Street west of Main Street.

^fFrom New Hampshire count station 82315185 located on Baldwin Street over B&M railroad.

EB = eastbound; WB = westbound; NB = northbound; SB = southbound.

PEDESTRIAN AND BICYCLE FACILITIES

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in September 2018. The field inventory consisted of a review of the location of sidewalks and pedestrian crossing locations along the study roadways and at the study intersections, as well as the location of bicycle facilities. Sidewalks are provided along both sides of Amherst Street and Prescott Street, along the entire west side of Baldwin Street, along the east side of Baldwin Street from Amherst Street to approximately 100 feet south of Prescott Street, along both sides of Fairmount Street west of Baldwin Street, along the south side of Fairmount Street east of Baldwin Street, and along the west side of North Intervale Street. Crosswalks are provided across all approaches to the intersection of Amherst Street and Baldwin Street and across the northbound approach to the intersection of Baldwin Street at Prescott Street. A mid-block pedestrian crosswalk is also provided on Baldwin Street in the vicinity of the proposed site driveway. No exclusive bicycle accommodations are present within the study area.

WEEKDAY MORNING PEAK HOUR

WEEKDAY EVENING PEAK HOUR

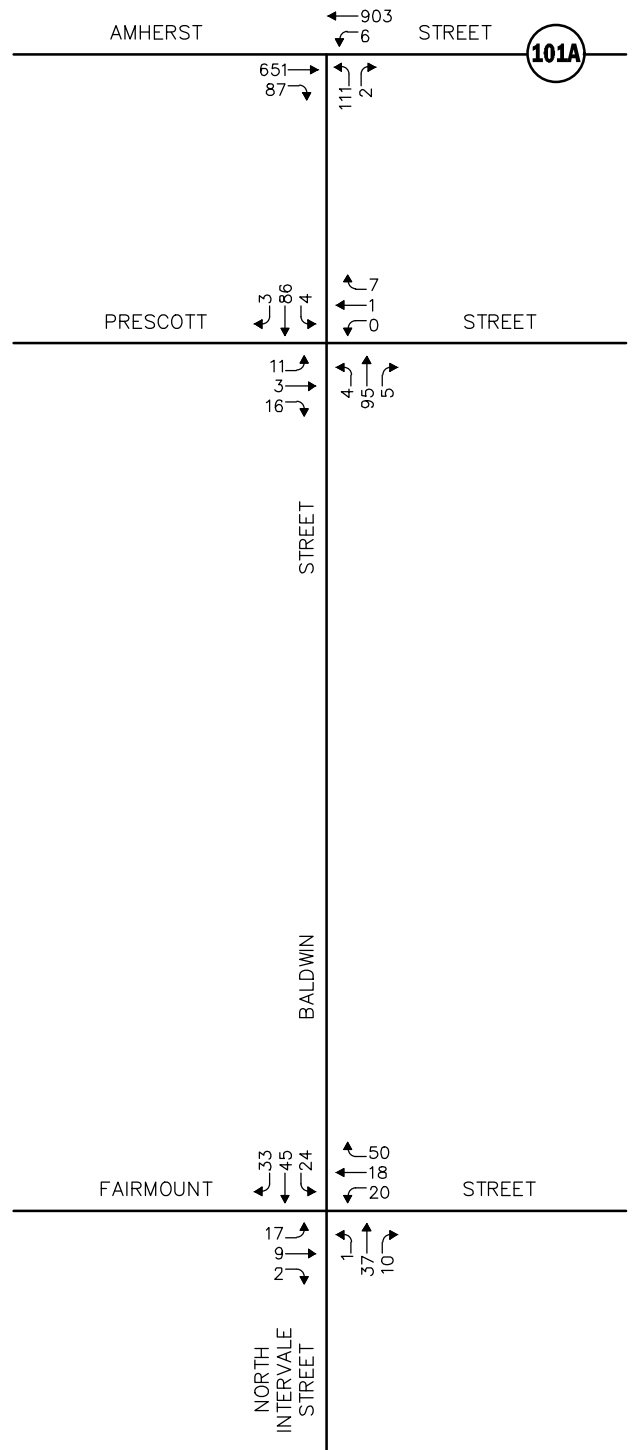
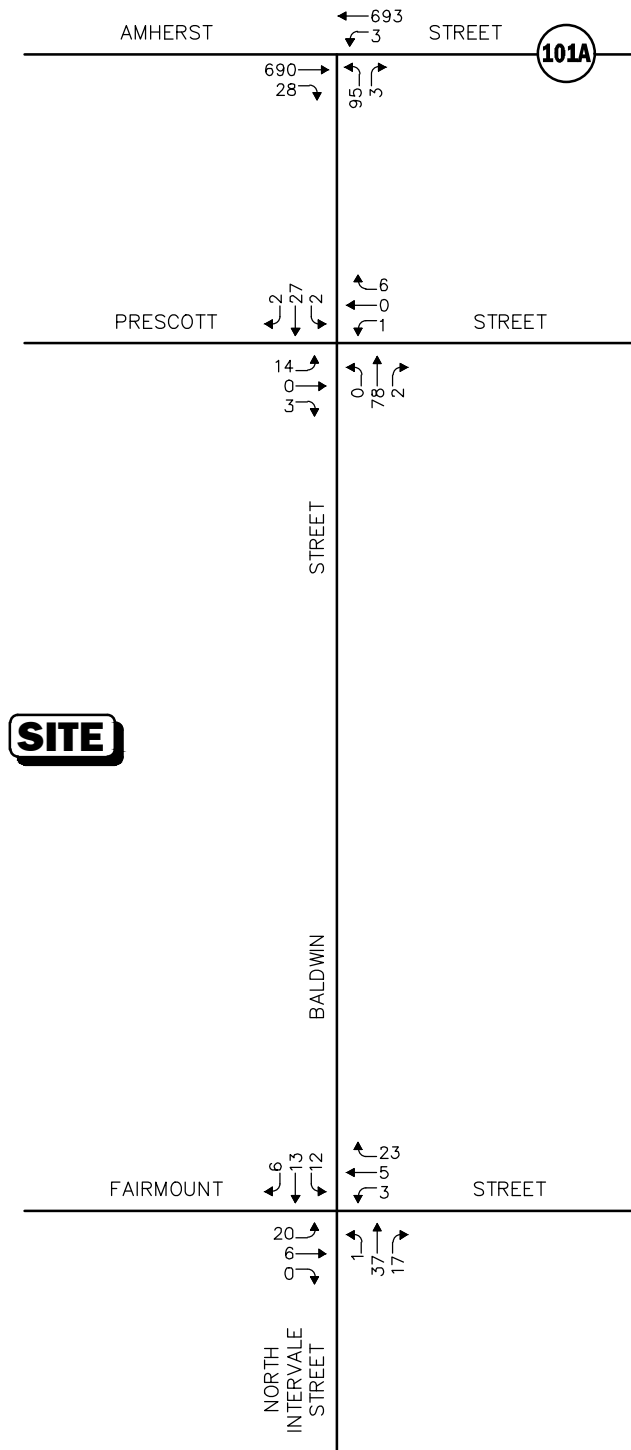


Figure 3

2018 Existing
Peak Hour Traffic Volumes

PUBLIC TRANSPORTATION

Public transportation services are provided within the study area by the Nashua Transit System (NTS) for fixed-route bus services. Bus Route 2 – Amherst Street/Concord Street stops at the intersection of Amherst Street and Baldwin Street, located approximately 1000 feet north of the Project site. Route 2 operates on a 60 minute frequency during the weekdays beginning at 6:15 AM and continuing until 6:35 PM. On Saturdays Route 2 operates on a 60 minute frequency starting at 9:15 AM and continuing until 5:35 PM. No Sunday service is provided.

Bus Route 2A – Amherst Street/Concord Street stops at the intersection of Amherst Street and Baldwin Street, located approximately 1000 feet north of the Project site. Route 2A operates on a 60 minute frequency during the weekdays beginning at 6:15 AM and continuing until 6:05 PM. No weekend service is provided.

Bus Route 9 – Broad Street/Nashua North stops on Broad Street Parkway just east of the Baldwin Street Bridge which is approximately 500 feet north of the Project site. Route 9 operates on a 60 minute frequency during the weekdays beginning at 6:15 AM and continuing until 6:05 PM. On Saturdays Route 9 operates on a 60 minute frequency starting at 9:15 AM and continuing until 5:05 PM. No Sunday service is provided.

Bus Route Central – French Hill/Broad Street stops at the intersection of Amherst Street and Sargent Avenue, located approximately 1400 feet north of the Project site. Route Central operates on a 60 minute frequency during the weekdays beginning at 6:45 PM and continuing until 10:35 PM. On Saturdays Route Central operates on a 60 minute frequency starting at 5:45 PM and continuing until 10:35 PM. No Sunday service is provided.

Bus Route North End – North End/Amherst Street stops at the intersection of Amherst Street and Baldwin Street, located approximately 1000 feet north of the Project site. Route North End operates on a 60 minute frequency during the weekdays beginning at 6:45 PM and continuing until 10:35 PM. On Saturdays Route North End operates on a 60 minute frequency starting at 5:45 PM and continuing until 10:35 PM. No Sunday service is provided.

Schedules and fare information for the fixed-route bus services are provided in the Appendix.

MOTOR VEHICLE CRASH DATA

Motor vehicle crash information for the study area intersections was obtained from the City of Nashua Police Department for the most recent three year period available (2015 through 2017) in order to examine motor vehicle crash trends occurring within the study area. The data is summarized by intersection, type, severity, weather and lighting conditions, and day of occurrence, and presented in Table 2.

A total of 9 motor vehicle collisions were recorded at the intersection of Amherst Street at Baldwin Street, for an average of 3 motor vehicle collisions per year over the three-year review period. The majority of these crashes resulted in property damage only (5 out of 9), occurred on a weekday (8 out of 9), during the daylight (6 out of 9), under clear weather conditions (8 out of 9), and were reported as rear-end collisions (5 out of 9). A total of 2 motor vehicle collisions were recorded at the intersection of Baldwin Street at Prescott Street, for an average of 0.67 motor vehicle collisions per year over the three-year review period. The majority of these crashes resulted in property damage only (2 out of 2), on a dark lighted roadway (2 out of 2), and were

reported as fixed-object collisions (2 out of 2). One of the crashes occurred on a Saturday and the other on a Sunday. One crash occurred in clear weather conditions while the other occurred in the rain. The intersection of Fairmount Street at Baldwin Street and North Intervale Street experienced no crashes over the three-year review period. No fatalities were reported at the study area interactions over the three-year review period.

Table 2
MOTOR VEHICLE CRASH DATA SUMMARY^a

	Amherst Street at Baldwin Street	Baldwin Street at Prescott Street	Fairmount Street at Baldwin Street and North Intervale Street
Traffic Control Type: ^b	TS	U	U
<i>Year:</i>			
2015	4	1	0
2016	2	0	0
<u>2017</u>	<u>3</u>	<u>1</u>	<u>0</u>
Total	9	2	0
Average	3.00	0.67	0.00
<i>Type:</i>			
Angle	3	0	0
Rear-End	5	0	0
Sideswipe	0	0	0
Head-On	0	0	0
Fixed Object	0	2	0
Pedestrian	1	0	0
<u>Unknown/Other</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	9	2	0
<i>Severity:</i>			
Property Damage Only	5	2	0
Personal Injury	4	0	0
Fatal	0	0	0
<u>Other/Unknown</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	9	2	0
<i>Weather Conditions:</i>			
Clear	8	1	0
Cloudy	0	0	0
Rain	0	1	0
Sleet	1	0	0
Snow/Ice	0	0	0
<u>Unknown</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	9	2	0
<i>Lighting</i>			
Daylight	6	0	0
Dawn/Dusk	1	0	0
Dark (Road Lit)	2	2	0
Dark (Road Unlit)	0	0	0
<u>Other/Unknown</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	9	2	0
<i>Day of Week:</i>			
Monday through Friday	8	0	0
Saturday	1	1	0
<u>Sunday</u>	<u>0</u>	<u>1</u>	<u>0</u>
Total	9	2	0

^aSource: City of Nashua Police Department

^bTraffic Control Type: U = unsignalized; TS = traffic signal.

SIGHT DISTANCE EVALUATION

Sight distances were reviewed at the locations of the two driveways onto Dean Avenue in accordance with NHDOT and American Association of State Highway and Transportation Officials (AASHTO)¹ standards.

Stopping sight distance (SSD) is the minimum distance required for an approaching driver at a height of 3.5 feet to perceive and react accordingly to a stationary object 2 feet tall in its path. The values are based on a perception and reaction time of 2.5 seconds and braking distance required under wet, level pavements. Intersection sight distance (ISD) is based on the time required to perceive, react, and complete desired exiting maneuver from a driveway once the driver decides to execute the maneuver. Values for exiting sight distance represent the time to (1) turn left or right, in addition to accelerating to the operating speed of the roadway, without causing approaching vehicles to reduce speed by more than 10 mph, and (2) upon turning left, to clear the near half of the intersection without conflicting with the vehicles approaching from the left. When the roadway is either on an upgrade or downgrade, grade correction factors are applied. Table 3 presents the results of the analysis with values from the AASHTO design reference for 85th percentile and posted speeds, along with values measured in the field.

Table 3
SUMMARY OF SIGHT DISTANCE ANALYSIS
BALDWIN STREET AT PROPOSED SITE DRIVEWAY

Sight Distance	Design Speed Criteria ^a (Feet)	Measured Distance (Feet)
<i>Baldwin Street at Site Drive</i>		
<i>Stopping Sight Distance</i>		
Looking north to the driveway	152	+500
Looking south to the driveway	152	334 ^b
<i>Intersection Sight Distance</i>		
Looking north from the driveway	276	+500
Looking south from the driveway	276	334 ^b

^aBased on posted speed limit of 25 mph.

^bMeasured to Fairmount Street.

As summarized in Table 3, SSD and ISD are satisfied for the posted speed limit at the proposed Site driveway.

¹A Policy on Geometric Design of Highway and Streets, 6th Edition; American Association of State Highway and Transportation Officials (AASHTO); 2011.

FUTURE CONDITIONS

Traffic volumes in the study area were projected to the year 2028, which reflect a ten-year planning horizon and was requested by the Nashua City Traffic Engineer. Independent of the proposed project, traffic volumes on the roadway network in the year 2028 under No-Build conditions, include all existing traffic and new traffic resulting from background traffic growth. Anticipated project-generated traffic volumes superimposed upon the 2028 No-Build traffic networks reflect 2028 Build conditions with the project.

BACKGROUND TRAFFIC GROWTH

Traffic growth is a function of the expected land development in the immediate area and the surrounding region. Several methods can be used to estimate this growth. A procedure frequently employed estimates an annual percentage increase in traffic growth and applies that percentage to all traffic volumes under study. However, the drawback to such a procedure is that some turning volumes may actually grow at either a higher or lower rate at particular intersections.

An alternative procedure identifies the location and type of planned development, estimates the traffic to be generated, and assigns it to the area roadway network. This procedure produces a more realistic estimate of growth for local traffic. However, the drawback of this procedure is that potential growth in population and development external to the study area would not be accounted for in the traffic projections.

To provide a conservative analysis framework, both procedures were used.

Specific Development by Others

The City of Nashua was contacted in order to determine if there are any planned or approved specific development projects within the area that would have an impact on future traffic volumes at the study intersections. Based on these discussions the following projects were identified:

34 Franklin Street – This development entails the redevelopment of the existing mill building at 34 Franklin Street into 200 apartment units. Parking will be provided for 214 vehicles. Traffic

volumes for this development were taken from the Traffic Impact Report² (TIR) dated November 2015 and added to the future condition networks.

30 Fairmount Street – This development entails the construction of 9 single family residences to be located on the southeast corner of the intersection of Fairmount Street at Baldwin Street and North Intervale Street. Seven of the homes will have access onto North Intervale Street while the other two will have access onto Fairmount Street. Traffic volumes for this development were estimated using ITE LUC 210 – Single-Family Detached Housing and added to the future condition networks.

Prescott Square – This development entails the construction of 41 condominium dwelling units to be located at the south end of Bennett Street. Eleven of the condominiums will be single-story while the other 31 will be two-story units. Traffic volumes for this development were taken from the Traffic Impact Assessment³ (TIA) dated May 2006 and added to the future condition networks.

General Background Traffic Growth

Traffic-volume data compiled by NHDOT from permanent count stations in the area were reviewed in order to determine general background traffic growth trends. Based on a review of this data, it was determined that the traffic volumes in the area are decreasing. However, to provide a conservative analysis and as required by the City Traffic Engineer, a 1.0 percent per year compounded annual background traffic growth rate was used to account for future traffic growth and presently unforeseen development within the study area.

Roadway Improvement Projects

The City of Nashua was contacted in order to determine if there are any planned roadway improvement projects expected to be completed within the study area over the ten-year study duration. Based on these discussions no roadway improvements are planned beyond basic maintenance.

NO-BUILD TRAFFIC VOLUMES

The 2028 No-Build peak-month peak-hour traffic-volume networks were developed by applying the 1.0 percent per year compounded annual background traffic growth rate to the 2018 Existing peak-month peak-hour traffic volumes and adding the traffic volumes from the specific development projects identified above. The resulting 2028 No-Build weekday morning and evening peak-month peak-hour traffic-volume networks are shown on Figure 4.

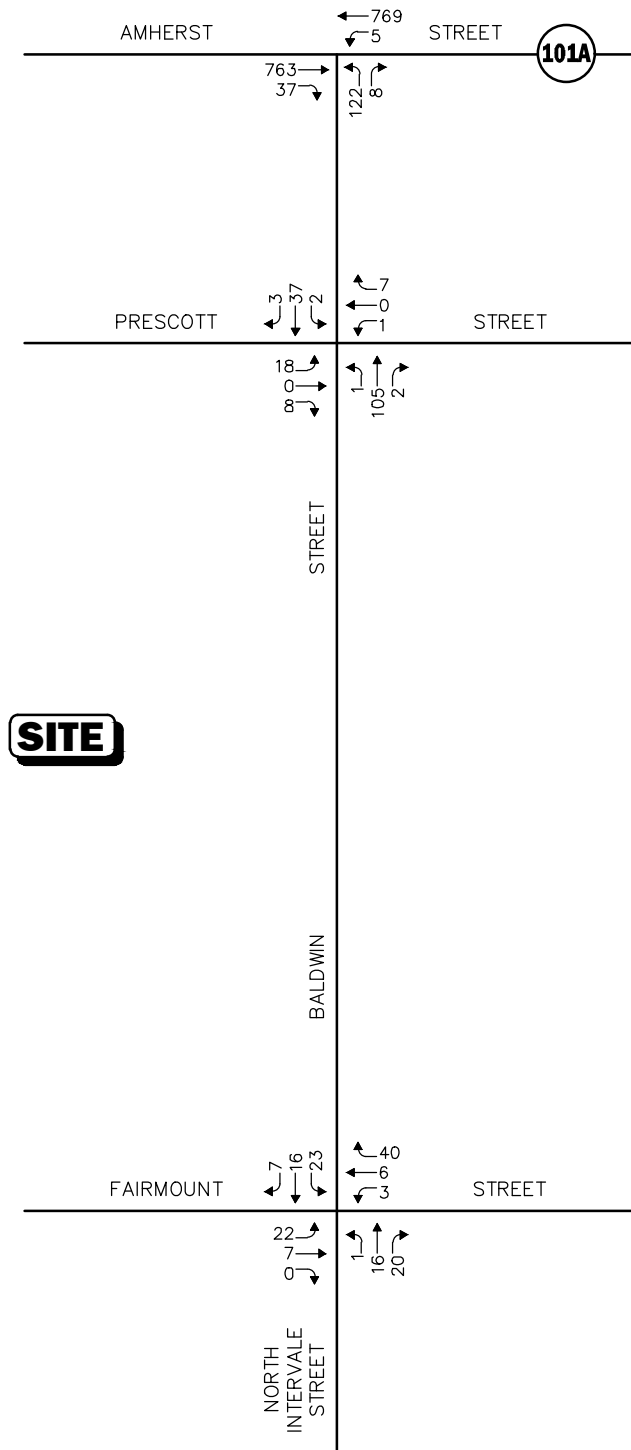
PROJECT-GENERATED TRAFFIC

The proposed project entails the construction of four 4-story buildings containing a total of 181 apartment units. In order to develop the traffic characteristics of the proposed project,

² *Traffic Impact Report: Mill Redevelopment – 34 Franklin Street – Nashua, NH*; TEC; November 5, 2015.

³ *Traffic Impact Assessment: Proposed Bennett Street Housing Nashua, New Hampshire*; Stephen G. Pernaw & Company Inc.; May 2006.

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR

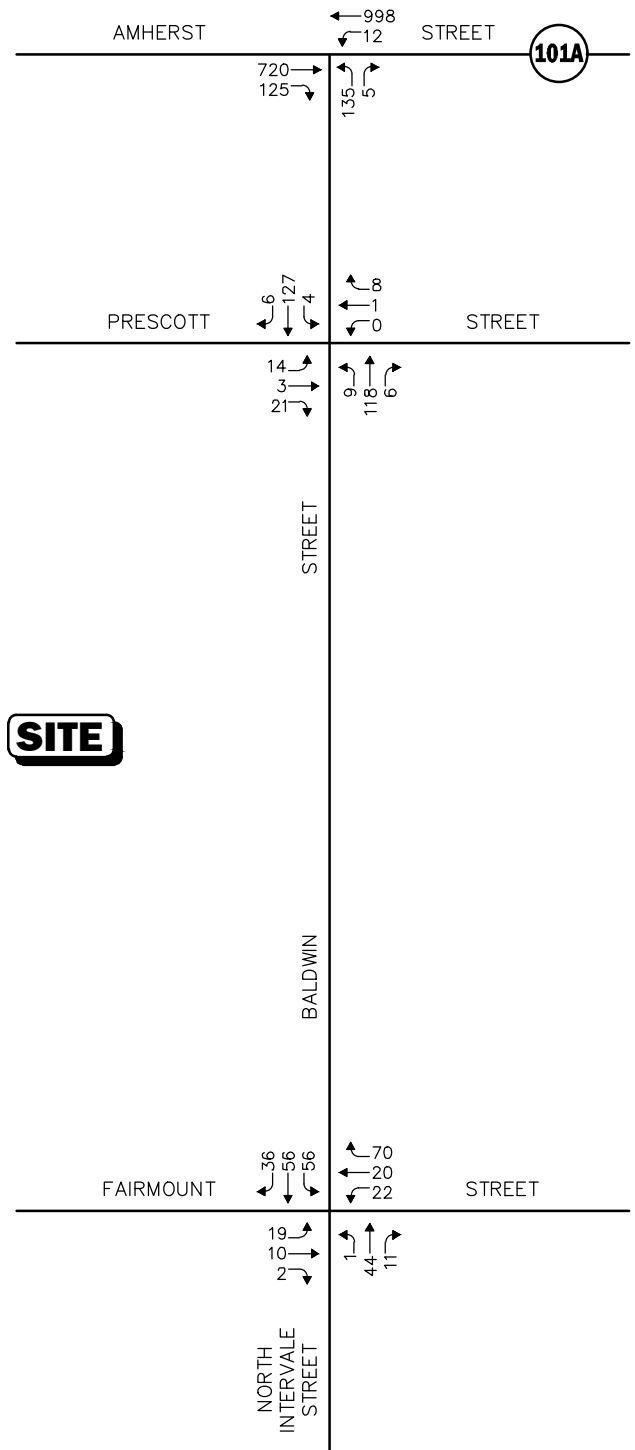


Figure 4

2028 No-Build
Peak Hour Traffic Volumes

trip-generation statistics published by the Institute of Transportation Engineers (ITE⁴) for land uses consistent with those proposed were used. ITE Land Use Code (LUC) 221, Multifamily Housing (Mid-Rise) were used to develop the traffic generation of the proposed development. Table 4 depicts the detailed trip generation estimates for the site.

As can be seen in Table 4, the project is expected to generate approximately 984 vehicle trips (490 entering and 490 exiting) during an average weekday. During the weekday morning peak hour the project is expected to generate approximately 61 vehicle trips (16 entering and 45 exiting) and during the weekday evening peak hour 78 vehicle trips (48 entering and 30 exiting).

Table 4
TRIP GENERATION SUMMARY

Time Period/Direction	Project Vehicle Trips
Weekday Daily	984
<i>Weekday Morning Peak Hour:</i>	
Entering	16
<u>Exiting</u>	<u>45</u>
Total	61
<i>Weekday Evening Peak Hour:</i>	
Entering	48
<u>Exiting</u>	<u>30</u>
Total	78

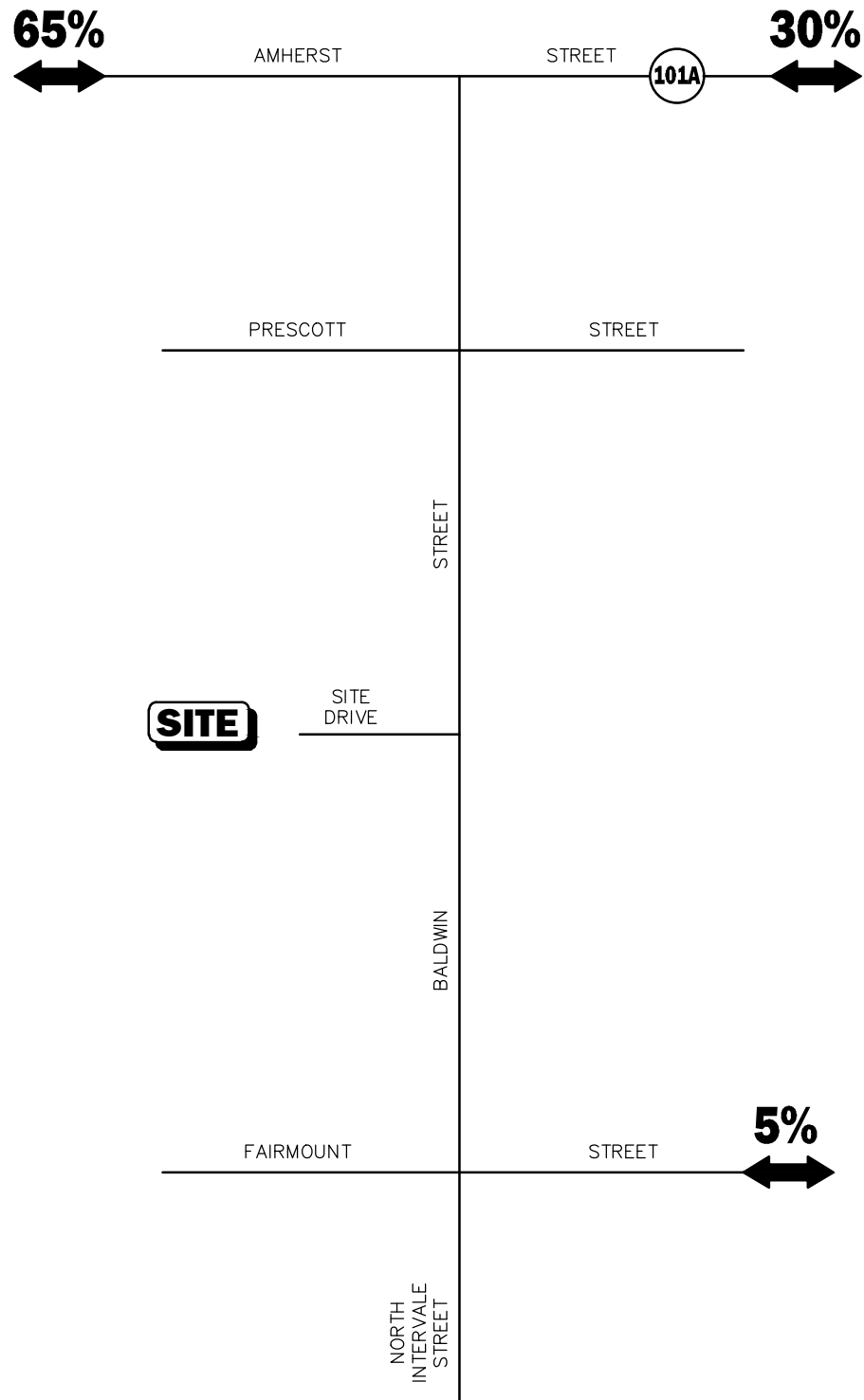
^aBased on ITE LUC 221, Multifamily Housing (Mid-Rise), 181 units.

Trip Distribution and Assignment

The directional distribution of the site-generated trips to and from the proposed development was determined based on a review of existing travel patterns at the study area intersections and Journey to work data for Nashua obtained from the United States Census Bureau⁵. The trip distribution for the project is summarized in Table 5 and graphically depicted on Figure 5. The weekday morning and weekday evening peak-hour traffic volumes expected to be generated by the project were assigned on the study area roadway network as shown on Figure 6.

⁴*Trip Generation, 10th Edition*; Institute of Transportation Engineers; Washington, D.C.; 2017.

⁵ 2009-2013 5-Year American Community Survey; U.S. Census Bureau; 2016.



Not To Scale



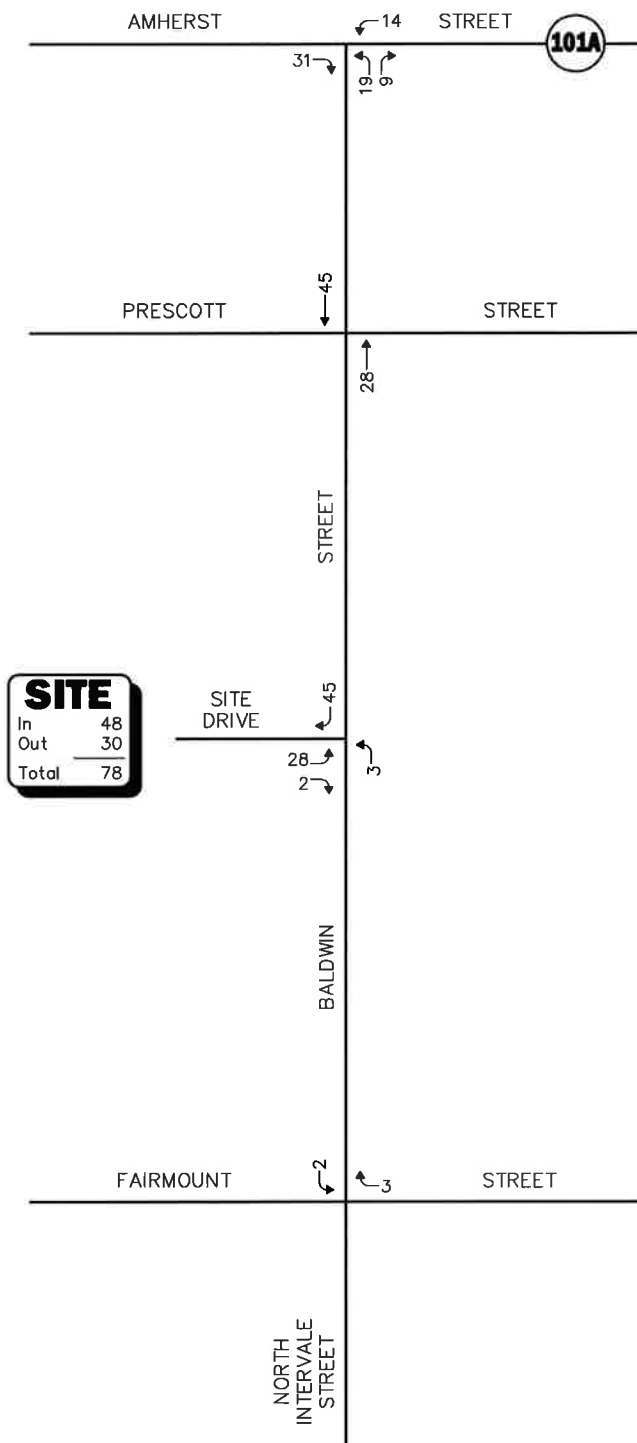
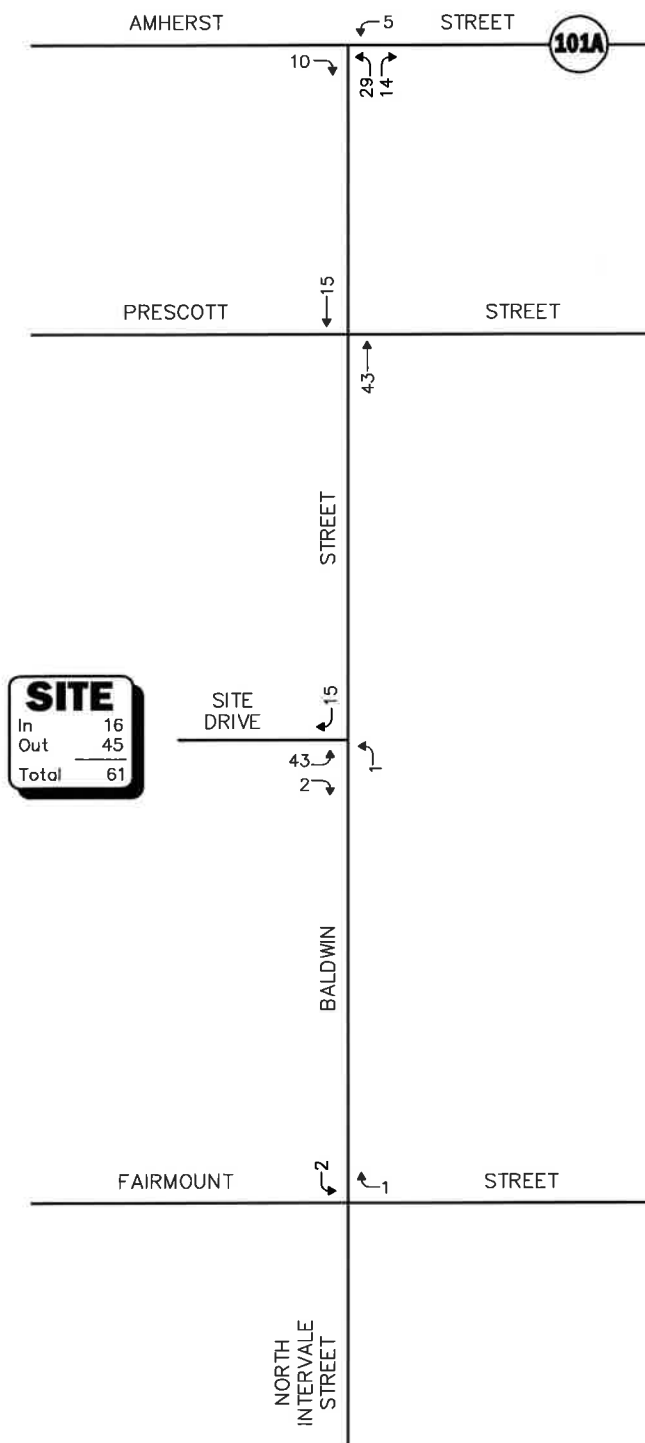
Vanasse & Associates, Inc.
Transportation Engineers & Planners

Figure 5

Trip Distribution Map

WEEKDAY MORNING PEAK HOUR

WEEKDAY EVENING PEAK HOUR



Not To Scale



Figure 6

Site Generated
Peak Hour Traffic Volumes

Table 5
TRIP-DISTRIBUTION SUMMARY

Roadway	To/From Site (Direction)	To/From Site (Percent)
Amherst Street	East	30
Amherst Street	West	65
Fairmount Street	East	<u>5</u>
TOTAL		100

FUTURE TRAFFIC VOLUMES - BUILD CONDITION

The 2028 Build condition networks were developed by superimposing the traffic expected to be generated by the proposed project onto the 2028 No-Build peak-month peak-hour traffic-volume networks. The 2028 Build peak-month peak-hour traffic-volume networks are graphically depicted on Figure 7.

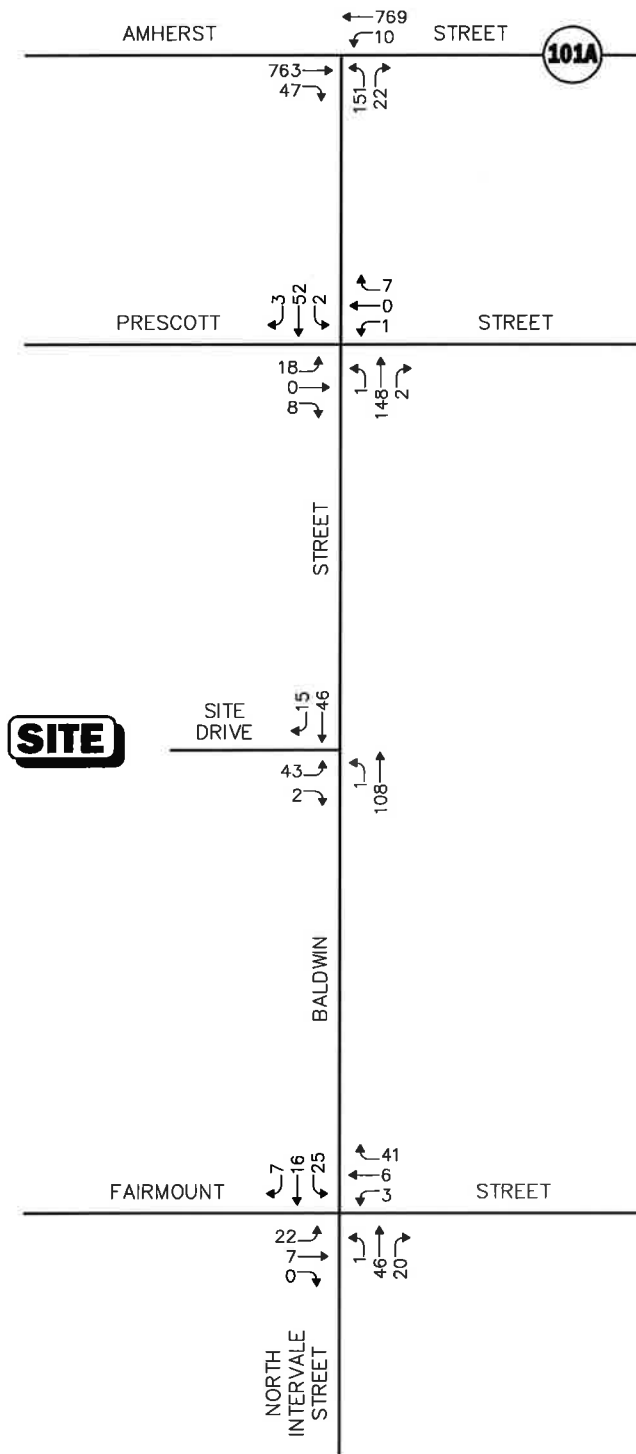
A summary of peak-month peak-hour projected traffic-volume increases external to the study area that is the subject of this assessment is shown in Table 6. These volumes are based on the projected traffic volume increases from the Project.

Table 6
PEAK-HOUR TRAFFIC-VOLUME INCREASES^a

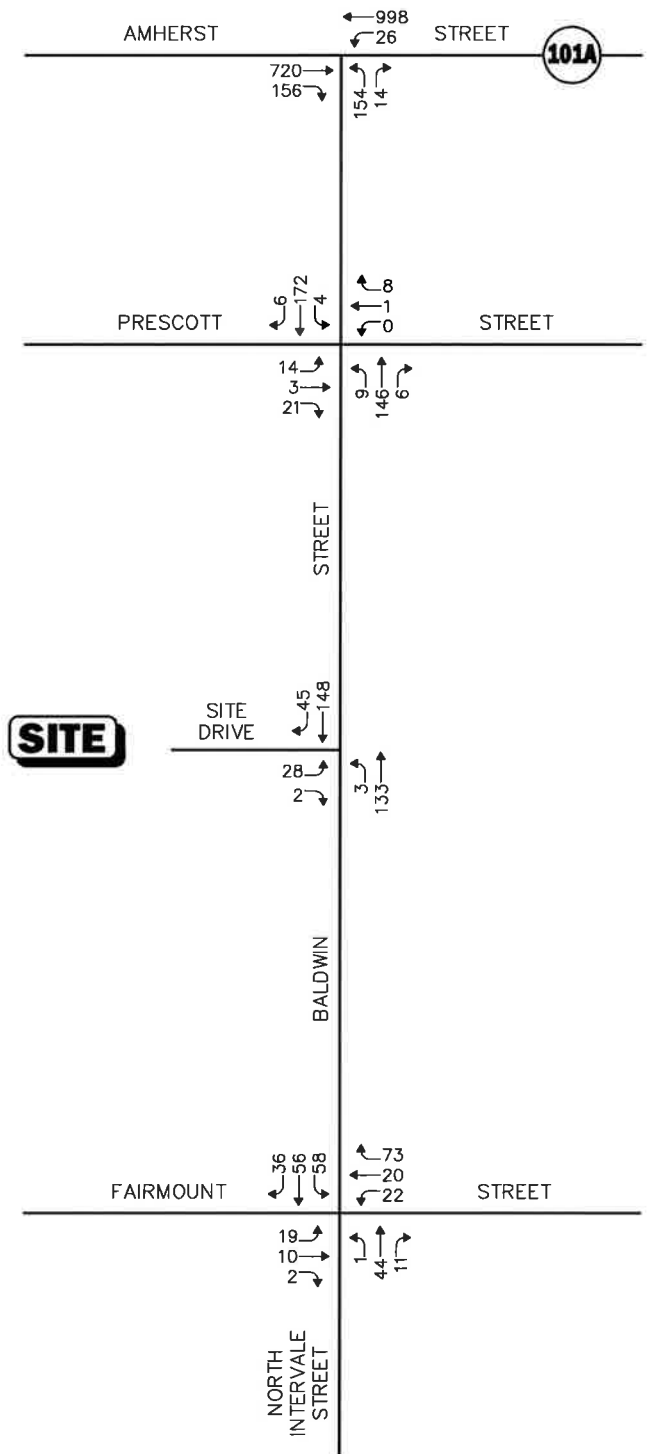
Location/Peak Hour	2028 No-Build	2028 Build	Traffic Volume Increase Over No-Build	Percent Increase Over No-Build
<i>Amherst Street, east of Baldwin Street:</i>				
Weekday Morning	1,545	1,564	19	1.2
Weekday Evening	1,735	1,758	23	1.3
<i>Amherst Street, west of Baldwin Street:</i>				
Weekday Morning	1,691	1,730	39	2.3
Weekday Evening	1,978	2,028	50	2.5
<i>Fairmount Street, west of Baldwin Street:</i>				
Weekday Morning	99	102	3	3.0
Weekday Evening	189	194	5	2.6

As shown in Table 6, the project-related traffic-volume increases are anticipated to range from 1.2 to 3.0 percent, depending on location and time period.

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR



Not To Scale



Figure 7

**2028 Build
Peak Hour Traffic Volumes**

TRAFFIC OPERATIONS ANALYSIS

Measuring existing and future traffic volumes quantifies traffic flow within the study area. To assess quality of flow, roadway capacity and vehicle queue analyses were conducted under Existing, No-Build, and Build traffic-volume conditions. Capacity analyses provide an indication of how well the roadway facilities serve the traffic demands placed upon them, with vehicle queue analyses providing a secondary measure of the operational characteristics of an intersection or section of roadway under study.

METHODOLOGY

Levels of Service

A primary result of capacity analyses is the assignment of level of service to traffic facilities under various traffic-flow conditions.⁶ The concept of level of service 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 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 level-of-service (LOS) A representing the best operating conditions and LOS F representing congested or constrained 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.

⁶The capacity analysis methodology is based on the concepts and procedures presented in the *Highway Capacity Manual 6th Edition*; Transportation Research Board; Washington, DC; 2016.

Unsignalized Intersections

The six levels of service for unsignalized intersections may be described as follows:

- *LOS A* represents a condition with little or no control delay to minor street traffic.
- *LOS B* represents a condition with short control delays to minor street traffic.
- *LOS C* represents a condition with average control delays to minor street traffic.
- *LOS D* represents a condition with long control delays to minor street traffic.
- *LOS E* represents operating conditions at or near capacity level, with very long control delays to minor street traffic.
- *LOS F* represents a condition where minor street demand volume exceeds capacity of an approach lane, with extreme control delays resulting.

The levels of service of unsignalized intersections are determined by application of a procedure described in the *Highway Capacity Manual 6th Edition*.⁷ Level of service is measured in terms of average control delay. Mathematically, control delay is a function of the capacity and degree of saturation of the lane group and/or approach under study and is a quantification of motorist delay associated with traffic control devices such as traffic signals and STOP signs. Control delay includes the effects of initial deceleration delay approaching a STOP sign, stopped delay, queue move-up time, and final acceleration delay from a stopped condition. Definitions for level of service at unsignalized intersections are also given in the *Highway Capacity Manual 6th Edition*. Table 7 summarizes the relationship between level of service and average control delay for two-way stop controlled and all-way stop controlled intersections.

Table 7
LEVEL-OF-SERVICE CRITERIA FOR
UNSIGNALIZED INTERSECTIONS^a

Level-Of-Service by Volume-to-Capacity Ratio		Average Control Delay (Seconds Per Vehicle)
$v/c \leq 1.0$	$v/c > 1.0$	
A	F	≤ 10.0
B	F	10.1 to 15.0
C	F	15.1 to 25.0
D	F	25.1 to 35.0
E	F	35.1 to 50.0
F	F	> 50.0

^aSource: *Highway Capacity Manual 6th Edition*; Transportation Research Board; Washington, DC; 2016; page 20-6.

⁷*Highway Capacity Manual 6th Edition*; Transportation Research Board; Washington, DC; 2016.

Signalized Intersections

The six levels of service for signalized intersections may be described as follows:

- * *LOS A* describes operations with very low control delay; most vehicles do not stop at all.
- * *LOS B* describes operations with relatively low control delay. However, more vehicles stop than *LOS A*.
- * *LOS C* describes operations with higher control delays. Individual cycle failures may begin to appear. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
- * *LOS D* describes operations with control delay in the range where the influence of congestion becomes more noticeable. Many vehicles stop and individual cycle failures are noticeable.
- * *LOS E* describes operations with high control delay values. Individual cycle failures are frequent occurrences.
- * *LOS F* describes operations with high control delay values that often occur with over-saturation. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Levels of service for signalized intersections are calculated using the operational analysis methodology of the *Highway Capacity Manual 6th Edition*. This method assesses the effects of signal type, timing, phasing, and progression; vehicle mix; and geometrics on delay. Level-of-service designations are based on the criterion of control or signal delay per vehicle. Control or signal delay is a measure of driver discomfort, frustration, and fuel consumption, and includes initial deceleration delay approaching the traffic signal, queue move-up time, stopped delay and final acceleration delay. Table 8 summarizes the relationship between level-of-service and control delay. The tabulated control delay criterion may be applied in assigning level-of-service designations to individual lane groups, to individual intersection approaches, or to entire intersections.

Table 8
LEVEL-OF-SERVICE CRITERIA
FOR SIGNALIZED INTERSECTIONS^a

Level-Of-Service by Volume-to-Capacity Ratio		Average Control Delay (Seconds Per Vehicle)
$v/c \leq 1.0$	$v/c > 1.0$	
A	F	≤ 10.0
B	F	10.1 to 20.0
C	F	20.1 to 35.0
D	F	35.1 to 55.0
E	F	55.1 to 80.0
F	F	> 80.0

^aSource: *Highway Capacity Manual 6th Edition*; Transportation Research Board; Washington, DC; 2016; page 19-16.

SIDRA Analysis

Due to limitations with the HCM methodology the analysis results presented for the intersection of Fairmount Street at Baldwin Street and North Intervale Street is based on the procedures described in the *Traffic Signalized and Unsignalized Intersection Design and Research Aid (SIDRA) Intersection*.⁸ The main features of the *SIDRA Intersection* method for unsignalized capacity estimation are the dependence of gap acceptance parameters on roadway geometry, entry lane flows, and the designation of traffic control on approach lanes.

The SIDRA analytical model calculates several components of delay. One of these, the average total delay component, produces level-of-service results based on the concepts described in the HCM. The delay ranges that define levels of service for roundabouts are shown in Table 9.

Table 9
LEVEL-OF-SERVICE CRITERIA FOR SIDRA:
UNSIGNALIZED INTERSECTIONS^a

Level-Of-Service by Volume-to-Capacity Ratio		Control Delay Per Vehicle (Seconds)
v/c ≤ 1.0	v/c > 1.0	
A	F	≤10.0
B	F	10.1 to 15.0
C	F	15.1 to 25.0
D	F	25.1 to 35.0
E	F	35.1 to 50.0
F	F	>50.0

^aSource: *SIDRA Intersection 6.1 User Guide*; Akcelik & Associates Pty Ltd; Greythorn, Victoria 3104, Australia; December 2015.

Synchro Analysis

The analysis results presented for the signalized intersection in Table 11 were determined by assessing the intersection using the Synchro methodology. This method in general aligns with the HCM methodology previously detailed.

ANALYSIS RESULTS

Level-of-service and vehicle queue analyses were conducted for 2018 Existing, 2028 No-Build, and 2028 Build conditions for the intersections within the study area. The results of the unsignalized intersection capacity analyses are summarized in Table 10, with the results of the signalized intersection capacity analyses summarized in Table 11. The analysis worksheets are presented in the Appendix.

⁸Traffic Signalized and Unsignalized Intersection Design and Research Aid, *SIDRA Intersection 6.1 User Guide*; Akcelik & Associates Pty Ltd; Greythorn, Victoria 3104, Australia; December 2015.

Unsignalized Intersection Analysis Results

Baldwin Street at Prescott Street

Under 2018 Existing, 2028 No-Build, and 2028 Build conditions all movements operate at LOS A.

Fairmount Street at Baldwin Street and North Interavle Street

Under 2018 Existing, 2028 No-Build, and 2028 Build conditions all movements operate at LOS A.

Baldwin Street at Site Drive

Under 2028 Build conditions the critical movement, the site drive exiting movement, operates at LOS A during the weekday morning peak hour and at LOS B during the weekday evening peak hour.

Signalized Intersection Analysis Results

Amherst Street (Route 101A) at Baldwin Street

Under all conditions, the overall intersection operates at LOS B during the weekday morning and weekday evening peak hours.

Table 10**UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY**

Unsignalized Intersection/Peak Hour/Movement	2018 Existing				2028 No-Build				2028 Build			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 95 th	V/C	Delay	LOS	Queue ^d 95 th	V/C	Delay	LOS	Queue ^d 95 th
Baldwin Street at Prescott Street												
<i>Weekday Morning:</i>												
Prescott Street EB LT/TH/RT	0.02	7	A	3	0.03	7	A	3	0.04	8	A	3
Prescott Street WB LT/TH/RT	0.01	7	A	0	0.01	7	A	0	0.01	7	A	0
Baldwin Street NB LT/TH/RT	0.10	7	A	8	0.13	8	A	13	0.19	8	A	18
Baldwin Street SB LT/TH/RT	0.04	7	A	3	0.05	7	A	5	0.07	7	A	5
<i>Weekday Evening:</i>												
Prescott Street EB LT/TH/RT	0.04	7	A	3	0.05	8	A	5	0.05	8	A	5
Prescott Street WB LT/TH/RT	0.01	7	A	0	0.01	7	A	0	0.01	7	A	0
Baldwin Street NB LT/TH/RT	0.13	8	A	10	0.16	8	A	15	0.20	8	A	18
Baldwin Street SB LT/TH/RT	0.11	8	A	10	0.17	8	A	15	0.23	8	A	23
Fairmount Street at Baldwin Street and North Intervale Street												
<i>Weekday Morning:</i>												
Fairmount Street EB LT/TH/RT	0.03	9	A	3	0.03	9	A	3	0.03	9	A	3
Fairmount Street WB LT/TH/RT	0.03	9	A	3	0.05	9	A	5	0.05	9	A	5
Baldwin Street SB LT/TH/RT	0.03	9	A	3	0.05	9	A	5	0.05	9	A	5
<i>Weekday Evening:</i>												
Fairmount Street EB LT/TH/RT	0.03	9	A	3	0.04	9	A	5	0.04	9	A	5
Fairmount Street WB LT/TH/RT	0.10	9	A	10	0.12	9	A	15	0.13	9	A	15
Baldwin Street SB LT/TH/RT	0.11	9	A	13	0.17	10	A	20	0.17	10	A	20
Baldwin Street at Site Drive												
<i>Weekday Morning:</i>												
Site Drive EB LT/RT	--	--	--	--	--	--	--	--	0.06	10	A	5
<i>Weekday Evening:</i>												
Site Drive EB LT/RT	--	--	--	--	--	--	--	--	0.05	11	B	5

^aVolume to capacity ratio.^bAverage control delay per vehicle (in seconds).^cLevel-of-Service.^dQueue length in feet.

NB = northbound; SB = southbound; EB = eastbound; WB = westbound; LT = left-turning movements; TH = through movements; RT = right-turning movements.

Table 11
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak Hour/Movement	2018 Existing				2028 No-Build				2028 Build			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
Amherst Street (Route 101A) at Baldwin Street												
<i>Weekday Morning:</i>												
Amherst Street EB TH/RT	0.66	14	B	115/485	0.69	15	B	137/580	0.69	15	B	140/586
Amherst Street WB LT/TH	0.41	9	A	47/167	0.42	9	A	55/191	0.42	9	A	55/191
Baldwin Street NB LT/RT	0.36	27	C	25/92	0.53	34	C	39/140	0.71	43	D	53/208
Overall	--	13	B	--	--	14	B	--	--	15	B	--
<i>Weekday Evening:</i>												
Amherst Street EB TH/RT	0.66	13	B	115/725	0.68	13	B	143/516	0.71	13	B	152/552
Amherst Street WB LT/TH	0.50	10	A	66/222	0.51	9	A	76/251	0.58	10	A	84/277
Baldwin Street NB LT/RT	0.40	30	C	28/128	0.57	39	D	42/193	0.69	44	D	51/237
Overall	--	12	B	--	--	13	B	--	--	14	B	--

^aVolume to capacity ratio.

^bAverage control delay per vehicle (in seconds).

^cLevel-of-Service.

^dQueue length in feet.

NB = northbound; SB = southbound; EB = eastbound; WB = westbound; LT = left-turning movements; TH = through movements; RT = right-turning movements.

CONCLUSIONS AND RECOMMENDATIONS

RECOMMENDATIONS

The traffic assessment contained herein indicates that the Project presents negligible impacts to intersection LOS, and Project-related traffic increases are expected to be no greater than 1.2 to 3.0 percent during the peak hours at any of the locations studied. The Project did not result in the degradation of LOS below LOS D for any locations studied; therefore mitigation is not required.

It is recommended that the following be implemented for the Project:

- The site driveway should be placed under STOP-sign control where it intersects Baldwin Street, with a painted STOP-bar on the driveway at the STOP-sign location.
- Any landscaping or building features should not exceed 24 inches in height or should be placed out of the lines of sight for motorists exiting the site and those approaching the driveway on Baldwin Street.

CONCLUSIONS

VAI has completed a detailed transportation assessment of the potential impacts on the surrounding transportation infrastructure associated with the proposed residential development to be located off Baldwin Street in Nashua, New Hampshire. The following specific areas have been evaluated as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; under existing and future conditions, both with and without the Project. Based on this assessment, we have concluded the following with respect to the Project:

The roadways and intersections in the vicinity of the Project can accommodate the projected traffic increases without significant impact to motorist delays. Based on the above, VAI has concluded that the Project can be safely accommodated with minimal impact on the area road network.