

## *4 Traffic Impact and Access Study*

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October 29, 2012

Town of Wellesley Planning Board

RE: A&M Project # 1828-02  
Wellesley Country Club  
Turf Care and Paddle Facility PSI  
Project  
Traffic Impact Analysis

Allen & Major Associates Inc. (A&M) is pleased to submit this traffic summary regarding the potential impacts on the surrounding roadway network as a result of this project.

The Traffic Impact and Access Study report was prepared by Ron Muller & Associates as is included herein.



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# Traffic Impact and Access Study

## Wellesley Country Club Improvements Wellesley, Massachusetts

Prepared for:

**Allen & Major Associates, Inc.**  
10 Main Street  
Lakeville, MA 02347

**July 5, 2012**

**Quality**



**Accuracy**



**Integrity**





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## Traffic Impact and Access Study

To: Mr. Phil Cordeiro  
Allen & Major Associates, Inc.  
10 Main Street  
Lakeville, MA 02347

Reg: Country Club Improvements  
Wellesley Country Club  
Wellesley, Massachusetts

From: Ron Müller, P.E., Principal

Date: July 5, 2012  
Project #: 12016

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### INTRODUCTION

*Ron Müller & Associates* (RMA) has conducted this Traffic Impact and Access Study to evaluate the traffic and pedestrian/bicycle safety portions of the Special Permit for a Project of Significant Impact (PSI) with respect to improvements proposed at the Wellesley Country Club in Wellesley, Massachusetts. This study has been prepared in accordance with Section XVIA (Project Approval) of the Wellesley bylaws.

As part of the proposed improvement project, a comfort station will be developed in the northeast corner of the site, a 2,300± square foot golf cart refueling and wash-down station and 20 additional parking spaces will replace the existing maintenance building, and a new 22,000± square foot maintenance building as well as an environmental management center will be developed off of the existing Forest Street driveway. Based on the size of the relocated maintenance building, this project exceeds the thresholds for a PSI.

The improvement project will not add new employees or services that would bring additional traffic to the site or surrounding areas. Rather, it is an improvement to facilities that currently exist at the country club. However, the relocation of the maintenance building from the club house area off of Wellesley Avenue to Forest Street will result in a slight redistribution of traffic on the local roadway network. Accordingly, this study evaluates the impact of the maintenance building relocation as well as the additional requirements defined in the local bylaws for PSI submissions related to vehicle, pedestrian, and bicycle traffic. The site in relation to the surrounding roadway network is shown in Figure 1.

**Figure 1**  
**Site Location Map**



## EXISTING CONDITIONS

### Study Area

Evaluation of the traffic impacts associated with the proposed country club improvements, specifically the relocation of the existing maintenance building, requires an evaluation of existing and projected traffic volumes, the volume of traffic expected to be redistributed as a result of the project, and the impact that this traffic redistribution will have on the adjacent streets and nearby intersections. The traffic study area was established based on the roadways

and intersections potentially impacted by the proposed project as well as border the site and include the following roadways and intersections:

- Wellesley Avenue
- Forest Street
- Wellesley Avenue at Forest Street
- Wellesley Avenue at Brookside Road
- Forest Street at the existing/proposed site driveway

In addition, sight distances were reviewed at the existing site driveways along Wellesley Avenue to assure that safe operating conditions exist. Although the project will likely reduce traffic to these driveways as a result of the maintenance facility relocation, the review revealed a recommendation that will improve access/egress for those vehicles that will continue to use these driveways. All roadways and intersections within this study area are under the jurisdiction of the Town of Wellesley. The proposed country club improvement project is expected to have a negligible effect on traffic operations beyond this study area.

**Wellesley Avenue** is two lane roadway (one lane in each direction) with a well-defined double yellow center and white edge lines providing 11-foot wide travel lanes and 2-foot wide shoulders. Land use along Wellesley Avenue in the vicinity of the site includes the Wellesley Country Club, Babson College, and residential dwellings. Pavement along Wellesley Avenue is generally in good condition. There are no sidewalks along Wellesley Road adjacent to site. However, there is a 5-foot wide bituminous concrete sidewalk located within 600 feet of the site property to the west beyond the intersection of Forest Street on the southerly side of the roadway adjacent to Babson College. This sidewalk is part of the sidewalk network adjacent to Babson College extending along Forest Street as well as part of the Charles River Link Trail. The sidewalk appears to be in fair to good condition with no significant signs of cracking, deterioration, heaving, sinking, shifting, patching, missing sections, encroaching vegetation, or obstacles. There is one section of the sidewalk where it appears tree roots are beginning to heave the sidewalk as shown in Figure 2.

**Forest Street** is two lane roadway (one lane in each direction) with a well-defined double yellow center line and white edge lines providing 12-foot wide travel lanes and 2-foot wide shoulders south of Wellesley Avenue and 11-foot wide travel lanes and 1-foot wide shoulders north of Wellesley Avenue. Land use along Forest Street in the vicinity of the site includes the Wellesley Country Club, Babson College, and residential dwellings. Pavement along Forest Street is generally in fair to good condition. There is a 6-foot wide bituminous sidewalk on the westerly side of Forest Street extending from the Babson College driveway northerly through the intersection with Wellesley Avenue. An 8-foot wide painted crosswalk is provided across the Wellesley Avenue eastbound intersection approach connecting the area sidewalk network. The sidewalk appears in good condition with no significant signs of cracking, deterioration, heaving, sinking, shifting, patching, missing sections, encroaching vegetation, or obstacles as shown in Figure 3.

**Figure 2**  
**Wellesley Road looking west towards the Wellesley Country Club (left)**  
**Wellesley Road sidewalk looking east towards Forest Street (right)**



**Figure 3**  
**Forest Street looking north towards Wellesley Road**



*Wellesley Avenue and Forest Street* intersect to form a four-way unsignalized intersection under all-way STOP-sign control. Left-turns from the Wellesley Avenue westbound approach to Forest Street and right-turns from Forest Street northbound onto Wellesley Avenue are channelized by a raised delta island and are also under STOP-sign control. Both the Wellesley Avenue eastbound and westbound approaches provide a 12-foot wide single lane approach with

a 2-foot wide shoulder under STOP control and have visible STOP lines. An 8-foot wide painted crosswalk is provided across the west leg of the intersection. The Forest Street northbound approach provides a 12-foot wide single lane with a 2-foot wide shoulder under STOP-sign control and has a visible STOP line. The Forest Street southbound approach provide an 11-foot wide single lane with a 1-foot wide shoulder under STOP-sign control and has a visible STOP line. Sightlines are provided on each of the four intersection approaches that allow each vehicle at the STOP line to see vehicles at each of the other three STOP lines. The intersection delta island is shown in Figure 4.

**Figure 4**  
**Wellesley Avenue intersection with Forest Street**



**Wellesley Avenue and Brookside Road** intersect to form a four-way unsignalized intersection with the Brookside Road northbound and southbound approaches under STOP-sign control. The Brookside Road northbound approach traffic is separated by a raised median island as shown in Figure 5 and provides a 15-foot wide general-purpose lane. The Brookside Road southbound approach provides a single 11-foot wide general-purpose lane. The Wellesley Avenue eastbound and westbound approaches each provide an 11-foot wide single general-purpose lane. A sightline evaluation for this intersection is provided in the “Sight Distance” section of this report.

**Forest Street and the Existing/Proposed Site Driveway** meet to form a three-way unsignalized intersection with the westbound site driveway approach under STOP control. The Forest Street approaches each provide a 12-foot wide single general purpose lane with 1- to 2-foot wide shoulders as shown in Figure 6. The site driveway approach provides a 14-foot wide single general-purpose lane which widens at the intersection with Forest Street. A sightline evaluation for this intersection is provided in the “Sight Distance” section of this report.

**Figure 5**  
**Brookside Road northbound approach to Wellesley Road**



**Figure 6**  
**Brookside Road northbound approach to Wellesley Road**



## **Traffic Volumes**

Base traffic conditions within the study area were developed by conducting automatic traffic recorder (ATR) counts on Wellesley Avenue east of the site and along Forest Street adjacent to the existing/proposed site driveway to collect weekday as well as weekend traffic volume data and by conducting manual turning movement and vehicle classification counts (TMCs) at the study area intersections. The Wellesley Avenue ATR counts and all traffic TMC's were conducted in March 2012 and the Forest Street ATR counts were performed in June 2012. All traffic count data are provided in the Appendix.

The TMCs were performed during the weekday AM peak period (7:00 to 9:00 AM), the weekday PM peak period (4:00 to 6:00 PM), and the Saturday midday peak period (11:00 AM to 2:00 PM) to collect peak period data during times when both the adjacent street volumes are highest. The count data indicate that the weekday AM peak hour generally occurs from 7:45 to 8:45 AM, the weekday PM peak hour from 4:30 to 5:30 PM, and the Saturday midday peak hour from 12:00 to 1:00 PM. However, the individual intersection peak hours were used to present a conservative analytical framework.

To determine if the count data needed to be adjusted to represent annual average month conditions consistent with state and local guidelines for traffic impact assessment, historical traffic volume data were obtained from the Massachusetts Department of Transportation (MassDOT). The nearest MassDOT permanent count station is located on I-95 in Newton, south of Route I-90 (Station No. 415). Based on this information, traffic during the month of March is approximately 0.5 percent below annual average month traffic conditions and therefore, the March traffic count data were increased by 0.5 percent to reflect annual average traffic volume conditions. June traffic volumes (Forest Street ATR) are approximately 4.5 percent above annual average month conditions and were therefore used without any adjustment. The MassDOT permanent count station data are provided in the Appendix and the peak hour traffic flows are summarized in Table 1. The 2012 Existing peak hour traffic flow networks are provided on Figure 7.



**Table 1**  
**Existing Average-Month Traffic Volume Summary**

Location/Time Period	Daily Volume <sup>a</sup>	Peak Hour Volume <sup>b</sup>	K-Factor <sup>c</sup>	Directional Distribution <sup>d</sup>
<b>Wellesley Avenue</b>				
<b>East of the Site:</b>				
Weekday	9,180	AM: 1,038 PM: 856	11.3% 9.3%	60% EB 53% WB
Saturday	5,660	Midday: 471	8.3%	51% EB
Sunday	4,050	Midday: 401	9.9%	51% EB
<b>Forest Street</b>				
<b>Adjacent to the Site:</b>				
Weekday	5,880	AM: 433 PM: 560	7.4% 9.5%	55% SB 57% NB
Saturday	4,100	Midday: 467	11.3%	50% NB
Sunday	4,200	Midday: 405	9.6%	50% NB

<sup>a</sup>In vehicles per day. Note: Daily volumes were adjusted by applying the K-Factor from the ATR counts to the TMC volumes.

<sup>b</sup>In vehicles per hour from TMCs.

<sup>c</sup>Percentage of daily traffic occurring during the peak hour.

<sup>d</sup>EB = eastbound, WB = westbound, NB = northbound, SB = southbound.

## **Accidents**

Accident data for the study area intersections were obtained from MassDOT for the period between 2007 and 2009, the latest three years of available data. A summary of the MassDOT accident data is provided in Table 2. In addition to the summary, accident occurrence should also be compared to the volume of traffic through a particular intersection to determine any significance. Accordingly, the accident rate was calculated for each intersection and compared with the statewide and district-wide averages. An intersection accident rate is a measure of the frequency of accidents compared to the volume of traffic through an intersection and is presented in accidents per million entering vehicles (acc/mev). For unsignalized intersections, the statewide average accident rate is 0.61 acc/mev and the district-wide accident rate is 0.57 acc/mev. A comparison of the calculated accident rate to the statewide and district-wide averages can be used to establish the significance of accident occurrence and whether or not potential safety problems exist. The crash rate worksheets are provided in the Appendix.

**Table 2**  
**Accident Summary**

Location	Number of Accidents			Severity <sup>a</sup>			Accident Type <sup>b</sup>						% During Wet/Icy Conditions
	Total	Avg./Year	Accident Rate <sup>c</sup>	PD	PI	F	CM	RE	HO	FO	Ped	Other	
Wellesley Ave at Forest Street	11	3.7	0.80	9	2	0	6	5	0	0	0	0	45%
Wellesley Ave at Brookside Road	9	3.0	0.80	8	1	0	5	1	0	3	0	0	29%
Site Driveway Intersections	0	0.0	0.00	0	0	0	0	0	0	0	0	0	0%

Source: MassDOT Traffic Operations Safety Management System – 2007 through 2009 data.

<sup>a</sup> PD = property damage only; PI = personal injury; F = fatality.

<sup>b</sup> CM = cross movement/angle; RE = rear end; HO = head on; FO = fixed object; Ped = pedestrian.

<sup>c</sup> Measured in accidents per million entering vehicles.

As shown in Table 2, the intersection of Wellesley Avenue with Forest Street experienced 11 accidents over a three-year period. Although the calculated accident rate is above both the statewide and district-wide averages for unsignalized intersections, almost half of the accidents occurred during adverse weather conditions. It was noticed that at this four-way STOP intersection, two of the approaches were missing the “4-way” sign under the STOP sign. Inclusion of this sign would better advise the drivers of the 4-way STOP condition. Of the 11 accidents, only 2 reported personal injuries and none of the accidents involved a pedestrian or bicycle.

The intersection of Wellesley Avenue with Brookside Road experienced 9 accidents over a three-year period. Although the calculated accident rate is above both the statewide and district-wide averages for unsignalized intersections, 3 of the 9 accidents were drivers hitting a fixed object with one including a deer. Sight distances were reviewed at this location and indicate no safety issues. However, vegetation at the intersection corners should be periodically trimmed to assure that adequate sight distances are maintained. Of the 9 accidents, only 1 reported a personal injury and none of the accidents involved a pedestrian or bicycle. There were no reported accidents at the Wellesley Country Club driveways during this three-year time period.

### **Vehicle Speeds**

Speed measurements were conducted along Wellesley Avenue east of the site and along Forest Street adjacent to the existing/proposed site driveway by measuring the elapsed time for vehicles traveling a short, pre-measured distance between two checkpoints. The travel time was recorded

using automatic traffic recorders and the speed is derived by dividing the elapsed time into the measured distance between checkpoints. The results of the speed measurements are summarized in Table 3.

**Table 3**  
**Observed Travel Speeds <sup>a</sup>**

Location/Direction	Posted Speed Limit <sup>b</sup>	Average Speed	85 <sup>th</sup> Percentile Speed <sup>c</sup>
<b>Wellesley Avenue</b>			
<b>East of the Site:</b>			
<i>Eastbound</i>	NA <sup>c</sup>	36	41
<i>Westbound</i>	NA	36	40
<b>Forest Street</b>			
<b>Adjacent to the Site:</b>			
<i>Northbound</i>	NA <sup>c</sup>	29	33
<i>Southbound</i>	NA	36	43

<sup>a</sup> In miles per hour (mph).

<sup>b</sup> Speed limit not posted.

<sup>c</sup> Speed at, or below which 85 percent of all observed vehicles travel.

### **Sight Distance**

To identify potential safety concerns associated with site access and egress, sight distances have been evaluated at the existing/proposed site driveway intersection with Forest Street as well as the existing site driveways along Wellesley Avenue to determine if the available sight distances for vehicles exiting the site meet or exceed the minimum distances required for approaching vehicles to safely stop. Sight distances were also reviewed at the Wellesley Avenue and Brookside Road intersection as this intersection was included within the study area. The available sight distances were compared with minimum requirements, as established by the American Association of State Highway and Transportation Officials (AASHTO).<sup>1</sup> AASHTO is the national standard by which vehicle sight distance is calculated, measured, and reported.

Intersection sight distance (ISD) is provided on minor street approaches to allow the drivers of stopped vehicles a sufficient view of the major roadway to decide when to enter the major roadway. By definition, ISD is the minimum distance required for a motorist exiting a minor street to turn onto the major street, without being overtaken by an approaching vehicle reducing its speed from the design speed to 70 percent of the design speed. ISD is measured from an eye height of 3.5 feet to an object height of 3.5 feet above street level. The use of an object height

<sup>1</sup>A *Policy on Geometric Design of Highways and Streets*; American Association of State Highway and Transportation Officials (AASHTO); 2004.

equal to the driver eye height makes intersection sight distances reciprocal (i.e., if one driver can see another vehicle, then the driver of that vehicle can also see the first vehicle). When the minor street is on an upgrade that exceeds 3 percent, grade correction factors are applied.

SSD is generally more important as it represents the minimum distance required for safe stopping while ISD is based only upon acceptable speed reductions to the approaching traffic stream. However, the ISD must be equal to or greater than the minimum required SSD in order to provide safe operations at the intersection. In accordance with the AASHTO manual, *“If the available sight distance for an entering or crossing vehicle is at least equal to the appropriate stopping sight distance for the major road, then drivers have sufficient sight distance to anticipate and avoid collisions. However, in some cases, this may require a major-road vehicle to stop or slow to accommodate the maneuver by a minor-road vehicle. To enhance traffic operations, intersection sight distances that exceed stopping sight distances are desirable along the major road.”* Accordingly, ISD should be at least equal to the distance required to allow a driver approaching the minor road to safely stop.

The available SSD and ISD at the site driveways as well as the Wellesley Avenue intersection with Brookside Road were measured and compared to minimum requirements as established by AASHTO. Since the requirements are based on the speed of traffic on the adjacent streets, the results of the vehicle speed observations were used for this purpose. The required minimum sight distances for these speeds are compared to the available distances, as shown in Table 4.

As shown, the available intersection sight distances in both directions at the Brookside Road approaches to Wellesley Road are in excess of the minimum requirements and desirable distances and safe operation can therefore be expected. The sight distances to the north and south of the proposed Forest Street driveway are currently obscured by brush and trees on the site and within the Forest Street layout. It is therefore recommended that this brush be cleared and smaller trees removed to achieve the distances shown in the table above. With this work, the minimum and desirable sight distances can be exceeded and safe operation can therefore also be expected at the proposed Forest Street driveway.

The available sight distances at the existing Wellesley Avenue driveways exceed the minimum sight distances with the trimming of the existing bushes between the two site driveways and safe operation can therefore also be expected. The desirable intersection sight distances to the east of the eastern site driveway and to the west of the western site driveway are not meet. Intersection sight distance, however, is only based upon acceptable speed reductions and ample distance exists for an oncoming motorist on Wellesley Avenue to stop and avoid a collision with a vehicle exiting the driveway.

**Table 4**  
**Sight Distance Summary**

Location/Direction	Intersection Sight Distance (feet)		
	Measured	Minimum Required <sup>a</sup>	Desirable <sup>b</sup>
<b>Brookside Rd. (NB) at Wellesley Ave.:</b>			
East of intersection	500+	305	445
West of Intersection	500+	315	455
<b>Brookside Rd. (SB) at Wellesley Ave.:</b>			
East of intersection	500+	305	445
West of Intersection	500	315	455
<b>Forest Street at Site Driveway</b>			
North of intersection	140/475 <sup>c</sup>	340	475
South of intersection	170/365 <sup>c</sup>	230	365
<b>Wellesley Ave. East Site Driveway</b>			
East of intersection	410	305	445
West of intersection	500 <sup>d</sup>	315	455
<b>Wellesley Ave. West Site Driveway</b>			
East of intersection	500 <sup>d</sup>	305	445
West of intersection	350	315	455

<sup>a</sup> Values based on AASHTO SSD requirements for vehicles driving at the observed 85<sup>th</sup> percentile speeds.  
<sup>b</sup> Values based on AASHTO ISD requirements for vehicles driving at the observed 85<sup>th</sup> percentile speeds.  
<sup>c</sup> First distance is the current available sight distance and the second distance assumes the clearing of vegetation along the site to the north and south to obtain desired distance.  
<sup>d</sup> Distance assumes the trimming of bushes between the two site driveways.

## **FUTURE CONDITIONS**

### **Traffic Growth**

Future traffic conditions were projected to the year 2017, representing a 5-year design horizon consistent with state requirements for traffic impact analysis. Traffic volumes on the roadway network at that time will include existing traffic, new traffic due to normal population and traffic growth, and traffic related to any significant development by others expected to be completed within the area by 2017. Consideration of these factors resulted in the development of 2017 No-Build traffic volumes, which assume that the improvements are not constructed and the maintenance building is not relocated. The incremental impacts of the project may then be

determined by reallocating site-generated traffic volumes (Build conditions) and making comparisons to the No-Build conditions.

To project traffic conditions within this design horizon, two components of traffic growth were included. First, an annual average traffic growth rate was determined to account for general population growth and smaller development projects that may impact traffic along the study roadways and intersections in the site vicinity. Although there are not traffic counts collected by MassDOT in the Town of Wellesley to determine a trend in traffic growth, there are enough traffic volume counts in the adjacent community of Newton that indicates a general decrease in traffic volumes over the past five to ten years. However, this trend may not continue into the future and a conservative traffic growth rate of 1.0 percent per year was therefore assumed.

Second, any planned or approved specific developments in the area that would generate a significant volume of traffic on study area roadways within the next five years were considered. Based on discussions with Town of Wellesley officials, there is one development project currently planned. The project is being developed by National Development and includes a 30,000 square foot commercial building and 135 independent living units currently under construction at 27 Washington Street, approximately 10 miles from the Wellesley Country Club and north of the Massachusetts Turnpike. This project will not have an impact on the traffic volumes within the study area. It can therefore be assumed that any traffic increases would be included within the 1.0 percent annual traffic growth rate.

### **No-Build Conditions**

The 2017 No-Build networks were accordingly developed by applying a compounded 1.0 percent annual growth rate (5.1 percent over five years) to the existing adjacent street volumes. The 2017 No-Build peak-hour traffic-flow networks are shown on Figure 8.

### **Trip Generation**

The proposed project is not expected to generate additional traffic to the area roadway network. However, as a result of the relocation of the maintenance garage, some traffic may be diverted. There are currently 25 employees at the maintenance facility and most work from 6 AM to 2 PM with approximately 6 employees potentially working later hours during the summer months. No additional staff will be hired as a result of the proposed improvements and facility relocation. Therefore, most course maintenance personnel arrive at the site before the weekday AM peak hour and leave before the weekday PM peak hour. Therefore, this traffic does not correspond to the commuting peak hours. All golf utility vehicles will continue to use the on-site paths and cross Wellesley Avenue at the designated crossing. There are three registered maintenance vehicles that would use Forest Street including a pick-up truck, dump truck, and back hoe. It is also expected that most material deliveries would arrive to the site during off-peak hours. There



is expected to be approximately 3 loam and stone deliveries a year and approximately 20 sand deliveries a year, all expected to be during off-peak hours.

For the purpose of this study, it was assumed that 10 vehicle trips will be diverted to the Forest Street entrance during the analyzed peak hours, with 5 vehicles entering and 5 vehicles exiting the new maintenance facility. This is a conservative value as it is expected that there will be fewer trips in and out of the driveway during the peak hours.

According to the Wellesley Zoning By-Laws, an impacted roadway is one that is traversed by 20 or more vehicles related to the project in a single direction during any single hour. Based on the above trip estimates, the project will not exceed this threshold on any roadway or intersection.

### **Trip Distribution**

The distribution of these 10 vehicle trips on the area roadways is based on the expected travel routes between the site driveways and along the roadway network. Accordingly, 8 trips (4 entering and 4 exiting) will be redistributed through the Forest Street and Wellesley Avenue intersection. The remaining 2 vehicle trips (1 entering and 1 exiting) are assumed to travel to and from the south along Forest Street. For vehicles traveling through the Forest Street and Wellesley Avenue intersection, it was assumed that 4 trips (2 entering and 2 exiting) will be to/from the east along Wellesley Avenue, 2 trips (1 entering and 1 exiting) are expected to/from the west on Wellesley Avenue, and 2 trips (1 entering and 1 exiting) are expected to/from the north on Forest Street.

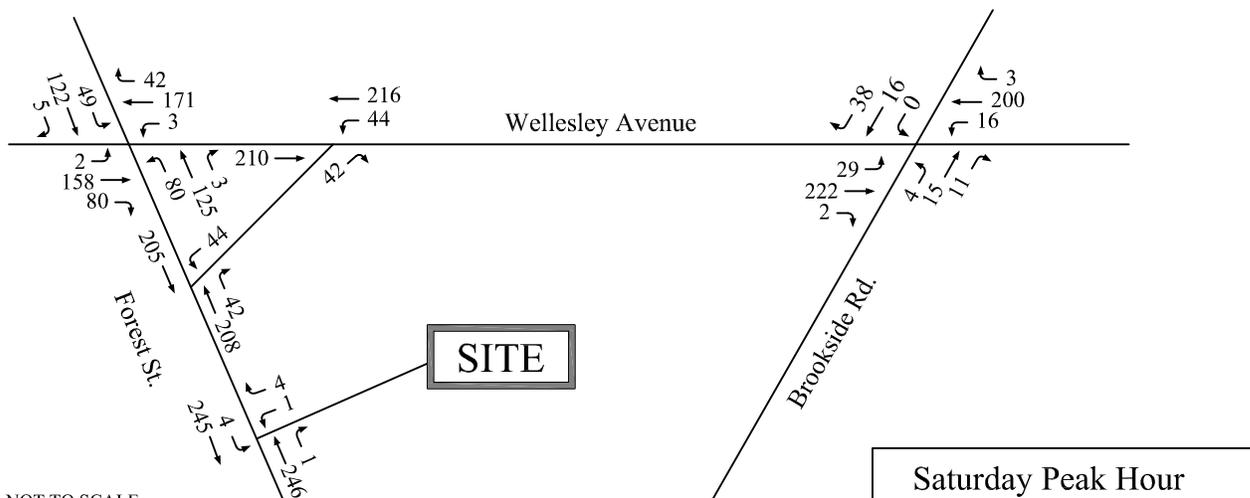
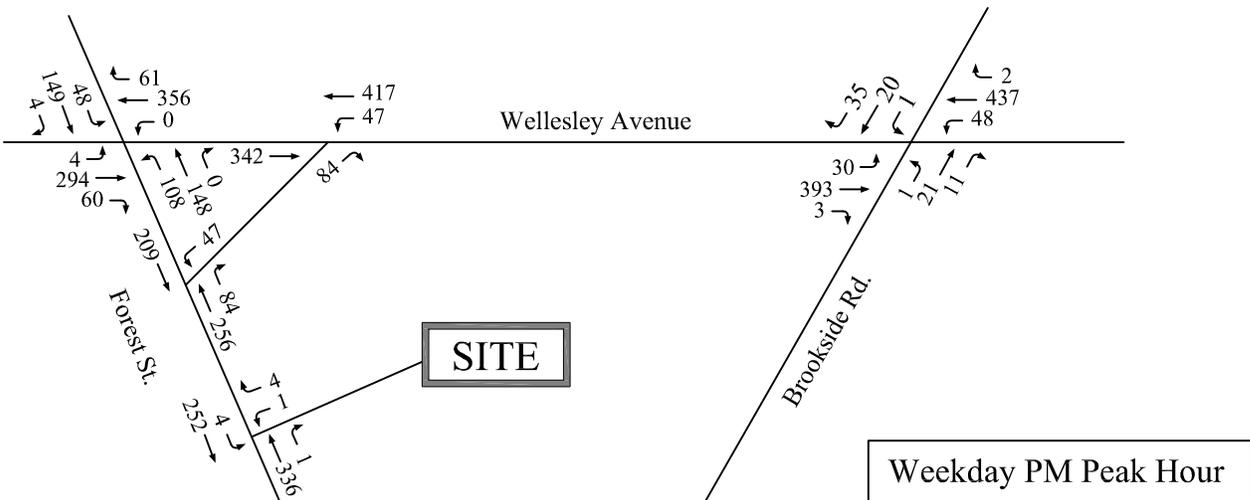
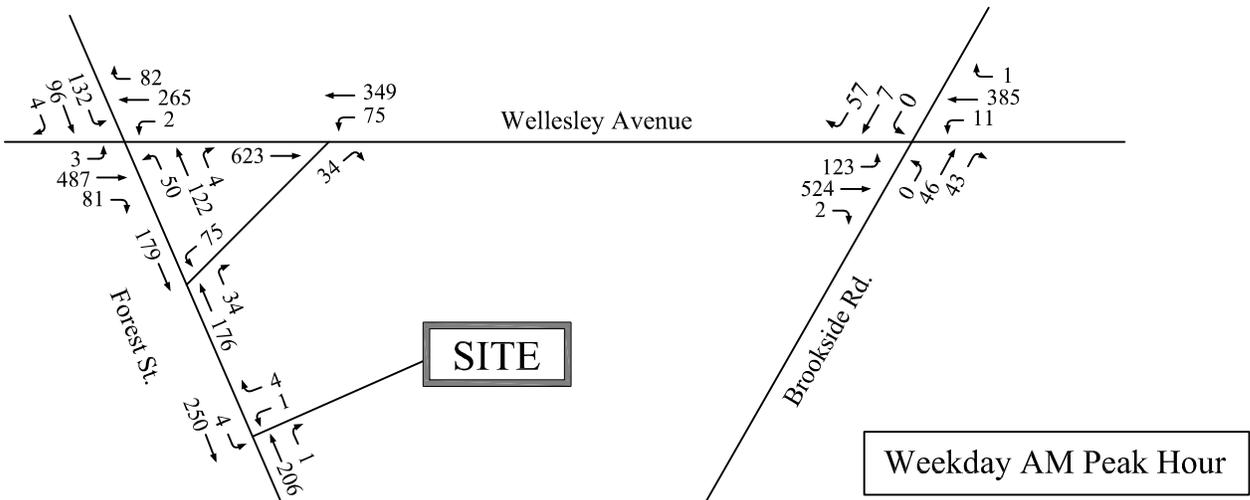
### **Build Conditions**

Based on these conservative assumptions, the traffic volumes diverted by the proposed maintenance facility relocation were assigned to the roadway network as shown on Figure 9 and were added to the 2017 No-Build traffic volumes to develop the 2017 Build traffic volumes. The 2017 Build traffic volume networks are graphically depicted on Figure 10.

### **Traffic Increases**

There are between 922 and 1,433 peak hour vehicles traveling through the Wellesley Avenue intersection with Forest Street under projected No-Build conditions. Since the traffic for the relocated maintenance facility will be diverted traffic and most employee traffic is outside of the peak hours, the project results primarily in a redistribution of traffic from one movement to another through this intersection. A conservative increase of 4 peak hour vehicles is expected through the intersection, or approximately 0.3 to 0.4 percent over the No-Build conditions. These additional vehicles are expected to be diverted from the driveways on Wellesley Avenue and use the channelized turns created by the delta island and not the existing all-way STOP

Figure 10  
 2017 Build  
 Peak Hour Traffic Volumes



NOT TO SCALE

intersection. At the all-way STOP intersection, the project will only divert traffic from one movement to another movement, as shown on Figure 9. No traffic volume changes are expected at the intersection of Wellesley Avenue and Brookside Road.

## **CAPACITY ANALYSIS**

Level-of-service (LOS) analyses were conducted at the study area intersections under existing and projected volume conditions to determine the effect that the site redistributed traffic will have on traffic operations. The capacity analysis methodology is based on the concepts and procedures in the *Highway Capacity Manual*<sup>2</sup> (HCM) and is described in the Appendix. The 95<sup>th</sup> percentile queue represents the length of queue of the critical minor-street movement that is not expected to be exceeded 95 percent of the time during the analysis period (typically one hour). In this case, the queue length is a function of the capacity of the movement and the movement's degree of saturation. The level-of-service and queue results are presented in Table 5 and are discussed below. All analysis worksheets are provided in the Appendix.

### **Wellesley Avenue at Forest Street (4-way STOP)**

As shown in Table 5, the Wellesley Avenue eastbound approach operates at LOS F during the weekday AM peak hour under the Existing, No-Build, and Build conditions and LOS E during the weekday PM peak hour under the No-Build and Build conditions. The Wellesley Avenue westbound approach operates at LOS F during the weekday PM peak hour No-Build and Build conditions. All other approaches, are expected to operate at LOS D or better during the peak hours analyzed. As shown in Table 5 and described in this report, the proposed project is not expected to increase traffic through this portion of the intersection. The redistribution of traffic is expected to have a negligible impact on the operation of this intersection.

### **Channelized Turns at Wellesley Avenue**

As shown in Table 5, all approaches are expected to operate at LOS B or better during the weekday AM, weekday PM, and Saturday midday peak hours under all analyzed conditions. The redistribution of traffic at this intersection is expected to have a negligible impact on the operation of this intersection.

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<sup>2</sup> *Highway Capacity Manual 2010*; Transportation Research Board; Washington, DC; 2010.

**Table 5**  
**Level-of-Service Analysis Summary**

Location/Peak Hour Movement	2012 Existing				2017 No-Build				2017 Build			
	v/c <sup>a</sup>	Del. <sup>b</sup>	LOS <sup>c</sup>	Queue <sup>d</sup>	v/c	Del.	LOS	Queue	v/c	Del.	LOS	Queue
<b>Wellesley Avenue at Forest Street (4-way Stop)</b>												
<i>Weekday AM Peak</i>												
EB All	1.10	65.6	F	>999	1.20	66.9	F	>999	1.20	66.9	F	>999
WB All	0.78	31.0	D	268	0.84	37.8	E	388	0.83	37.5	E	378
SB All	0.65	24.0	C	138	0.69	27.1	D	170	0.69	27.1	D	170
NB All	0.40	16.6	C	50	0.43	17.7	C	55	0.43	17.8	C	58
<i>Weekday PM Peak</i>												
EB All	0.75	28.2	D	215	0.84	39.6	E	383	0.84	39.7	E	385
WB All	0.82	34.7	D	335	0.93	52.1	F	815	0.92	51.8	F	795
SB All	0.48	18.4	C	70	0.55	21.8	C	93	0.55	21.8	C	93
NB All	0.66	24.2	C	145	0.74	31.3	D	213	0.74	31.8	D	220
<i>Sat. Peak Hour</i>												
EB All	0.36	11.2	B	43	0.39	11.8	B	48	0.39	11.8	B	48
WB All	0.34	11.2	B	40	0.37	11.7	B	43	0.36	11.7	B	43
SB All	0.30	11.1	B	33	0.32	11.5	B	35	0.32	11.5	B	35
NB All	0.35	11.6	B	40	0.37	12.2	B	45	0.38	12.2	B	45
<b>Channelized Turns at Wellesley Avenue</b>												
<i>Weekday AM Peak</i>												
EB All	0.39	0.0	A	0	0.41	0.0	A	0	0.41	0.0	A	0
WB All	0.08	2.4	A	7	0.09	2.5	A	7	0.09	2.6	A	8
NB All	0.07	13.4	B	6	0.08	13.9	B	7	0.09	13.9	B	7
<i>Weekday PM Peak</i>												
EB All	0.21	0.0	A	0	0.22	0.0	A	0	0.22	0.0	A	0
WB All	0.04	1.2	A	3	0.04	1.2	A	3	0.04	1.3	A	3
NB All	0.13	11.0	B	11	0.14	11.2	B	12	0.14	11.2	B	12
<i>Sat. Peak Hour</i>												
EB All	0.13	0.0	A	0	0.14	0.0	A	0	0.14	0.0	A	0
WB All	0.03	1.5	A	3	0.04	1.5	A	3	0.04	1.6	A	3
NB All	0.05	9.6	A	4	0.05	9.7	A	4	0.06	9.7	A	5

<sup>a</sup> Volume-to-capacity ratio

<sup>b</sup> Average control delay in seconds per vehicle

<sup>c</sup> Level of service

<sup>d</sup> 95th percentile queue in feet, assuming 25 feet per vehicle

**Table 5 (continued)**  
**Level-of-Service Analysis Summary**

Location/Peak Hour Movement	2012 Existing				2017 No-Build				2017 Build			
	v/c <sup>a</sup>	Del. <sup>b</sup>	LOS <sup>c</sup>	Queue <sup>d</sup>	v/c	Del.	LOS	Queue	v/c	Del.	LOS	Queue
<b>Channelized Turns at Forest Street</b>												
<i>Weekday AM Peak</i>												
SB All	0.12	11.6	B	11	0.13	11.8	B	11	0.14	12.0	B	12
EB All	0.00	0.0	A	0	0.00	0.0	A	0	0.00	0.0	A	0
WB All	0.13	0.0	A	0	0.13	0.0	A	0	0.14	0.0	A	0
<i>Weekday PM Peak</i>												
SB All	0.09	12.7	B	8	0.10	13.1	B	8	0.11	13.2	B	9
EB All	0.00	0.0	A	0	0.00	0.0	A	0	0.00	0.0	A	0
WB All	0.21	0.0	A	0	0.22	0.0	A	0	0.22	0.0	A	0
<i>Sat. Peak Hour</i>												
SB All	0.08	12.0	B	6	0.09	12.3	B	7	0.09	12.4	B	7
EB All	0.00	0.0	A	0	0.00	0.0	A	0	0.00	0.0	A	0
WB All	0.15	0.0	A	0	0.16	0.0	A	0	0.16	0.0	A	0
<b>Wellesley Avenue at Brookside Road</b>												
<i>Weekday AM Peak</i>												
EB All	0.11	2.8	A	9	0.12	2.9	A	10	0.12	2.9	A	10
WB All	0.01	0.4	A	1	0.01	0.4	A	1	0.01	0.4	A	1
NB All	0.51	35.7	E	67	0.59	43.3	E	82	0.59	43.3	E	82
SB All	0.14	14.2	B	12	0.15	14.7	B	13	0.15	14.7	B	13
<i>Weekday PM Peak</i>												
EB All	0.03	0.9	A	2	0.03	0.9	A	2	0.03	0.9	A	2
WB All	0.04	1.3	A	3	0.05	1.3	A	4	0.05	1.3	A	4
NB All	0.13	20.2	C	11	0.15	21.4	C	13	0.15	21.4	C	13
SB All	0.20	17.5	C	18	0.22	18.6	C	21	0.22	18.6	C	21
<i>Sat. Peak Hour</i>												
EB All	0.02	1.1	A	2	0.02	1.1	A	2	0.02	1.1	A	2
WB All	0.01	0.7	A	1	0.01	0.7	A	1	0.01	0.7	A	1
NB All	0.07	12.6	B	6	0.08	12.8	B	6	0.08	12.8	B	6
SB All	0.09	11.0	B	7	0.10	11.2	A	8	0.10	11.2	A	8

<sup>a</sup> Volume-to-capacity ratio

<sup>b</sup> Average control delay in seconds per vehicle

<sup>c</sup> Level of service

<sup>d</sup> 95th percentile queue in feet, assuming 25 feet per vehicle

**Table 5 (continued)**  
**Level-of-Service Analysis Summary**

Location/Peak Hour Movement	2012 Existing				2017 No-Build				2017 Build			
	v/c <sup>a</sup>	Del. <sup>b</sup>	LOS <sup>c</sup>	Queue <sup>d</sup>	v/c	Del.	LOS	Queue	v/c	Del.	LOS	Queue
<b>Forest Street at Proposed Site Driveway</b>												
<i>Weekday AM Peak</i>												
WB All	--	--	--	--	--	--	--	--	0.01	10.2	B	1
NB All	--	--	--	--	--	--	--	--	0.14	0.0	A	0
SB All	--	--	--	--	--	--	--	--	0.00	0.2	A	0
<i>Weekday PM Peak</i>												
WB All	--	--	--	--	--	--	--	--	0.01	11.4	B	1
NB All	--	--	--	--	--	--	--	--	0.22	0.0	A	0
SB All	--	--	--	--	--	--	--	--	0.00	0.2	A	0
<i>Sat. Peak Hour</i>												
WB All	--	--	--	--	--	--	--	--	0.01	10.5	B	1
NB All	--	--	--	--	--	--	--	--	0.16	0.0	A	0
SB All	--	--	--	--	--	--	--	--	0.02	0.2	A	0

<sup>a</sup> Volume-to-capacity ratio

<sup>b</sup> Average control delay in seconds per vehicle

<sup>c</sup> Level of service

<sup>d</sup> 95th percentile queue in feet, assuming 25 feet per vehicle

### **Channelized Turns at Forest Street**

As shown in Table 5, all approaches are expected to operate at LOS B or better during the weekday AM, weekday PM, and Saturday midday peak hours under all analyzed conditions. The slight increase in traffic at this intersection as a result of the project's redistributed traffic is expected to have a negligible impact on the operation of this intersection.

### **Wellesley Avenue at Brookside Road**

The Brookside Road northbound approach is expected to operate at LOS E under the Existing, No-Build, and Build conditions during the weekday AM peak hour. All other approaches are expected to operate at LOS C or better during the analyzed peak hours. As shown in Table 5 and described in this report, the proposed project is not expected to change the traffic volumes through this intersection and therefore not impact traffic operations.

### **Forest Street at the Existing/Proposed Site Driveway**

The site driveway on Forest Street is expected to operate at LOS B under the Build condition during each of the analyzed peak hours. The Forest Street approaches to the proposed site driveway are expected to operate at LOS A during the analyzed peak hours. Therefore, the additional turning traffic created at this driveway as a result of the relocated maintenance facility will have little impact on traffic along Forest Street.

### **RECOMMENDED IMPROVEMENTS**

The proposed improvements at the Wellesley Country Club are expected to have a negligible impact on traffic at the study area intersections that does not warrant traffic improvements. However, the sight lines at the existing/proposed site driveway on Forest Street are currently obstructed by vegetation to the north and south of the driveway. It is therefore recommended that trees and brush be cleared within the sight triangles, defined as a point in the driveway 14.5 feet from the Forest Street shoulder and a distance of 475 feet to the center of the southbound Forest Street lane and a distance of 365 feet to the center of the northbound Forest Street lane. Any proposed landscaping or signs in the vicinity of the site driveway be kept low to the ground (less than 3 feet above street level) or set back outside the sight triangles so as not to impede sight distances for drivers exiting the site. It is also recommended that at the existing country club driveways on Wellesley Avenue, the bushes between the two site driveways be maintained to assure sightlines are provided for vehicles exiting these driveways.

Although not warranted as part of this project, consideration should be given to the installation of “4-way” sign plaques to be placed under the STOP signs on the two approaches to the Wellesley Avenue and Forest Street intersection currently missing these signs. As with all unsignalized intersections, vegetation within the right-of-way should be periodically trimmed to assure proper sight lines for vehicles exiting an approach under STOP-sign control.

### **CONCLUSIONS**

Existing and future conditions at the study area intersections have been described and analyzed with respect to traffic operations and the impact of the proposed site redevelopment. Conclusions of this effort and recommendations are presented below.

- The proposed project is expected to redirect 10 vehicle trips (5 in and 5 out) during the analyzed peak hours. Although this is a conservative estimate (higher than expected) due to employee shift times as well as the ability to use on-site paths to travel around the

Wellesley Country Club, the analyses show that even with this conservative assumption, the proposed project will have a negligible impact on the surround roadway network.

- The proposed maintenance facility will utilize an existing gravel driveway along Forest Street. Turning movements into and out of this driveway are expected to operate at desirable levels. Clearing of vegetation to the north and south of the site driveway is recommended to provide adequate sight lines to meet both minimum and desirable sight distance requirements based on the observed travel speeds. It is further recommended that any landscaping or signs be kept low to the ground or set back sufficiently so as not to impede sight distances for drivers exiting the site.
- Peak hour traffic-volume increases on the study roadways and intersections are expected to be minimal. At the Wellesley Avenue and Forest Street intersection, increases ranging from 0.3 to 0.4 percent are expected as a result of the redirected site traffic. These increases are well within the daily fluctuation of traffic on these streets and the impacts of the project will be negligible.
- Although operational constraints currently exist on some approaches to the Wellesley Avenue and Forest Street intersection, the relocation of the maintenance facility will not add any new traffic through the 4-way STOP intersection, but rather will redistribute traffic from one movement to another. This redistribution of traffic has a negligible effect on traffic operations.
- The proposed project is not expected to add traffic volumes to the Wellesley Avenue and Brookside Road intersection or impact the intersection operations.