11. Traffic Study

Transportation Impact Assessment

The Residences at Stow Acres
58 Randall Road
Stow, Massachusetts

Prepared for:

MCO & Associates, Inc.
Harvard, Massachusetts

November 2023

Prepared by:

Vanasse & Associates inc
Transportation Engineers & Planners

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Vanasse & Associates inc
Transportation Engineers & Planners

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Dear Reviewer:

This letter shall certify that this *Transportation Impact Assessment* has been prepared under my direct supervision and responsible charge. I am a Registered Professional Engineer (P.E.) in the Commonwealth of Massachusetts (Massachusetts P.E. No. 38871, Civil) and hold Certification as a Professional Traffic Operations Engineer (PTOE) from the Transportation Professional Certification Board, Inc. (TPCB), an affiliate of the Institute of Transportation Engineers (ITE) (PTOE Certificate No. 993). I am also a Fellow of the Institute of Transportation Engineers (FITE).

Sincerely,

VANASSE & ASSOCIATES, INC.

Jeffrey Dirk

Jeffrey S. Dirk, P.E., PTOE, FITE
Managing Partner

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EXECUTIVE SUMMARY

Vanasse & Associates, Inc. (VAI) has conducted a Transportation Impact Assessment (TIA) in order to determine the potential impacts on the transportation infrastructure associated with the proposed construction of a residential community to be known as The Residences at Stow Acres that will be situated within a portion of the Stow Acres Country Club located at 58 Randall Road, in Stow, Massachusetts (hereafter referred to as the "Project"). This assessment was prepared in consultation with the Town of Stow and the Massachusetts Department of Transportation (MassDOT), and was performed in accordance with MassDOT's *Transportation Impact Assessment (TIA) Guidelines* and the standards of the Traffic Engineering and Transportation Planning professions for the preparation of such reports.

Based on this assessment, we have concluded the following with respect to the Project:

1. Using trip-generation statistics published by the Institute of Transportation Engineers (ITE)[1], the Project is expected to generate approximately 1,676 vehicle trips on an average weekday and 1,622 vehicle trips on a Saturday (both two-way, 24-hour volumes), with 122 vehicle trips expected during the weekday morning peak-hour, 164 vehicle trips expected during the weekday evening peak-hour and 159 vehicle trips expected during the Saturday midday peak-hour;

2. The Project will not result in a significant impact (increase) on motorist delays or vehicle queuing over anticipated future conditions without the Project (No-Build condition), with all movements at the study area intersections shown to continue to operate at a level-of-service (LOS) B or better with the addition of Project-related traffic, where an LOS of "D" or better is defined as "acceptable" traffic operations;

3. All movements exiting the Project site roadway to Randall Road are predicted to operate at LOS B or better during the peak hours with vehicle queues of up to one (1) vehicle predicted;

4. Independent of the Project, the Randall Road/Cross Street intersection was found to have a motor vehicle crash rate that is above the MassDOT average crash rate for a similar intersection. As such, specific recommendations have been provided to advance safety-related improvements at the intersection; and

[1] *Trip Generation*, 11th Edition; Institute of Transportation Engineers; Washington, DC; 2021.

5. Lines of sight to and from the intersection of the Project site roadway with Randall Road were found to exceed or could be made to exceed the required minimum distances for the intersection to function in a safe and efficient manner.

In consideration of the above, we have concluded that the Project can be accommodated within the confines of the existing transportation infrastructure in a safe and efficient manner with the implementation of the recommendations that follow.

RECOMMENDATIONS

A detailed transportation improvement program has been developed that is designed to provide safe and efficient access to the Project site and address any deficiencies identified at off-site locations evaluated in conjunction with this study. The following improvements have been recommended as a part of this evaluation and, where applicable, will be completed in conjunction with the Project subject to receipt of all necessary rights, permits and approvals.

Project Access

Access to the Project site will be provided by way of a new roadway that will intersect the north side of Randall Road approximately 480 feet (ft) west of Cross Street, with secondary access for emergency vehicles provided by way of a gated driveway that will intersect the north side of Randall Road approximately 180 ft east of the Project site roadway. A raised island is proposed along a portion of the driveway approaching Randall Road that will separate entering and exiting traffic, transitioning thereafter to non-divided access. The following recommendations are offered with respect to the design and operation of the Project site access and internal circulation:

- The entering and exiting travel lanes on the portion of the Project site roadway that includes a raised island will be 12 feet in width and the corner radii and intersection geometry will be designed to support the turning and maneuvering requirements of the largest anticipated responding emergency vehicle and service vehicles (i.e., trash/recycling, etc.).

- Within the Project site beyond the segment of roadway that includes the raised median, the Project site roadway and internal intersecting roadways and alleys should be a minimum of 20 feet in width and designed to accommodate the turning and maneuvering requirements of emergency and service vehicles. If a roadway width of less than 24 feet is used, "No Stopping Any Time" signs shall be installed along both sides of the roadways.

- The emergency vehicle access road should be a minimum of 20 feet in width unless a reduced width is approved by the Fire Department, and should be paved or constructed of a stabilized base material that will support travel by the largest anticipated responding emergency vehicle under all weather conditions and secured by means of a gate or other suitable means of restricting access by general traffic as approved by the Fire Department.

- Where perpendicular parking is proposed, the drive aisle behind the parking should be a minimum of 23 feet in width to facilitate parking maneuvers.

- Vehicles exiting the Project site to Randall Road should be placed under STOP-sign control with a marked STOP-line provided. Within the Project site, STOP-signs and marked STOP-lines should be provided at major intersections.

- "Keep Right" signs should be provided on the approaches to the raised island.

- All signs and pavement markings to be installed within the Project should conform to the applicable standards of the *Manual on Uniform Traffic Control Devices* (MUTCD).[2]

- A sidewalk should be provided along at least one side of the Project site roadway and the internal roadway network that should extend to Randall Road.

- Marked crosswalks and Americans with Disabilities Act (ADA)-compliant wheelchair ramps should be provided for crossing the Project site roadway and at pedestrian crossings within the Project site.

- Signs and landscaping to be installed as a part of the Project within intersection sight triangle areas should be designed and maintained so as not to restrict lines of sight.

- Snow accumulations (windrows) within sight triangle areas should be promptly removed where such accumulations would impede sight lines.

Off-Site

Randall Road at Cross Street

Independent of the Project, the Randall Road/Cross Street intersection was identified to have a motor vehicle crash history that warrants further review and the advancement of specific improvements to enhance safety. In an effort to improve safety at the intersection, consideration should be given to making Cross Street one-way northeastbound (toward Route 62), to the extent the improvement is desired by the Town, which would address the predominant crash pattern (single vehicle collisions where a motorist traveling on Cross Street toward Randall Road slid on a snow or ice covered roadway and collided with a fixed roadside object). In lieu of or prior to the implementation of one-way operation of Cross Street, the following improvements should be considered for advancement at the intersection:

- Install a STOP-sign and marked STOP-line on the Cross Street approach to reflect the predominant traffic flow at the intersection (along Randall Road). In conjunction with the STOP-sign installation, red reflective tape should be added to the STOP-sign post and an advance "Stop Sign Ahead" warning sign (W3-1) should be installed on Cross Street approximately 100 feet north of the intersection;

- Remove the "Yield" sign on the Randall Road westbound approach; and

- Install "Intersection Ahead" warning signs (graphic symbol) with a supplemental street name sign ("Cross Street") on the Randall Road approaches approximately 100 feet east and west of Cross Street, with the sign posts to include yellow reflective tape.

The Project proponent will coordinate with the Town on the desired improvement strategy and will design and construct the selected improvements prior to the issuance of a Certificate of Occupancy subject to receipt of all necessary rights, permits and approvals.

With the implementation of the above recommendations, safe and efficient access can be provided to the Project site and the Project can be accommodated within the confines of the existing transportation infrastructure.

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[2] *Manual on Uniform Traffic Control Devices (MUTCD)*; Federal Highway Administration; Washington, D.C.; 2009.

INTRODUCTION

Vanasse & Associates, Inc. (VAI) has conducted a Transportation Impact Assessment (TIA) in order to determine the potential impacts on the transportation infrastructure associated with the proposed construction of a residential community to be known as The Residences at Stow Acres that will be situated within a portion of the Stow Acres Country Club located at 58 Randall Road, in Stow, Massachusetts (hereafter referred to as the "Project"). This study evaluates the following specific areas as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; and identifies and analyzes existing traffic conditions and future traffic conditions, both with and without the Project, along Randall Road, Hudson Road and Gleasondale Road (Route 62), and at major intersections located along these roadways through which Project-related traffic will travel.

PROJECT DESCRIPTION

As proposed, the Project will entail the construction of a 189-unit residential community to be situated within the northern portion of the Stow Acres Country Club located at 58 Randall Road in Stow, Massachusetts. The residential community will include 124 single-family homes, 40 cottage style rental units and 25 age-qualified (age 62+) multifamily units. The Project site encompasses approximately 70.0± acres of land located within the Stow Acres Country Club that is bound by wetlands and areas of open and wooded space and portions of the Stow Acres golf course to the north; Randall Road and residential properties to the south; residential properties and portions of the Stow Acres golf course to the east; and portions of the Stow Acres golf course and areas of open and wooded space to the west. The Project site currently contains a portion of the golf course associated with the Stow Acres Country Club that will be reconfigured to accommodate the addition of the residential units. Figure 1 depicts the Project site in relation to the existing roadway network.

Access to the Project site will be provided by way of a new roadway that will intersect the north side of Randall Road approximately 480 feet (ft) west of Cross Street, with secondary access for emergency vehicles provided by way of a gated driveway that will intersect the north side of Randall Road approximately 180 ft east of the Project site roadway. A raised island is proposed along a portion of the driveway approaching Randall Road that will separate entering and exiting traffic, transitioning thereafter to non-divided access. On-site parking will be provided for a

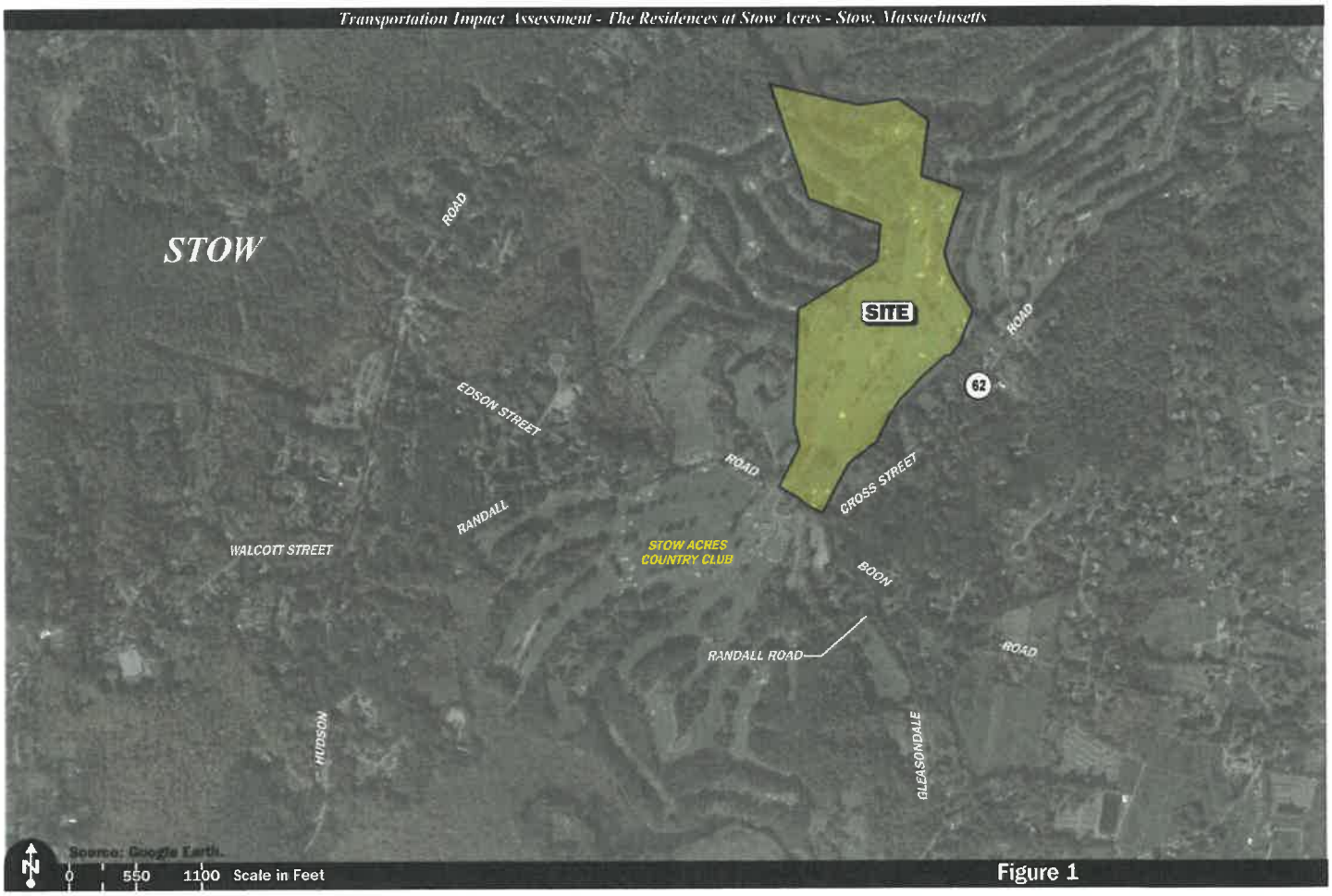

Figure 1

Site Location Map

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minimum of two (2) parking spaces per unit or home consistent with parking requirements of Section 7.3.3.3, *Schedule of Minimum Parking: Residential*, of the Town of Stow Zoning Bylaws.[3]

STUDY METHODOLOGY

This study was prepared in consultation with the Massachusetts Department of Transportation (MassDOT) and the Town of Stow; was performed in accordance with MassDOT's *Transportation Impact Assessment (TIA) Guidelines* and the standards of the Traffic Engineering and Transportation Planning professions for the preparation of such reports; 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; pedestrian and bicycle facilities; on-street parking; public transportation services; observations of traffic flow; and collection of pedestrian, bicycle and vehicle 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. A seven-year time horizon from the date of publication of this assessment was selected for analyses consistent with MassDOT's *Transportation Impact Assessment (TIA) Guidelines*. The traffic analysis conducted in stage two identifies existing or projected future roadway capacity, traffic safety, and site access 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.

[3]Two spaces per dwelling unit is required for residential dwellings containing less than five bedrooms plus one parking space for each additional bedroom and sufficient off-street parking for visitors.

EXISTING CONDITIONS

A comprehensive field inventory of existing conditions within the study area was conducted in December 2022. The field investigation consisted of an inventory of existing roadway geometrics; pedestrian and bicycle facilities; public transportation services; traffic volumes; and operating characteristics; as well as posted speed limits and land use information within the study area. The study area that was assessed for the Project consisted of Randall Road, Hudson Road and Gleasondale Road (Route 62), and the following specific intersections:

- Hudson Road at Edson Street
- Hudson Road at Walcott Street and Randall Road
- Randall Road at Edson Street
- Randall Road at the Stow Acres Country Club Main Driveway
- Randall Road at Cross Street
- Route 62 at Cross Street
- Route 62 at Boon Road
- Route 62 at Randall Road

The following describes the study area roadway and the intersections.

ROADWAYS

Randall Road

- Two-lane local roadway under Town jurisdiction;
- Traverses the study area in a general east-west direction;
- Provides an approximate 20-foot wide traveled-way that accommodates two-way travel with no marked centerline or shoulders in the vicinity of the Project site;
- The posted speed limit is 25 miles per hour (mph) in the vicinity of the Project site;
- Sidewalks and illumination (street lights) are not provided within the study area; and
- Land use within the study area consists of the Project site, residential properties and areas of open and wooded space.

Hudson Road

- Two-lane, urban collector roadway under town jurisdiction;
- Traverses the study area in a north-south direction;
- Provides two 11-foot-wide lanes that are separated by a double-yellow centerline with 2 to 3-foot wide marked shoulders;
- Posted speed limit is 40 mph;
- Sidewalks are not provided;
- Illumination is provided intermittently by way of street lights mounted on wood poles;
- Land use consists of residential and commercial properties, and areas of open and wooded space.

Gleasondale Road (Route 62)

- Two-lane, urban principal arterial roadway under town jurisdiction;
- Traverses the study area in a north-south direction;
- Provides two 10- to 11-foot-wide lanes that are separated by a double-yellow centerline with 1 to 2-foot wide marked shoulders;
- Posted speed limit is 30 mph;
- Sidewalks are not provided within the study area;
- Illumination is provided intermittently by way of street lights mounted on wood poles;
- Land use consists of residential and commercial properties, and areas of open and wooded space.

INTERSECTIONS

Table 1 and Figure 2 summarize existing lane use, traffic control, and pedestrian and bicycle accommodations at the study area intersections as observed in December 2022.

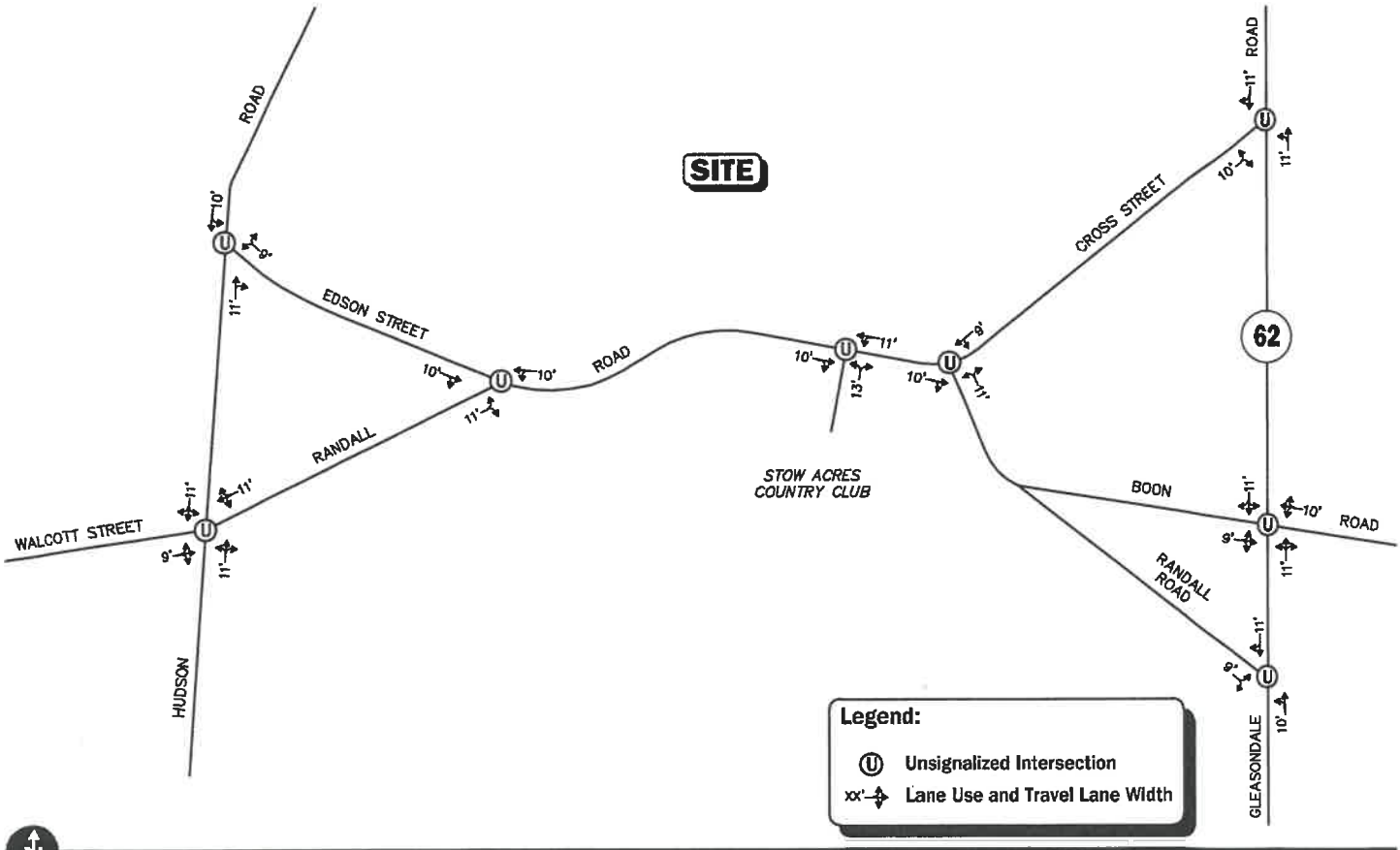

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Figure 2

Existing Intersection Lane Use, Travel Lane Width, and Pedestrian Facilities

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Table 1
STUDY AREA INTERSECTION DESCRIPTION

Intersection	Traffic Control Type[a]	No. of Travel Lanes Provided	Shoulder Provided? (Yes/No/Width)	Pedestrian Accommodations? (Yes/No/Description)	Bicycle Accommodations? (Yes/No/Description)
Hudson Rd./ Edson St.	S	1 general-purpose travel lane provided on all approaches	Yes; 2- to 3-feet on Hudson Rd.	No	No
Hudson Rd./ Walcott St./ Randall Rd.	S	1 general-purpose travel lane provided on all approaches	Yes; 2- to 3-feet on Hudson Rd.	No	No
Randall Rd./ Edson St.	Y	1 general-purpose travel lane provided on all approaches	No	No	No
Randall Rd./ Stow Acres CC Main Driveway	S	1 general-purpose travel lane provided on all approaches	No	No	No
Randall Rd./ Cross St.	Y	1 general-purpose travel lane provided on all approaches	No	No	No
Rte. 62/ Cross St.	S	1 general-purpose travel lane provided on all approaches	Yes; 1- to 2-feet on Rte. 62	No	No
Rte. 62/ Boon Rd.	S	1 general-purpose travel lane provided on all approaches	Yes; 1- to 2-feet on Rte. 62	No	No
Rte. 62/ Randall Rd.	S	1 general-purpose travel lanes provided on all approaches	Yes; 1- to 2-feet on Rte. 62	No	No

[a]S = STOP-sign control; Y = YIELD-sign control.

EXISTING TRAFFIC VOLUMES

In order to determine existing traffic-volume demands and flow patterns within the study area, automatic traffic recorder (ATR) counts, turning movement counts (TMCs), and vehicle classification counts were completed in December 2022. The ATR counts were conducted on Randall Road, west of Cross Street, on December 1st through 3rd, 2022 (Thursday through Saturday, inclusive) in order to record weekday and Saturday daily traffic conditions over an extended period, with weekday morning (7:00 to 9:00 AM) and evening (4:00 to 6:00 PM) peak-period TMCs performed at the study area intersections on Thursday, December 1st, 2022, and during the Saturday midday (11:00 AM to 2:00 PM) peak period on Saturday, December 3rd, 2022. These time periods were selected for analysis purposes as they are representative of the peak-traffic-volume hours for both the Project and the adjacent roadway network.

Traffic-Volume Adjustments

In order to evaluate the potential for seasonal fluctuation of traffic volumes within the study area, MassDOT weekday seasonal factors for Urban Groups 4-7 (major and minor collectors and local roads and streets, the functional classifications of the majority of the study area roadways) were reviewed.[4] Based on a review of this data, it was determined that traffic volumes for the month of December are 4.0 percent *below* average-month conditions. As such, the December traffic volumes were adjusted upwards by 4.0 percent in order to be representative of average-month conditions, consistent with MassDOT guidelines.

MassDOT no longer requires pandemic-related adjustment of traffic counts performed after March 2022 except in locations where the predominant land use consists of offices or similar uses.[5] Given that the predominant land use within the study area is residential, no further adjustment (beyond the seasonal adjustment) is necessary.

It should be noted that the traffic volume data does not include trips associated with the Stow Acres Country Club (18 hole golf course with supporting amenities), which was not in operation at the time the traffic counts were performed (December). Trips associated with the Stow Acres Country Club were estimated using data available from the ITE[6] and are included the future condition (No-Build and Build) traffic volumes (discussion follows).

The 2022 Existing traffic volumes are summarized in Table 2, with the weekday morning, weekday evening and Saturday midday peak-hour traffic volumes graphically depicted on Figures 3, 4 and 5, respectively. Note that the peak-hour traffic volumes presented in Table 2 were obtained from aforementioned figures.

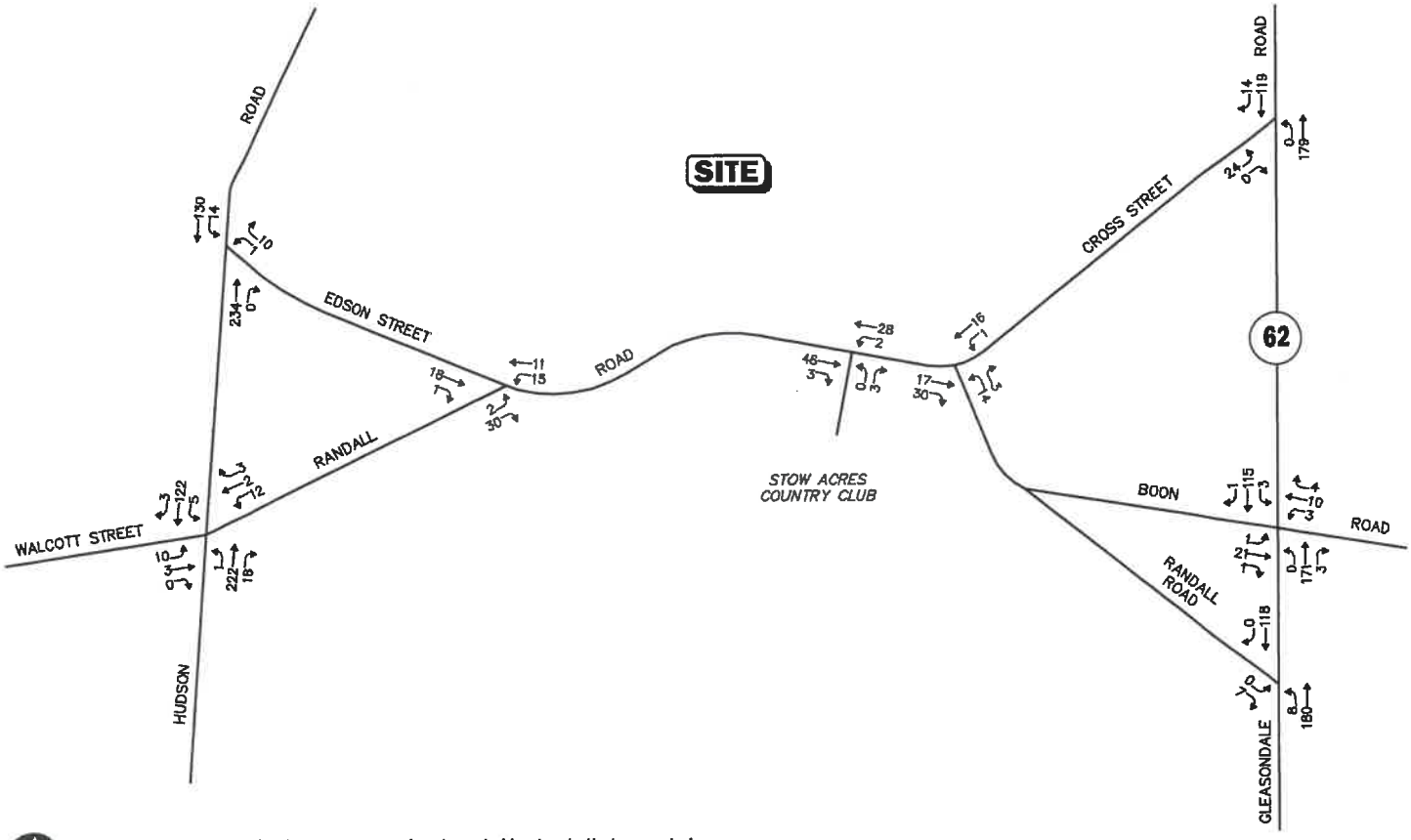
Table 2
2022 EXISTING TRAFFIC VOLUMES

Location/Peak Hour	AWT[a]	Saturday[b]	VPH[c]	K Factor[d]	Directional Distribution[e]
Randall Road, west of Cross Street:	795	675	--	--	--
Weekday Morning (7:15 – 8:15 AM)	--	--	77	9.7	61.0% EB
Weekday Evening (4:00 – 5:00 PM)	--	--	65	8.2	52.3% EB
Saturday Midday (11:30 AM – 12:30 PM)	--	--	70	10.4	50.0% EB

[a]Average weekday traffic in vehicles per day.
[b]Average Saturday traffic in vehicles per day.
[c]Vehicles per hour.
[d]Percent of daily traffic occurring during the peak hour.
[e]Percent traveling in peak direction.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound.

As can be seen in Table 2, Randall Road in the vicinity of the Project site was found to accommodate 795 vehicles on an average weekday and 675 vehicles on a Saturday (both two-way, 24-hour volumes), with approximately 77 vehicles per hour (vph) during the weekday morning peak-hour, 65 vph during the weekday evening peak-hour and 70 vph during the Saturday midday peak-hour.

[4]MassDOT statewide Traffic Data Collection; 2019 Weekday Seasonal Factors, Groups U4-7.
[5]*25% Design Submission Guidelines*; MassDOT Highway Division, Traffic and Safety Engineering; Revised May 31, 2022.
[6]Institute of Transportation Engineers, op. cit. 1.



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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Figure 3

2022 Existing
Weekday Morning
Peak-Hour Traffic Volumes

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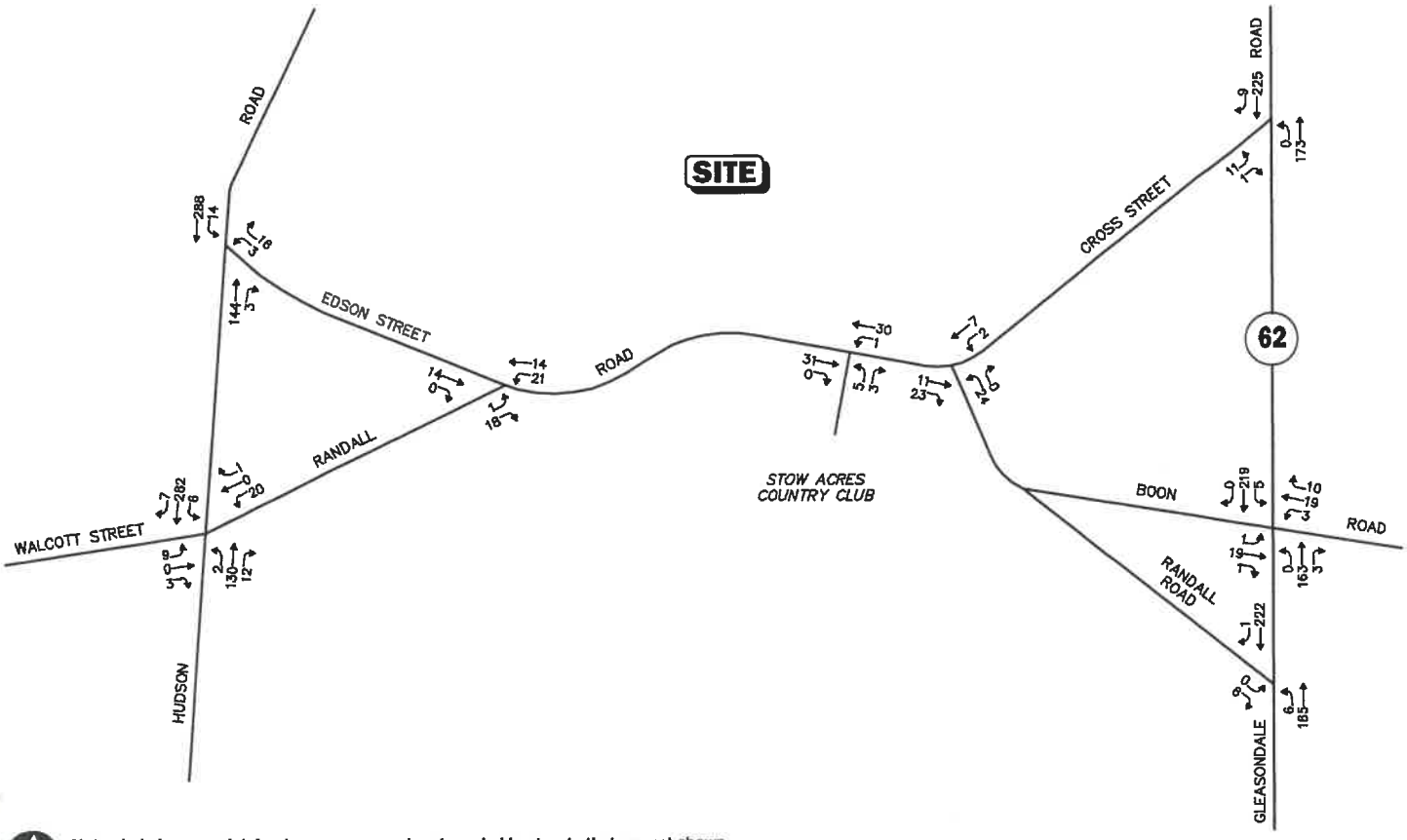

Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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Figure 4

2022 Existing
Weekday Evening
Peak-Hour Traffic Volumes

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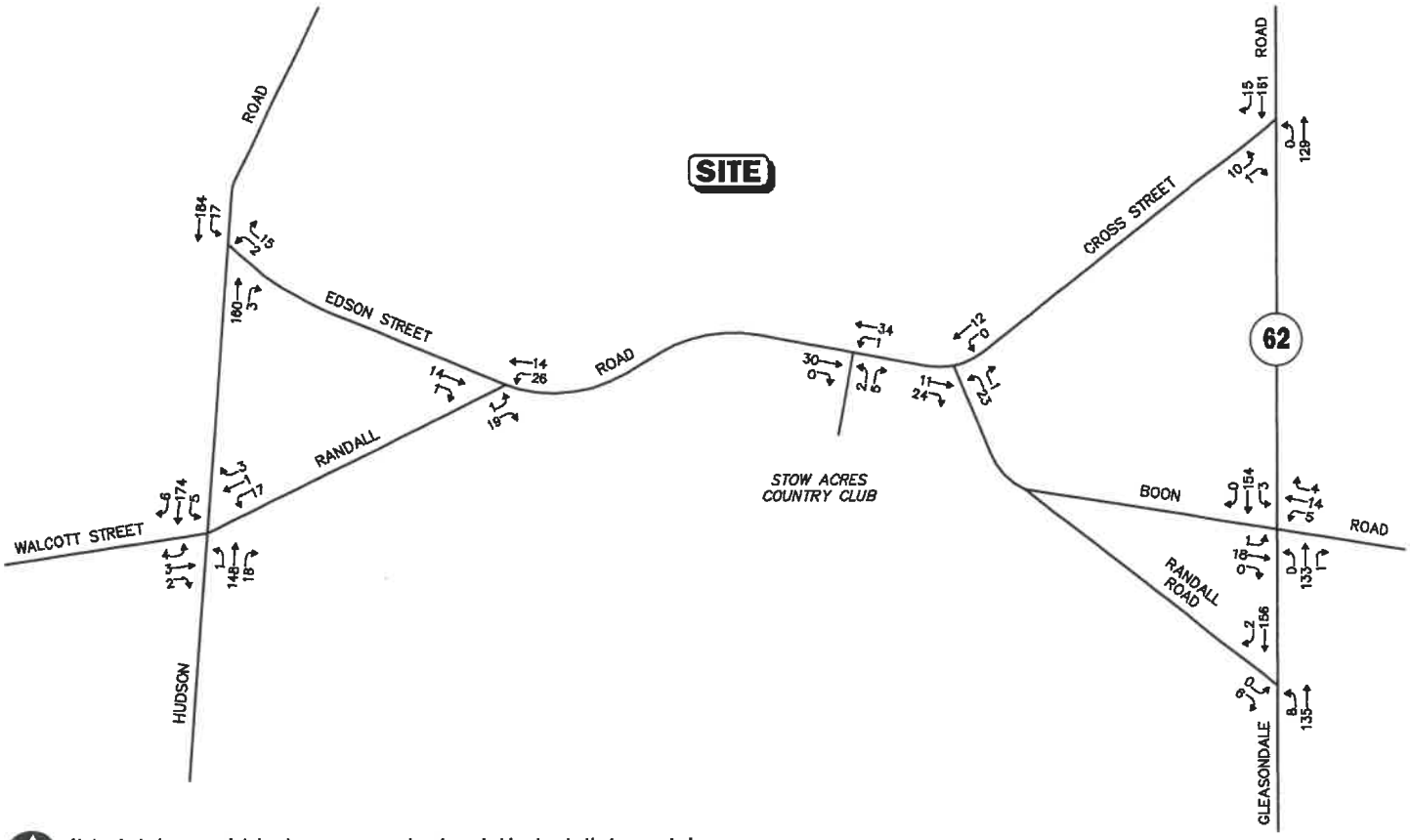

Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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Figure 5

2022 Existing
Saturday Midday
Peak-Hour Traffic Volumes

Vanasse & Associates inc

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SPOT SPEED MEASUREMENTS

Vehicle travel speed measurements were performed on Randall Road in the vicinity of the Project site in conjunction with the ATR counts. Table 3 summarizes the vehicle travel speed measurements.

Table 3
VEHICLE TRAVEL SPEED MEASUREMENTS

	Randall Road	
	Eastbound	Westbound
Mean Travel Speed (mph)	28	28
85th Percentile Speed (mph)	32	31
Posted Speed Limit (mph)	25	25

mph = miles per hour.

As can be seen in Table 3, the mean vehicle travel speed along Randall Road in the vicinity of the Project site was found to be 28 mph in both the eastbound and westbound directions. The measured 85th percentile vehicle travel speed, or the speed at which 85 percent of the observed vehicles traveled at or below, was found to be 32 mph eastbound and 31 mph westbound, which is 6 to 7 mph *above* the posted speed limit (25 mph) in the vicinity of the Project site. The 85th percentile speed is used as the basis of engineering design and in the evaluation of sight distances, and is often used in establishing posted speed limits.

PEDESTRIAN AND BICYCLE FACILITIES

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in December 2022. 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 existing and planned future bicycle facilities. Pedestrian facilities (i.e., sidewalks and crosswalks) are not provided within the study area. Additionally, formal bicycle facilities are not currently provided within the study area, and the study area roadways do not provide sufficient width on a continuous basis (combined travel lane and shoulder) to support bicycle travel in a shared traveled-way configuration.[7]

In 2018, the prepared a Complete Streets Prioritization Plan[8] that included specific recommendations for the addition of a shared-use path or a sidewalk with on-road bicycle accommodations along both Hudson Road and Route 62 within the study area.

[7]A minimum combined travel lane and paved shoulder width of 14-feet is required to support bicycle travel in a shared traveled-way condition.

[8]*Complete Streets Prioritization Plan*, Stow, Massachusetts; Howard Stein Hudson; April 2018.

PUBLIC TRANSPORTATION

Regularly scheduled public transportation services are not currently provided within the study area. To the northeast of the Project site, the Massachusetts Bay Transit Authority (MBTA) provides Commuter Rail service to South Station in Boston on the Fitchburg Line by way of South Acton Station, which is located at 4 Central Street in Acton (approximately 6 miles from the Project site). The Stow Council on Aging (COA) provides on-demand rides for resident senior citizens for weekly shopping trips and rides to and from medical appointments in Stow and the surrounding area.

MOTOR VEHICLE CRASH DATA

Motor vehicle crash information for the study area intersections was provided by the MassDOT Highway Division Safety Management/Traffic Operations Unit for the most recent five-year period available (2016 through 2020, inclusive) in order to examine motor vehicle crash trends occurring within the study area. The data is summarized by intersection, type, severity, roadway and weather conditions, and day of occurrence, and presented in Table 4.

Based on a review of this data, no (0) motor vehicle crashes were reported to have occurred over the five-year review period at the Hudson Road/Edson Street, Hudson Road/Walcott Street/ Randall Road and Randall Road/Edson Street intersections, and no (0) crashes were reported to have occurred along Randall Road in the vicinity of the proposed access to the Project site. As can be seen in Table 4, the remaining study area intersections were found to have experienced an average of less than one (1) reported motor vehicle crash per year over the five-year review period, the majority of which occurred on a weekday; during daylight; under clear weather conditions; and involved collisions with a fixed-object. With the exception of the Randall Road/Cross Street intersection, the study area intersections were identified to have a motor vehicle crash rate that are *below* both the MassDOT statewide and District average crash rates for similar intersections for the MassDOT Highway Division District in which the intersections are located (District 3).

The Randall Road/Cross Street intersection was found to have experienced three (3) report motor vehicle crashes over the five-year review period, the majority of which occurred on a weekday; during daylight; under snowy/icy conditions; and involved collisions with a fixed-object that resulted in property damage only. The intersection was identified to have a motor vehicle crash rate that is *above* the MassDOT statewide and District average crash rates or similar intersections. As such, specific safety-related improvements have been identified for this intersection that will be undertaken as a part of this Project (discussed in the *Recommendations* sections of this assessment).

A review of the MassDOT statewide High Crash Location List indicated that there are no Highway Safety Improvement Program (HSIP) eligible high crash locations within the Town of Stow. In addition, no fatal motor vehicle crashes were reported to have occurred at the study area intersections over the five-year review period. The detailed MassDOT Crash Rate Worksheets and High Crash Location mapping are provided in the Appendix.

Table 4
MOTOR VEHICLE CRASH DATA SUMMARY[a]

	Randall Rd./ Stow Acres CC Driveway	Randall Rd./ Cross St.	Rte. 62/ Cross St.	Rte. 62/ Boon Rd.	Rte. 62/ Randall Rd.
Traffic Control Type[b]	U	U	U	U	U
Year:					
2016	0	0	1	0	0
2017	0	3	0	1	0
2018	0	0	0	0	0
2019	1	0	1	1	1
2020	0	0	1	0	0
Total	1	3	3	2	1
Average	0.20	0.60	0.60	0.40	0.20
Rate[c]	0.40	2.21	0.35	0.22	0.12
MassDOT Crash Rate:[d]	0.61/0.57	0.61/0.57	0.61/0.57	0.61/0.57	0.61/0.57
Significant?[e]	No	Yes	No	No	No
Type:					
Angle	1	0	0	1	0
Rear-End	0	0	0	0	0
Head-On	0	0	0	0	0
Sideswipe	0	0	0	1	0
Fixed Object	0	3	3	0	1
Pedestrian/Bicycle	0	0	0	0	0
Unknown/Other	0	0	0	0	0
Total	1	3	3	2	1
Conditions:					
Clear	1	1	3	1	0
Cloudy	0	0	0	1	0
Rain	0	0	0	0	0
Fog/Smog/Smoke	0	0	0	0	0
Snow/Ice	0	2	0	0	1
Total	1	3	3	2	1
Lighting:					
Daylight	1	2	2	2	1
Dawn/Dusk	0	0	0	0	0
Dark (Road Lit)	0	0	0	0	0
Dark (Road Unlit)	0	1	1	0	0
Total	1	3	3	2	1
Day of Week:					
Monday through Friday	0	2	2	1	1
Saturday	1	0	1	0	0
Sunday	0	1	0	1	0
Total	1	3	3	2	1
Severity:					
Property Damage Only	0	2	1	1	0
Personal Injury	1	0	2	1	1
Fatality	0	0	0	0	0
Unknown	0	1	0	0	0
Total	1	3	3	2	1

[a]Source: MassDOT Safety Management/Traffic Operations Unit records, 2016 through 2020.
[b]Traffic Control Type: U = unsignalized.
[c]Crash rate per million vehicles entering the intersection.
[d]Districtwide/Statewide crash rate.
[e]The intersection crash rate is significant if it is found to exceed the MassDOT crash rate for the MassDOT Highway Division District in which the Project is located (District 3).

FUTURE CONDITIONS

Traffic volumes in the study area were projected to the year 2030, which reflects a seven-year planning horizon from the date of publication of this assessment consistent with MassDOT's *Transportation Impact Assessment (TIA) Guidelines*. Independent of the Project, traffic volumes on the roadway network in the year 2030 under No-Build conditions include all existing traffic and new traffic resulting from background traffic growth. Anticipated Project-generated traffic volumes superimposed upon the 2030 No-Build traffic volumes reflect 2030 Build traffic volume conditions with the Project.

FUTURE TRAFFIC GROWTH

Future 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. The drawback to such a procedure is that some turning volumes may actually grow at either a higher or a 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, potential population growth and development external to the study area would not be accounted for in the resulting traffic projections.

To provide a conservative analysis framework, both procedures were used, the salient components of which are described below.

Specific Development by Others

The Town of Stow Planning Department was consulted in order to determine if there were any projects planned within the study area that would have an impact on future traffic volumes at the study intersections. Based on this consultation, the following projects were identified for inclusion in this assessment:

- ***Pennie Lane Residential Development, Walcott Street, Stow, Massachusetts.*** This project entails the construction of five (5) single-family homes to be located off of Walcott Street and west of the Project site. Traffic volumes associated with this project were estimated

using data published by the Institute of Transportation Engineers (ITE)[9] and were incorporated into the future condition traffic volumes.

- ***Joanne Drive Residential Development, Sudbury Road, Stow, Massachusetts.*** This project entails the construction of seven (7) single-family homes to be located off of Sudbury Road and east of the Project site. Traffic volumes associated with this project within the study area of this assessment are expected to be relatively minor and would be reflected in the general background growth rate (discussion follows).

- ***Athens Street Residential Development, Athens Street, Stow, Massachusetts.*** This project entails the construction of a 141± unit residential community to be located off Athens Street. The residential units will be designed for and marketed toward active adults. Traffic volumes associated with this project were obtained from the traffic study prepared for the project[10] and were incorporated into the future conditions traffic volumes.

- ***Masters' Academy at Former Bose Site, Great Road, Stow, Massachusetts.*** This project entails the redevelopment of the former Bose Stow campus into an academic and sports focused private school for grades 6-12. The redevelopment of the approximately 82± acre site will include substantial renovations to the existing building, the construction of a new ice rink, the addition of workforce housing, and installation of outdoor athletics fields. At this time, a formal application for the project has not been submitted to the Town and, as such, this project and any necessary roadway improvements that would be required to support the project have not been included in the future condition traffic volumes.

No other developments were identified at this time that are expected to result in an increase in traffic within the study area beyond the general background traffic growth rate.

General Background Traffic Growth

Traffic-volume data compiled by MassDOT from permanent count stations located in the area were reviewed in order to determine general traffic growth trends in the area. This data indicates that traffic volumes have fluctuated over the past several years, with the average traffic growth rate found to be approximately 0.61 percent. In order to provide a prudent planning condition for the Project, a slightly higher 1.0 percent per year compounded annual background traffic growth rate was used in order to account for future traffic growth and presently unforeseen development within the study area.

Roadway Improvement Projects

The Town of Stow and MassDOT were contacted in order to determine if there were any planned future roadway improvement projects expected to be complete by 2030 within the study area. Based on these discussions and a review of the roadway improvements that have been identified for other projects within the study area, the following roadway improvement projects were identified within the study area:

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[9]Institute of Transportation Engineer, op. cit. 1.

[10]*Transportation Impact Assessment*; Proposed Active Adult Residential Community, Stow, Massachusetts; VAI; April 2022; and *Response to Transportation Peer Review*, Proposed Residential Development - Athens Street, Stow, Massachusetts; VAI; November 1, 2022.

- ***Hudson Road/Edson Street Intersection Improvements*** – In conjunction with the Athens Street residential development, a STOP-sign and marked STOP-line will be installed on the Edson Street approach to Hudson Road.

- ***Hudson Road/Walcott Street/Randall Road Intersection Improvements*** – In conjunction with the Athens Street residential development, the following improvements will be undertaken at the intersections of Hudson Road with Walcott Street and Randall Road:

  - Replace the STOP-signs and marked STOP-lines on the Walcott Street and Randall Road approaches to include high visibility, thermoplastic pavement markings and the addition or red reflective tape to the sign posts;
  - Selectively trim/remove vegetation located within the sight triangle areas for motorists exiting from Walcott Street and Randall Road; and
  - Install "Intersection Ahead" warning signs (graphic symbol) on Hudson Road north of Randall Road and south of Walcott Street with supplemental street name plaques.

As identified previously, the Town of Stow has completed a Complete Streets Prioritization Plan[11] that identified a number of pedestrian, bicycle, traffic calming and safety improvements for roadways and intersections within the Town. Within the study area, the identified improvements include the construction of a shared-use path or sidewalks along Hudson Road and Route 62. The improvements within the study area are not currently funded at this time; however, the proponent of the Athens Street residential development has committed to providing funding to the Town on a proportional basis ("fair-share" allocation) to advance the improvements identified in the Complete Streets Prioritization Plan along Hudson Road.

Outside of the immediate study area, the proponent of the Athens Street residential development performed a Road Safety Audit (RSA) in order to identify safety-related improvements for the Great Road (Route 117)/Hudson Road intersection and the Town is advancing the design of improvements at the intersection that include the installation of a traffic control signal.

No additional roadway improvement projects aside from routine maintenance activities were identified to be planned within the study area at this time.

No-Build Traffic Volumes

The 2030 No-Build condition peak-hour traffic-volumes were developed by: i) applying the 1.0 percent per year compounded annual background traffic growth rate to the 2022 Existing peak-hour traffic volumes; ii) adding trips generated by the existing operations at the Stow Acres Country Club (18 hole golf course with supporting amenities) which was not in operation at the time the traffic counts that form the basis of this assessment were performed (December);[12] and iii) adding the peak-hour traffic associated with the identified specific development Projects by others (Pennie Lane and Athens Street residential developments). The resulting 2030 No-Build weekday morning, weekday evening and Saturday midday peak-hour traffic volumes are shown on Figures 6, 7 and 8, respectively.

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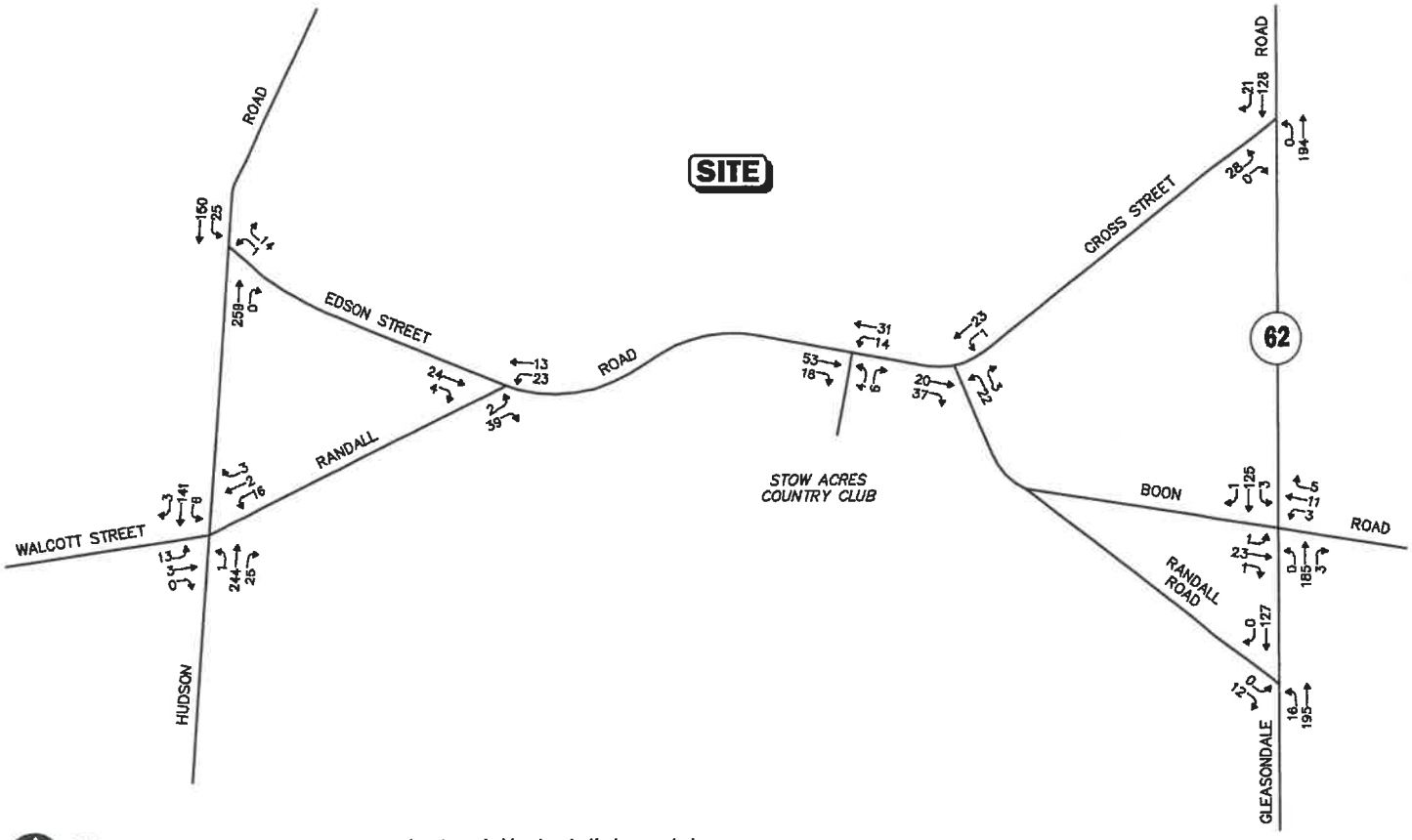
[11]MassDOT Highway Division, Traffic and Safety Engineering, op. cit. 10.

[12]Trips associated with the existing golf course were generated using ITE LUC 430, *Golf Course*, which includes supporting amenities such as a clubhouse, restaurant and functional hall.



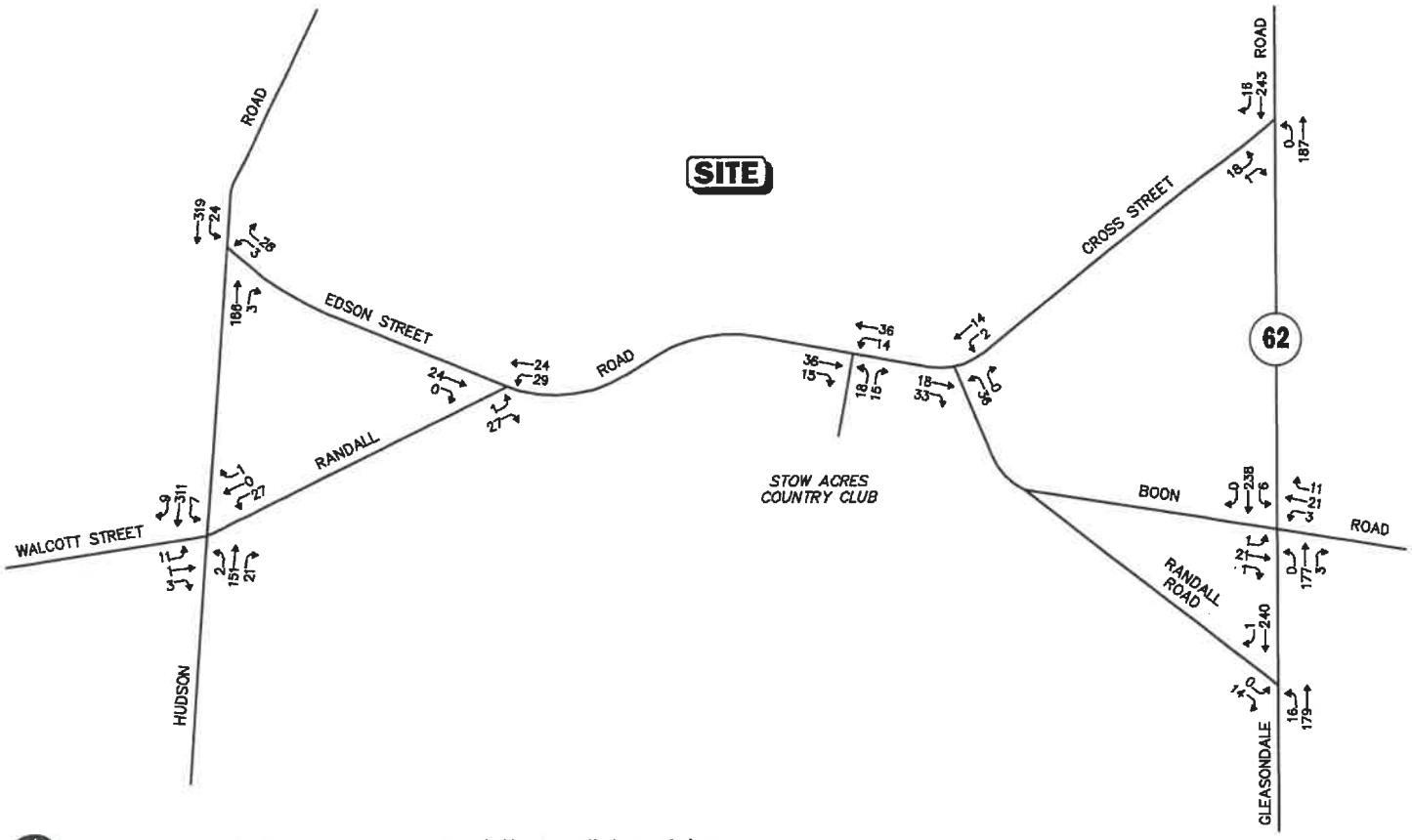
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not to scale

Figure 6

2030 No-Build
Weekday Morning
Peak-Hour Traffic Volumes

Vanasse & Associates inc



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not to scale

Figure 7

2030 No-Build
Weekday Evening
Peak-Hour Traffic Volumes

Vanasse & Associates inc

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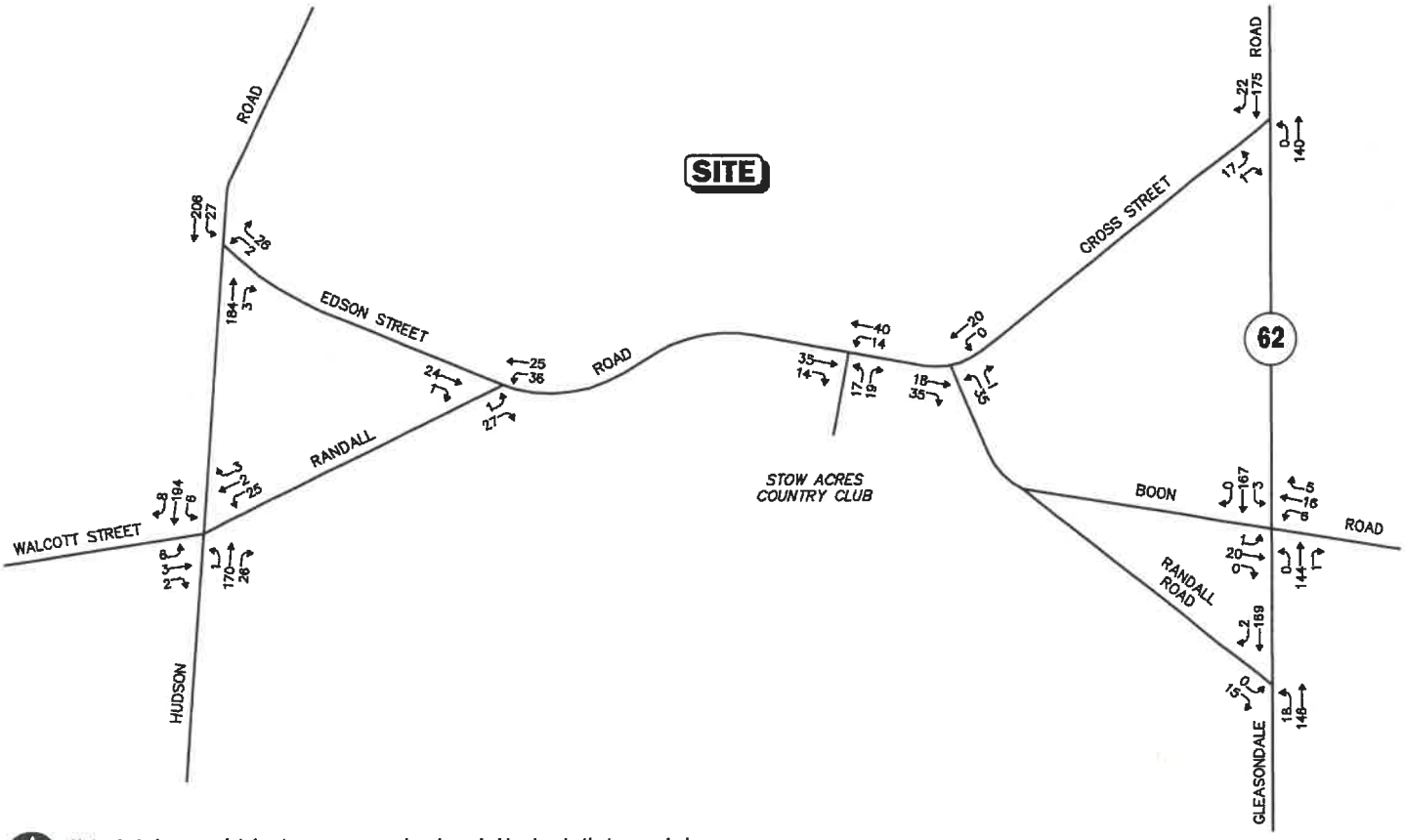

Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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Figure 8

2030 No-Build
Saturday Midday
Peak-Hour Traffic Volumes

Vanasse & Associates inc

PROJECT-GENERATED TRAFFIC

Design year (2030 Build) traffic volumes for the study area roadways were determined by estimating Project-generated traffic volumes and assigning those volumes on the study roadways. The following sections describe the methodology used to develop the anticipated traffic characteristics of the Project.

As proposed, the Project will entail the construction of a 189± unit residential community to be located within a portion of the Stow Acres Country Club. The residential community will include 124± single-family homes, 40± cottage style rental units and 25± age-qualified (age 62+) multifamily units. In order to develop the traffic characteristics of the Project, trip-generation statistics published by the Institute of Transportation Engineers (ITE)[13] for similar land uses as those proposed were used. ITE Land Use Codes (LUCs) 210, *Single-Family Detached Housing*, and 252, *Senior Adult Housing – Multifamily*, were used to develop the base trip-generation characteristics for the Project. Table 5 summarizes the anticipated traffic characteristics of the Project using the above methodology.

[13]Institute of Transportation Engineers, op. cit. 1.

Table 5
TRIP-GENERATION SUMMARY

Time Period/Direction	Vehicle Trips (A) Single-Family Homes and Rental Cottage Units[a]	(B) Senior Housing[b]	(C=A+B) Total Trips (189 Homes)
Average Weekday Daily:			
Entering	796	42	838
Exiting	796	42	838
Total	1,592	84	1,676
Weekday Morning Peak Hour:			
Entering	29	2	31
Exiting	88	3	91
Total	117	5	122
Weekday Evening Peak Hour:			
Entering	100	4	104
Exiting	58	2	60
Total	158	6	164
Average Saturday Daily:			
Entering	776	35	811
Exiting	776	35	811
Total	1,552	70	1,622
Saturday Midday Peak Hour:			
Entering	81	4	85
Exiting	70	4	74
Total	151	8	159

[a]Based on ITE LUC 210, *Single-Family Detached Housing*, applied to 124 single-family homes and the 40 rental cottages units(164 dwelling units total).
[b]Based on ITE LUC 252, *Senior Adult Housing – Multifamily* (25 dwelling units).

Project-Generated Traffic-Volume Summary

As can be seen in Table 5, the Project is expected to generate approximately 1,676 vehicle trips on an average weekday (two-way, 24-hour volume, or 838 vehicles entering and 838 exiting) and approximately 1,622 vehicle trips on a Saturday (also two-way, 24-hour volume, or 811 vehicles entering and 811 exiting), with 122 vehicle trips (31 vehicles entering and 91 exiting) expected during the weekday morning peak-hour, 164 vehicle trips (104 vehicles entering and 60 exiting) expected during the weekday evening peak-hour and 159 vehicle trips (85 vehicles entering and 74 exiting) expected during the Saturday midday peak-hour.

TRIP DISTRIBUTION AND ASSIGNMENT

The directional distribution of generated trips to and from the Project site was determined based on a review of Journey-to-Work data obtained from the U.S. Census for residents of the Town of Stow, and then refined based on existing traffic patterns within the study area. The general trip distribution for the Project is graphically depicted on Figure 9. Traffic volumes expected to be generated by the Project were assigned onto the study area roadway network as shown on Figures 10, 11 and 12 for the weekday morning, weekday evening and Saturday midday peak hours, respectively.

FUTURE TRAFFIC VOLUMES – BUILD CONDITION

The 2030 Build condition traffic volumes consist of the 2030 No-Build traffic volumes with the addition of the traffic expected to be generated by the Project added to them. The 2030 Build weekday morning, weekday evening and Saturday midday peak-hour traffic-volumes are graphically depicted on Figures 13, 14 and 15, respectively. It should be noted that ***traffic volumes attributable to the existing Stow Acres Country Club are included in the 2030 Build condition traffic volumes as the golf course and associated facilities will continue to function with the Project.***

A summary of peak-hour projected traffic-volume increases outside of the study area that is the subject of this assessment is shown in Table 6. These changes are a result of the construction of the Project.

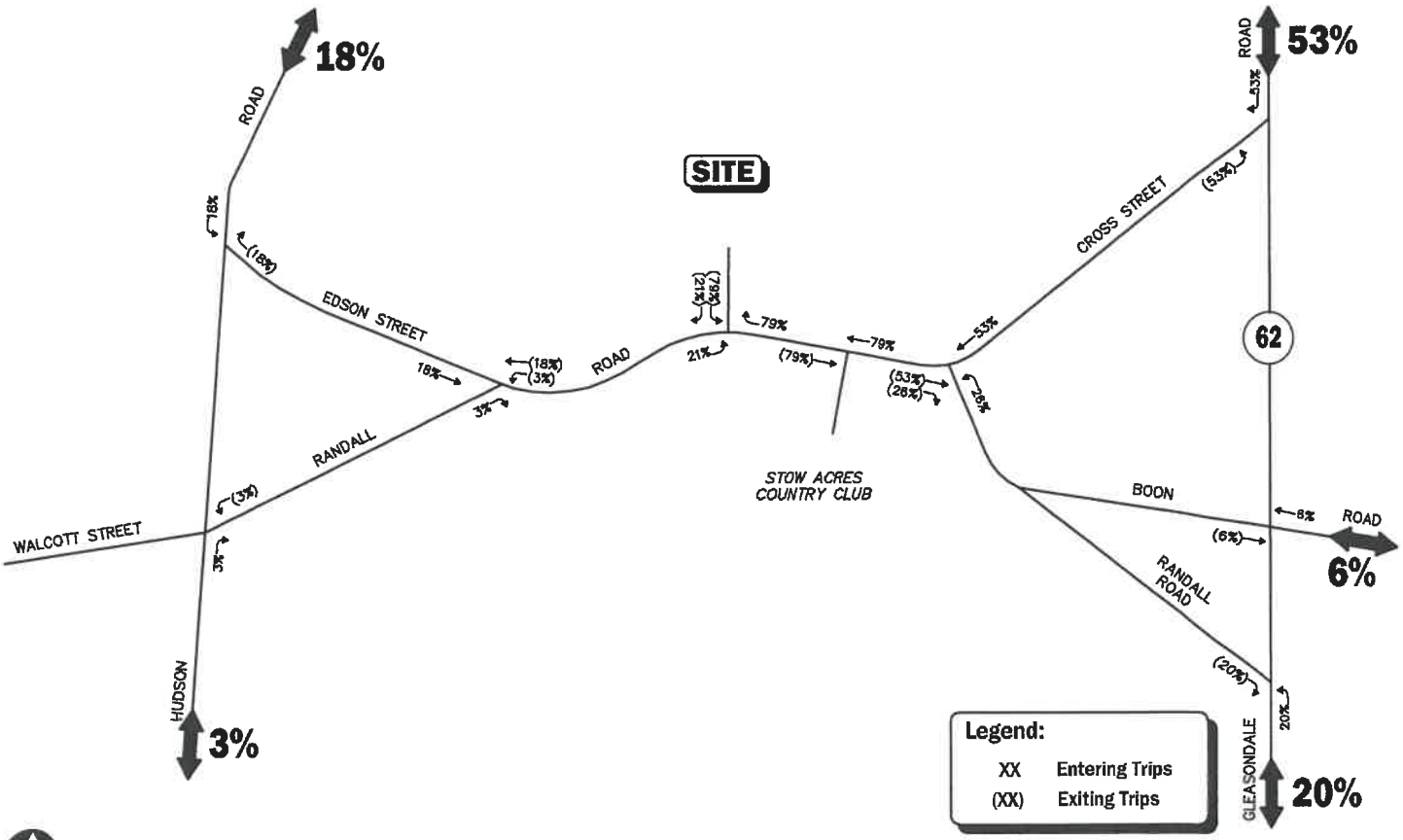

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Figure 9

Trip Distribution Map

Vanasse & Associates inc

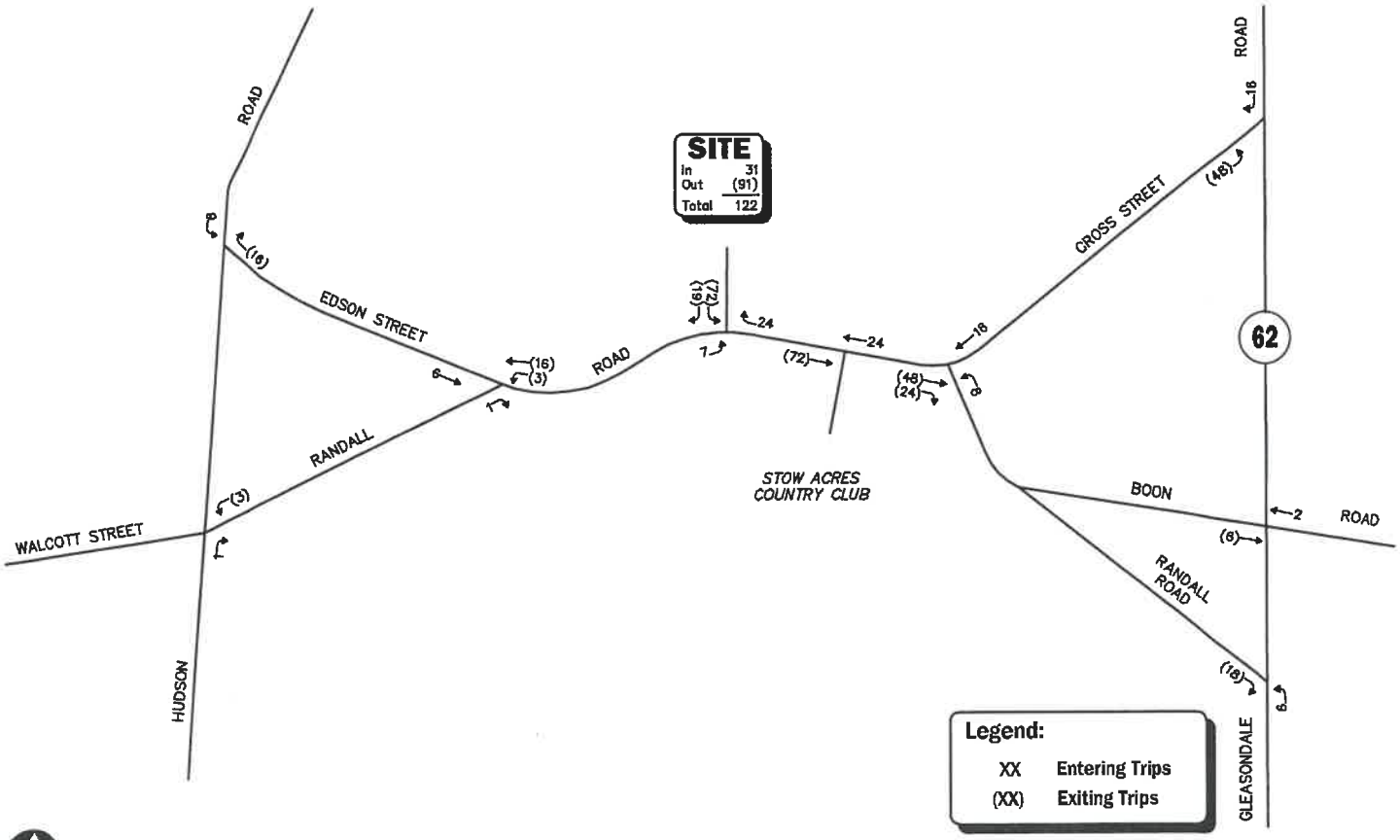

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Figure 10

Project-Generated Weekday Morning Peak-Hour Traffic Volumes

Vanasse & Associates inc

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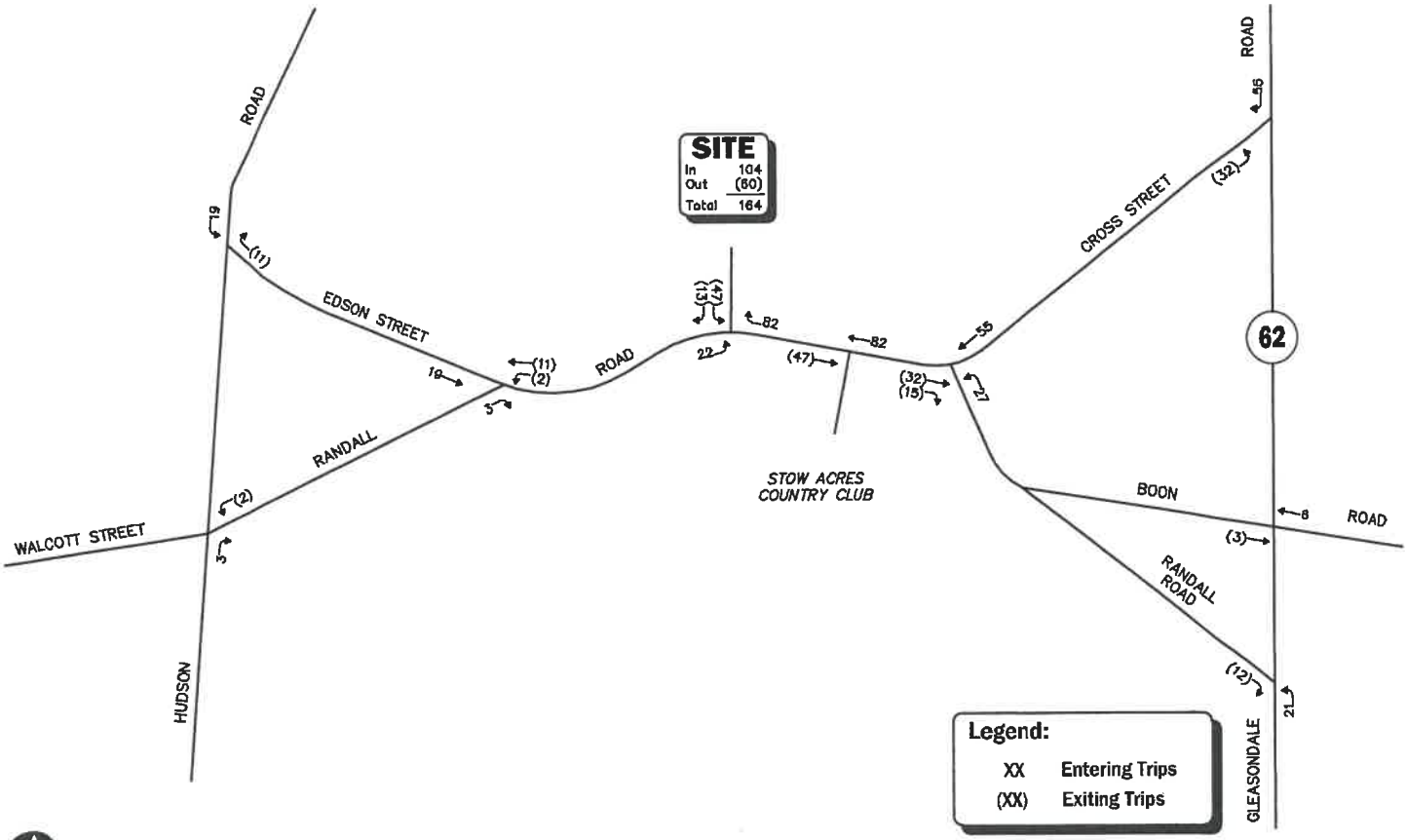

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Figure 11

Project-Generated Weekday Evening Peak-Hour Traffic Volumes

Vanasse & Associates inc

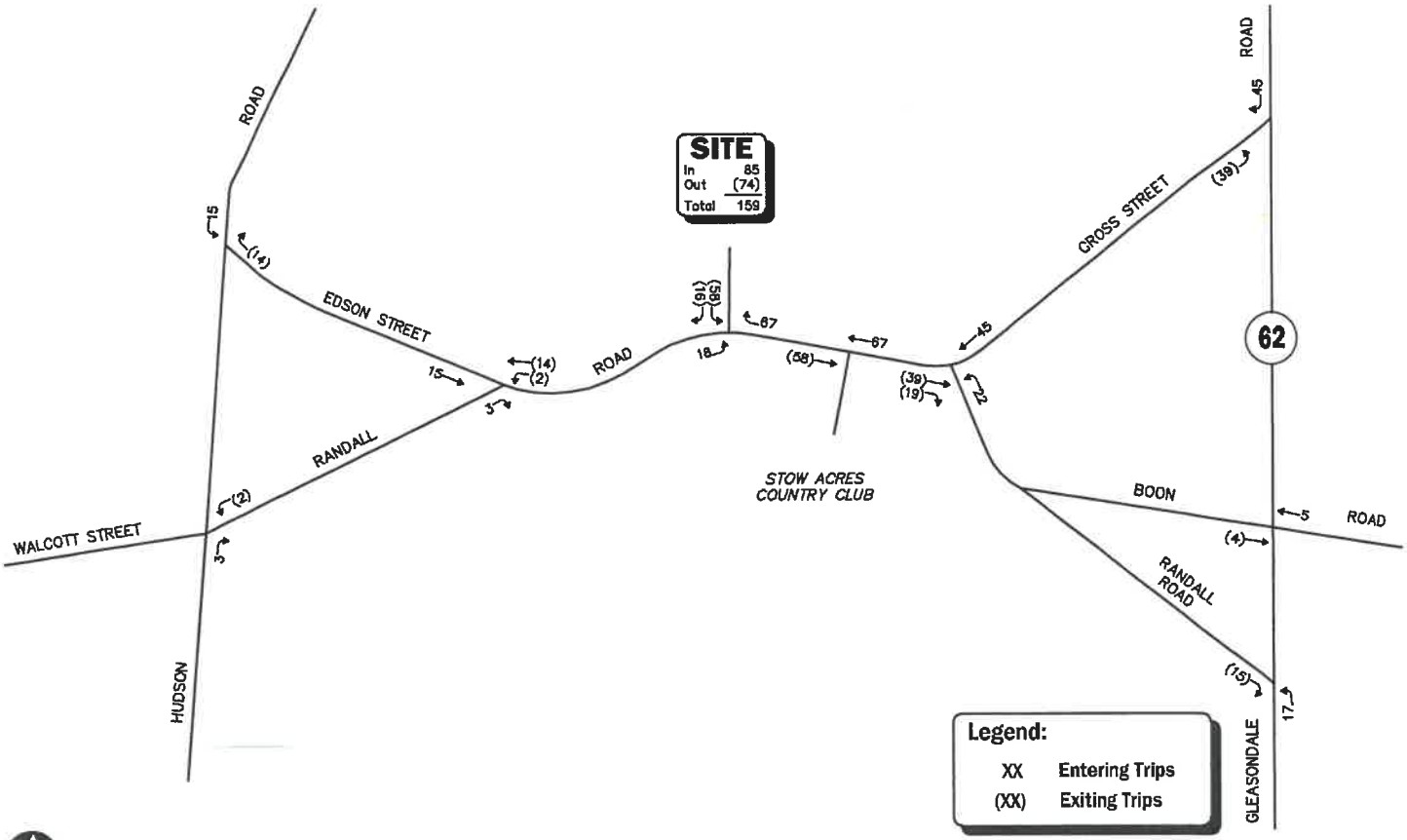

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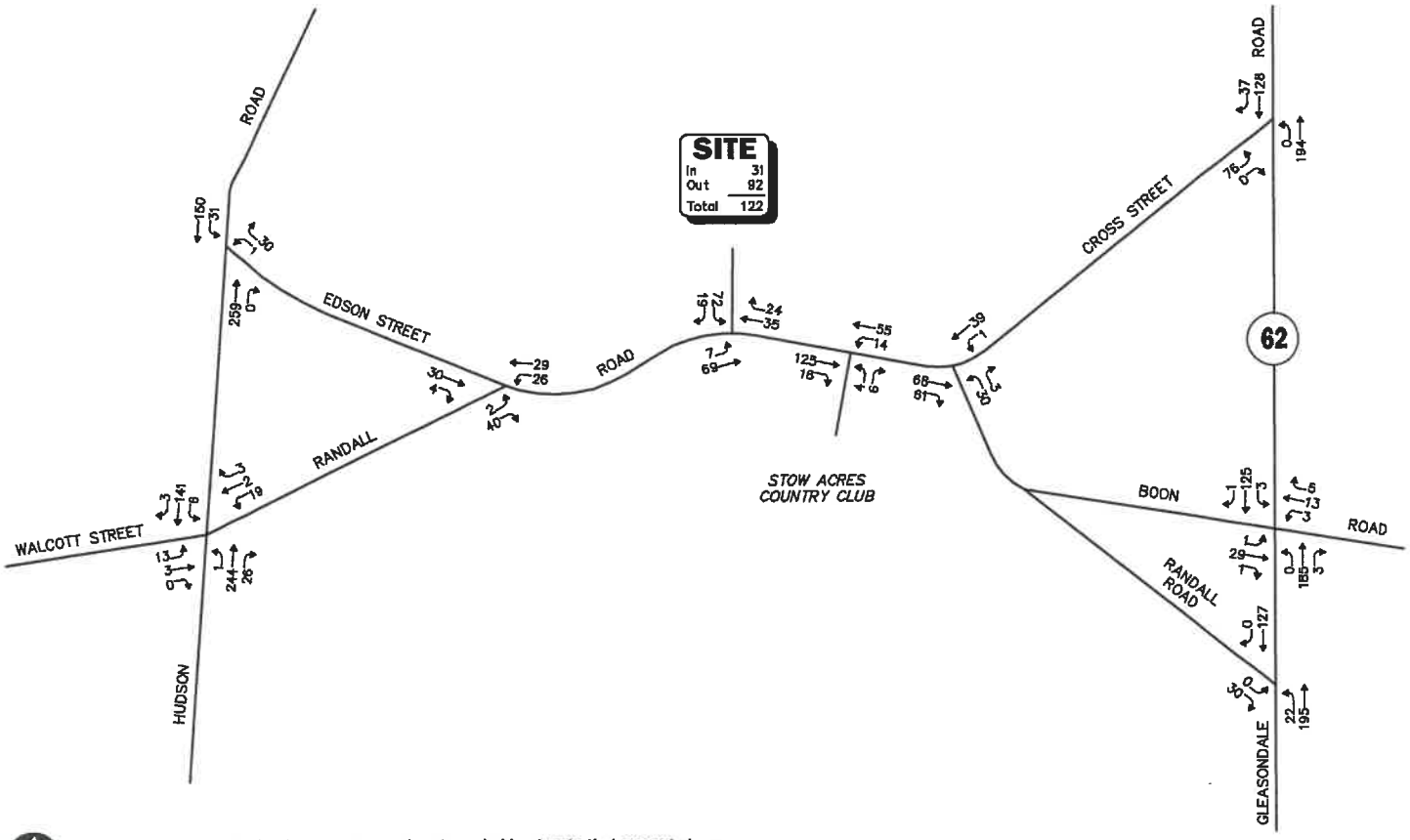
Figure 12

Project-Generated
Saturday Midday
Peak-Hour Traffic Volumes

Vanasse & Associates inc



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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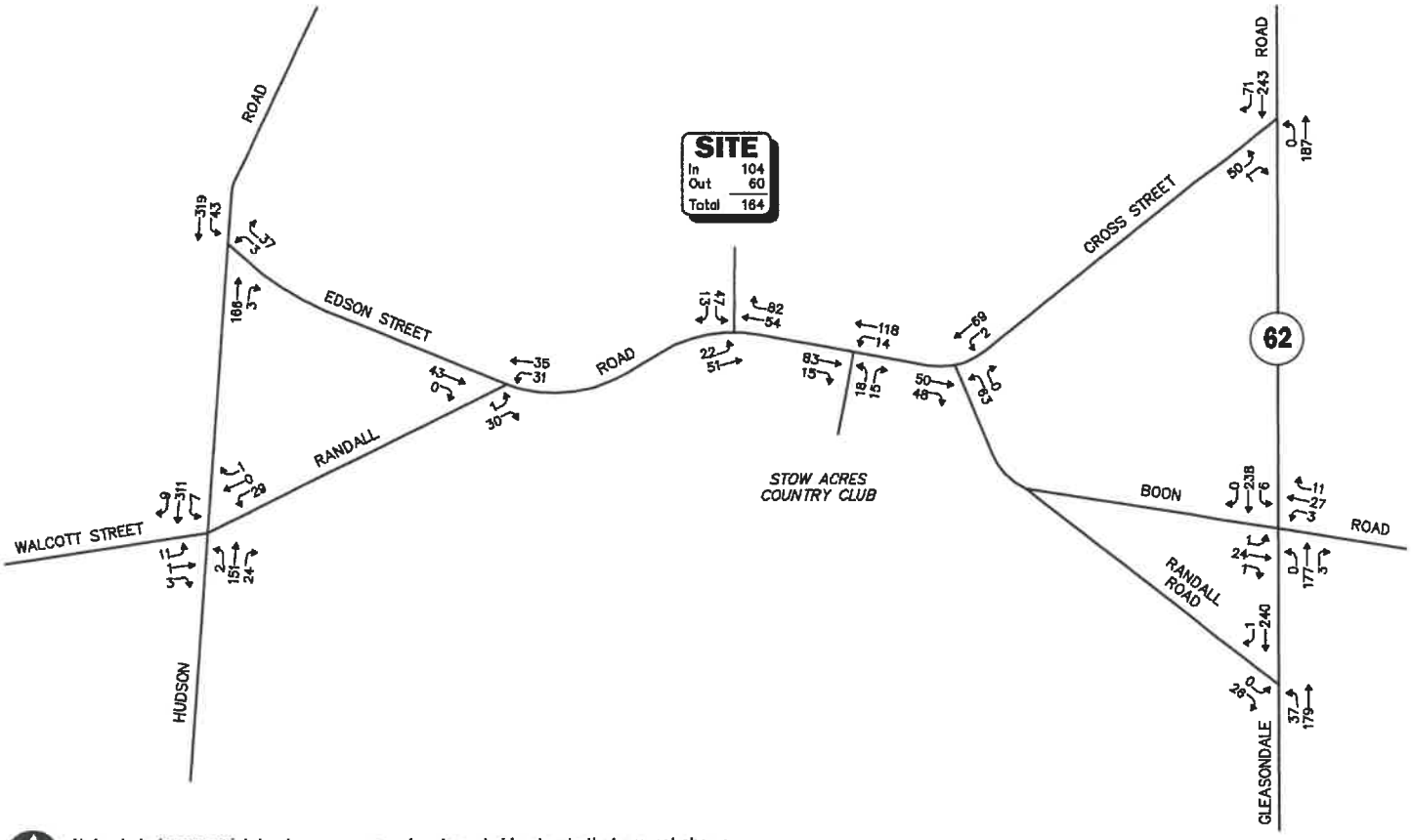
Figure 13

2030 Build
Weekday Morning
Peak-Hour Traffic Volumes

Vanasse & Associates inc



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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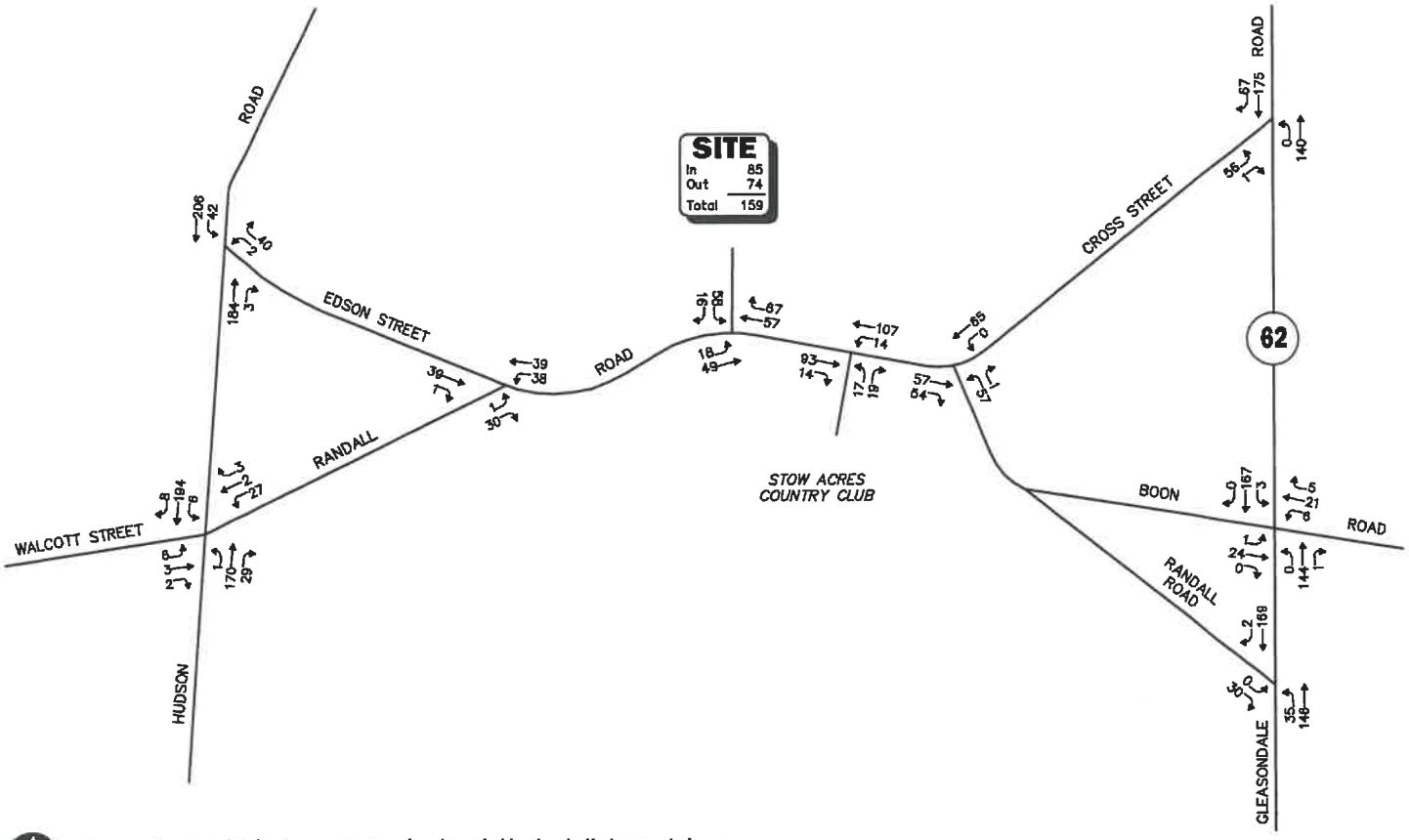
Figure 14

2030 Build
Weekday Evening
Peak-Hour Traffic Volumes

Vanasse & Associates inc



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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Figure 15

2030 Build
Saturday Midday
Peak-Hour Traffic Volumes

Vanasse & Associates inc

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Table 6
PEAK-HOUR TRAFFIC-VOLUME INCREASES

Location/Peak Hour	2022 Existing	2030 No-Build	2030 Build	Traffic Volume Increase Over No-Build	Percent Increase Over No-Build
Hudson Road, north of Edson Street:					
Weekday Morning	338	448	470	22	4.9
Weekday Evening	462	535	565	30	5.6
Saturday Midday	376	443	472	29	6.5
Hudson Road, south of Walcott Street:					
Weekday Morning	375	427	431	4	0.9
Weekday Evening	449	515	520	5	1.0
Saturday Midday	360	418	423	5	1.2
Route 62, north of Cross Street:					
Weekday Morning	336	371	435	64	17.3
Weekday Evening	418	464	551	87	18.1
Saturday Midday	315	354	438	84	23.7
Route 62, south of Randall Road:					
Weekday Morning	313	350	374	24	6.9
Weekday Evening	399	449	482	33	7.3
Saturday Midday	305	348	380	32	9.2
Boon Road, east of Route 62:					
Weekday Morning	44	48	56	8	16.7
Weekday Evening	59	65	74	9	13.9
Saturday Midday	45	51	60	9	17.6

As shown in Table 6, Project-related traffic-volume changes outside of the study area relative to 2030 No-Build conditions are anticipated to range from increases of 0.9 to 23.7 percent during the peak periods, with vehicle increases shown to range from 4 to 87 vehicles.

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.[14] 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.

[14]The capacity analysis methodology is based on the concepts and procedures presented in the *Highway Capacity Manual;* Transportation Research Board; Washington, DC; 2010.

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.*[15] 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
v/c ≤ 1.0	v/c > 1.0	(Seconds Per Vehicle)
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

[a]Source: *Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2016; page 20-6.

[15]*Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2016.

Vehicle Queue Analysis

Vehicle queue analyses are a direct measurement of an intersection's ability to process vehicles under various traffic control and volume scenarios and lane use arrangements. The vehicle queue analysis was performed using the Synchro® intersection capacity analysis software which is based upon the methodology and procedures presented in the 6th Edition *Highway Capacity Manual*. The Synchro® vehicle queue analysis methodology is a simulation based model which reports the number of vehicles that experience a delay of six seconds or more at an intersection. For signalized intersections, Synchro® reports both the average (50th percentile) the 95th percentile vehicle queue. For unsignalized intersections, Synchro® reports the 95th percentile vehicle queue. Vehicle queue lengths are a function of the capacity of the movement under study and the volume of traffic being processed by the intersection during the analysis period. The 95th percentile vehicle queue is the vehicle queue length that will be exceeded only 5 percent of the time, or approximately 3 minutes out of 60 minutes during the peak one hour of the day (during the remaining 57 minutes, the vehicle queue length will be less than the 95th percentile queue length).

ANALYSIS RESULTS

Level-of-service and vehicle queue analyses were conducted for 2022 Existing, 2030 No-Build and 2030 Build conditions for the intersections within the study area. The results of the intersection capacity and vehicle queue analyses are summarized in Table 8. With the detailed analysis results presented in the Appendix.

The following is a summary of the level-of-service and vehicle queue analyses for the intersections within the study area. For context, we note that an LOS of "D" or better is generally defined as "acceptable" operating conditions.

Hudson Road at Edson Street

The addition of Project-related traffic was shown to result in an increase in average motorist delay of 0.1 seconds during the weekday evening and Saturday midday peak hours on the Edson Street approach that caused a change in level-of-service from LOS A to LOS B with a corresponding increase in vehicle queuing of one (1) vehicle (from (0) vehicles to one (1) vehicle).

Hudson Road at Walcott Street and Randall Road

No change in level-of-service or vehicle queuing is predicted to occur for any movement over No-Build conditions, with Project-related impacts generally defined as a predicted increase in average motorist delay of less than 1.0 seconds. All movements at the intersection are predicted to operate at LOS B or better with vehicle queues of up to one (1) vehicle.

Randall Road at Edson Street

No change in level-of-service or vehicle queuing is predicted to occur for any movement over No-Build conditions, with Project-related impacts generally defined as a predicted increase in average motorist delay of less than 1.0 seconds. All movements at the intersection are predicted to operate at LOS A with negligible vehicle queuing predicted.

Randall Road at the Stow Acres Country Club Main Driveway

The addition of Project-related traffic was shown to result in an increase in average motorist delay on the Stow Acres Country Club Main Driveway approach of 1.2 seconds during the weekday evening peak-hour and 0.9 seconds during the Saturday midday peak-hour that caused a change in level-of-service from LOS A to LOS B with a corresponding increase in vehicle queuing of one (1) vehicle (from (0) vehicles to one (1) vehicle).

Randall Road at Cross Street

The addition of Project-related traffic was shown to result in an increase in average motorist delay on the Randall Road northbound approach of 1.3 seconds during the weekday evening peak-hour and 1.6 seconds during the Saturday midday peak-hour that caused a change in level-of-service from LOS A to LOS B with a corresponding increase in vehicle queuing of one (1) vehicle (from (0) vehicles to one (1) vehicle).

Route 62 at Cross Street

No change in level-of-service is predicted to occur for any movement over No-Build conditions with Project-related impacts generally defined as a predicted increase in average motorist delay of up to 1.5 seconds and in vehicle queuing of up to one (1) vehicle. All movements at the intersection are predicted to operate at LOS B or better with vehicle queues of up to one (1) vehicle.

Route 62 at Boon Road

No change in level-of-service is predicted to occur for any movement over No-Build conditions with Project-related impacts generally defined as a predicted increase in average motorist delay of less than 1.0 seconds and in vehicle queuing of up to one (1) vehicle. All movements at the intersection are predicted to operate at LOS B or better with vehicle queues of up to one (1) vehicle.

Route 62 at Randall Road

The addition of Project-related traffic was shown to result in an increase in average motorist delay on the Randall Road approach of 0.2 seconds during the weekday evening peak-hour that caused a change in level-of-service from LOS A to LOS B with no increase in vehicle queueing. All movements at the intersection are predicted to operate at LOS B or better with negligible vehicle queuing predicted.

Randall Road at the Project Site Roadway

All movements exiting the Project site roadway were shown to operate at LOS B or better during the peak periods with vehicle queues of up to one (1) vehicle. All movements along Randall Road approaching the Project site roadway are predicted to operate at LOS A with negligible vehicle queuing.

Table 8
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2022 Existing				2030 No-Build				2030 Build			
Unsignalized Intersection/Peak Hour/Movement	Demand[a]	Delay[b]	LOS[c]	Queue[d] 95th	Demand	Delay	LOS	Queue 95th	Demand	Delay	LOS	Queue 95th
Hudson Road at Edson Street												
Weekday Morning:												
Edson Street WB LT/RT	11	9.9	A	0	15	10.1	B	0	31	10.2	B	0
Hudson Road NB TH/RT	234	0.0	A	0	259	0.0	A	0	259	0.0	A	0
Hudson Road SB LT/TH	144	0.8	A	0	175	1.1	A	0	181	1.4	A	0
Weekday Evening:												
Edson Street WB LT/RT	19	9.8	A	0	29	9.9	A	0	40	10.0	B	1
Hudson Road NB TH/RT	147	0.0	A	0	169	0.0	A	0	169	0.0	A	0
Hudson Road SB LT/TH	302	0.4	A	0	343	0.5	A	0	362	0.9	A	0
Saturday Midday:												
Edson Street WB LT/RT	17	9.6	A	0	28	9.9	A	0	42	10.0	B	1
Hudson Road NB TH/RT	163	0.0	A	0	187	0.0	A	0	187	0.0	A	0
Hudson Road SB LT/TH	201	0.6	A	0	233	0.9	A	0	248	1.3	A	0
Hudson Road at Walcott Street and Randall Road												
Weekday Morning:												
Walcott Street EB LT/TH/RT	13	11.9	B	0	16	12.5	B	0	13	12.5	B	0
Randall Road WB LT/TH/RT	17	11.5	B	0	21	12.3	B	1	24	12.4	B	1
Hudson Road NB LT/TH/RT	241	0.0	A	0	270	0.0	A	0	271	0.0	A	0
Hudson Road SB LT/TH/RT	130	0.3	A	0	150	0.3	A	0	150	0.3	A	0
Weekday Evening:												
Walcott Street EB LT/TH/RT	12	12.2	B	0	15	13.2	B	0	15	13.2	B	0
Randall Road WB LT/TH/RT	21	13.0	B	0	28	14.3	B	1	30	14.4	B	1
Hudson Road NB LT/TH/RT	144	0.1	A	0	174	0.1	A	0	177	0.1	A	0
Hudson Road SB LT/TH/RT	295	0.2	A	0	327	0.2	A	0	327	0.2	A	0
Saturday Midday:												
Walcott Street EB LT/TH/RT	9	11.3	B	0	11	12.0	B	0	11	12.0	B	0
Randall Road WB LT/TH/RT	21	11.5	B	0	30	12.5	B	0	32	12.5	B	0
Hudson Road NB LT/TH/RT	167	0.0	A	0	197	0.0	A	0	200	0.0	A	0
Hudson Road SB LT/TH/RT	185	0.2	A	0	208	0.2	A	0	208	0.2	A	0
Randall Road at Edson Street												
Weekday Morning:												
Edson Street SEB TH/RT	19	0.0	A	0	27	0.0	A	0	34	0.0	A	0
Randall Road NWB LT/TH	26	4.2	A	0	36	4.7	A	0	55	4.7	A	0
Randall Road EB LT/RT	32	8.7	A	0	41	8.8	A	0	42	8.9	A	0
Weekday Evening:												
Edson Street SEB TH/RT	14	0.0	A	0	24	0.0	A	0	43	0.0	A	0
Randall Road NWB LT/TH	35	4.4	A	0	53	4.4	A	0	66	4.4	A	0
Randall Road EB LT/RT	19	8.6	A	0	27	8.7	A	0	31	8.9	A	0
Saturday Midday:												
Edson Street SEB TH/RT	15	0.0	A	0	25	0.0	A	0	40	0.0	A	0
Randall Road NWB LT/TH	40	4.7	A	0	61	4.7	A	0	77	4.7	A	0
Randall Road EB LT/RT	20	8.6	A	0	28	8.7	A	0	31	8.9	A	0

See notes at end of Table.

Table 8 (Continued)
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2022 Existing				2030 No-Build				2030 Build			
Unsignalized Intersection/Peak Hour/Movement	Demand[a]	Delay[b]	LOS[c]	Queue[d] 95th	Demand	Delay	LOS	Queue 95th	Demand	Delay	LOS	Queue 95th
Randall Road at the Stow Acres CC Driveway												
Weekday Morning:												
Randall Road EB TH/RT	49	0.0	A	0	69	0.0	A	0	141	0.0	A	0
Randall Road WB LT/TH	30	0.5	A	0	45	2.3	A	0	69	2.3	A	0
Stow Acres CC Driveway NB LT/RT	3	8.6	A	0	10	9.1	A	0	10	9.8	A	0
Weekday Evening:												
Randall Road EB TH/RT	31	0.0	A	0	51	0.0	A	0	98	0.0	A	0
Randall Road WB LT/TH	31	0.2	A	0	50	2.1	A	0	132	2.1	A	0
Stow Acres CC Driveway NB LT/RT	8	8.9	A	0	33	9.5	A	0	33	10.7	B	1
Saturday Midday:												
Randall Road EB TH/RT	30	0.0	A	0	49	0.0	A	0	107	0.0	A	0
Randall Road WB LT/TH	35	0.2	A	0	54	1.9	A	0	121	1.9	A	0
Stow Acres CC Driveway NB LT/RT	7	8.7	A	0	36	9.2	A	0	36	10.1	B	1
Randall Road at Cross Street												
Weekday Morning:												
Randall Road EB TH/RT	47	0.0	A	0	57	0.0	A	0	129	0.0	A	0
Cross Street WB LT/TH	17	0.5	A	0	24	0.5	A	0	40	0.5	A	0
Randall Road NB LT/RT	17	8.9	A	0	25	9.0	A	0	33	9.7	A	0
Weekday Evening:												
Randall Road EB TH/RT	34	0.0	A	0	51	0.0	A	0	98	0.0	A	0
Cross Street WB LT/TH	9	1.6	A	0	16	1.6	A	0	71	1.6	A	0
Randall Road NB LT/RT	24	8.9	A	0	36	9.2	A	0	63	10.5	B	1
Saturday Midday:												
Randall Road EB TH/RT	35	0.0	A	0	53	0.0	A	0	111	0.0	A	0
Cross Street WB LT/TH	12	0.0	A	0	20	0.0	A	0	65	0.0	A	0
Randall Road NB LT/RT	24	8.8	A	0	36	9.1	A	0	58	10.7	B	1
Route 62 at Cross Street												
Weekday Morning:												
Cross Street EB LT//RT	24	11.0	B	0	28	11.3	B	0	76	12.3	B	1
Route 62 NB LT/TH	179	0.0	A	0	194	0.0	A	0	194	0.0	A	0
Route 62 SB TH/RT	133	0.0	A	0	149	0.0	A	0	165	0.0	A	0
Weekday Evening:												
Cross Street EB LT//RT	12	11.8	B	0	19	12.4	B	0	51	13.9	B	1
Route 62 NB LT/TH	173	0.0	A	0	187	0.0	A	0	187	0.0	A	0
Route 62 SB TH/RT	234	0.0	A	0	259	0.0	A	0	314	0.0	A	0
Saturday Midday:												
Cross Street EB LT//RT	11	10.5	B	0	18	10.9	B	0	57	12.1	B	1
Route 62 NB LT/TH	129	0.0	A	0	140	0.0	A	0	140	0.0	A	0
Route 62 SB TH/RT	176	0.0	A	0	197	0.0	A	0	242	0.0	A	0

See notes at end of Table.

Table 8 (Continued)
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2022 Existing				2030 No-Build				2030 Build			
Unsignalized Intersection/Peak Hour/Movement	Demand[a]	Delay[b]	LOS[c]	Queue[d] 95th	Demand	Delay	LOS	Queue 95th	Demand	Delay	LOS	Queue 95th
Route 62 at Boon Road												
Weekday Morning:												
Boon Road EB LT/TH/RT	23	11.8	B	0	25	12.1	B	0	31	12.3	B	1
Boon Road WB LT/TH/RT	17	11.4	B	0	19	11.6	B	0	21	11.8	B	0
Route 62 NB LT/TH/RT	174	0.0	A	0	188	0.0	A	0	189	0.0	A	0
Route 62 SB LT/TH/RT	119	0.2	A	0	129	0.2	A	0	129	0.2	A	0
Weekday Evening:												
Boon Road EB LT/TH/RT	21	13.1	B	0	23	13.7	B	1	26	13.8	B	1
Boon Road WB LT/TH/RT	32	12.1	B	0	35	12.5	B	1	41	12.9	B	1
Route 62 NB LT/TH/RT	166	0.0	A	0	180	0.0	A	0	180	0.0	A	0
Route 62 SB LT/TH/RT	224	0.2	A	0	244	0.2	A	0	244	0.2	A	0
Saturday Midday:												
Boon Road EB LT/TH/RT	19	11.7	B	0	21	12.0	B	0	24	12.1	B	1
Boon Road WB LT/TH/RT	23	11.2	B	0	27	11.5	B	0	32	11.7	B	1
Route 62 NB LT/TH/RT	134	0.0	A	0	145	0.0	A	0	145	0.0	A	0
Route 62 SB LT/TH/RT	157	0.2	A	0	170	0.2	A	0	170	0.2	A	0
Route 62 at Randall Road												
Weekday Morning:												
Randall Road EB LT//RT	7	9.0	A	0	12	9.1	A	0	30	9.3	A	0
Route 62 NB LT/TH	188	0.3	A	0	211	0.6	A	0	217	0.8	A	0
Route 62 SB TH/RT	118	0.0	A	0	127	0.0	A	0	127	0.0	A	0
Weekday Evening:												
Randall Road EB LT//RT	6	9.7	A	0	14	9.9	A	0	26	10.1	B	0
Route 62 NB LT/TH	171	0.3	A	0	201	0.6	A	0	216	1.4	A	0
Route 62 SB TH/RT	223	0.0	A	0	241	0.0	A	0	241	0.0	A	0
Saturday Midday:												
Randall Road EB LT//RT	6	9.2	A	0	15	9.4	A	0	30	9.5	A	0
Route 62 NB LT/TH	143	0.4	A	0	164	0.8	A	0	181	1.5	A	0
Route 62 SB TH/RT	158	0.0	A	0	171	0.0	A	0	171	0.0	A	0

See notes at end of Table.

Table 8 (Continued)
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Unsignalized Intersection/Peak Hour/Movement	2022 Existing				2030 No-Build				2030 Build			
	Demand[a]	Delay[b]	LOS[c]	Queue[d] 95th	Demand	Delay	LOS	Queue 95th	Demand	Delay	LOS	Queue 95th
Randall Road at the Project Site Roadway												
Weekday Morning:												
Randall Road EB LT/TH	--	--	--	--	--	--	--	--	76	0.5	A	0
Randall Road WB TH/RT	--	--	--	--	--	--	--	--	59	0.0	A	0
Project Site Roadway SB LT/RT	--	--	--	--	--	--	--	--	91	9.8	A	1
Weekday Evening:												
Randall Road EB LT/TH	--	--	--	--	--	--	--	--	73	1.6	A	0
Randall Road WB TH/RT	--	--	--	--	--	--	--	--	136	0.0	A	0
Project Site Roadway SB LT/RT	--	--	--	--	--	--	--	--	60	10.4	B	1
Saturday Midday:												
Randall Road EB LT/TH	--	--	--	--	--	--	--	--	67	1.6	A	0
Randall Road WB TH/RT	--	--	--	--	--	--	--	--	124	0.0	A	0
Project Site Roadway SB LT/RT	--	--	--	--	--	--	--	--	74	10.1	B	1

[a]Demand in vehicles per hour.
[b]Average control delay per vehicle (in seconds).
[c]Level of service.
[d]Queue length in vehicles.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound; LT = left-turning movements; TH = through movements; RT = right-turning movements

SIGHT DISTANCE EVALUATION

Sight distance measurements were performed at the intersection of the Project site roadway with Randall Road in accordance with MassDOT and American Association of State Highway and Transportation Officials (AASHTO)[16] requirements. Both stopping sight distance (SSD) and intersection sight distance (ISD) measurements were performed. In brief, SSD is the distance required by a vehicle traveling at the design speed of a roadway, on wet pavement, to stop prior to striking an object in its travel path. ISD or corner sight distance (CSD) is the sight distance required by a driver entering or crossing an intersecting roadway to perceive an on-coming vehicle and safely complete a turning or crossing maneuver with on-coming traffic. In accordance with AASHTO standards, if the measured ISD is at least equal to the required SSD value for the appropriate design speed, the intersection can operate in a safe manner. Table 9 presents the measured SSD and ISD at the subject intersection.

[16] *A Policy on Geometric Design of Highway and Streets,* 7th Edition; American Association of State Highway and Transportation Officials (AASHTO); Washington D.C.; 2018.

Table 9
SIGHT DISTANCE MEASUREMENTS[a]

Intersection/Sight Distance Measurement	Feet		
	Required Minimum (SSD)	Desirable (ISD)[b]	Measured
Randall Road at Project Site Roadway			
Stopping Sight Distance:			
Randall Road approaching from the east	250	--	500+
Randall Road approaching from the west	250	--	500+
Intersection Sight Distance:			
Looking east from the Project Site Roadway	250	335	78/500+[c]
Looking west from the Project Site Roadway	250	390	265/500+[c]

[a]Recommended minimum values obtained from *A Policy on Geometric Design of Highways and Streets,* 7th Edition; American Association of State Highway and Transportation Officials (AASHTO); 2018; and based on a 35 mph approach speed on Randall Road.

[b]Values shown are the intersection sight distance for a vehicle turning right or left exiting a roadway under STOP control such that motorists approaching the intersection on the major street should not need to adjust their travel speed to less than 70 percent of their initial approach speed.

[c]With the selective trimming or removal of vegetation along the north side of Randall Road within the sight triangle areas of the Project site roadway.

As shown in Table 9, with the selective trimming and/or removal of trees and vegetation located within the sight triangle areas of the Project site roadway along the north side of Randall Road, the available lines of sight at the intersection of the Project site roadway with Randall Road were found to exceed the recommended minimum distances to function in a safe (SSD) and efficient (ISD) manner based on a 35 mph approach speed along Randall Road, which is above both the measured 85th percentile speed vehicle travel speed (32/31 mph) and the posted speed limit in the vicinity of the Project site roadway (25 mph).

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

VAI has completed a detailed assessment of the potential impacts on the transportation infrastructure associated with the proposed construction of a residential community to be known as The Residences at Stow Acres that will be situated within a portion of the Stow Acres Country Club located at 58 Randall Road, in Stow, Massachusetts. 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:

1. Using trip-generation statistics published by the ITE[17], the Project is expected to generate approximately 1,676 vehicle trips on an average weekday and 1,622 vehicle trips on a Saturday (both two-way, 24-hour volumes), with 122 vehicle trips expected during the weekday morning peak-hour, 164 vehicle trips expected during the weekday evening peak-hour and 159 vehicle trips expected during the Saturday midday peak-hour;

2. The Project will not result in a significant impact (increase) on motorist delays or vehicle queuing over anticipated future conditions without the Project (No-Build condition), with all movements at the study area intersections shown to continue to operate at a LOS B or better with the addition of Project-related traffic, where an LOS of "D" or better is defined as "acceptable" traffic operations;

3. All movements exiting the Project site roadway to Randall Road are predicted to operate at LOS B or better during the peak hours with vehicle queues of up to one (1) vehicle predicted;

4. Independent of the Project, the Randall Road/Cross Street intersection was found to have a motor vehicle crash rate that is above the MassDOT average crash rate for a similar intersection. As such, specific recommendations have been provided to advance safety-related improvements at the intersection; and

[17]Institute of Transportation Engineer, op. cit. 1.

5. Lines of sight to and from the intersection of the Project site roadway with Randall Road were found to exceed or could be made to exceed the required minimum distances for the intersection to function in a safe and efficient manner.

In consideration of the above, we have concluded that the Project can be accommodated within the confines of the existing transportation infrastructure in a safe and efficient manner with the implementation of the recommendations that follow.

RECOMMENDATIONS

A detailed transportation improvement program has been developed that is designed to provide safe and efficient access to the Project site and address any deficiencies identified at off-site locations evaluated in conjunction with this study. The following improvements have been recommended as a part of this evaluation and, where applicable, will be completed in conjunction with the Project subject to receipt of all necessary rights, permits and approvals.

Project Access

Access to the Project site will be provided by way of a new roadway that will intersect the north side of Randall Road approximately 480 ft west of Cross Street, with secondary access for emergency vehicles provided by way of a gated driveway that will intersect the north side of Randall Road approximately 180 ft east of the Project site roadway. A raised island is proposed along a portion of the driveway approaching Randall Road that will separate entering and exiting traffic, transitioning thereafter to non-divided access. The following recommendations are offered with respect to the design and operation of the Project site access and internal circulation:

- The entering and exiting travel lanes on the portion of the Project site roadway that includes a raised island will be 12 feet in width and the corner radii and intersection geometry will be designed to support the turning and maneuvering requirements of the largest anticipated responding emergency vehicle and service vehicles (i.e., trash/recycling, etc.).

- Within the Project site beyond the segment of roadway that includes the raised median, the Project site roadway and internal intersecting roadways and alleys should be a minimum of 20 feet in width and designed to accommodate the turning and maneuvering requirements of emergency and service vehicles. If a roadway width of less than 24 feet is used, "No Stopping Any Time" signs shall be installed along both sides of the roadways.

- The emergency vehicle access road should be a minimum of 20 feet in width unless a reduced width is approved by the Fire Department, and should be paved or constructed of a stabilized base material that will support travel by the largest anticipated responding emergency vehicle under all weather conditions and secured by means of a gate or other suitable means of restricting access by general traffic as approved by the Fire Department.

- Where perpendicular parking is proposed, the drive aisle behind the parking should be a minimum of 23 feet in width to facilitate parking maneuvers.

- Vehicles exiting the Project site to Randall Road should be placed under STOP-sign control with a marked STOP-line provided. Within the Project site, STOP-signs and marked STOP-lines should be provided at major intersections.

- "Keep Right" signs should be provided on the approaches to the raised island.

- All signs and pavement markings to be installed within the Project should conform to the applicable standards of the *Manual on Uniform Traffic Control Devices* (MUTCD).[18]

- A sidewalk should be provided along at least one side of the Project site roadway and the internal roadway network that should extend to Randall Road.

- Marked crosswalks and Americans with Disabilities Act (ADA)-compliant wheelchair ramps should be provided for crossing the Project site roadway and at pedestrian crossings within the Project site.

- Signs and landscaping to be installed as a part of the Project within intersection sight triangle areas should be designed and maintained so as not to restrict lines of sight.

- Snow accumulations (windrows) within sight triangle areas should be promptly removed where such accumulations would impede sight lines.

Off-Site

Randall Road at Cross Street

Independent of the Project, the Randall Road/Cross Street intersection was identified to have a motor vehicle crash history that warrants further review and the advancement of specific improvements to enhance safety. In an effort to improve safety at the intersection, consideration should be given to making Cross Street one-way northeastbound (toward Route 62), to the extent the improvement is desired by the Town, which would address the predominant crash pattern (single vehicle collisions where a motorist traveling on Cross Street toward Randall Road slid on a snow or ice covered roadway and collided with a fixed roadside object). In lieu of or prior to the implementation of one-way operation of Cross Street, the following improvements should be considered for advancement at the intersection:

- Install a STOP-sign and marked STOP-line on the Cross Street approach to reflect the predominant traffic flow at the intersection (along Randall Road). In conjunction with the STOP-sign installation, red reflective tape should be added to the STOP-sign post and an advance "Stop Sign Ahead" warning sign (W3-1) should be installed on Cross Street approximately 100 feet north of the intersection;

- Remove the "Yield" sign on the Randall Road westbound approach; and

- Install "Intersection Ahead" warning signs (graphic symbol) with a supplemental street name sign ("Cross Street") on the Randall Road approaches approximately 100 feet east and west of Cross Street, with the sign posts to include yellow reflective tape.

The Project proponent will coordinate with the Town on the desired improvement strategy and will design and construct the selected improvements prior to the issuance of a Certificate of Occupancy subject to receipt of all necessary rights, permits and approvals.

With the implementation of the above recommendations, safe and efficient access can be provided to the Project site and the Project can be accommodated within the confines of the existing transportation infrastructure.

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[18]Federal Highway Administration, op. cit. 3.