TRAFFIC IMPACT AND ACCESS STUDY

WOODBRIDGE CROSSING
RESIDENTIAL DEVELOPMENT/
STOUGHTON, MASSACHUSETTS

GPI

GPI

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PREPARED FOR:

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500 BROADWAY
EVERETT, MASSACHUSETTS 02149

MAY 2008

Traffic Impact and Access Study
Proposed Woodbridge Crossing
Residential Development
Stoughton, Massachusetts
May 2008

TECHNICAL MEMORANDUM

REF: HTS-2003574

DATE: May 27, 2008

TO: Mr. Thomas Kennedy
Kennedy Development Group
500 Broadway
Everett, Massachusetts 02149

FROM: Mr. James E. Winn, P.E., Project Manager
Ms. Mary C. Bowers, E.I.T., Traffic Engineer

RE: Traffic Impact and Access Study
Woodbridge Crossing Residential Development
Stoughton, Massachusetts

INTRODUCTION

Greenman-Pedersen, Inc. (GPI) has prepared this Traffic Impact and Access Study (TIAS) for a proposed residential development to be located on Central Street (Route 27), Island Street, and Mill Street in Stoughton, Massachusetts. The site is currently vacant with some areas of disturbed earth. The previously proposed development consisted of constructing 7 three-story buildings containing 192 residential condominiums with a total of 350 bedrooms. The proposed development has been changed to consist of 208 apartment units with a total of 298 bedrooms, a 15 percent reduction in the number of bedrooms from the previous proposal. The change in development has been evaluated in this revised TIAS and assumes the same time periods and design horizons as the previously submitted traffic study.

The site is bounded by residential homes to the north, commercial businesses and residential homes to the south, Island Street to the east, and Mill Street and commercial businesses to the west. Access to and egress from the development is proposed to be provided via three site driveways. The construction of Lantern Lane and Lamplighter Circle will provide access to the proposed development via Mill Street and Island Street, respectively. An existing driveway on Central Street will be relocated to the west across from West Street to form a four-legged intersection. An internal connection will provide access to Central Street, Mill Street, and Island Street from all units. Figure 1 shows the site in relation to the surrounding roadways.

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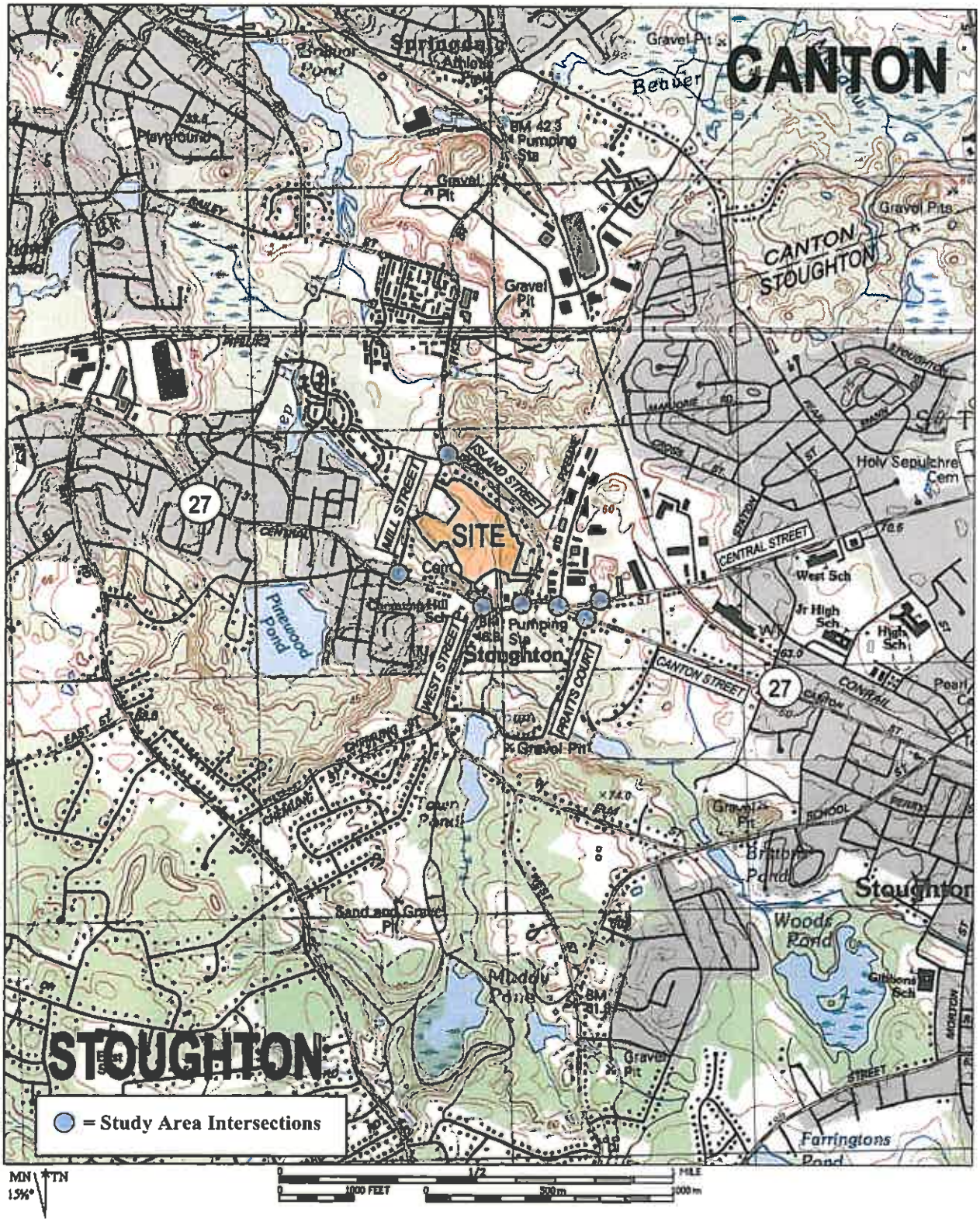

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Figure 1
Site Location Map

EXISTING CONDITIONS

Study Area

Evaluation of the traffic impacts associated with the proposed project requires an evaluation of existing and projected traffic volumes on the adjacent streets, the volume of traffic expected to be generated by the project, and the impact that this traffic will have on the adjacent streets and nearby intersections. Based on the project's expected traffic impacts and comments received from the Town of Stoughton, the following intersections have been analyzed and evaluated in this report:

- Central Street (Route 27) at West Street
- Central Street (Route 27) at Island Street
- Central Street (Route 27) at Mill Street
- Canton Street (Route 27) at Central Street
- Canton Street (Route 27) at Pratts Court
- Central Street at Pratts Court
- Island Street at Mill Street

Traffic Volumes

Base traffic conditions within the study area were developed by conducting Automatic Traffic Recorder (ATR) counts, manual-turning movement counts (TMCs), and vehicle classification counts between September and November of 2003 and in November of 2005. The ATR counts were conducted on Central Street east of West Street, on Island Street north of Central Street, and on Mill Street north of Central Street, each for a 24-hour weekday period. The TMCs and vehicle classification counts were performed during the weekday AM peak period (7:00 to 9:00 AM) and the weekday PM peak period (4:00 to 6:00 PM). The TMCs conducted in November of 2005 revealed existing traffic volumes that were significantly lower than the volumes recorded in September and November of 2003. Therefore, to provide a conservative analysis scenario, the traffic counts conducted in 2003 were used. In addition, they were upwardly adjusted to reflect a base 2005 traffic volume condition. All traffic count data are provided in the Appendix.

Seasonal Adjustment

Traffic on a given roadway typically fluctuates throughout the year depending on the area and the type of roadway. To determine if the data needed to be adjusted to account for this fluctuation, traffic-volume data from the Massachusetts Highway Department (MassHighway) were researched. Based on statewide traffic-volume data from MassHighway, traffic during the months of September, October, and November represent above average-month conditions.[1] Therefore, to provide a conservative (worse than expected) analysis scenario, no seasonal adjustments were made to the roadway traffic volume data. The MassHighway traffic-volume data are provided in the Appendix.

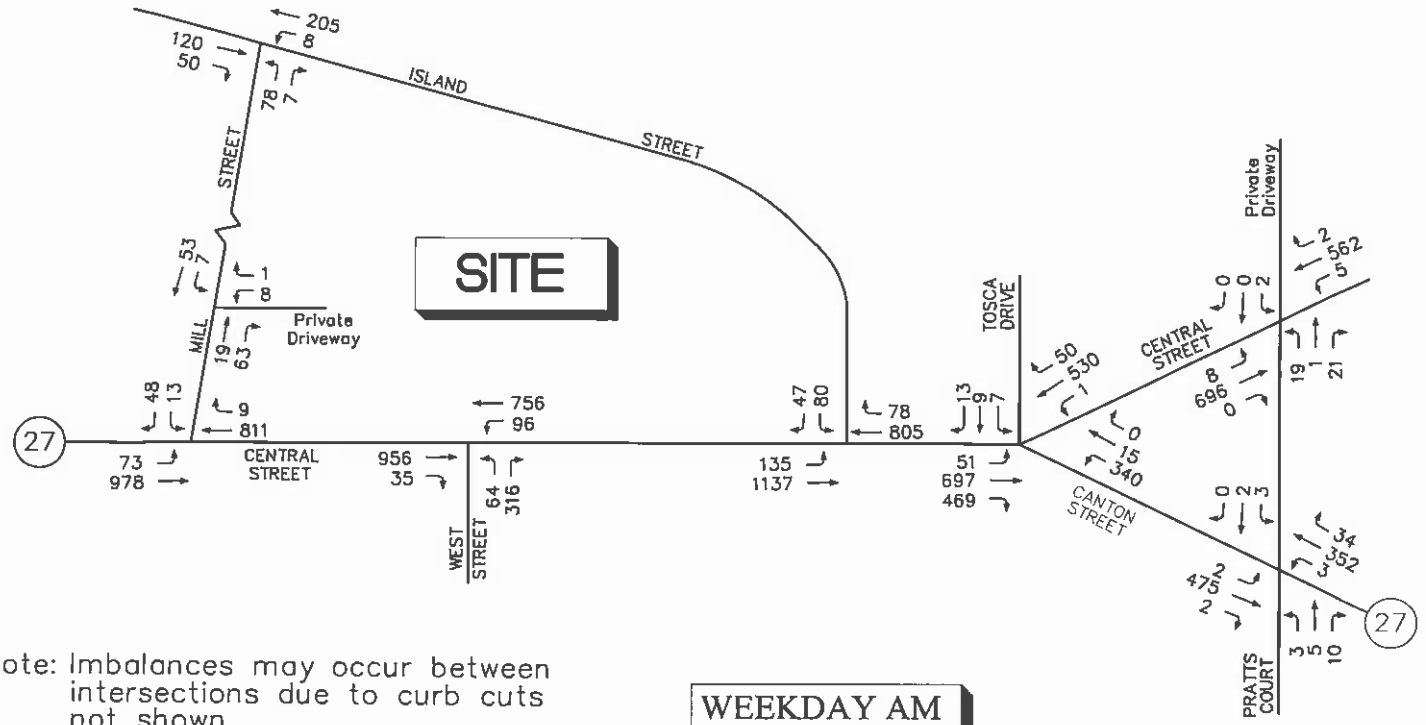
Table 1 summarizes the weekday daily and peak-hour traffic volumes within the study area adjusted to reflect 2005 traffic-volume conditions. The 2005 Existing weekday AM and weekday PM peak hour traffic-flow networks are shown graphically on Figure 2.

Table 1
EXISTING TRAFFIC-VOLUME SUMMARY

Location/Time Period	Traffic Volume	K Factor[c]	Directional Distribution[d]
Central Street east of the site:			
Weekday Daily (vpd[a])	25,500		
Weekday AM Peak Hour (vph[b])	2,124	8.3	60% EB
Weekday PM Peak Hour (vph)	2,239	8.8	51% WB
Island Street north of Central Street:			
Weekday Daily (vpd)	3,800		
Weekday AM Peak Hour (vph)	340	8.9	63% NB
Weekday PM Peak Hour (vph)	348	9.2	56% SB
Mill Street north of Central Street:			
Weekday Daily (vpd)	1,900		
Weekday AM Peak Hour (vph)	143	7.5	57% NB
Weekday PM Peak Hour (vph)	142	7.5	59% SB

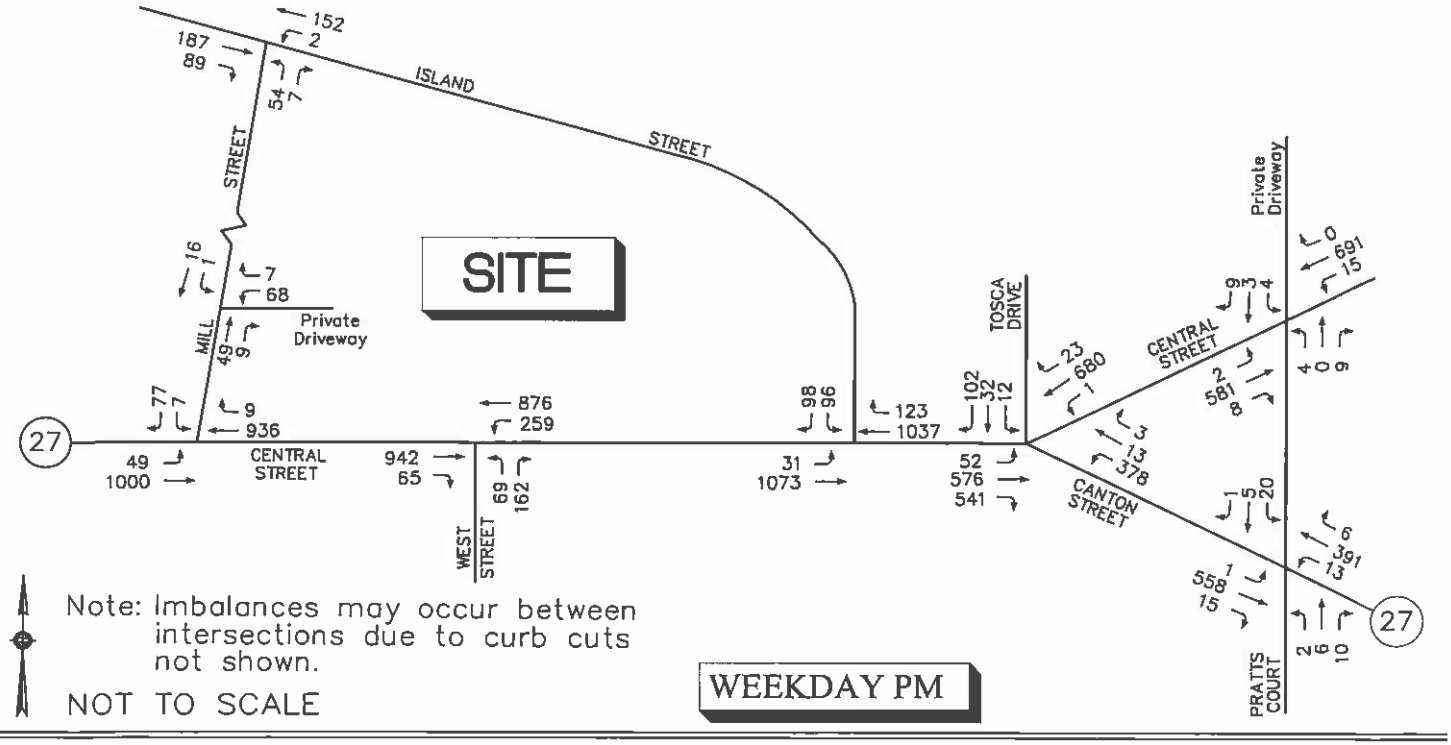
[a]Vehicles per day.
[b]Vehicles per hour.
[c]Percent of average daily traffic occurring during the peak hour.
[d]EB = eastbound; WB = westbound, NB = northbound, SB = southbound.

[1] *2003 Weekday Seasonal Factors;* Massachusetts Highway Department – Statewide Traffic Data Collection.



Note: Imbalances may occur between intersections due to curb cuts not shown.

WEEKDAY AM



Note: Imbalances may occur between intersections due to curb cuts not shown.

NOT TO SCALE

WEEKDAY PM

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Figure 2

2005 Existing
Peak Hour Traffic Volumes

Accidents

Accident data for the study area intersections were obtained from the Town of Stoughton for the period between 2002 and 2004. A summary of the Town accident data at the study area intersections is provided in Table 2. In addition to the summary, accident occurrence also should be compared to the volume of traffic through a particular intersection to determine any significance. Accordingly, the accident rates were calculated for each study area 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 is 0.66 acc/mev and the district-wide average is 0.59 acc/mev. A comparison of the calculated accident rate to these averages can be used to establish the significance of accident occurrence and whether or not potential safety problems exist. All crash rate worksheets are provided in the Appendix.

The intersection of Central Street and Island Street experienced the highest frequency of accidents with 29 accidents over the three-year study period (average 9.7 accidents per year). Approximately 66 percent (19 of 29) of the accidents involved property damage only and 76 percent (22 of 29) involved cross movement collisions. Approximately 34 percent of the incidents have occurred during the peak hours. The accident trend shows difficulty for turning movements from Island Street onto Central Street. The calculated crash rate for this location (0.95 acc/mev) is higher than both the district-wide and statewide averages. Improvements are recommended at this location as described in the *Recommended Roadway Improvements* section of this report.

The remaining study area intersections experienced 4 or fewer accidents per year with crash rates well below both the district-wide and statewide averages. There does not appear to be any specific accident trend at any other study location. There were no fatalities reported at the study area intersections within the time period studied.

Table 2
ACCIDENT SUMMARY

Location	Number of Accidents			Severity[a]			Accident Type[b]						Percent During Peak Hours
	Total	Average per Year	Accident Rate[c]	PD	PI	F	CM	RE	HO	FO	Ped	Other	
Central Street at West Street	5	1.7	0.17	4	1	0	1	3	0	0	0	1	60%
Central Street at Island Street	29	9.7	0.95	19	10	0	22	5	1	1	0	0	34%
Central Street at Mill Street	4	1.3	0.15	4	0	0	1	3	0	0	0	0	0%
Canton Street at Central Street	11	3.7	0.37	5	6	0	7	4	0	0	0	0	45%
Canton Street at Pratts Court	0	0	0.00	0	0	0	0	0	0	0	0	0	0%
Central Street at Pratts Court	1	0.3	0.06	1	0	0	1	0	0	0	0	0	0%
Island Street at Mill Street	0	0	0.00	0	0	0	0	0	0	0	0	0	0%
TOTAL	50	--	--	33	17	0	32	15	1	1	0	1	--

Source: Town of Stoughton.
[a]PD = property damage only; PI = personal injury; F = fatality.
[b]CM = cross movement/angle; RE = rear end; HO = head on; FO = fixed object; Ped = pedestrian.
[c]Measured in accidents per million entering vehicles.

Sight Distance

To identify potential safety concerns associated with site access and egress, sight distances have been evaluated at the proposed site driveway locations on Central Street, Island Street, and Mill Street 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. The available sight distances were compared with minimum requirements, as established by the American Association of State Highway and Transportation Officials (AASHTO)[2]. AASHTO is the national standard by which vehicle sight distance is calculated, measured, and reported. The Massachusetts Executive Office of Transportation and Construction (EOTC) and the Executive Office of Environmental Affairs (EOEA) require the use of AASHTO sight distance standards when preparing traffic impact assessments and studies, as stated in their guidelines for traffic impact assessments.

Sight distance is the length of roadway ahead that is visible to the driver. Stopping Sight Distance (SSD) is the minimum distance required for a vehicle traveling at a certain speed to safely stop before reaching a stationary object in its path. The values are based on a driver perception and reaction time of 2.5 seconds and a braking distance calculated for wet, level pavements. When the roadway is either on an upgrade or downgrade, grade correction factors are applied. Stopping sight distance is measured from an eye height of 3.5 feet to an object height of 2 feet above street level, equivalent to the taillight height of a passenger car. The SSD is measured along the centerline of the traveled way of the major road.

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 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. The ISD design values for right turns from a minor street are less than the design values for left turns because, in making right turns, drivers generally accept gaps that are slightly shorter than those accepted in making left turns.

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*

[2] *A Policy on Geometric Design of Highways and Streets*; American Association of State Highway and Transportation Officials (AASHTO); 2004.

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 proposed site driveway location were measured and compared to minimum requirements as established by AASHTO. Since the distance required to stop a vehicle is dependent on the speed of that vehicle, the SSD and ISD requirements at these intersections were calculated based on the posted speed limit. The required minimum sight distances are compared to the available distances, as shown in Table 3.

Table 3
SIGHT DISTANCE SUMMARY

	Stopping Sight Distance (feet)		Intersection Sight Distance (feet)		
Location	Measured	Required[a]	Measured	Minimum Required[b]	Desirable (30 mph)
Central Street at Site driveway:					
East of intersection	200	200	200	200	290
West of intersection	200	200	200	200	335
Island Street at Site driveway:					
North of intersection	300	200	345	200	290
South of intersection	340	200	400	200	335
Mill Street at Site driveway:					
North of intersection	400+	200	400+	200	335
South of intersection	340	200	340	200	290

[a]Values based on AASHTO requirements for legal speed limit of 30 mph.
[b]Values based on minimum SSD requirements.

As indicated in Table 3, available sight distances at the proposed site driveways on Central Street, Island Street, and Mill Street meet or exceed the minimum SSD and ISD requirements for safe operation. Although the proposed site driveway on Central Street will not meet desirable sight distances, improvement measures are proposed as described in the *Recommended Roadway Improvements* section of this study. Accordingly, safe operation can be expected at the three proposed site driveways. It is recommended that any proposed landscaping and signs in the vicinity of the site driveways be located sufficiently back from Central Street, Island Street, and Mill Street or kept low to the ground so as not to impede the available sight distances.

FUTURE CONDITIONS

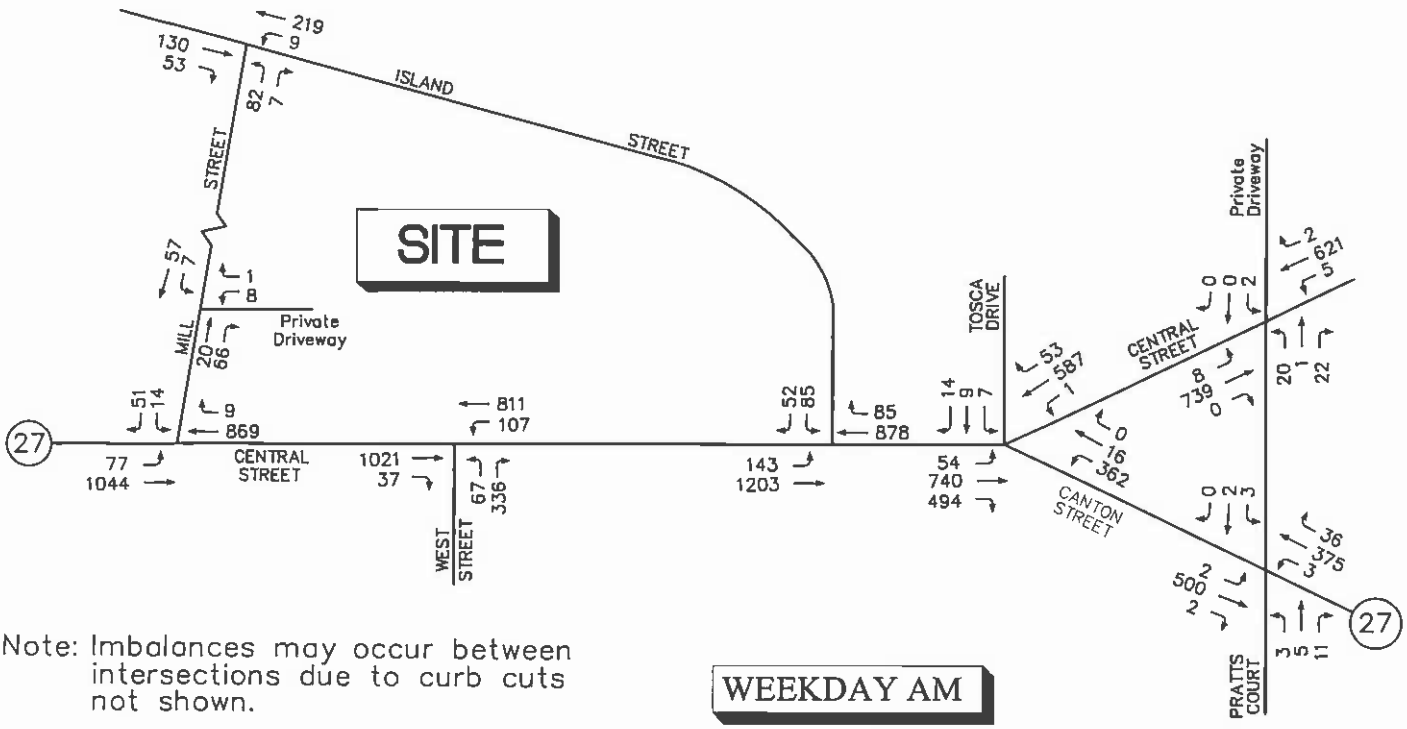
Traffic Growth

Traffic volumes on the study area roadways were projected out five years, consistent with Executive Office of Environmental Affairs/Executive Office of Transportation and Construction (EOEA/EOTC) guidelines for the preparation of traffic impact studies. To develop the five-year forecast, two components of traffic growth were considered. First, an annual-average traffic-growth percentage was determined. Based on MassHighway data gathered throughout District 5, a negative growth rate was determined to be representative of the area. However, to provide a conservative (worse-case) analysis scenario, a 1.0 percent compounded annual growth rate was used. The MassHighway data are provided in the Appendix.

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 included. Based on discussions with officials from the Town of Stoughton, there is one development planned in the vicinity of the project that will add traffic to the study area roadways. Quail Run Apartments, located on Buckley Road approximately 1 mile from the proposed site, has been approved for construction. This development will include 132 residential rental units. Also, there is an existing mill building abutting the site, which is not currently occupied. Since this building could be reoccupied without approval, it was assumed to be fully occupied under future No-Build conditions.

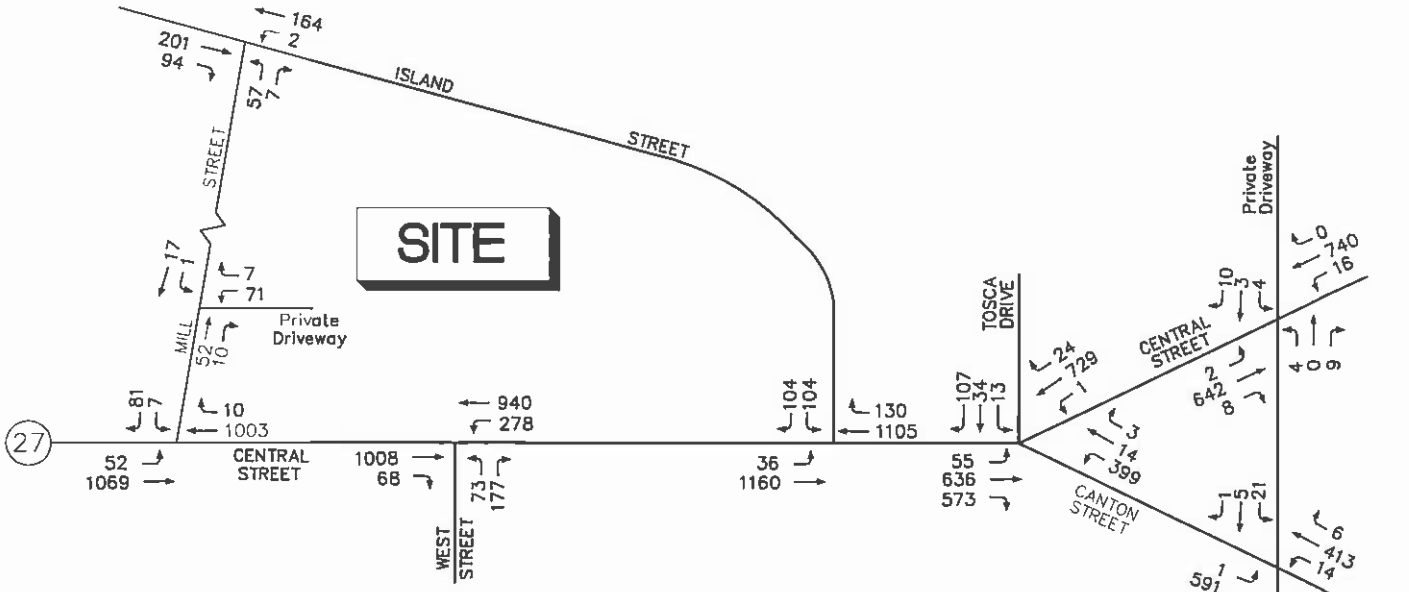
No-Build Conditions

The 2010 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 traffic volumes and by adding the traffic associated with Quail Run Apartments and a fully occupied mill building. The 2010 No-Build peak-hour traffic-flow networks are shown on Figure 3.



Note: Imbalances may occur between intersections due to curb cuts not shown.

WEEKDAY AM



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NOT TO SCALE

WEEKDAY PM

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Figure 3

2010 No-Build
Peak Hour Traffic Volumes

Trip Generation

This TIAS compares trip generation information from the traffic study prepared for the previously proposed development of 192 residential condominiums with the 208 apartment units currently proposed. To estimate the volume of traffic to be generated by the residential development, the Institute of Transportation Engineers (ITE) *Trip Generation*[3] manual Land Use Code 223 (Mid-Rise Apartment) trip generation estimates were compared with the trip generation estimates for the previously proposed project using Land Use Code 230 (Residential Condominium/ Townhouse). Table 4 summarizes the trip-generation comparison of the two land uses considered. The ITE data worksheets are provided in the Appendix.

Table 4
TRIP-GENERATION SUMMARY

Time Period/Direction	Apartment Trips (208 Units)[a]	Condominium Trips (192 Units)[b]	**Trips Used**
Weekday Daily	822	1,120	**1,120**
Weekday AM Peak Hour:			
In	22	15	**15**
Out	50	73	**73**
Total	72	88	**88**
Weekday PM Peak Hour:			
In	52	69	**69**
Out	37	34	**34**
Total	89	103	**103**

[a]ITE Land Use Code 223 (Mid Rise Apartment) for 208 dwelling units.
[b]ITE Land Use Code 230 (Residential Condominium/ Townhouse) for 192 dwelling units.

As shown in Table 4, the proposed 208-unit apartment development is expected to generate less traffic than the previously proposed 192-unit condominium development. Although the project has reduced in size, the trip generation volumes associated with the previously proposed condominium development have been maintained to provide a conservative (worse-case) analysis scenario.

[3] *Trip Generation*, Seventh Edition; Institute of Transportation Engineers; Washington, DC; 2003.

Trip Distribution

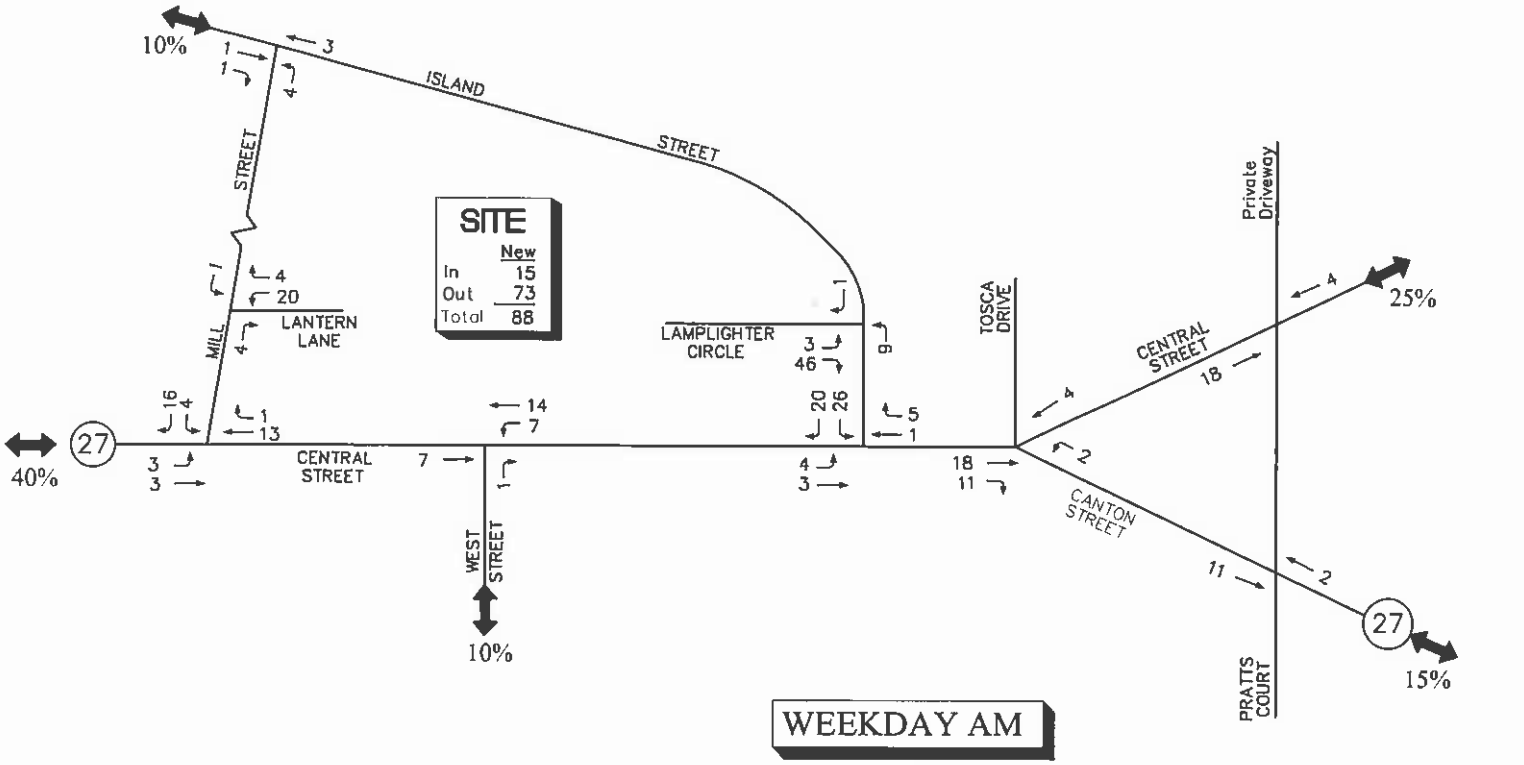
The distribution of proposed site traffic on the area roadways is based on journey-to-work census information and expected travel routes to the site. Accordingly, approximately 40 percent of the site traffic is expected to and from the west on Central Street, 25 percent to and from the east on Central Street, 15 percent to and from the east on Canton Street, 10 percent to and from the north on Island Street, and 10 percent to and from the south on West Street.

Build Conditions

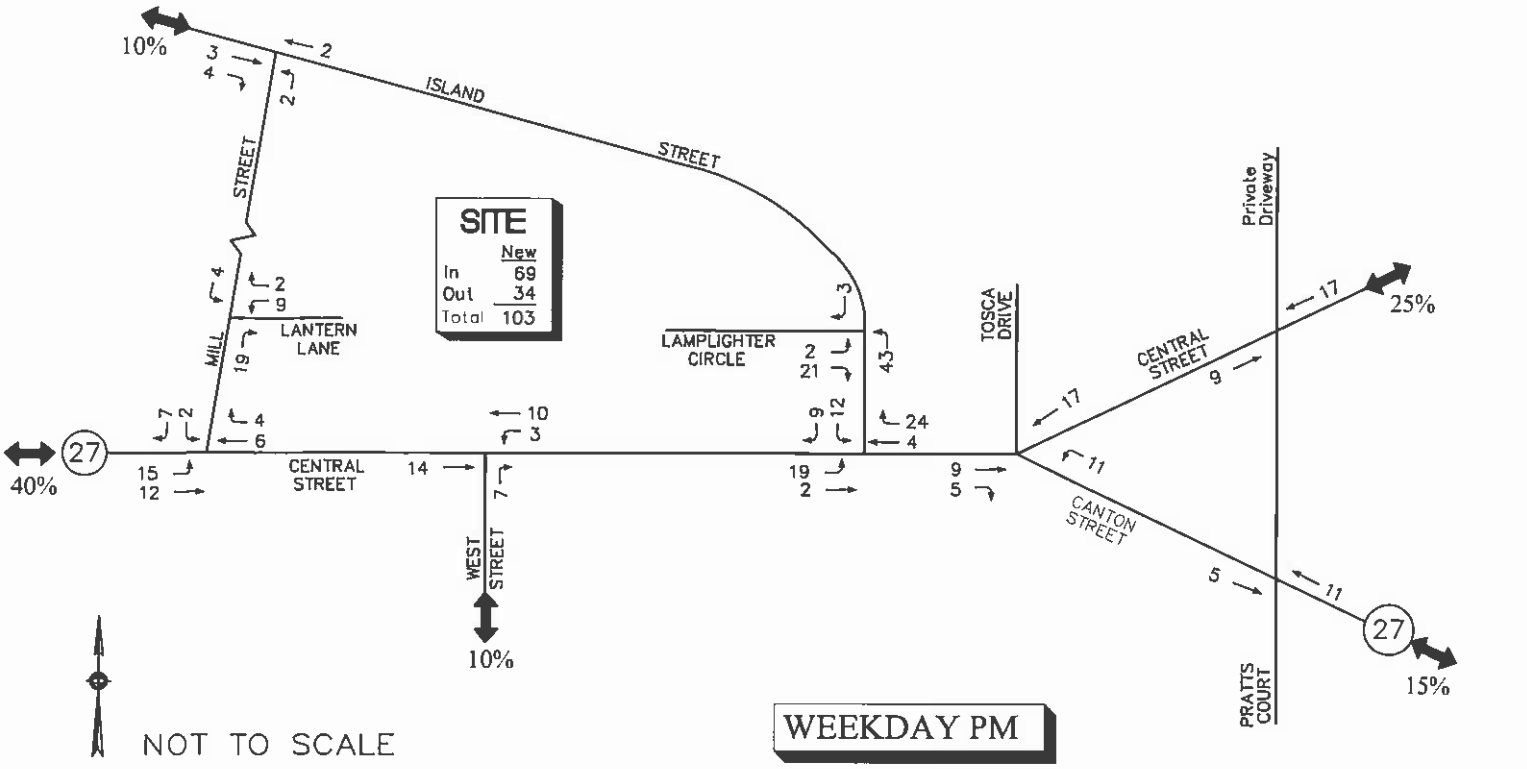
Based on the traffic generation and distribution estimates for this project, the additional traffic volumes from the proposed project were assigned to the roadway network as shown on Figure 4 and were added to the 2010 No-Build traffic volumes to develop the 2010 Build traffic volumes. The 2010 Build weekday AM and weekday PM peak-hour traffic-flow networks are graphically depicted on Figure 5. Note that in addition to site generated traffic, volumes in and out of the Central Street site driveway include the relocated mill building driveway and the re-occupancy of the mill building. Due to the proposed internal connections, some traffic generated by the re-occupancy of the mill building traveling northbound on Island Street may now use Lamplighter Circle instead of Central Street.

Traffic Increases

The volume increases on the study area roadway network due to the proposed project are expected to be minimal. Traffic-volume increases on the roadways leading beyond the study area are expected in the range of 8 to 42 vehicles during the peak hours as shown in Table 5. The development's largest increase in traffic will occur on Central Street west of the site during the weekday PM peak hour (42 vehicles). These increases represent, on average, less than one additional vehicle per minute during the peak hours.



WEEKDAY AM



WEEKDAY PM

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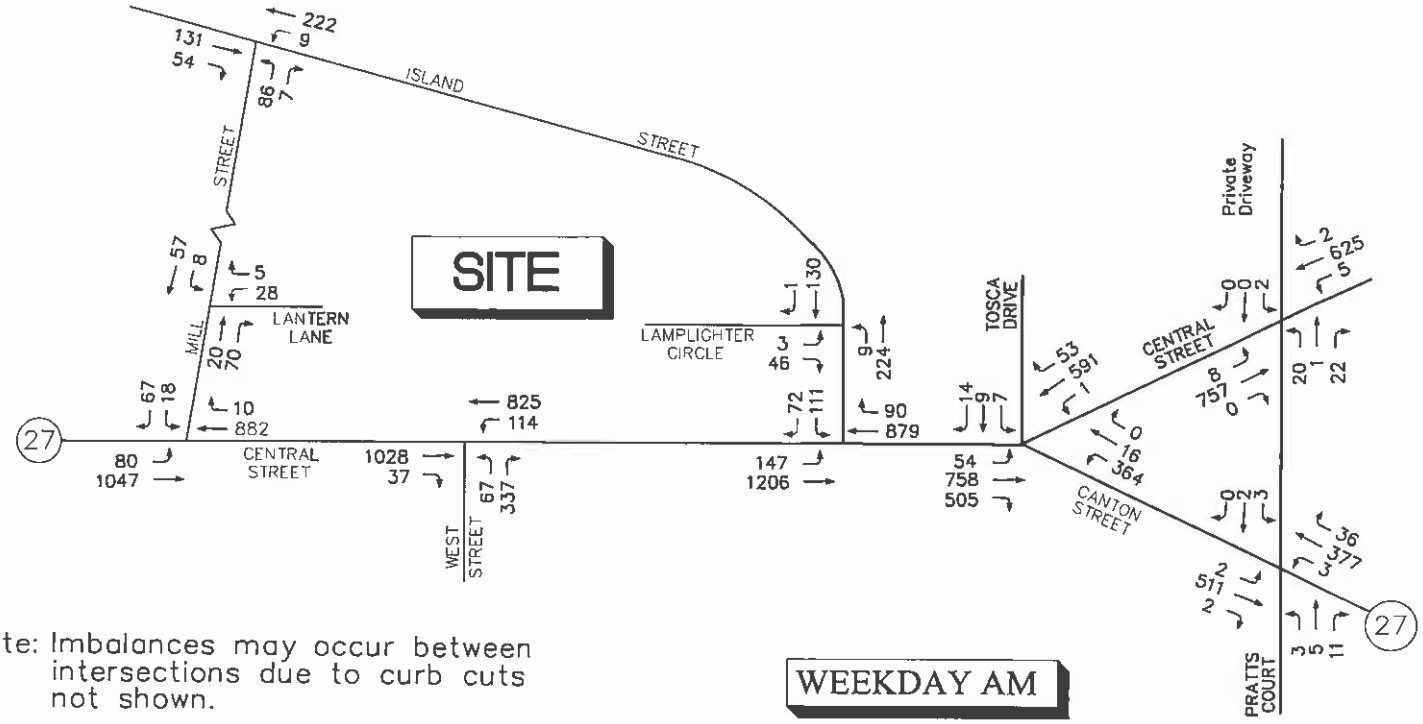
Figure 4

Site Generated
Peak Hour Traffic Volumes



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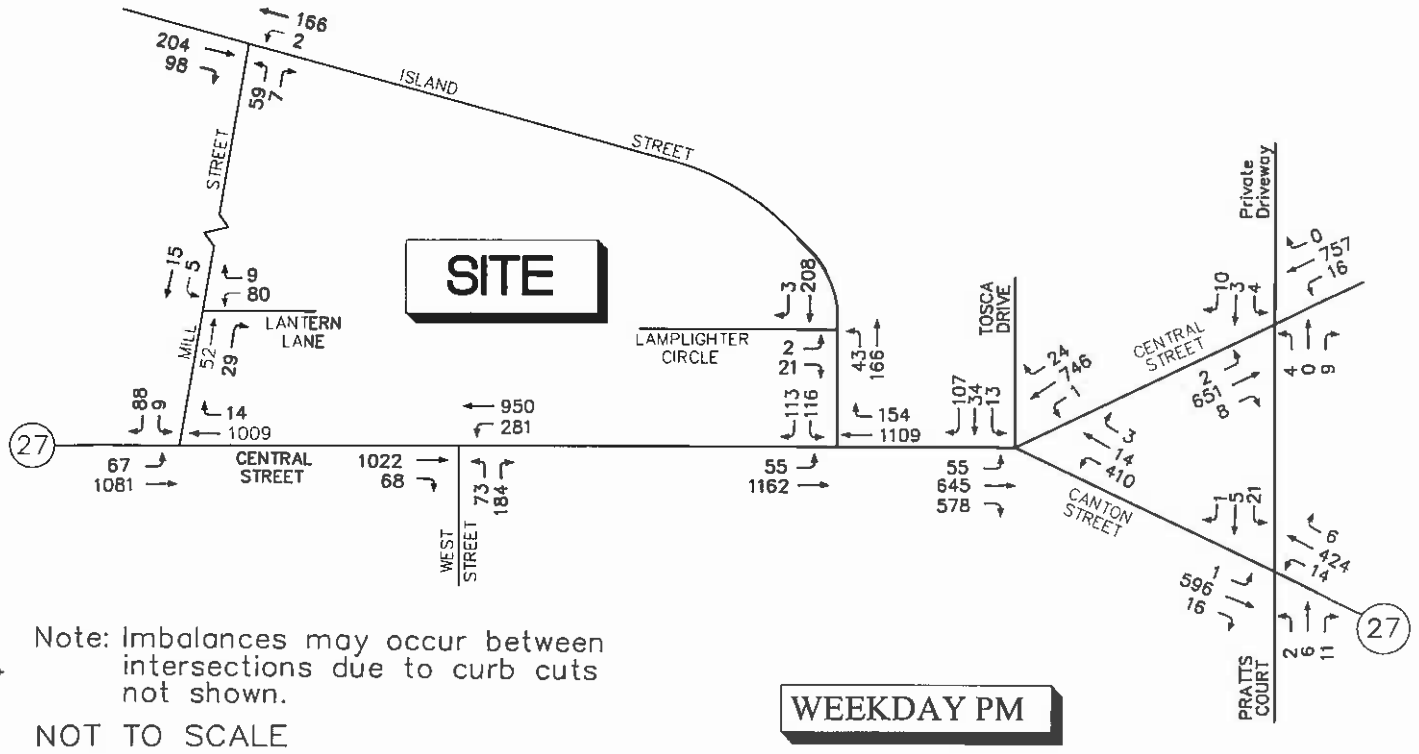
WEEKDAY AM



Note: Imbalances may occur between intersections due to curb cuts not shown.

NOT TO SCALE

WEEKDAY PM

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Figure 5

2010 Build
Peak Hour Traffic Volumes

Table 5
PROJECTED TRAFFIC-VOLUME INCREASES

Location/Peak Hour	No-Build Volume	Build Volume	Volume Increase
Central Street west of Mill Street:			
Weekday AM	2,040	2,075	35
Weekday PM	2,205	2,247	42
Central Street east Pratts Court:			
Weekday AM	1,392	1,414	22
Weekday PM	1,412	1,438	26
Canton Street east Pratts Court:			
Weekday AM	929	942	13
Weekday PM	1,056	1,071	15
West Street south of Central Street:			
Weekday AM	547	555	8
Weekday PM	596	606	10
Island Street north of Mill Street:			
Weekday AM	484	494	10
Weekday PM	516	526	10

Traffic in vehicles per hour

CAPACITY ANALYSIS

Level of Service

Level-of-service (LOS) analyses were conducted at the study area locations under Existing, No-Build, and Build conditions. The capacity analysis methodology is based on the concepts and procedures in the *Highway Capacity Manual* (HCM)[4] and is described in the Appendix. The LOS results are presented and discussed below. All analysis worksheets are provided in the Appendix.

[4]*Highway Capacity Manual 2000*; Transportation Research Board; Washington, D.C.; 2000.

As shown in Table 6, all major street movements at the study area intersections operate at desirable levels (LOS C or better) during the weekday AM and weekday PM peak hours under Existing, No-Build, and Build conditions. The turns from the minor streets onto Central Street experience long delays (LOS E/F) under Existing, No-Build, and Build conditions. Long delays for minor street traffic are particularly noticeable at West Street, Island Street, and Canton Street. However, ample capacity is available at the intersection of Central Street and Mill Street as indicated by the low volume of traffic and the low volume-to-capacity ratios (under 1.00).

The site driveways on Mill Street and Island Street are expected to operate at optimal levels (LOS A) during the weekday AM and weekday PM peak hours. The proposed site driveway on Central Street opposite West Street would operate with capacity constraints if left under STOP-sign control. Improvements are proposed at this intersection and are detailed in the *Recommended Roadway Improvements* section of this study.

Due to the additional traffic expected to be added to the critical left-turn movements from Island Street onto Central Street as a result of the proposed development, delays will increase on the Island Street approach to Central Street. As described in the *Accidents* section of this study, this location has a specific accident trend of cross movement collisions particularly during the commuter peak hours. The Town has commented that the roadway width of Island Street (20 feet) between the proposed site driveway and Central Street could be a capacity/safety concern. Improvements are proposed at the intersection of Central Street and Island Street and along Island Street to address these issues. The improvements are detailed in the *Recommended Roadway Improvements* section of this study.

At the intersections of Central Street at Canton Street and Tosca Drive, Canton Street at Pratts Court, and Central Street at Pratts Court, movements on the Canton Street eastbound and westbound approaches operate at desirable levels (LOS C or better) during all peak hours under Existing, No-Build, and Build conditions. The turns from Pratts Court onto Central Street experience long delays (LOS E) during the weekday AM peak hour under Existing, No-Build, and Build conditions. However, ample capacity is available as indicated by the low volume of traffic and the low volume-to-capacity ratios (under 1.00). The turns from Canton Street and Tosca Drive (northbound and southbound, respectively) at the intersection with Central Street currently operate with capacity constraints. However, increases in delay as a result of site-generated traffic are expected to be minimal over the No-Build conditions. Potential improvement measures at this location are being further investigated.

Queues

For unsignalized intersections, the 95th 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. Queue analysis results for the study area intersections are presented in Table 6. All analysis worksheets are provided in the Appendix.

The queue analysis results indicate that 95th percentile projected queue lengths at the majority of the study area intersections do not exceed available storage capacities under Existing, No-Build, and Build conditions. However, long queues currently exist along West Street, Island Street, and Canton Street at their intersections with Central Street. These queues are expected to increase in the future with the addition of background growth and site-generated traffic. Improvements are proposed to improve these conditions and are detailed in the *Recommended Roadway Improvements* section of this study.

Table 6
LEVEL-OF-SERVICE ANALYSIS SUMMARY

Intersection/Peak Hour	2005 Existing				2010 No-Build				2010 Build			
	V/C[a]	Del.[b]	LOS[c]	Queue[d]	V/C	Del.	LOS	Queue	V/C	Del.	LOS	Queue
Central Street at West Street												
Weekday AM:												
Central Street EB approach	--	--	--	--	--	--	--	--	0.02	0.8	A	2
Central Street WB approach	0.16	4.4	A	14	0.19	5.6	A	17	0.18	5.6	A	17
West Street NB approach	2.42	702.0	F	845	3.06	NC	F	NC	5.05	NC	F	NC
Site driveway SB left-turns	--	--	--	--	--	--	--	--	NC	NC	F	NC
Site driveway SB through/right-turns	--	--	--	--	--	--	--	--	0.31	59.7	F	30
Weekday PM:												
Central Street EB approach	--	--	--	--	--	--	--	--	0.04	1.5	A	3
Central Street WB approach	0.40	12.6	B	49	0.46	16.7	C	61	0.46	16.7	C	60
West Street NB approach	4.24	NC	F	NC	6.28	NC	F	NC	19.98	NC	F	NC
Site driveway SB left-turns	--	--	--	--	--	--	--	--	28.14	NC	F	NC
Site driveway SB through/right-turns	--	--	--	--	--	--	--	--	0.69	208.5	F	63
Central Street at Island Street												
Weekday AM:												
Central Street EB left-turns/through	0.19	7.6	A	18	0.22	10.3	B	21	0.22	10.7	B	21
Island Street SB approach	2.85	1016.8	F	358	3.96	NC	F	NC	4.74	NC	F	NC
Weekday PM:												
Central Street EB left-turns/through	0.06	2.1	A	4	0.07	3.1	A	6	0.07	3.4	A	6
Island Street SB approach	2.65	868.7	F	478	3.64	NC	F	NC	4.05	NC	F	NC

[a]Volume-to-capacity ratio.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]Maximum queue length in feet per lane during a 95th percentile cycle (assuming 25 feet per vehicle).
NC = No Capacity Available

Table 6 (continued)
LEVEL-OF-SERVICE ANALYSIS SUMMARY

Intersection/Peak Hour	2005 Existing				2010 No-Build				2010 Build			
	V/C[a]	Del.[b]	LOS[c]	Queue[d]	V/C	Del.	LOS	Queue	V/C	Del.	LOS	Queue
Central Street at Mill Street												
Weekday AM:												
Central Street EB left-turns/through	0.10	3.2	A	8	0.11	3.9	A	9	0.12	4.1	A	10
Mill Street SB approach	0.40	41.1	E	44	0.50	56.0	F	59	0.59	62.6	F	75
Weekday PM:												
Central Street EB left-turns/through	0.07	2.2	A	6	0.08	2.7	A	6	0.08	2.9	A	6
Mill Street SB approach	0.37	29.5	D	40	0.44	35.6	E	51	0.49	40.2	E	60
Canton Street at Central Street/ Tosca Drive												
Weekday AM:												
Central Street EB approach	0.75	4.1	A	0	0.80	4.1	A	0	0.81	4.1	A	0
Central Street WB approach	0.55	15.1	C	148	0.62	16.0	C	193	0.63	16.1	C	193
Canton Street NB approach	3.12	1029.5	F	2884	3.32	1122.6	F	3419	3.35	1135.0	F	3419
Tosca Drive SB approach	0.47	125.5	F	81	0.58	178.9	F	120	0.61	195.8	F	120
Weekday PM:												
Central Street EB approach	0.72	4.8	A	0	0.77	4.7	A	0	0.78	4.7	A	0
Central Street WB approach	0.70	17.1	C	242	0.77	18.7	C	306	0.79	19.5	C	337
Canton Street NB approach	3.46	1179.5	F	3211	3.64	1266.6	F	3713	3.74	1312.5	F	3919
Tosca Drive SB approach	1.28	244.0	F	637	1.36	288.4	F	822	1.36	292.5	F	855

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

Table 6 (continued)
LEVEL-OF-SERVICE ANALYSIS SUMMARY

Intersection/Peak Hour	2005 Existing				2010 No-Build				2010 Build			
	V/C[a]	Del.[b]	LOS[c]	Queue[d]	V/C	Del.	LOS	Queue	V/C	Del.	LOS	Queue
Canton Street at Pratts Court												
Weekday AM:												
Canton Street EB approach	0.00	0.1	A	0	0.00	0.1	A	0	0.00	0.1	A	0
Canton Street WB approach	0.00	0.1	A	0	0.00	0.1	A	0	0.00	0.1	A	0
Pratts Court NB approach	0.05	15.0	B	4	0.05	15.5	C	4	0.06	15.7	C	4
Pratts Court SB approach	0.02	20.5	C	2	0.02	21.9	C	2	0.02	22.3	C	2
Weekday PM:												
Canton Street EB approach	0.00	0.0	A	0	0.00	0.0	A	0	0.00	0.0	A	0
Canton Street WB approach	0.01	0.4	A	1	0.02	0.5	A	1	0.02	0.5	A	1
Pratts Court NB approach	0.06	17.0	C	5	0.07	17.8	C	5	0.07	18.0	C	5
Pratts Court SB approach	0.13	25.1	D	11	0.16	27.9	D	14	0.16	28.5	D	14
Central Street at Pratts Court												
Weekday AM:												
Central Street EB approach	0.01	0.2	A	1	0.01	0.3	A	1	0.01	0.3	A	1
Canton Street WB approach	0.01	0.2	A	0	0.01	0.2	A	1	0.01	0.2	A	1
Pratts Court NB approach	0.22	28.3	D	20	0.27	33.6	D	25	0.27	34.9	D	27
Pratts Court SB approach	0.02	36.9	E	1	0.02	43.3	E	2	0.02	44.8	E	2
Weekday PM:												
Central Street EB approach	0.00	0.1	A	0	0.00	0.1	A	0	0.00	0.1	A	0
Canton Street WB approach	0.02	0.4	A	1	0.02	0.5	A	1	0.02	0.5	A	1
Pratts Court NB approach	0.06	20.6	C	4	0.07	22.8	C	5	0.07	23.4	C	6
Pratts Court SB approach	0.08	23.7	C	6	0.09	27.1	D	8	0.10	28.0	D	8

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

Table 6 (continued)
LEVEL-OF-SERVICE ANALYSIS SUMMARY

Intersection/Peak Hour	2005 Existing V/C[a]	2005 Existing Del.[b]	2005 Existing LOS[c]	2005 Existing Queue[d]	2010 No-Build V/C	2010 No-Build Del.	2010 No-Build LOS	2010 No-Build Queue	2010 Build V/C	2010 Build Del.	2010 Build LOS	2010 Build Queue
Island Street at Mill Street												
Weekday AM:												
Island Street WB left-turns/through	0.01	0.3	A	1	0.1	0.4	A	1	0.01	0.4	A	1
Mill Street NB approach	0.18	12.7	B	17	0.20	13.2	B	19	0.21	13.4	B	20
Weekday PM:												
Island Street WB left-turns/through	0.00	0.1	A	0	0.00	0.1	A	0	0.00	0.1	A	0
Mill Street NB approach	0.11	11.8	B	10	0.13	12.2	B	11	0.13	12.3	B	11
Mill Street at Private Driveway (Lantern Lane)												
Weekday AM:												
Mill Street SB left-turns/through	0.00	0.9	A	0	0.00	0.9	A	0	0.01	1.0	A	0
Private Driveway WB approach	0.01	9.1	A	1	0.01	9.2	A	1	0.03	9.2	A	2
Weekday PM:												
Mill Street SB left-turns/through	0.00	0.4	A	0	0.00	0.4	A	0	0.00	1.4	A	0
Private Driveway WB approach	0.08	9.2	A	7	0.09	9.2	A	7	0.10	9.3	A	8
Island Street at Lamplighter Circle												
Weekday AM:												
Island Street NB left-turns/through	--	--	--	--	--	--	--	--	0.00	0.1	A	0
Site driveway EB approach	--	--	--	--	--	--	--	--	0.03	9.6	A	2
Weekday PM:												
Island Street NB left-turns/through	--	--	--	--	--	--	--	--	0.01	0.6	A	1
Site driveway EB approach	--	--	--	--	--	--	--	--	0.02	10.1	A	1

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

RECOMMENDED ROADWAY IMPROVEMENTS

The final phase of the transportation analysis process is to identify improvement measures necessary to minimize the impact of the project and to improve existing operating conditions on the transportation system. Mitigation measures considered necessary to address existing and future roadway system deficiencies are discussed below.

The existing intersection of Central Street and West Street currently operates with capacity constraints in addition to experiencing long queues on the West Street approach. As part of the development, an existing driveway on Central Street is proposed to be relocated to the west across from West Street to form a four-legged intersection. With the addition of site-generated traffic, this intersection is expected to continue to operate with capacity constraints under the 2010 Build condition. To determine if traffic signal control will be warranted at this intersection, a traffic signal warrant analysis was conducted under the Existing traffic-volume conditions.

As previously described, ATR counts were conducted along Central Street adjacent to the site in 2003. The 2003 average-month existing traffic-volume data were compared with the requirements established in the Manual on Uniform Traffic Control Devices (MUTCD)[5], a Federal Highway Administration publication. The intersection was analyzed using the following MUTCD Warrants were applicable:

- Warrant 1 – Eight Hour Vehicular Volume
  - Condition A – Minimum Vehicular Volume
  - Condition B – Interruption of Continuous Traffic
  - Combination of Conditions A and B
- Warrant 2 – Four-Hour Vehicular Volume; and
- Warrant 3 – One-Hour Vehicular Volume

In accordance with the MUTCD, a traffic control signal shall only be installed if at least one of the signal warrants is met. However, a number of factors are involved in determining if signal control should be installed, including intersection operations, safety, and engineering judgment. It is not common to install a traffic control signal on the basis of the peak hour warrant alone. Preferably, at least one of the eight-hour warrants (Warrant 1, Condition A or B) should be met before signal control is considered. The peak-hour volume warrant is applied only in unusual cases such as driveways serving large office/industrial complexes, manufacturing plants, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short period of time. In addition, the combination of Conditions A and B under Warrant 1 should only be applied after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems. Table 7 summarizes the result of the signal warrant analysis. The warrant analysis worksheets are provided in the Appendix.

[5]*Manual on Uniform Traffic Control Devices*; Federal Highway Administration; Washington, DC; December 2000.

Table 7
TRAFFIC SIGNAL WARRANT ANALYSIS SUMMARY

Intersection	Warrant 1 A	Warrant 1 B	Warrant 1 Combo	Warrant No. 2	Warrant No. 3	Signal Recommended?
Central Street at West Street	NA	NA	NA	Yes	Yes	Yes

NA = Eight hours of traffic count data not available on Central Street.

As shown in Table 7, based on 2003 Existing average-month traffic volumes, the intersection of Central Street at West Street meets the four-hour warrant (Warrant 2) and the one-hour warrant (Warrant 3) of the volume-related warrants for traffic signal installation. In addition, based on the four hours of count data that was collected on West Street, the intersection currently meets the eight hour warrants during all four hours. Accordingly, and based on the traffic operating conditions without such control, a traffic control signal should be installed at the Central Street and West Street intersection independent of the proposed residential project.

Central Street at West Street and Proposed Site Driveway

In addition to traffic signal control, geometric improvements are proposed at the intersection of Central Street, West Street, and the site driveway to improve operating conditions. Due to the operational constraints that would be experienced without traffic signal control and geometric improvements, the proponent has committed to implement the following improvements prior to site occupancy:

- Install a fully-actuated traffic control signal capabilities.
- Widen the Central Street eastbound and westbound approaches to provide an exclusive left-turn lane and a shared through/right-turn lane.
- Widen West Street to provide a shared left-turn/through lane and a channelized right-turn lane.

Hansen Elementary School

The Helen H. Hansen Elementary School is located on the southwest corner of the intersection of Central Street and West Street. Access to the school is currently provided via a single driveway on Central Street and a single driveway on West Street. Town officials and community residents have expressed concern with existing access to the school, especially during peak times when parents are picking up and dropping off students. While implementation of the proposed mitigation measures will improve intersection operation and safety at this location, modifications to the school property improving traffic circulation will be investigated and evaluated as part of the proposed project.

Central Street at Island Street

Geometric improvements are proposed at the intersection of Central Street and Island Street to improve operating conditions. Due to the operational constraints that would be experienced without geometric improvements, the proponent has committed to implement the following improvements prior to site occupancy:

- Widen the Central St. eastbound approach to provide an exclusive left-turn lane and a through lane.
- Widen the Central Street westbound approach to provide a through lane and a channelized right-turn lane.
- Widen Island Street to provide an exclusive left-turn lane and a channelized right-turn lane.
- Widen Island Street between the proposed site driveway and Central Street from 20 feet to 24 feet.

Central Street at Canton Street and Tosca Drive

The existing intersection of Central Street, Canton Street and Tosca Drive currently operates with capacity constraints in addition to experiencing long queues on the Island Street approach. Without improvements, this intersection is expected to continue to operate with capacity constraints with or without the proposed project. As indicated in the level of service analysis summary, the project is expected to have little impact to this intersection. However, as part of this project, a contribution will be provided towards intersection improvements. Additional measures could involve geometric improvements and/or signalization. With this intersection under traffic signal control, a safer operation of the intersection can be expected, with a significant reduction in delay on Central Street and Tosca Drive. In addition, installation of a traffic signal at this location will create additional gaps in the flow of traffic providing improved operations at the Canton Street intersection with Island Street.

Analysis Results

Capacity and queue analyses were conducted at the intersection of Central Street, West Street, and the proposed site driveway assuming implementation of the improvements described above. Table 8 summarizes the results of the analyses under Build conditions with improvements. All analysis worksheets are provided in the Appendix.

With these improvements implemented, the intersection of Central Street, West Street, and the proposed site driveway is expected to operate at an overall LOS C during the weekday AM and weekday PM peak hours under Build with improvements conditions. The West Street northbound movements improve from a failing condition (LOS F) to an acceptable condition (LOS D) during the weekday AM peak hour, and improve to LOS E during the PM peak hour as a result of the improvements. With this intersection under traffic signal control, a safer operation of the intersection can be expected, with a significant reduction in delay. In addition, installation of a traffic signal at this location will create gaps in the flow of traffic providing improved operations at the Mill Street intersection with Central Street. A conceptual plan of the proposed intersection improvements are provided in the Appendix.

Table 8
LEVEL-OF-SERVICE ANALYSIS WITH MITIGATION SUMMARY

Intersection/Peak Hour	2010 No-Build				2010 Build				2010 Build with Improvements			
	V/C[a]	Del.[b]	LOS[c]	Queue[d]	V/C	Del.	LOS	Queue	V/C	Del.	LOS	Queue
Central Street at West Street and Site Driveway												
Weekday AM:												
Central Street EB approach	--	--	--	--	0.02	0.8	A	--/2	--	--	--	--
Central Street EB left-turns	--	--	--	--	--	--	--	--	0.04	6.6	A	4/14
Central Street EB through/right-turns	--	--	--	--	--	--	--	--	0.92	29.4	C	644/1,071
Central Street WB approach	0.19	5.6	A	17	0.18	5.6	A	--/17	--	--	--	--
Central Street WB left-turns	--	--	--	--	--	--	--	--	0.39	41.7	D	42/68
Central Street WB through/right-turns	--	--	--	--	--	--	--	--	0.61	3.2	A	100/163
West Street NB approach	3.06	NC	F	NC	5.05	NC	F	--/NC	--	--	--	--
West Street NB left-turns/through	--	--	--	--	--	--	--	--	0.56	52.6	D	51/95
West Street NB right-turns	--	--	--	--	--	--	--	--	0.84	54.8	D	230/324
Site driveway SB left-turns	--	--	--	--	NC	NC	F	--/NC	0.13	45.6	D	11/31
Site driveway SB through/right-turns	--	--	--	--	0.31	59.7	F	--/30	0.18	45.9	D	19/47
Overall Intersection	--	--	--		--	--	--		**0.90**	**25.3**	**C**	

[a]Volume-to-capacity ratio.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]Maximum queue length in feet per lane during an average/95th percentile cycle (assuming 25 feet per vehicle).
NC = No Capacity Available

Table 8 (continued)
LEVEL-OF-SERVICE ANALYSIS WITH MITIGATION SUMMARY

Intersection/Peak Hour	2010 No-Build				2010 Build				2010 Build with Improvements			
	V/C[a]	Del.[b]	LOS[c]	Queue[d]	V/C	Del.	LOS	Queue	V/C	Del.	LOS	Queue
Central Street at West Street and Site Driveway												
Weekday PM:												
Central Street EB approach	--	--	--	--	0.04	1.5	A	--/3	--	--	--	--
Central Street EB left-turns	--	--	--	--	--	--	--	--	0.08	8.1	A	8/24
Central Street EB through/right-turns	--	--	--	--	--	--	--	--	0.94	34.3	C	800/1,195
Central Street WB approach	0.46	16.7	C	--/61	0.46	16.7	C	--/60	--	--	--	--
Central Street WB left-turns	--	--	--	--	--	--	--	--	0.86	50.3	D	168/231
Central Street WB through/right-turns	--	--	--	--	--	--	--	--	0.64	5.5	A	215/467
West Street NB approach	6.28	NC	F	--/NC	19.98	NC	F	--/NC	--	--	--	--
West Street NB left-turns/through	--	--	--	--	--	--	--	--	0.64	62.4	E	63/115
West Street NB right-turns	--	--	--	--	--	--	--	--	0.41	38.3	D	110/169
Site driveway SB left-turns	--	--	--	--	28.14	NC	F	--/NC	0.18	50.4	D	14/38
Site driveway SB through/right-turns	--	--	--	--	0.69	208.5	F	--/63	0.17	50.1	D	20/48
Overall Intersection	--	--	--	--	--	--	--	--	**0.90**	**26.7**	**C**	--

[a]Volume-to-capacity ratio.
[b]Average control delay in seconds per vehicle.
[c]Level of service.
[d]Maximum queue length in feet per lane during an average/95th percentile cycle (assuming 25 feet per vehicle).
NC = No Capacity Available

CONCLUSIONS AND RECOMMENDATIONS

Existing and future conditions in the study area have been described, analyzed, and evaluated with respect to traffic operations and the impact of the proposed residential development. Conclusions of this effort and recommendations are presented below.

- The previously proposed development consisted of constructing 7 three-story buildings containing 192 residential condominiums. The proposed development has been changed to consist of 208 apartment units. With the project change including the reduction in the number of residential units, the traffic generation estimates associated with the previous residential condominiums evaluation are higher than the current estimates for the apartment development. Therefore, the trip generation rates for the previously proposed condominium development have been maintained to provide a conservative analysis scenario.

- The analysis assumed a total generation of 1,118 vehicle trips during a weekday with 88 vehicle trips (15 entering and 73 exiting) during the weekday AM peak hour and 103 vehicle trips (69 entering and 34 exiting) during the weekday PM peak hour. This additional traffic represents an increase of approximately two percent or less on roadways leading beyond the study area.

- Available sight distances at the proposed site driveway intersections with Central Street, Island Street, and with Mill Street will meet the minimum SSD and ISD requirements for safe operation. Any proposed landscaping or signs in the vicinity of the site driveways should be located sufficiently back from Central Street, Island Street, and Mill Street, or kept low to the ground, so as not to impede the available sight distances.

- Peak-hour volume increases on study-area roadways as a result of the development will have little impact on intersection operations within the study area. Under Build conditions, all movements at the site driveways will operate at desirable levels.

- The intersection of Central Street and West Street currently operates with capacity deficiencies. The construction of the site driveway opposite West Street and adding site generated traffic will further degrade operations at this intersection. The proponent has committed to install a fully actuated traffic signal and provide geometric improvements at the intersection of Central Street, West Street, and the site driveway prior to site occupancy. These improvements are expected to enhance overall operation of the intersections from a LOS F to a LOS C during the weekday AM and weekday PM peak hours.

- The installation of the traffic signal at this intersection will create gaps in the flow of traffic along Central Street in the vicinity of the intersection. The gaps created in the traffic flow will provide improved operations at the Mill Street and Canton Street intersections with Central Street.

- The intersection of Central Street and Island Street currently operates with capacity deficiencies. The proponent has committed to provide geometric improvements at the intersection of Central Street and Island Street prior to site occupancy. These improvements are expected to enhance overall operation and safety.

- A contribution towards intersection improvements have been committed to at the intersection of Central Street, Canton Street, and Tosca Drive by the project proponent. These funds could be used towards improvements including potential geometric improvements and/or signalization.

- A contribution towards on-site changes to the Hansen Elementary School has been committed to by the project proponent. These funds could be used to address current concerns regarding student drop off and pick up as it relates to the operation of the surrounding roadway network.