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MEMORANDUM

TO: David Hale
FROM: Kenneth P. Cram, P.E.
CC:
DATE: April 23, 2020
RE: Proposed Cedar Crossing and Cedar Edge Residential Development
Unsignalized Intersection Level of Service Clarification
Summer Street, Walpole, MA

This memorandum has been prepared to clarify the existing and future levels of service at the intersections of Summer Street and Neponset Street, Neponset Street, Water Street and Washington Street and Summer Street and Washington Street. Specifically, this memorandum explains how and why video recording was used to determine the actual current level of service at these intersections. This memorandum also explains how the actual observed (video recorded) level of service (LOS) was used to calibrate the capacity analysis model's predictions of the future levels of service.

This memorandum provides a summary of available traffic volume data, and existing delays and vehicle queues as reported in the January 6, 2020 Traffic Impact and Access Study (TIAS) prepared for the project. As discussed above, the existing intersections of Summer Street and Neponset Street, Neponset Street, Water Street and Washington Street and Summer Street and Washington Street currently operate at a good level of service as reported in the TIAS prepared for the project. This assessment is based on the videoing and recording of actual intersection operations. With the proposed development, the intersections are projected to continue to operate at acceptable levels of service (with volume to capacity (v/c) ratios less than 1.0).

PROJECT DESCRIPTION

The project will consist of the development of 300 residential units, of which 192 will be apartments units, 48 will be townhouse units and 60 will be single-family homes. Parking for a total of 677 (includes garage and surface parking) vehicles will be provided at the site. Access to the site will be provided by way of a driveway to Summer Street. Figure 1 shows the study area in relation to the surrounding roadway network.

EXISTING CONDITIONS

Summer Street, Neponset Street, Washington Street and Water Street

These unsignalized intersections are under the jurisdiction of the Town of Walpole. There are three intersections that form this triangle intersection.

Summer Street and Neponset Street This northwest intersection consists of Summer Street as the east and west legs and Neponset Street as the north and south legs. All approaches to the intersection consist of a single lane and are under STOP sign control. Sidewalks are present on the south side of the Summer Street eastbound approach, the Neponset Street departure leg (west side) and the north side of the Summer Street westbound approach. There is a crosswalk diagonally across in the center of the intersection. Land use at the intersection is primarily residential.

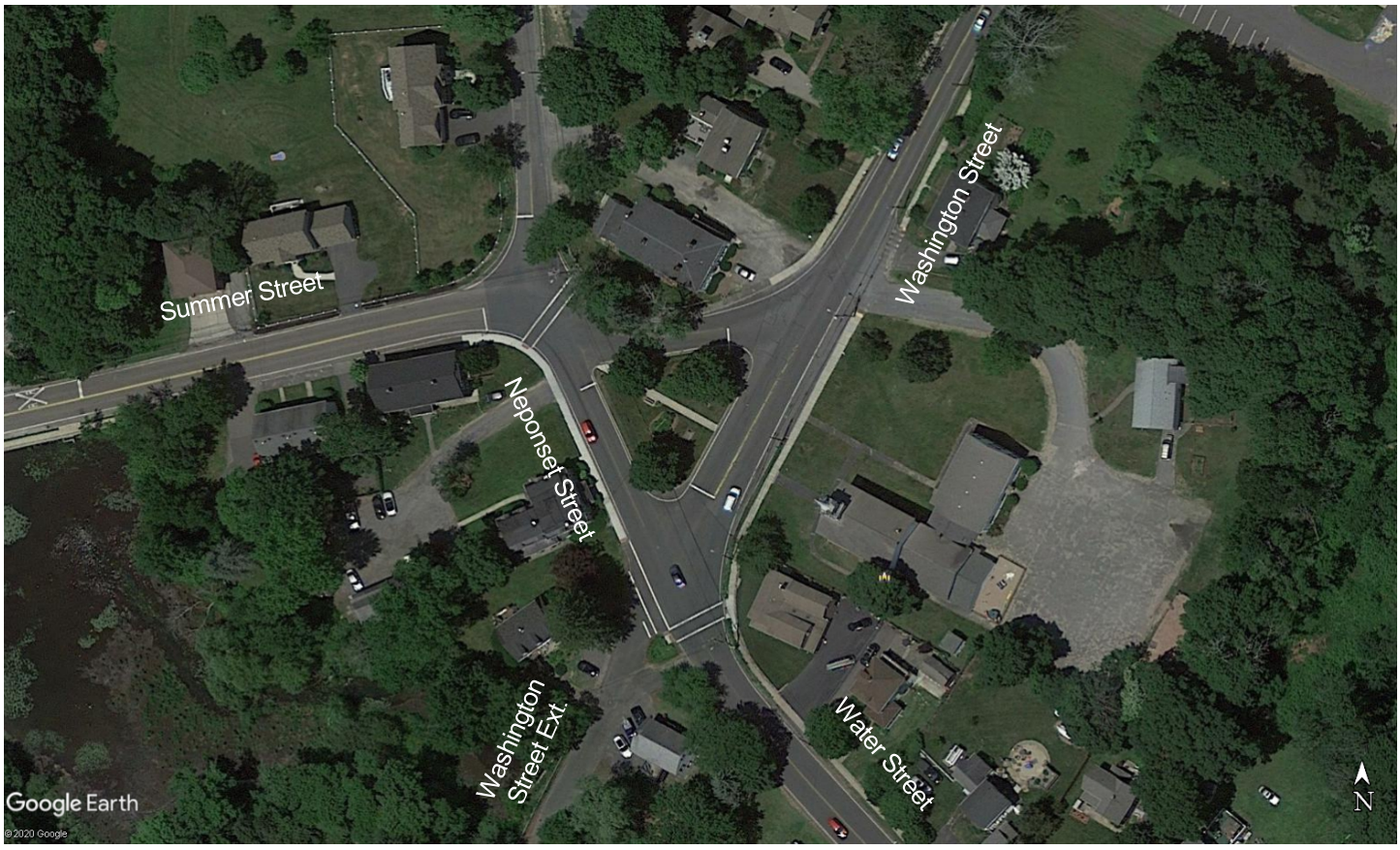

Figure 1
Site Location Map

Washington Street and Summer Street This northeast intersection consists of Washington Street as the north and south legs, Summer Street as the west leg and a driveway as the east leg. All approaches to the intersection consist of

a single lane permitting all movements. The Summer Street approach is under STOP sign control. Sidewalks are present on the east side of Washington Street, along the north side of Summer Street and the west side of Washington Street (north of the intersection). Land use at the intersection is primarily residential along with a church.

Washington Street, Washington Street Extension, Neponset Street and Water Street This southern intersection consists of Washington Street as the northeast leg, Washington Street Extension as the southwest leg, Neponset Street as the northwest leg and Water Street as the southeast leg. The Washington Street approaches are under STOP sign control. All approaches consist of a single lane permitting all legal movements. Sidewalks are present on the west side of Neponset Street, the north side of Water Street and the east side of Washington Street. Crosswalks exist across the northbound Washington Street Extension approach and across the Water Street approach. Land use at the intersection is primarily residential along with a church.

FUTURE CONDITIONS

As indicated, the project will consist of the development of 300 residential units, of which 192 will be apartment units, 48 will be townhouse units and 60 will be single-family homes. Access to the site will be provided by way of a driveway to Summer Street.

The impacts of the project were analyzed and summarized in the January 6, 2020 Traffic Impact and Access Study (TIAS) for the intersections of Summer Street and Neponset Street, Neponset Street, Water Street and Washington Street and Summer Street and Washington Street. These results are Summarized in Table 1 on the following page.

Existing Geometry Conditions Analysis

Levels of service for intersections are typically calculated using the methodology and procedures described in the 2010 *Highway Capacity Manual*[1] *(HCM)*. The methodology assesses an intersection based on type of traffic control, vehicle mix, and intersection geometrics. Traffic Engineers use this model to analyze both current and future intersection levels of service. The formulas utilized in the mathematical capacity analysis models sometimes do not perfectly match the conditions at real intersections which can cause a mismatch between the models predicted current level of service and the actual current level of service. In such instances, video recording can be used to determine actual vehicle queues, delay times and volume to capacity ratios. The capacity analysis model can then be ***calibrated*** by inserting these actual data into the model to create a more realistic result for existing conditions from which to predict future levels of service.

Manual turning movement counts were originally conducted at the study area intersections on Wednesday, September 11, 2019. When the results of the mathematical model were analyzed, it was determined that the model's predicted current level of service was significantly worse than the anecdotally observed level of service. Therefore it was decided to video record the operation of the intersections mentioned above to determine the hard data actual observed levels of service at the three key approaches (the 'critical movement' for which the level of service is assessed at an unsignalized intersection). The intersections were video recorded

[1] *Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2010.

from 7:00 to 9:00 AM and 4:00 to 6:30 PM on Wednesday, November 11, 2019. From the video, actual queues and delay times s were determined. The video recordings have been made available to the town and its traffic consultant

As expected, the video recorded actual queues and delay times were significantly better that the mathematically predicted level of service. For instance, the model predicted the current weekday morning peak hour 95th percentile queue on Summer Street (eastbound) to Washington Street (northbound) of 162.5 feet (approximately 7 vehicles) and the actual video recorded 95th percentile vehicle queue was 100[2] feet (4 vehicles). The corresponding volume to capacity (v/c) ratio was 0.79 using the capacity analysis model and found to be 0.27 for the actual observed value.

Using the actual vehicle observed queues and delay times as a starting point to calibrate the capacity analysis model results in a more accurate prediction of future levels of service. This can be seen in Table 1 where the calibrated level of service for the future build condition for the weekday morning and weekday evening eastbound for Summer Street at Washington Street predicted to be LOS E and LOS C respectively, and the actual calibrated delays represent LOS B and LOS A operations respectively.

Shown in Table 1 are the modeled and actual calibrated levels of service results based on the actual video recorded delays observed for the key approaches at the intersections. Actual field observations indicate that drivers at the study area intersections experience less delay than calculated by the HCM methodology. These analyses indicate that the proposed project will not result in a significant impact on traffic operations at the study area intersections over No-Build conditions. Based on the observed and recorded vehicle delays and queues at three of the unsignalized study area intersections, actual intersection operations are considerably better than the capacity model indicates. Review of the unsignalized calibrated intersection capacity analyses indicate that the critical movements at the unsignalized intersections will operate at a LOS E or better under future 2026 Build conditions. With the proposed development, the intersections are projected to continue to operate at acceptable levels of service (with volume to capacity (v/c) ratios less than 1.0).

It should be noted that the intersection of Summer Street and Neponset Street is a four-way, STOP controlled intersection and the software package used for the analysis (Synchro) does not allow for the model to be calibrated based on actual intersection operations. As noted in Table 1, the actual observed delays are significantly lower than what the capacity model indicated by approximately two-thirds. Therefore, under Build conditions, where the capacity analysis model indicates the Neponset Street approach will operate at LOS E with a calculated delay of approximately 39 seconds, actual delays will be lower and result in a better level of service.

[2] Note that the calibrated model indicates a vehicle queue of 27 feet (1 vehicle), again indicating a mismatch between the HCM methodology and actual observed results.

TABLE 1
UNSIGNALIZED LEVEL-OF-SERVICE COMAPRISON

Critical Movement/ Peak Hour	2019 Existing					2019 Existing with Calibrated Model					2026 No-Build					2026 No-Build with Calibrated Model					2026 Build					2026 Build with Calibrated Model				
	Demand[a]	V/C[b]	Delay[c]	LOS[d]	Queue[e]	Demand	V/C	Delay	LOS	Queue	Demand	V/C	Delay	LOS	Queue	Demand	V/C	Delay	LOS	Queue	Demand	V/C	Delay	LOS	Queue	Demand	V/C	Delay	LOS	Queue
Washington Street and Summer Street																														
All movements from Summer Street (EB):																														
Weekday Morning	244	0.79	47.2	E	162.5	244	0.27	10.1	B	27.0	261	0.92	71.3	F	220.0	261	0.29	10.3	B	30.0	282	1.00	90.5	F	265.0	282	0.31	10.4	B	33.0
Weekday Evening	70	0.34	21.9	C	35.0	70	0.08	7.8	A	6.0	75	0.39	24.8	C	45.0	75	0.08	7.7	A	6.0	89	0.48	28.3	D	60.0	89	0.09	7.7	A	8.0
Washington Street, Washington Street Extension, Water Street and Neponset Street																														
All movements from Washington Street (SWB):																														
Weekday Morning	120	0.35	20.2	C	37.5	120	0.09	7.9	A	8.0	129	0.41	22.9	C	47.5	129	0.10	7.9	A	8.0	129	0.48	28.5	D	60.0	129	0.10	7.8	A	8.0
Weekday Evening	339	1.11	113.6	F	380.0	339	0.70	23.9	C	137.0	363	1.28	178.2	F	502.5	363	0.78	30.0	D	178.0	363	1.59	312.7	F	660.0	363	0.87	43.8	E	235.0
Summer Street and Neponset Street																														
All movements from Summer Street (EB):																														
Weekday Morning	456	0.57	12.8	B	92.5	-	-	-	-	-	488	0.62	14.1	B	110.0	-	-	-	-	-	575	0.75	19.2	C	72.5	-	-	-	-	-
Weekday Evening	211	0.39	11.7	B	45.0	-	-	-	-	-	226	0.43	12.6	B	52.5	-	-	-	-	-	283	0.59	17.7	C	97.5	-	-	-	-	-
All movements from Summer Street (WB):																														
Weekday Morning	57	0.14	9.4	A	12.5	-	-	-	-	-	61	0.15	9.6	A	12.5	-	-	-	-	-	68	0.17	10.1	B	15.0	-	-	-	-	-
Weekday Evening	255	0.53	14.7	B	77.5	-	-	-	-	-	273	0.59	16.6	C	95.0	-	-	-	-	-	296	0.71	23.5	C	142.5	-	-	-	-	-
All movements from Neponset Street (NB)[f]:																														
Weekday Morning	133	0.23	10.2	B	22.5	-	-	3.0	-	125.0	142	0.25	10.5	B	25.0	-	-	-	-	-	165	0.30	11.5	B	32.5	-	-	-	-	-
Weekday Evening	350	0.62	17.7	C	105.0	-	-	5.0	-	125.0	375	0.68	20.7	C	130.0	-	-	-	-	-	447	0.87	39.1	E	247.5	-	-	-	-	-
All movements from Neponset Street (SB):																														
Weekday Morning	10	0.03	10.4	B	2.5	-	-	-	-	-	11	0.03	10.5	B	2.5	-	-	-	-	-	11	0.04	11.0	B	2.5	-	-	-	-	-
Weekday Evening	12	0.03	9.3	A	2.5	-	-	-	-	-	13	0.04	9.6	A	2.5	-	-	-	-	-	13	0.05	10.7	B	2.5	-	-	-	-	-

[a]Demand of critical movements in vehicles per hour.
[b]Volume-to-capacity ratio.
[c]Delay in seconds per vehicle.
[d]Level of service.
[e]95th percentile queue in feet.
[f]Delay shown in Calibrated Model Column is actual observed delay and the queue shown is the maximum queue observed queue in feet. HCM methodology does not allow any calibration for all-way STOP analyses.

CONCLUSION

The existing intersections of Summer Street and Neponset Street, Neponset Street, Water Street and Washington Street and Summer Street and Washington Street currently operate at a good level of service as reported in the TIAS prepared for the project. Based on the observed and recorded vehicle delays and queues at three of the unsignalized study area intersections, actual intersection operations are considerably better than the capacity model indicates and the intersections as configured will continue to operate at acceptable levels under the future build scenario.