

Ref: 10397

March 25, 2026

Mr. Paul Materazzo, Director of Planning & Land Use
Community Development & Planning
Town of Andover
36 Bartlet Street
Andover, MA 01810

Re: Response to Traffic Peer Review #1
Proposed Multifamily Residential Development – 100 Old River Road
Andover, Massachusetts

Dear Director Materazzo:

Vanasse & Associates, Inc. (VAI) is providing responses to the comments that were raised in the March 19, 2026 *Traffic Peer Review #1* memorandum prepared by Apex Companies, LLC (Apex) concerning their review of the November 2025 *Transportation Impact Assessment* (the “November 2025 TIA”) and the February 27, 2026 supplement to the November 2025 TIA that were prepared in support of the proposed multifamily residential development to be located at 100 Old River Road in Andover, Massachusetts (hereafter referred to as the “Project”). Listed below are the comments that were identified by Apex in the subject memorandum followed by a response by VAI or the appropriate member of the Project team on behalf of the Project proponent.

Introduction

Comment 1: *The TIA states that “applying the density bonus that is allowable under the MBTA Communities Zoning law as approved by the Andover Town Meeting, the number of residential units that could be constructed at the Project site would increase to 432-units in a five-story residential building.” The analysis is based on the site having 432 units, which is a density of 45 units per acre. Per the Multifamily Overlay District Zoning Bylaw approved in 2024, this density is only permitted with a Special Permit. Apex requests confirmation that this permit is being applied for or has been granted.*

Response: **The Applicant will apply for the requisite permits and approvals necessary to apply the density bonus to the Project that is allowable under the Multifamily Overlay District Zoning Bylaw.**

Existing Conditions

Comment 2: *We note the following discrepancies and omissions in the existing conditions descriptions. We note these items only for consistency as they are not anticipated to impact the findings of this TIA.*

- *River Road and North Street / Greater Lawrence Tech Driveway*
 - *The westbound approach contains four lanes: one left-turn lane, two through lanes, and one right-turn lane that exits by way of a channelized lane*
 - *A crosswalk is provided on the River Road east leg, rather than west*
 - *Pedestrian signal equipment is not provided to cross North Street and Greater Lawrence Tech Driveway*
 - *The layout of the shoulders on River Road suggests that they function as bicycle lanes, despite symbols not being provided*
 - *The travel way width of the North Street approach is only 12 feet, which is lower than the minimum required to be considered a shared traveled-way*
- *River Road and Old River Road / Federal Street*
 - *We note that bicycle accommodations are not provided on any approaches other than the shared traveled-way on Old River Road.*
- *River Road and I-93 Northbound Ramps*
 - *The shoulders appear to range from one (1) to six (6) feet wide.*
- *River Road and Shattuck Road / Minuteman Road*
 - *It appears that pedestrian signal equipment is only provided for the crossing across River Road and not Minuteman Road.*
 - *We note that bicycle accommodations are not provided on any approaches other than the bicycle lane on River Road eastbound, which does terminate just before the intersection.*

Response: **No response required.**

Comment 3: *Based on our review of the existing traffic volumes, it appears that volumes were balanced between the following three intersections, which was verified by VAI during our meeting and as outlined in the supplementary memo:*

- *River Road and Old River Road / Federal Street*
- *River Road and I-93 Northbound Ramps*
- *River Road and I-93 Southbound Ramps*

Apex takes no exception to this methodology; however, we do note that this balancing increased movement volumes by up to approximately 80 vehicles.

Response: **No response required.**

Comment 4: *The TIA reports that the Merrimack Valley Transit (MeVa) serves the Project site via Route 37; we note that the MEVA website indicates this route is Route 7, “Beacon St/Mount Vernon”. While this does not impact the findings of the TIA itself, we note the discrepancy with regards to the information that will be disseminated as part of the Transportation Demand Management (TDM) discussed in the Recommendations Section at the end of the TIA.*



Response: **Comment noted. The materials associated with the TDM program will reflect the applicable MeVa bus route and other services that are available in the area of the Project.**

Comment 5: *While the crash rates are below the statewide and district averages, indicating no significant safety deficiency, we note that the intersections of River Road at North Street / Greater Lawrence Tech Driveway and River Road at I-93 Southbound Ramps experience crash rates that are just below these averages. Furthermore, the majority of crashes at these two locations are rear-end type, which may be susceptible to improvement by modifying signal timing clearances if deemed inadequate. As such, Apex recommends reviewing vehicle clearances and proposing modifications to the Build Mitigated signal timings as necessary.*

Response: **As identified by Apex and detailed in the November 2025 TIA, all of the study intersections were found to have motor vehicle crash rates that were below the MassDOT average crash rates for similar intersections and a review of the MassDOT statewide High Crash Location List indicated that there are no Highway Safety Improvement Program (HSIP) eligible high crash locations within the study area. That being said, we agree that the vehicle clearance intervals (“yellow” and “all-red”) at the River Road/North Street/Greater Lawrence Tech Driveway and River Road/I-93 Southbound Ramps intersections should be reviewed and adjusted as may be necessary to meet current MassDOT standards. The Applicant has proposed to provide a financial contribution to the Town in an amount sufficient to allow for the retiming of the traffic signals along the River Road corridor that would include the review of the vehicle clearance intervals at the subject intersections.**

Future Conditions

Comment 6: *The no-build condition shown in Figures 5 and 6 of the TIA use a 1.5% background growth rate for movements where background growth is expected to increase, i.e. along the mainline and to/from I-93. No background growth was assumed for turning movements to/from the side roads, as the side roads within the study area primarily provide access to existing or proposed developments with an assumed relatively static trip generation. Apex takes no exception to this methodology; however, we note that any existing vehicles traveling to the side roads along this corridor from I-93 were included in the increase for background growth at the intersections of River Road at the I-93 Ramps, and therefore this imbalance was applied to the mainline through movements, resulting in increases of up to 70 vehicles for each analysis period. The methodology was not applied consistently through the roadway network and appears to primarily impact the resultant traffic volumes at the intersection of River Road at Old River Road and Federal Street. However, given the acceptable operations at this intersection, we do not anticipate a substantial impact to the operations.*

Response: **No response required.**



Comment 7: *As described in the TIA, the nearby project at 3000 Minuteman Road includes the optimization of the four coordinated traffic signals on River Road as part of the mitigation for that project, but does not include any changes to the uncoordinated intersection of River Road and North Street / Greater Lawrence Tech Driveway. We note that this intersection appears to have been included in the optimization to obtain the no-build condition as well. As this intersection was optimized again as part of the mitigation for the subject project and given the acceptable operations, we request no further revisions to the analysis.*

Response: **No response required.**

Comment 8: *As discussed in the supplemental memorandum, since no pass-by data is available for the weekday morning peak hour, VAI used the lowest available percentage to apply to this peak hour. While we take no exception to using the available data, without knowing the type of retail proposed for the site, one could argue that there may not be many, if any, pass-by trips at this time. However, we note that this only equates to a reduction of two (2) vehicle trips during the weekday morning peak hour, which is well within a normal fluctuation of traffic, and no further revisions are requested.*

Response: **No response required.**

Traffic Operations Analysis

Comment 9: *Based on discussions with the Town, it is our understanding that the office development at the existing site has been underutilized for many years (up to approximately 20 years), generating significantly fewer vehicles than a fully-occupied building. To establish the future No-Build conditions, VAI incorporated the impacts of the fully-occupied building, under which the site is currently approved to operate. Through our discussions, the Town indicated a concern about overestimating the impacts of the existing project when compared to the proposed project. As such, during our meeting with VAI, Apex requested that they prepare a future No-Build condition that only accounts for a projection of the existing traffic volumes without the assumption of a fully-occupied building, which was included in the supplemental memorandum prepared by VAI. The following summarizes our findings based on the revised traffic analysis:*

- a. All intersections are expected to operate at an overall Level of Service (LOS) C or better during both the weekday morning and evening peak hours under the future conditions, with or without the project.*
- b. At the intersection of River Road at North Street and Greater Lawrence Tech Driveway, the North Street northbound left-turn lane is expected to operate at an unacceptable LOS E during the morning peak hour under the future No-Build conditions, and is expected to continue to operate at an LOS E with approximately two (2) additional seconds of delay under the Build conditions due to the impacts of the Project. However, based on*



the Build Mitigated conditions, this movement is expected to improve to an acceptable LOS D.

- c. At the intersection of River Road at Old River Road and Federal Street, the Old River Road southbound shared left-turn/through lane is expected to operate at an acceptable LOS D during the morning peak hour under the future No-Build conditions, and is expected to degrade to an unacceptable LOS E under the Build conditions due to the impacts of the project, with a notable additional 20 seconds of delay between No-Build and Build conditions. We note that the operations for all movements at this intersection look very similar between the Build and Build Mitigated conditions, and that there appears to be additional capacity for many of the other movements that could potentially allow further optimization to improve the operations for the southbound movement. Apex requests clarification on the optimized timings selected for this mitigation and if changes could be applied to improve upon the southbound operations.*
- d. There are several movements that are expected to experience slightly more delay as a result of the project (up to four (4) seconds additional delay) but are still expected to operate at an acceptable LOS D or better. In some cases, these degradations have been mitigated under the Build Mitigated conditions*

Response:

The analyses that were presented in the November 2025 TIA and as affirmed by the February 27, 2026 supplemental analysis demonstrate the limited impact of the Project at the study area intersections with or without consideration of full or partial occupancy of the existing office building that currently occupies the Project site and that could be retananted as-of-right. Recognizing the limited impact of the Project and acknowledging the overall benefit that traffic signal retiming will have on traffic operations, the Applicant has committed to provide a financial contribution to the Town in an amount sufficient to allow the Town to design and implement these improvements. The amount of the financial contribution will be determined in consultation with the Town and will be deposited in an escrow account for use by the Town for said purpose as a condition of the issuance of the Building Permit for the Project.

Comment 10:

Through discussions with the Town, it seems that the traffic analysis does not capture certain peak hours when vehicles are queued along River Road; these queues appear to be a result of traffic on I-93, which subsequently backs up along the I-93 Northbound On-Ramp, and onto River Road westbound, and further extends through the intersection of River Road at Old River Road and Federal Street. We note that the Synchro analysis would not account for such backups as the software does not account for impacts to operations based on other intersections and external factors outside of the study area. There is concern that the additional traffic from the development may further exacerbate the traffic that is unaccounted for in the analysis. While the corridor has been optimized as mitigation for this project, we note that the analysis may not reflect the operations that are currently experienced.



Response: **The back-ups that occur along the River Road corridor are confined to the weekday evening peak-hour and are directly-related to the flow of traffic along I-93 northbound. The variability of these conditions cannot be modeled in any meaningful manner. During this period, it is common for vehicle queues on the River Road westbound approach to the I-93 northbound on-ramp to extend through the River Road/Old River Road/Federal Street intersection. It is important to note that the majority of the trips associated with the Project will be entering the Project site and turning left or right from River Road to Old River Road and will not be adding traffic to the delayed movements along the River Road corridor. During those instances when the River Road/Old River Road/Federal Street intersection is blocked, vehicles destined to the Project and other uses along Old River Road queue within the eastbound left-turn lane and do not impede through traffic along River Road.**

Comment 11: *Under existing conditions, the intersection of River Road at Old River Road and Federal Street does not include a pedestrian phase in the signal timing. We note that if an exclusive pedestrian phase was added as part of improvements to the intersection, the traffic operations may be significantly impacted.*

Response: **No response required. We agree that the addition of an exclusive pedestrian phase to the River Road/Old River Road/Federal Street intersection would result in added delay.**

Comment 12: *In the supplemental analysis, the 2032 Build operations reported in Table 10R for the River Road and North Street / Greater Lawrence Tech Driveway intersection do not match the Synchro analysis sheets for the weekday evening peak hour. It appears the operations were not updated from the original analysis.*

Response: **Table 10R has been corrected and is attached.**

Sight Distance Evaluation

Comment 13: *The TIA states that tree trimming and removal, regrading of embankment areas, and modification of a stone wall are necessary to provide the sight distances reported at the site driveways. Apex reviewed the line of sight triangle provided on the overall landscape plan of the project site plans. The plan appears to indicate approximately 200 feet of intersection sight distance looking both north and south on Old River Road, which is less than the reported 281 feet looking south and 251 feet looking north, assuming the clearing and modifications discussed above. We note that 200 feet meets the minimum required Stopping Sight Distance (SSD) but does not meet the desired Intersection Sight Distance (ISD).*

Response: **The intent of the sight triangle plan is to define the required minimum sight distance for the Project site driveway intersections to function in a safe manner (SSD). The actual sight distances that will be provided with the recommended selective trimming/removal of trees and vegetation, the regrading of embankment areas and modification of the existing stone walls**



along the south side of Old River Road where present within the sight triangle areas of the Project site driveways, will exceed the 200 feet minimum required sight distance as noted by Apex.

Conclusions and Recommendations

Comment 14: *The TIA states that drive aisles will be a minimum of 23-feet wide in places where perpendicular parking is proposed. We note that according to the Town of Andover zoning bylaws, a minimum width of 24-feet is required for two-way drive aisles.*

VAI Response: **The drive aisles will be 24-feet in width as required by the Zoning Bylaws.**

Comment 15: *The TIA outlines recommendations for off-site improvements to the River Road corridor traffic signal system, which includes optimizing traffic signal timing, phasing, and coordination. Apex understands that since some of the intersections along the corridor are under MassDOT jurisdiction, improvements would have to be addressed with MassDOT. We recommend Town involvement and coordination with both MassDOT and the Applicant to provide input on any off-site improvements. The Board may wish to consider further coordination regarding off-site improvements as a condition of any approval that may issued.*

VAI Response: **The Applicant has had initial consultations with MassDOT with regard to the Project and has discussed the potential off-site improvements. These initial discussions have been consistent with the information and approach to mitigation that is presented in the November 2025 TIA. The Town will be included in future discussions with MassDOT concerning the off-site improvements that are associated with the Project.**

Comment 16: *The TIA states that the Project proponent proposes to provide a financial contribution to the Town for improvements, the amount of which will be determined in consultation with the Town. The TIA also states that the Project proponent will partner with the Town to prepare an application for a MassWorks or HousingWorks grant to construct the off-site improvement measures. Apex recommends establishing the level of off-site improvements before submitting the grant application and determining and agreeing upon a contribution from the Project proponent outside of the grant funding that is commensurate with the impacts of the Project.*

VAI Response: **The Applicant will consult with the Town to establish a financial contribution to be provided to the Town as the match to support a MassWorks or HousingWorks grant.**

Comment 17: *The TIA also outlines recommendations for mobility improvements along Old River Road. These improvements include constructing a sidewalk along the north side of Old River Road from the south Project site driveway to Campanelli Drive, installing a crosswalk across Old River Road with a Rectangular Rapid Flashing Beacon (RRFB), and constructing pedestrian ramps*



in compliance with Americans with Disabilities Act (ADA). Apex notes that these improvements leave a relatively short gap in pedestrian connectivity to the intersection of River Road at Old River Road/Federal Street (approximately 200 feet to the south) and the existing sidewalk along the south side of River Road. The TIA notes that this extension could be provided as part of a larger improvement project with the grant funding assistance; however, we note that this pedestrian connectivity would benefit the residents and visitors of the development and if these improvements were done as part of a larger project, they would likely not be implemented until after the development has been completed. As such, Apex recommends consideration be made for extending the sidewalk along Old River Road to the intersection with River Road, as well as installing a crosswalk across River Road, constructing ADA-compliant pedestrian ramps, and installing pedestrian signal equipment at both the existing and proposed crosswalks for continuous pedestrian connectivity.

VAI Response: The cost associated with the sidewalk extension and the accompanying geometric improvements and traffic signing reconstruction at the River Road/Old River Road/Federal Street intersection is disproportionate to the impact of the Project. That being said, acknowledging the overall benefit to mobility, the requested improvements can be included in a *Community One Stop for Growth* grant application. The Applicant will assist the Town in preparing the grant application and will provide a “fair-share” cost contribution to the Town for the design and construction of the improvements that is commensurate with the impact of the Project at the intersection as defined by the increase in trips to the intersection that the Project represents over No-Build conditions during the weekday peak hours.

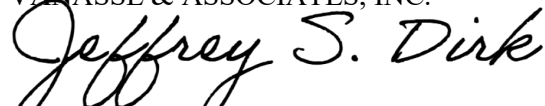
Comment 18: Apex recommends that the TDM plan be formalized and mutually agreed upon between the Applicant and the Town.

VAI Response: The TDM program will be formalized for review and approval by the Town prior to the issuance of a Certificate of Occupancy for the Project.

We trust that this information is responsive to the comments that were identified in the March 19, 2026 memorandum prepared by Apex concerning their review of the Project. If you should have any questions or would like to discuss our responses in more detail, please feel free to contact me.

Sincerely,

VANASSE & ASSOCIATES, INC.



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

Professional Engineer in CT, MA, ME, NH, RI, and VA

Attachment



ATTACHMENTS

Table 10R (Revised)

2032 Build Weekday Evening Peak-Hour Synchro Worksheets – River Road at North Street and
the Greater Lawrence Technical School Driveway

Table 10R (Revised)

**Table 10R – Revised PHFs, HV% and Future Condition PHF Set to 0.92
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY**

Signalized Intersection/Peak-Hour/Movement	2025 Existing				2032 No-Build				2032 Build			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
<i>River Road at North Street and Greater Lawrence Tech Driveway</i>												
<i>Weekday Morning:</i>												
River Road EB LT	0.72	40.0	D	5/9	0.70	42.3	D	4/10	0.70	42.3	D	4/10
River Road EB TH	0.41	13.6	B	3/9	0.43	15.6	B	4/11	0.43	15.6	B	4/11
River Road EB RT	0.44	0.9	A	0/0	0.43	0.9	A	0/0	0.43	0.9	A	0/0
River Road WB LT	0.39	44.5	D	1/2	0.40	46.8	D	1/2	0.40	46.8	D	1/2
River Road WB TH/RT	0.69	27.0	C	8/15	0.90	38.7	D	11/25	0.87	36.3	D	11/24
North Street NB LT	0.93	68.4	E	5/15	0.93	64.8	E	7/18	0.91	59.2	E	6/17
North Street NB TH/RT	0.24	28.0	C	2/5	0.20	26.5	C	2/4	0.20	26.5	C	2/4
Greater Lawrence Tech SB LT	0.60	33.9	C	3/4	0.30	27.5	C	2/5	0.30	27.5	C	2/5
Greater Lawrence Tech SB TH/RT	0.26	28.1	C	2/3	0.12	25.8	C	1/3	0.12	25.8	C	1/3
Overall	--	23.5	C	--	--	27.8	C	--	--	26.3	C	--
<i>Weekday Evening:</i>												
River Road EB LT	0.29	32.1	C	1/2	0.42	35.6	D	1/3	0.42	35.9	D	1/3
River Road EB TH	0.36	14.3	B	2/7	0.48	14.9	B	3/11	0.48	15.1	B	3/11
River Road EB RT	0.17	0.2	A	0/0	0.24	0.4	A	0/0	0.24	0.4	A	0/0
River Road WB LT	0.27	32.6	C	1/2	0.30	33.6	C	1/2	0.30	33.8	C	1/2
River Road WB TH/RT	0.64	17.8	B	4/13	0.64	17.0	B	4/15	0.65	17.3	B	4/15
North Street NB LT	0.59	23.7	C	2/9	0.63	25.3	C	3/10	0.63	25.3	C	3/10
North Street NB TH/RT	0.07	18.1	B	0/2	0.07	18.4	B	0/2	0.07	18.3	B	0/2
Greater Lawrence Tech SB LT	0.05	17.9	B	0/1	0.05	18.3	B	0/1	0.05	18.1	B	0/1
Greater Lawrence Tech SB TH/RT	0.04	17.9	B	0/2	0.04	18.3	B	0/2	0.04	18.1	B	0/2
Overall	--	15.6	B	--	--	15.1	B	--	--	15.3	B	--

See notes at end of Table.

Table 10R (Continued) – Revised PHFs, HV% and Future Condition PHF Set to 0.92
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak-Hour/Movement	2025 Existing				2032 No-Build				2032 Build			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
<i>River Road at Old River Road and Federal Street</i>												
<i>Weekday Morning:</i>												
River Road EB LT	0.55	31.1	C	3/4	0.73	32.3	C	4/5	0.64	30.0	C	3/4
River Road EB TH/RT	0.79	15.2	B	10/17	0.78	8.5	A	3/12	0.79	8.3	A	4/12
River Road WB LT	0.30	32.3	C	1/3	0.55	35.1	D	1/3	0.55	35.1	D	1/3
River Road WB TH/RT	0.57	11.4	B	7/11	0.71	12.4	B	9/12	0.68	11.8	B	8/11
Federal Street NB LT/TH	0.54	35.8	D	2/3	0.52	31.6	C	1/3	0.52	31.5	C	1/3
Federal Street NB RT	0.01	31.5	C	0/0	0.01	28.6	C	0/0	0.01	28.5	C	0/0
Old River Road SB LT/TH	0.63	39.7	D	2/4	0.72	46.2	D	2/4	0.82	60.6	E	2/5
Old River Road SB RT	0.08	0.1	A	0/0	0.08	0.1	A	0/0	0.14	0.2	A	0/0
Overall	--	16.2	B	--	--	13.6	B	--	--	12.9	B	--
<i>Weekday Evening:</i>												
River Road EB LT	0.31	42.3	D	1/2	0.39	41.9	D	1/2	0.55	40.1	D	2/3
River Road EB TH/RT	0.54	19.9	B	3/10	0.57	6.0	A	3/4	0.57	6.2	A	3/5
River Road WB LT	0.07	37.0	D	0/1	0.11	38.3	D	0/1	0.11	38.3	D	0/1
River Road WB TH/RT	0.70	24.6	C	8/9	0.70	19.1	B	10/15	0.74	21.3	C	11/15
Federal Street NB LT/TH	0.64	21.4	C	5/12	0.82	38.4	D	6/9	0.82	38.2	D	6/9
Federal Street NB RT	0.04	14.7	B	0/0	0.04	20.1	C	0/0	0.04	20.1	C	0/0
Old River Road SB LT/TH	0.31	16.7	B	2/3	0.51	24.0	C	2/4	0.42	23.2	C	2/3
Old River Road SB RT	0.25	0.3	A	0/0	0.25	0.3	A	0/0	0.22	0.3	A	0/0
Overall	--	18.7	B	--	--	15.0	B	--	--	16.7	B	--
<i>River Road at the I-93 Northbound Ramps</i>												
<i>Weekday Morning:</i>												
River Road EB LT	0.54	40.0	D	3/4	0.62	32.9	C	3/4	0.62	32.3	C	3/4
River Road EB TH	0.58	4.8	A	4/5	0.71	6.9	A	5/6	0.68	6.5	A	4/6
River Road WB TH	0.34	23.3	C	5/9	0.55	11.5	B	3/5	0.62	12.3	B	3/6
River Road WB RT	0.35	0.6	A	0/0	0.41	0.6	A	0/0	0.41	0.7	A	0/0
I-93 NB Ramps SB LT	0.74	31.1	C	6/7	0.69	25.8	C	5/7	0.69	25.8	C	5/7
I-93 NB Ramps SB RT	0.35	15.1	B	3/3	0.54	13.0	B	5/6	0.54	13.0	B	5/6
Overall	--	14.7	B	--	--	12.1	B	--	--	12.1	B	--
<i>Weekday Evening:</i>												
River Road EB LT	0.71	19.4	B	3/7	0.84	16.7	B	3/4	0.84	15.9	B	4/4
River Road EB TH	0.29	4.2	A	1/5	0.35	1.0	A	1/1	0.36	1.2	A	1/1
River Road WB TH	0.53	16.1	B	8/9	0.64	14.6	B	5/6	0.66	14.5	B	5/6
River Road WB RT	0.57	1.4	A	1/2	0.58	1.3	A	2/6	0.55	1.1	A	1/2
I-93 NB Ramps SB LT	0.42	33.2	C	2/3	0.50	34.5	C	2/3	0.62	36.0	D	3/5
I-93 NB Ramps SB RT	0.11	13.3	B	1/1	0.17	11.2	B	2/2	0.17	10.7	B	1/2
Overall	--	10.9	B	--	--	9.6	A	--	--	9.9	A	--

See notes at end of Table.

**Table 10R (Continued) – Revised PHFs, HV% and Future Condition PHF Set to 0.92
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY**

Signalized Intersection/Peak-Hour/Movement	2025 Existing				2032 No-Build				2032 Build			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
<i>River Road at the I-93 Southbound Ramps</i>												
<i>Weekday Morning:</i>												
River Road EB TH	0.44	13.1	B	3/3	0.68	18.0	B	5/7	0.69	19.0	B	5/7
River Road EB RT	0.09	0.1	A	0/0	0.13	0.1	A	0/0	0.13	0.1	A	0/0
River Road WB LT	0.51	36.4	D	3/4	0.67	31.4	C	2/4	0.80	35.6	D	3/6
River Road WB TH	0.35	11.5	B	4/7	0.76	15.0	B	8/12	0.76	14.8	B	9/13
I-93 SB Ramps NB LT	0.87	34.1	C	9/14	0.89	26.2	C	10/15	0.89	26.5	C	10/15
I-93 SB Ramps NB RT	0.61	1.6	A	0/0	0.69	2.2	A	0/0	0.67	2.0	A	0/0
Overall	--	15.4	B	--	--	15.2	B	--	--	15.9	B	--
<i>Weekday Evening:</i>												
River Road EB TH	0.45	14.1	B	5/9	0.85	21.4	C	9/18	0.87	22.5	C	9/19
River Road EB RT	0.25	0.3	A	0/0	0.46	0.6	A	0/0	0.46	0.6	A	0/0
River Road WB LT	0.68	49.9	D	5/6	0.68	37.7	D	5/8	0.67	38.9	D	6/8
River Road WB TH	0.14	1.0	A	0/1	0.23	1.2	A	1/1	0.23	1.2	A	1/1
I-93 SB Ramps NB LT	0.56	32.2	C	3/4	0.62	31.9	C	4/5	0.62	31.9	C	4/5
I-93 SB Ramps NB RT	0.35	0.5	A	0/0	0.35	0.5	A	0/0	0.36	0.6	A	0/0
Overall	--	14.8	B	--	--	14.5	B	--	--	15.1	B	--

See notes at end of Table.

Table 10R (Continued) – Revised PHFs, HV% and Future Condition PHF Set to 0.92
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak-Hour/Movement	2025 Existing				2032 No-Build				2032 Build			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
River Road at Shattuck Road and Minuteman Road												
<i>Weekday Morning:</i>												
River Road EB LT	0.33	39.5	D	1/1	0.43	32.4	C	1/2	0.43	32.4	C	1/2
River Road EB TH/RT	0.42	17.2	B	5/6	0.42	17.3	B	4/6	0.41	17.2	B	4/5
Eiver Road WB LT	0.69	36.8	D	5/5	0.69	25.4	C	4/5	0.69	25.8	C	4/5
River Road WB TH	0.63	6.9	A	3/15	0.81	19.5	B	12/19	0.82	19.9	B	12/19
River Road WB RT	0.19	0.2	A	0/0	0.64	1.1	A	0/0	0.64	1.1	A	0/0
Shattuck Road NB LT/TH	0.20	34.5	C	1/2	0.18	30.1	C	1/2	0.18	30.1	C	1/2
Shattuck Road NB RT	0.12	17.9	B	1/2	0.11	15.7	B	1/1	0.11	15.6	B	1/2
Minuteman Road SB LT	0.30	34.8	C	1/2	0.70	39.9	D	3/6	0.71	40.2	D	3/6
Minuteman Road SB LT/TH	0.30	34.8	C	1/2	0.72	41.0	D	2/6	0.72	41.0	D	2/6
Minuteman Road SB RT	0.01	0.0	A	0/0	0.01	0.0	A	0/0	0.01	0.0	A	0/0
Overall	--	16.9	B	--	--	15.9	B	--	--	16.0	B	--
<i>Weekday Evening:</i>												
River Road EB LT	0.22	38.9	D	0/1	0.37	39.9	D	1/1	0.37	39.9	D	1/1
River Road EB TH/RT	0.57	27.7	C	5/8	0.65	31.6	C	5/8	0.66	31.6	C	6/8
Eiver Road WB LT	0.40	40.9	D	2/3	0.39	35.6	D	1/2	0.40	35.2	D	1/2
River Road WB TH	0.62	25.6	C	5/14	0.73	27.7	C	5/15	0.71	25.8	C	5/14
River Road WB RT	0.03	0.0	A	0/0	0.19	0.3	A	0/0	0.19	0.3	A	0/0
Shattuck Road NB LT/TH	0.18	21.0	C	2/2	0.23	30.3	C	1/3	0.23	30.4	C	1/3
Shattuck Road NB RT	0.66	18.6	B	5/7	0.68	27.3	C	6/8	0.69	27.6	C	6/8
Minuteman Road SB LT	0.49	32.7	C	2/3	0.87	38.4	D	9/17	0.87	38.8	D	10/17
Minuteman Road SB LT/TH	0.49	32.7	C	2/3	0.87	39.0	D	9/16	0.88	39.4	D	9/16
Minuteman Road SB RT	0.01	0.0	A	0/0	0.03	0.0	A	0/0	0.03	0.0	A	0/0
Overall	--	24.4	C	--	--	29.3	C	--	--	29.3	C	--

^aVolume-to-capacity ratio.

^bControl (signal) delay per vehicle in seconds.

^cLevel of service.

^dQueue length in vehicles.

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

2032 Build Weekday Evening Peak-Hour Synchro Worksheets – River Road at North Street and the Greater Lawrence Technical School Driveway



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Lane Configurations													
Traffic Volume (vph)	29	611	340	24	835	12	220	21	27	16	14	14	
Future Volume (vph)	29	611	340	24	835	12	220	21	27	16	14	14	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	0.95	1.00	1.00	1.00	1.00	1.00	1.00	
Frt			0.850		0.998			0.916			0.925		
Flt Protected	0.950			0.950			0.950			0.950			
Satd. Flow (prot)	1532	3355	1546	1745	3415	0	1711	1611	0	1745	1699	0	
Flt Permitted	0.950			0.950			0.738			0.723			
Satd. Flow (perm)	1532	3355	1546	1745	3415	0	1329	1611	0	1328	1699	0	
Satd. Flow (RTOR)			315		1			29			15		
Adj. Flow (vph)	32	664	370	26	908	13	239	23	29	17	15	15	
Lane Group Flow (vph)	32	664	370	26	921	0	239	52	0	17	30	0	
Turn Type	Prot	NA	Free	Prot	NA		Perm	NA		Perm	NA		
Protected Phases	5	2		1	6			4			8		9
Permitted Phases			Free				4			8			
Detector Phase	5	2		1	6		4	4		8	8		
Switch Phase													
Minimum Initial (s)	5.0	10.0		5.0	10.0		5.0	5.0		5.0	5.0		5.0
Minimum Split (s)	11.0	16.0		11.0	16.0		10.0	10.0		10.0	10.0		23.0
Total Split (s)	11.0	43.0		11.0	43.0		32.0	32.0		32.0	32.0		23.0
Total Split (%)	10.1%	39.4%		10.1%	39.4%		29.4%	29.4%		29.4%	29.4%		21%
Maximum Green (s)	5.0	37.0		5.0	37.0		27.0	27.0		27.0	27.0		20.0
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0		2.0
All-Red Time (s)	2.0	2.0		2.0	2.0		1.0	1.0		1.0	1.0		1.0
Lost Time Adjust (s)	-2.0	-2.0		-2.0	-2.0		-1.0	-1.0		-1.0	-1.0		
Total Lost Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0		
Lead/Lag	Lead	Lag		Lead	Lag								
Lead-Lag Optimize?	Yes	Yes		Yes	Yes								
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0		3.0
Recall Mode	None	Min		None	Min		None	None		None	None		None
Walk Time (s)													7.0
Flash Don't Walk (s)													13.0
Pedestrian Calls (#/hr)													4
v/c Ratio	0.17	0.43	0.24	0.12	0.59		0.58	0.10		0.04	0.06		



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	Ø9
Control Delay (s/veh)	39.5	16.4	0.4	39.1	18.4		30.2	14.5		23.5	16.5		
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0		
Total Delay (s/veh)	39.5	16.4	0.4	39.1	18.4		30.2	14.5		23.5	16.5		
Queue Length 50th (ft)	11	68	0	8	103		63	5		4	3		
Queue Length 95th (ft)	58	261	0	46	378		#254	45		27	32		
Internal Link Dist (ft)		1435			1194			1039			1055		
Turn Bay Length (ft)	150		200	130						100			
Base Capacity (vph)	191	2338	1546	218	2380		665	820		664	857		
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0		
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0		
Storage Cap Reductn	0	0	0	0	0		0	0		0	0		
Reduced v/c Ratio	0.17	0.28	0.24	0.12	0.39		0.36	0.06		0.03	0.04		

Intersection Summary

Cycle Length: 109

Actuated Cycle Length: 64.4

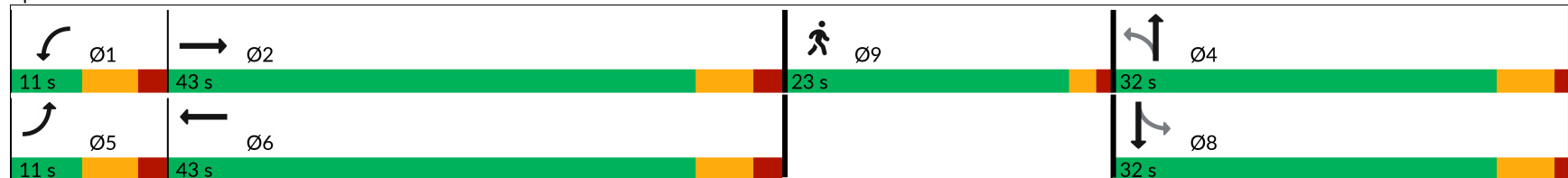
Natural Cycle: 80

Control Type: Actuated-Uncoordinated

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: North Street/Greater Lawrence Tech & River Road





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	29	611	340	24	835	12	220	21	27	16	14	14
Future Volume (vph)	29	611	340	24	835	12	220	21	27	16	14	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	10	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95		1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00		1.00	0.92		1.00	0.93	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1532	3355	1546	1745	3415		1711	1611		1745	1699	
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.74	1.00		0.72	1.00	
Satd. Flow (perm)	1532	3355	1546	1745	3415		1328	1611		1328	1699	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	32	664	370	26	908	13	239	23	29	17	15	15
RTOR Reduction (vph)	0	0	0	0	1	0	0	21	0	0	11	0
Lane Group Flow (vph)	32	664	370	26	920	0	239	31	0	17	19	0
Heavy Vehicles (%)	10%	4%	1%	0%	2%	0%	2%	5%	4%	0%	0%	0%
Turn Type	Prot	NA	Free	Prot	NA		Perm	NA		Perm	NA	
Protected Phases	5	2		1	6			4			8	
Permitted Phases			Free				4			8		
Actuated Green, G (s)	1.5	27.0	69.7	1.5	27.0		18.8	18.8		18.8	18.8	
Effective Green, g (s)	3.5	29.0	69.7	3.5	29.0		19.8	19.8		19.8	19.8	
Actuated g/C Ratio	0.05	0.42	1.00	0.05	0.42		0.28	0.28		0.28	0.28	
Clearance Time (s)	6.0	6.0		6.0	6.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	76	1395	1546	87	1420		377	457		377	482	
v/s Ratio Prot	0.02	0.20		0.01	c0.27			0.02			0.01	
v/s Ratio Perm			c0.24				c0.18			0.01		
v/c Ratio	0.42	0.48	0.24	0.30	0.65		0.63	0.07		0.05	0.04	
Uniform Delay, d1	32.1	14.8	0.0	31.9	16.3		21.8	18.2		18.1	18.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.7	0.3	0.4	1.9	1.0		3.5	0.1		0.0	0.0	
Delay (s)	35.9	15.1	0.4	33.8	17.3		25.3	18.3		18.1	18.1	



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Level of Service	D	B	A	C	B		C	B		B	B	
Approach Delay (s/veh)		10.6			17.8			24.0			18.1	
Approach LOS		B			B			C			B	

Intersection Summary

HCM 2000 Control Delay (s/veh)	15.3	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	69.7	Sum of lost time (s)	15.0
Intersection Capacity Utilization	49.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group