Vanasse & Associates inc
Transportation Engineers & Planners

35 New England Business Center Drive
Suite 140
Andover, MA 01810

Ref: 9141

July 15, 2022

Ms. Jacki Byerly, Town Planner
Town of Andover
36 Bartlett Street
Andover, MA 01810

Re: Response to Traffic Peer Review
3000 Minuteman Road – Initial Campus Redevelopment
Andover, Massachusetts

Dear Ms. Byerly:

Vanasse & Associates, Inc. (VAI) is providing responses to the comments that were raised in the July 8, 2022 *3000 Minuteman Road Traffic Peer Review* letter prepared by Environmental Partners (EP) in reference to their review of the June 10, 2022 *Transportation Impact Assessment* (the "June 2022 TIA") prepared by VAI in support of the initial phase of the redevelopment of the Philips Healthcare campus located at 3000 Minuteman Road in Andover, Massachusetts (hereafter referred to as the "Project"). Listed below are the comments that were identified by EP in the subject letter pertaining to the June 2022 TIA followed by our response on behalf of the Applicant.

Existing Conditions

Comment 1: *The TIA states that bicycle lanes are present along River Road between the 1776 Drive intersection and Minuteman Road/Shattuck Road intersection. EP notes that although a 5-foot-wide striping exists within that roadway segment, no bicycle lane markings are present.*

Response: Comment acknowledged.

Comment 2: *VAI noted that on study roadways other than the above-mentioned segment, bicycle accommodations exist in the form of a shared traveled-way. While EP concurs that these study roadways have a combined shoulder and travel lane width of 14-feet or wider, no specific bicycle accommodations are present on the roadways.*

Response: Comment acknowledged.

Comment 3: *The intersection of River Road at Minuteman Road/Shattuck Road was stated to include bicycle detection as a part of the traffic signal system. During out site visit, EP was unable to verify bicycle detection at this intersection; the appropriate signage and pavement marking are apparent.*

Response: Comment acknowledged.

Existing Traffic Volumes

Seasonal Adjustment

Comment 4: *EP agrees that volumes collected in May typically represent above-average month conditions, and we take no exception to VAI's approach.*

Response: No response required.

COVID-19 Adjustment

Comment 5: *EP concurs with VAI's methodology and the resultant decision to not adjust the volumes.*

Response: No response required.

Spot Speed Measurement

Comment 6: *EP takes no exception to the collected data.*

Response: No response required.

Public Transportation Services

Comment 7: *EP confirmed the provided information in the TIA.*

Response: No response required.

Motor Vehicle Crash Data

Comment 8: *Backup data has not been provided to support the crash data summary. Our independent review of the MassDOT Crash Portal revealed minor inconsistencies that would not significantly impact the crash rates, which are expected to remain below the State and District 4 average.*

Response: The requested backup data for the motor vehicle crash analysis that is presented in the June 2022 TIA is attached.

Comment 9: *EP typically recommends obtaining crash reports from the Police Department to further assess the crash history at the study area intersections.*

Response: The Andover Police Department was consulted during the preparation of the June 2022 TIA and the assessment reflects their input as it relates to the evaluation of the impact of the Project on the transportation infrastructure and the associated recommendations. To the extent deemed necessary by the Police Department, a supplemental assessment of motor vehicle crashes occurring within the study area will be undertaken. That being said, we do not anticipate that such an assessment would alter the findings of the crash analysis that is presented in the June 2022 TIA.

Future Conditions

Comment 10: *EP agrees with the methodology.*

Response: No response required.

Comment 11: *We assume that VAI's research and correspondence with the Town of Andover has adequately identified all major projects and developments that may impact travel patterns in the study period; verification from the Town is recommended.*

Response: VAI coordinated with the Planning Division of the Department of Community Development and Planning before and during the preparation of the June 2022 TIA to identify the specific development projects by others to be included in the future condition traffic volumes.

Comment 12: *Backups have not been included for the trips associated with the nearby developments; as such, we cannot verify all the volumes in Figure 4 of the TIA for the 2029 No-Build Peak-Hour Traffic Volumes.*

Response: Figures A-1, A-2 and A-3 are attached and illustrate the assignment of trips to the study area intersections associated with the reoccupancy of the Philips Healthcare campus and those attributable to the identified specific development projects by others.

Comment 13: *It is our understanding that under existing conditions, the former Philips Healthcare facilities are partially or fully vacant and are currently generating fewer vehicles than a fully-occupied campus. To estimate the 2029 No-Build conditions, VAI incorporated the impacts of the fully-occupied campus, under which the site is currently approved to operate, though not currently experienced. Although we do not take exception to this methodology, we not that the 2029 No-Build conditions do not reflect a projection of the existing conditions were the site vacancies to remain.*

Response: Significant portions of the former Philips Healthcare campus were vacant or underutilized at the time that the traffic counts that form the basis of the June 2022 TIA were completed (May 2022). As discussed with the Town and EP in advance of the preparation of the June 2022 TIA, it was agreed that the Existing conditions analysis would reflect conditions and the campus occupancy at the time that the traffic counts were performed, and that the future No-Build condition would reflect conditions with the reoccupancy of the campus by similar uses that existed when Philips Healthcare operated the campus given that such reoccupancy could occur "as-of-right".

Future Build Conditions

Project-Generated Traffic

Comment 14: *EP agrees with the use of these land use code and the methodology.*

Response: No response required.

Comment 15: *The trip generation for the former Philips Healthcare campus uses LUC 760 – "Research and Development Center" for a small portion of the total square footage, though the description of the existing buildings under the Project Description section of the TIA does not specify this lane use. Clarification is requested.*

Response: LUC 760 was applied to the building area within the former Philips Healthcare campus that was allocated to office space in Buildings 2 and 3 which included associated electronics manufacturing as the office function in these buildings was dedicated to electronics research and development. The combined building area within these buildings totaled 83,825 sf.

Comment 16: *Table 6 states that the number of vehicle trips includes the trips associated with the Link & Amenities Building. However, based on the trip generation backups in the appendix for the total square-footage of each land use code, it does not seem that these trips have been included. Based on the description in the TIA, EP understands that this building will operate similarly under both former and proposed conditions and therefore the trip generation will remain the same, any trips associated with this building should be included in the total trips.*

Response: The Link & Amenities Building (48,200± sf) contains amenities such as a cafeteria, meeting space and other services that are supportive of the other uses located within the campus (both formerly and proposed) and will not produce additional traffic beyond that attributable to the other buildings.

Comment 17: *Table 6 indicates an increase in the average weekday daily trips of 314 trips when comparing the fully-occupied former Philips Healthcare campus to the proposed Project, but a decrease of 117 vehicle trips during the weekday morning peak hour and a decrease of 87 vehicle trips during the weekday evening peak hour. As discussed above regarding the projection of the existing conditions to the future no-build conditions, although we do not take exception to this methodology as the site is currently approved to operate under the fully-occupied conditions, we not that in actuality, there will not be a decrease in vehicle trips based on the current existing conditions (with vacancies), and in fact, there will be an increase of between 600 and 700 vehicle trips during each of these peak hours.*

Response: We acknowledge the comment pertaining to the comparison to existing traffic volume conditions with the former campus essentially vacant; however, as discussed with the Town and EP in advance of the preparation of the June 2022 TIA, it was agreed that the relevant comparison is the impact of the Project as it relates to the full "as-of-right" reoccupancy of the campus given that such reoccupancy can and will occur to the extent that the Project were not advanced. Further, the transportation infrastructure along the River Road corridor and the at the access points to the Project site was designed and constructed to support the build-out of the properties along Minuteman Road, 1776 Drive and Shattuck Road, including the prior use of the campus.

Trip Distribution and Assignment

Comment 18: *EP concurs with this assumption.*

Response: No response required.

Build Traffic Volumes

Comment 19: *Based on the methodology and the assumptions, the 2029 Build conditions volumes appear to be accurate.*

Response: No response required.

Traffic Operations Analysis

Comment 20: *The peak hour factor (PHF) and heavy vehicle percentage Synchro inputs are inconsistent in No-Build and Build conditions compared to the existing conditions and collected data.*

Response: The PHFs and heavy vehicle percentages were adjusted to the default values for the No-Build condition given the change in traffic volumes and traffic patterns at the study intersections resulting from the "as-of-right" reoccupancy of the Philips Healthcare campus. The default values were retained for the Build condition in order to allow for a comparative assessment of the impact of the Project vs. the "as-of-right" reoccupancy (i.e., No-Build condition).

Comment 21: *At the intersection of River Road and Minuteman Road/Shattuck Road, the channelized westbound right turn lane operates under free control, and the channelized southbound right turn lane operates under yield control, though both movements are modeled under signalized control in the analysis. However, we note that with the signalized control, the analysis still shows and acceptable level of service.*

Response: Comment acknowledged. As indicated by EP, revising the analysis to remove the channelized right-turn movements would result in improved operating conditions at intersections that were indicated to be operating acceptably in the June 2022 TIA.

Comment 22: *In Table 7 of the TIA (Signalized Intersection Level-of-Service and Vehicle Queue Summary), we recommend presenting the actual delays when exceeding 80 seconds.*

Response: Table 7 has been updated to present the modeled delays for the movements that were identified to be operating over capacity (i.e., LOS "F"). We note that the modeled delays are not indicative of the delays that are or that will be experienced under such conditions, as the analysis model is not an accurate predictor of delays under oversaturated conditions where flow becomes unstable.

Comment 23: *Similar to the discussion above, comparing the 2029 No-Build conditions, which reflect the fully-occupied Philips Healthcare campus (although it is currently substantially vacant), to the 2029 Build conditions does not reflect the change in traffic operations compared to existing conditions. Based on the comparison of the*

proposed Project to the fully-occupied former use, we agree that the impacts of the proposed Project are minimal and in some instances provide an improvement in operations. However, when compared to the existing conditions which include site vacancies, the traffic operations are expected to degrade from the current LOS C to LOS F along the impacted movements at the intersection of River Road at Minuteman Road/Shattuck Road with significant increase in delay. EP notes that the proposed mitigation discussed under the Recommendations Section includes optimization of the traffic signal timings, which improves the traffic operations such that all movements are expected to operate at a LOS D or better.

Response: See response to Comments 13 and 17.

Comment 24: *Although the intersections with the Interstate 93 (I-93) ramps at River Road were not included in the study area based on the impacts of the proposed Project as presented, we note that the increase in the number of vehicle trips due to the proposed Project as compared to the current existing conditions will likely have a significant impact on these intersections, as it is assumed a large portion of these trips will not be locally-generated trips and will be using I-93 to access the site. Optimization to the traffic signal timings at these intersections should also be considered.*

Response: The scope of the June 2022 TIA was developed in consultation with and approved by the Town and EP. It was agreed that the appropriate condition to be assessed for the Project was based on the "as-of-right" reoccupancy of the former Philips Healthcare campus, consistent with the approach to conducting TIAs for redevelopment projects where the former use is or was occupied within the past 3-years, the statutory timeline established for consideration of the former use of a property under 301 CMR 11.00: *MEPA Regulations*.

As identified in the June 2022 TIA and acknowledged by EP, the Project will result in a reduction in traffic during the weekday peak hours when compared to the "as-of-right" reoccupancy of the Philips Healthcare campus. Accordingly, the Project will not result in an impact to operating conditions at the I-93 ramp intersections with River Road over the conditions that existed when the Phillips Healthcare campus was fully occupied. As such, the focus of the June 2022 TIA and the recommendations presented therein are on the access points to the campus, defined as the intersections of River Road at Minuteman Road and Shattuck Road and River Road at 1776 Drive. It was acknowledged that additional development beyond the initial phase that is the subject of the June 2022 TIA would be subject to further assessment to include an assessment of additional intersections along the River Road corridor.

Sight Distance Assessment

Comment 25: *EP takes not exception to the measured values reported.*

Response: No response required.

Recommendations

Comment 26: *The TIA states that drive aisles will continue to 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.*

Response: Comment acknowledged. The recommendation is intended to provide a minimum dimension for parking maneuvers.

Comment 27: *The parking lot located south of the existing Building 1 is shown on the site plans to have 60-degree angled parking spaces. According to the Town of Andover zoning bylaws, a minimum drive aisle of 18-feet-wide is required when angled parking spaces from 46- to 60-degrees are proposed. EP's measurements of both drive aisles at his parking lot appear to show narrower widths.*

Response: The subject drive aisle will be reviewed for maneuverability noting that a minimum drive aisle width of 13.5 feet is deemed acceptable for parking maneuvers with 60 degree angled parking. To the extent necessary, the required approvals will be sought from the Town of Andover for a reduced aisle width.

Comment 28: *Truck-turning templates should be provided for emergency vehicles, refuse vehicles, and other vehicles intended to use the Project site for review.*

Response: The requested turning templates will be included in a subsequent revision of the Site Plans that will be submitted by others under separate cover.

Comment 29: *Traffic sign and pavement markings plans should be provided for review.*

Response: The requested plan will be included in a subsequent revision of the Site Plans that will be submitted by others under separate cover.

Comment 30: *Accessible curb cut should be provided at the end of sidewalks in both the northern and southern parking lots.*

Response: ADA compliant ramps will be provided at the subject locations and shown on a subsequent revision of the Site Plans that will be submitted by others under separate cover.

Comment 31: *In the updated timing plans provided by VAI at the intersection of River Road and Minuteman Road/Shattuck Road, the exclusive pedestrian phase has been maintained at 26-seconds, which appears to be inadequate given the length of the crossings. We recommend reevaluating the pedestrian clearance and extending the phase as necessary to meet the requirements set forth in the Manual on Uniform Traffic Control Devices (MUTCD).*

Response: The pedestrian phase timing for the River Road crossing has been increased from 26 seconds to 30 seconds to reflect the current pedestrian phase timing requirements specified in the Manual on Uniform Traffic Control Devices (MUTCD)[1] for the subject crossing.[2] Table 10R summarizes operating conditions at the intersection with the revised pedestrian phase timing. As shown in Table 10R and consistent with the findings of the June 2022 TIA, all movements at the intersection of River Road at Minuteman Road/Shattuck Road are predicted to operate at LOS D or better with the implementation of an optimal traffic signal timing plan, inclusive of the revised pedestrian phase timing.

Additional Off-Site Mitigation

Comment 32: *EP recommends providing shortest path pedestrian connections between the closest transit station serving the Project site and each of the buildings.*

Response: Comment acknowledged. At the present time there are no transit stations located within the campus. That being said, the planning for future bus or shuttle stops within the campus will be consistent with this recommendation.

Comment 33: *As discussed above, depending on the level of impact, we recommend considering optimization of the traffic signal timings at the intersections of the I-93 ramps with River Road.*

Response: See response to Comment 24.

We trust that this information is responsive to the comments that were raised in the July 8, 2022 *3000 Minuteman Road Traffic Peer Review* letter prepared by EP pertaining to the June 2022 TIA. 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

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

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

DCL/jsd

Attachments

[1] *Manual on Uniform Traffic Control Devices (MUTCD)*; Federal Highway Administration; Washington, D.C.; 2009.
[2] The MUTCD requires that a seven (7) second initiation ("walk") time be provided plus an additional 3.5 seconds per foot for the length of the crosswalk, or 30 seconds in the case of subject crossing.

Table 7
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2022 Existing				2029 No-Build				2029 Build			
Signalized Intersection/Peak Hour/Movement	V/C[a]	Delay[b]	LOS[c]	Queue[d] 50th/95th	V/C	Delay	LOS	Queue 50th/95th	V/C	Delay	LOS	Queue 50th/95th
River Road at Minuteman Road and Shattuck Road												
Weekday Morning:												
River Road EB LT	0.02	16.0	B	0/1	0.17	18.6	B	1/2	0.18	19.0	B	1/2
River Road EB TH/RT	0.39	17.9	B	2/5	0.40	19.9	B	3/6	0.42	20.3	C	3/6
River Road WB LT	0.81	30.3	C	3/14	1.13	108.5	F	5/17	1.13	108.2	F	5/17
River Road WB TH	0.48	9.4	A	4/13	0.57	13.0	B	5/14	0.58	13.4	B	5/14
River Road WB RT	0.14	7.3	A	0/2	0.61	14.3	B	0/3	0.54	12.9	B	0/3
Shattuck Road NB LT/TH	0.15	23.6	C	1/2	0.19	27.8	C	1/2	0.19	27.4	C	1/2
Shattuck Road NB RT	0.14	15.5	B	1/2	0.21	20.4	C	1/2	0.21	20.1	C	1/2
Minuteman Road SB LT	0.28	26.1	C	1/2	0.42	26.8	C	2/7	0.43	26.2	C	2/7
Minuteman Road SB TH	0.28	26.0	C	1/3	0.42	26.8	C	2/7	0.43	26.2	C	2/7
Minuteman Road SB RT	0.00	24.4	C	1/2	0.01	24.1	C	0/0	0.01	23.4	C	0/0
Overall	--	**18.4**	**B**	--	--	**35.2**	**D**	--	--	**35.7**	**D**	--
Weekday Evening:												
River Road EB LT	0.03	19.5	B	0/1	0.07	21.6	C	0/1	0.07	21.6	C	0/1
River Road EB TH/RT	0.55	23.0	C	3/7	0.61	26.1	C	4/8	0.61	26.1	C	4/8
River Road WB LT	0.25	26.1	C	1/3	0.33	29.8	C	1/3	0.33	29.8	C	1/3
River Road WB TH	0.40	13.0	B	3/8	0.46	15.5	B	3/9	0.46	15.5	B	3/9
River Road WB RT	0.05	10.7	B	0/1	0.16	13.1	B	0/2	0.16	13.1	B	0/2
Shattuck Road NB LT/TH	0.21	25.3	C	1/2	0.25	28.8	C	1/3	0.25	28.9	C	1/3
Shattuck Road NB RT	0.66	23.5	C	3/4	0.80	32.3	C	4/6	0.80	32.3	C	4/6
Minuteman Road SB LT	0.45	27.6	C	2/4	1.99	492.7	F	11/30	1.76	392.6	F	10/26
Minuteman Road SB TH	0.44	27.6	C	2/4	2.02	505.7	F	12/30	1.72	374.6	F	9/25
Minuteman Road SB RT	0.01	24.7	C	0/0	0.04	27.5	C	0/0	0.04	27.5	C	0/0
Overall	--	**21.7**	**C**	--	--	**179.8**	**F**	--	--	**131.3**	**F**	--

[a]Volume-to-capacity ratio.
[b]Control (signal) delay per vehicle in seconds.
[c]Level-of-Service.
[d]Queue length in vehicles based on 25-feet per vehicle.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound.
LT = left-turning movements; TH = through movements; RT = right-turning movements.

Table 10R
MITIGATED SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2029 Build				2029 Build with Original Mitigation				2029 Build with Updated Mitigation			
Signalized Intersection/Peak-hour/Movement	V/C[a]	Delay[b]	LOS[c]	Queue[d] 50th/95th	V/C	Delay	LOS	Queue 50th/95th	V/C	Delay	LOS	Queue 50th/95th
River Road at Minuteman Road and Shattuck Road												
Weekday Morning:												
River Road EB LT	0.18	19.0	B	1/2	0.21	22.7	C	1/2	0.21	23.2	C	1/2
River Road EB TH/RT	0.42	20.3	C	3/6	0.49	24.3	C	3/6	0.51	24.9	C	3/7
River Road WB LT	1.13	>80.0	F	5/17	0.81	33.8	C	4/15	0.81	33.9	C	4/15
River Road WB TH	0.58	13.4	B	5/14	0.57	13.5	B	5/14	0.57	13.9	B	5/15
River Road WB RT	0.54	12.9	B	0/3	0.54	13.2	B	0/3	0.54	13.5	B	0/3
Shattuck Road NB LT/TH	0.19	27.4	C	1/2	0.16	28.1	C	1/1	0.16	28.3	C	1/2
Shattuck Road NB RT	0.21	20.1	C	1/2	0.16	17.3	B	1/2	0.16	17.5	B	1/2
Minuteman Road SB LT	0.43	26.2	C	2/7	0.48	29.4	C	2/7	0.48	29.5	C	2/8
Minuteman Road SB TH	0.43	26.2	C	2/7	0.48	29.3	C	2/7	0.48	29.4	C	2/8
Minuteman Road SB RT	0.01	23.4	C	0/0	0.01	26.0	C	0/0	0.01	26.1	C	0/0
Overall	--	**35.7**	**D**	--	--	**21.1**	**C**	--	--	**21.4**	**C**	--
Weekday Evening:												
River Road EB LT	0.07	21.6	C	0/1	0.09	31.1	C	1/2	0.10	32.3	C	1/2
River Road EB TH/RT	0.61	26.1	C	4/8	0.78	41.4	D	6/12	0.85	47.3	D	6/13
River Road WB LT	0.33	29.8	C	1/3	0.32	37.1	D	2/3	0.32	37.0	D	2/3
River Road WB TH	0.46	15.5	B	3/9	0.53	24.0	C	5/12	0.55	25.2	C	5/12
River Road WB RT	0.16	13.1	B	0/2	0.16	19.9	B	0/2	0.16	20.8	C	0/3
Shattuck Road NB LT/TH	0.25	28.9	C	1/3	0.33	39.9	D	1/2	0.33	39.3	D	1/4
Shattuck Road NB RT	0.80	32.3	C	4/6	0.89	49.8	D	6/6	0.89	48.9	D	6/6
Minuteman Road SB LT	1.76	>80.0	F	10/26	0.88	48.3	D	8/26	0.88	47.8	D	8/22
Minuteman Road SB TH	1.72	>80.0	F	9/25	0.86	45.6	D	8/21	0.85	45.2	D	8/22
Minuteman Road SB RT	0.04	27.5	C	0/0	0.04	24.1	C	0/0	0.01	24.0	C	0/0
Overall	--	**>80.0**	**F**	--	--	**40.0**	**D**	--	--	**41.0**	**D**	--

[a]Volume-to-capacity ratio.
[b]Control (signal) delay per vehicle in seconds.
[c]Level-of-Service.
[d]Queue length in vehicles.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound; LT = left-turning movements; TH = through movements; RT = right-turning movements

ATTACHMENTS

CRASH DATA BACKUP
BACKGROUND DEVELOPMENT NETWORKS
CAPACITY ANALYSIS WORKSHEETS

CRASH DATA BACKUPS

River Road at 1776 Drive

River Road at 1776 Drive

Crash Number	Crash Date	Day	Crash Severity	Crash Time	Crash Year	Light Conditions
4007781	02/12/2015	Thu	Property damage only (none injured)	5:27 PM	2015	Dark - lighted roadway
4331536	02/24/2017	Fri	Property damage only (none injured)	12:13 PM	2017	Daylight
4485134	11/18/2017	Sat	Property damage only (none injured)	11:57 PM	2017	Dark - lighted roadway
4578344	08/02/2018	Thu	Property damage only (none injured)	7:04 PM	2018	Daylight
4613962	10/25/2018	Thu	Non-fatal injury	12:10 PM	2018	Daylight
4708397	05/29/2019	Wed	Property damage only (none injured)	8:58 AM	2019	Daylight
4747294	09/05/2019	Thu	Property damage only (none injured)	5:54 PM	2019	Daylight
4786339	12/03/2019	Tue	Property damage only (none injured)	9:19 AM	2019	Daylight

River Road at 1776 Drive

Crash Number	Manner of Collision	Vehicle Actions Prior to Crash (All Vehicles)
4007781	Rear-end	V1: Slowing or stopped in traffic / V2: Slowing or stopped in traffic
4331536	Sideswipe, same direction	V1: Travelling straight ahead / V2: Travelling straight ahead
4485134	Single vehicle crash	V1: Turning right
4578344	Rear-end	V1: Travelling straight ahead / V2: Travelling straight ahead
4613962	Angle	V1: Travelling straight ahead / V2: Turning left
4708397	Sideswipe, same direction	V1: Changing lanes / V2: Slowing or stopped in traffic
4747294	Rear-end	V1: Travelling straight ahead / V2: Travelling straight ahead
4786339	Rear-end	V1: Turning right / V2: Travelling straight ahead

River Road at 1776 Drive

Crash Number	Vehicle Travel Directions (All Vehicles)	Weather Conditions	Street Number	Roadway
4007781	V1: E / V2: E	Snow	168	RIVER RD
4331536	V1: E / V2: E	Clear	170	RIVER RD
4485134	V1: N	Clear	170	RIVER RD
4578344	V1: W / V2: W	Rain	176	RIVER RD
4613962	V1: W / V2: S	Clear	170	RIVER RD
4708397	V1: E / V2: E	Cloudy	170	RIVER RD
4747294	V1: S / V2: S	Clear/Cloudy	170	RIVER RD
4786339	V1: W / V2: W	Snow/Snow	176	RIVER RD

River Road at Minuteman Road and Shattuck Road

River Road at Minuteman Road and Shattuck Road

Crash Number	Crash Date	Day	Crash Severity	Crash Time	Crash Year	Light Conditions
4155125	02/05/2016	Fri	Property damage only (none injured)	12:20 PM	2016	Daylight
4474081	03/18/2016	Fri	Property damage only (none injured)	7:09 PM	2016	Dark - lighted roadway
4181010	04/23/2016	Sat	Property damage only (none injured)	5:59 PM	2016	Daylight
4478902	07/26/2017	Wed	Property damage only (none injured)	3:42 PM	2017	Daylight

River Road at Minuteman Road and Shattuck Road

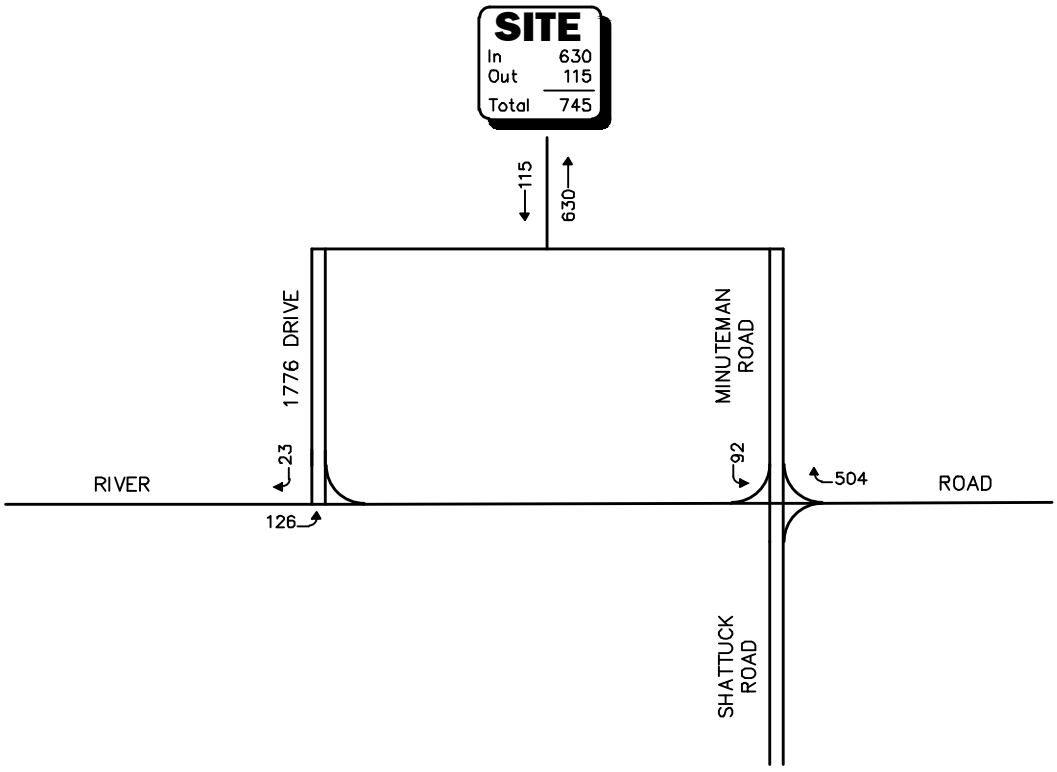
Crash Number	Manner of Collision	Vehicle Actions Prior to Crash (All Vehicles)
4155125	Rear-end	V1: Slowing or stopped in traffic / V2: Slowing or stopped in traffic
4474081	Rear-end	V1: Travelling straight ahead / V2: Travelling straight ahead
4181010	Rear-end	V1: Travelling straight ahead / V2: Travelling straight ahead
4478902	Rear-end	V1: Slowing or stopped in traffic / V2: Travelling straight ahead

River Road at Minuteman Road and Shattuck Road

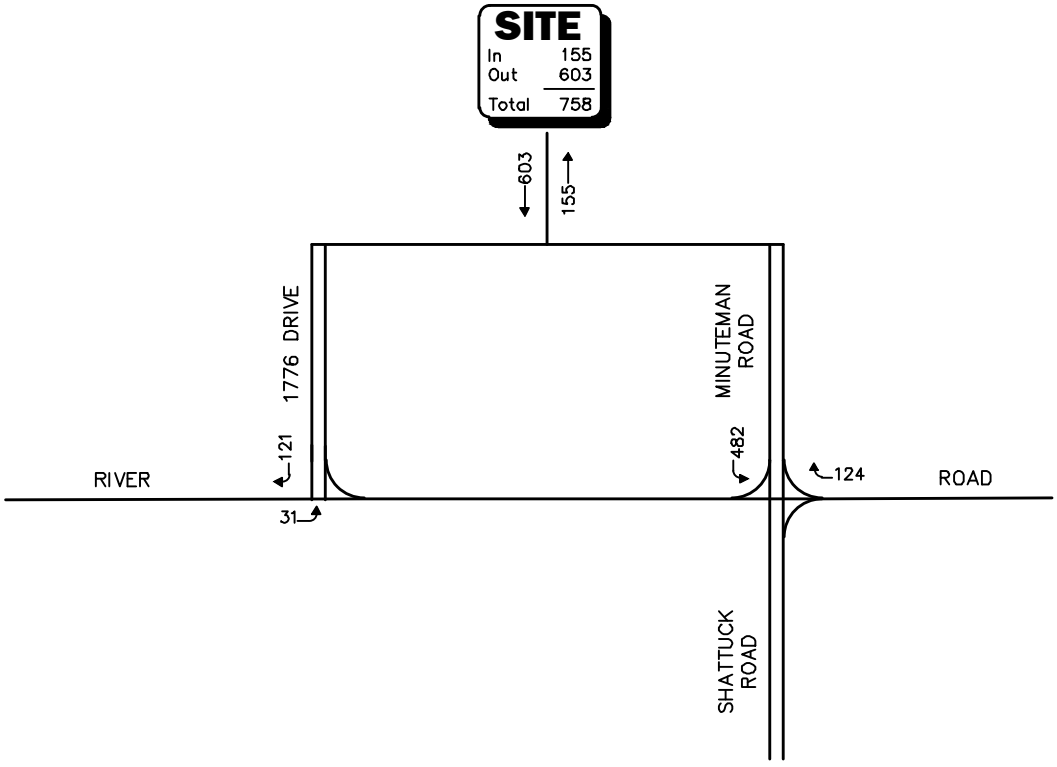
Crash Number	Vehicle Travel Directions (All Vehicles)	Weather Conditions	Street Number	Roadway
4155125	V1: E / V2: E	Snow	150	RIVER RD
4474081	V1: W / V2: W	Clear	155	RIVER RD
4181010	V1: E / V2: E	Clear/Clear	159	RIVER RD
4478902	V1: W / V2: W	Clear/Clear	159	RIVER RD

BACKGROUND DEVELOPMENT NETWORKS

WEEKDAY MORNING PEAK HOUR (7:30 - 8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)



N

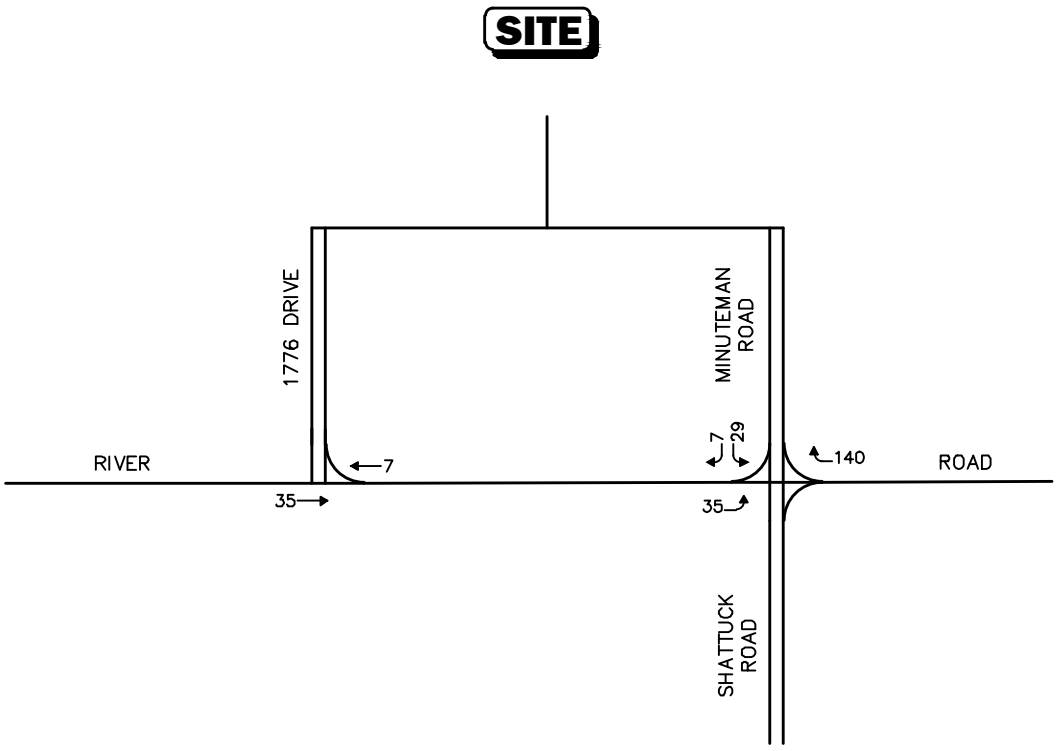
Not To Scale

Figure A-1

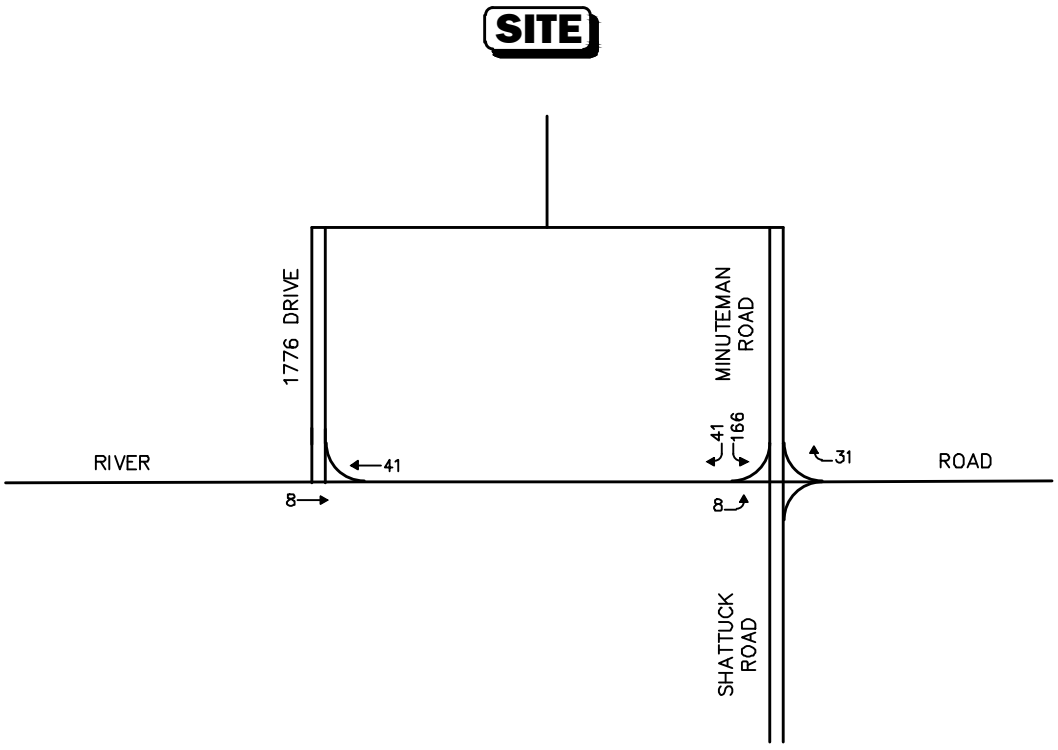
Added Phillips Academy Campus Trips Peak-Hour Traffic Volumes

Vanasse & Associates inc

WEEKDAY MORNING PEAK HOUR (7:30 - 8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)



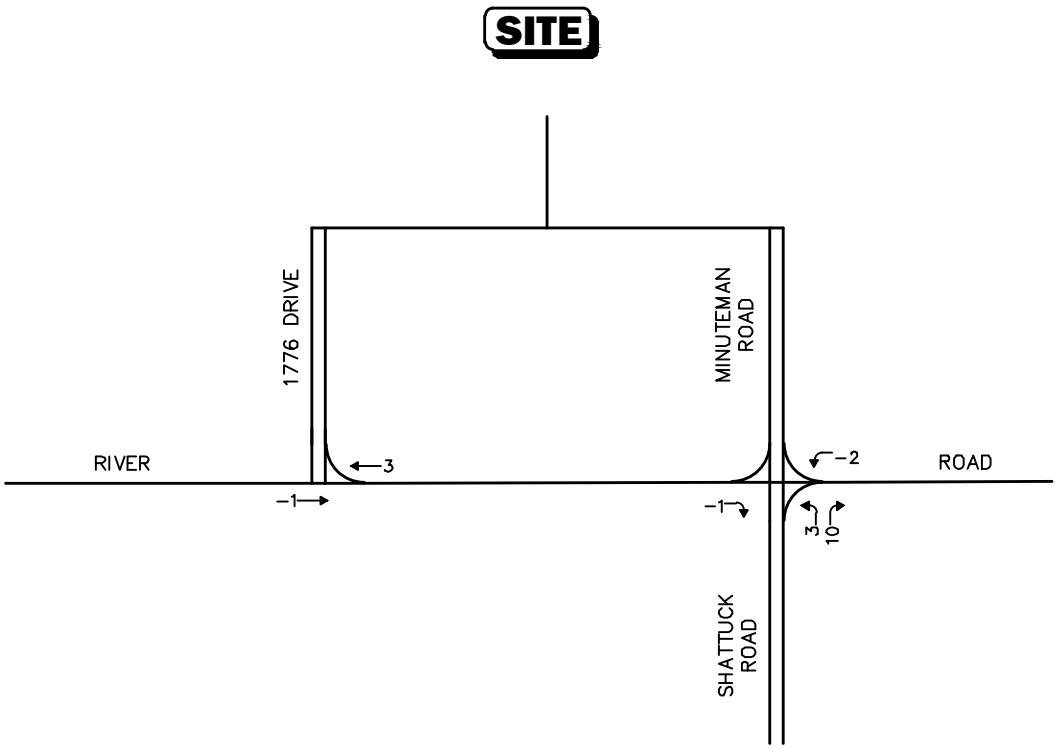
Not To Scale

Figure A-2

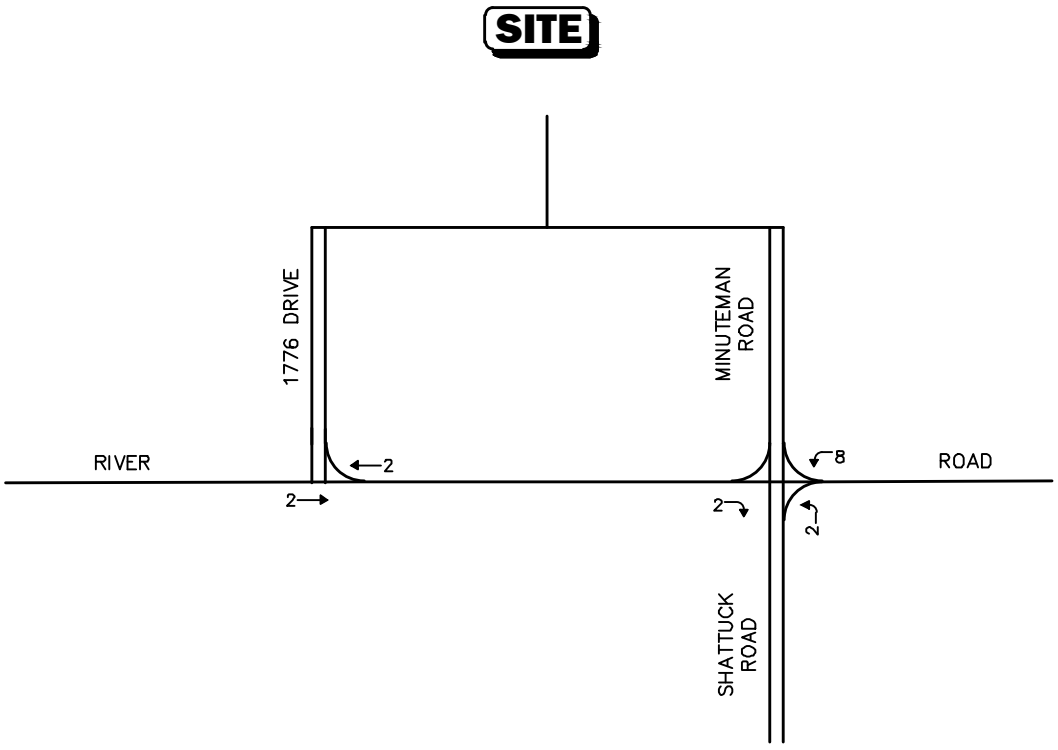
300 Minuteman Road
Peak-Hour Traffic Volumes

Vanasse & Associates inc

WEEKDAY MORNING PEAK HOUR (7:30 - 8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)



Not To Scale

Figure A-3

One Corporate Drive
Peak-Hour Traffic Volumes

Vanasse & Associates inc

CAPACITY ANALYSIS WORKSHEETS

River Road at Minuteman Road and Shattuck Road

River Road at Minuteman Road and Shattuck Road

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	39	312	45	509	441	760	24	4	114	209	4	14
Future Volume (vph)	39	312	45	509	441	760	24	4	114	209	4	14
Lane Util. Factor	1.00	0.95	0.95	0.97	1.00	1.00	1.00	1.00	0.88	0.95	0.95	1.00
Frt		0.981				0.850			0.850			0.850
Flt Protected	0.950			0.950				0.958		0.950	0.954	
Satd. Flow (prot)	1770	3422	0	3351	1783	1531	0	1624	2642	1681	1688	1583
Flt Permitted	0.482			0.950				0.958		0.950	0.954	
Satd. Flow (perm)	898	3422	0	3351	1783	1531	0	1624	2642	1681	1688	1583
Satd. Flow (RTOR)		14				826						129
Adj. Flow (vph)	42	343	49	572	496	826	28	4	133	227	4	15
Lane Group Flow (vph)	42	392	0	572	496	826	0	32	133	116	115	15
Turn Type	Perm	NA		Prot	NA	Perm	Split	NA	pt+ov	Split	NA	Perm
Protected Phases		2		1	6		8	8	8 1	4	4	
Permitted Phases	2					6						4
Detector Phase	2	2		1	6	6	8	8	8 1	4	4	4
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0
Minimum Split (s)	10.0	10.0		9.5	22.5	22.5	14.0	14.0		14.0	14.0	14.0
Total Split (s)	34.0	34.0		18.0	52.0	52.0	14.0	14.0		14.0	14.0	14.0
Total Split (%)	30.9%	30.9%		16.4%	47.3%	47.3%	12.7%	12.7%		12.7%	12.7%	12.7%
Maximum Green (s)	29.0	29.0		14.0	47.0	47.0	9.0	9.0		9.0	9.0	9.0
Yellow Time (s)	4.0	4.0		3.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	-1.0	-1.0		0.0	-1.0	-1.0		-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	4.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None		None	None	None	None	None		None	None	None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.21	0.51		0.81	0.56	0.70		0.16	0.13	0.47	0.47	0.04
Control Delay	27.6	26.5		39.6	17.5	5.1		35.9	14.6	40.3	40.2	0.2
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Total Delay	27.6	26.5		39.6	17.5	5.1		35.9	14.6	40.3	40.2	0.2
Queue Length 50th (ft)	13	65		102	117	0		11	16	41	41	0
Queue Length 95th (ft)	53	161		#376	377	80		53	42	#184	#182	0
Internal Link Dist (ft)		766			370			242			260	
Turn Bay Length (ft)	80			350					190	125		100
Base Capacity (vph)	407	1561		710	1295	1338		245	879	254	255	348
Starvation Cap Reductn	0	0		0	0	0		0	0	0	0	0
Spillback Cap Reductn	0	0		0	0	0		0	0	0	0	0
Storage Cap Reductn	0	0		0	0	0		0	0	0	0	0
Reduced v/c Ratio	0.10	0.25		0.81	0.38	0.62		0.13	0.15	0.46	0.45	0.04

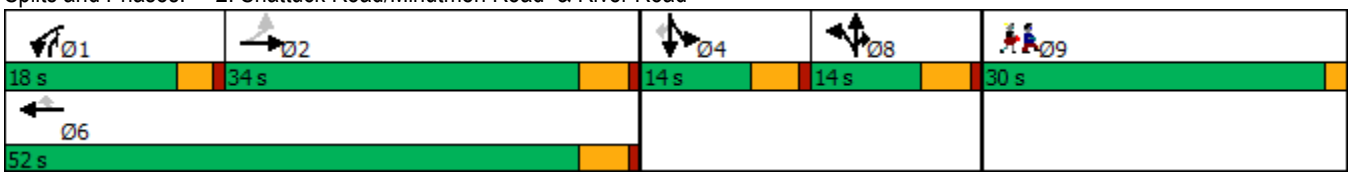
Intersection Summary
Cycle Length: 110

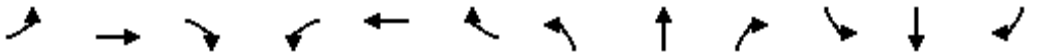
Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	30.0
Total Split (s)	30.0
Total Split (%)	27%
Maximum Green (s)	28.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	21.0
Pedestrian Calls (#/hr)	5
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 70.2
Natural Cycle: 85
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Shattuck Road/Minutmen Road & River Road

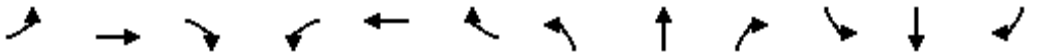




Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	39	312	45	509	441	760	24	4	114	209	4	14
Future Volume (vph)	39	312	45	509	441	760	24	4	114	209	4	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	10	10	11	12	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0		4.0	5.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95		0.97	1.00	1.00		1.00	0.88	0.95	0.95	1.00
Frt	1.00	0.98		1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	0.95	1.00
Satd. Flow (prot)	1770	3423		3351	1783	1531		1624	2642	1681	1688	1583
Flt Permitted	0.48	1.00		0.95	1.00	1.00		0.96	1.00	0.95	0.95	1.00
Satd. Flow (perm)	898	3423		3351	1783	1531		1624	2642	1681	1688	1583
Peak-hour factor, PHF	0.92	0.91	0.91	0.89	0.89	0.92	0.86	0.92	0.86	0.92	0.92	0.92
Adj. Flow (vph)	42	343	49	572	496	826	28	4	133	227	4	15
RTOR Reduction (vph)	0	11	0	0	0	425	0	0	0	0	0	13
Lane Group Flow (vph)	42	381	0	572	496	401	0	32	133	116	115	2
Heavy Vehicles (%)	2%	4%	0%	1%	3%	2%	5%	2%	4%	2%	2%	2%
Turn Type	Perm	NA		Prot	NA	Perm	Split	NA	pt+ov	Split	NA	Perm
Protected Phases		2		1	6		8	8	8 1	4	4	
Permitted Phases	2					6						4
Actuated Green, G (s)	14.6	14.6		14.9	33.5	33.5		7.7	22.6	9.2	9.2	9.2
Effective Green, g (s)	15.6	15.6		14.9	34.5	34.5		8.7	22.6	10.2	10.2	10.2
Actuated g/C Ratio	0.22	0.22		0.21	0.49	0.49		0.12	0.32	0.14	0.14	0.14
Clearance Time (s)	5.0	5.0		4.0	5.0	5.0		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	3.0
Lane Grp Cap (vph)	197	752		703	866	743		198	840	241	242	227
v/s Ratio Prot		0.11		c0.17	c0.28			c0.02	0.05	c0.07	0.07	
v/s Ratio Perm	0.05					0.26						0.00
v/c Ratio	0.21	0.51		0.81	0.57	0.54		0.16	0.16	0.48	0.48	0.01
Uniform Delay, d1	22.7	24.3		26.7	13.0	12.7		27.9	17.4	28.0	27.9	26.1
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.5		7.2	0.9	0.8		0.4	0.1	1.5	1.5	0.0
Delay (s)	23.2	24.9		33.9	13.9	13.5		28.3	17.5	29.5	29.4	26.1
Level of Service	C	C		C	B	B		C	B	C	C	C
Approach Delay (s)		24.7			19.8			19.6			29.2	
Approach LOS		C			B			B			C	

Intersection Summary			
HCM 2000 Control Delay	21.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	71.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	65.4%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	17	464	24	120	304	219	36	6	374	757	8	54
Future Volume (vph)	17	464	24	120	304	219	36	6	374	757	8	54
Lane Util. Factor	1.00	0.95	0.95	0.97	1.00	1.00	1.00	1.00	0.88	0.95	0.95	1.00
Frt		0.993				0.850			0.850			0.850
Flt Protected	0.950			0.950				0.958		0.950	0.953	
Satd. Flow (prot)	1770	3551	0	3351	1837	1531	0	1695	2720	1681	1686	1583
Flt Permitted	0.547			0.950				0.958		0.950	0.953	
Satd. Flow (perm)	1019	3551	0	3351	1837	1531	0	1695	2720	1681	1686	1583
Satd. Flow (RTOR)		4				238						129
Adj. Flow (vph)	18	510	26	141	358	238	54	7	558	823	9	59
Lane Group Flow (vph)	18	536	0	141	358	238	0	61	558	420	412	59
Turn Type	Perm	NA		Prot	NA	Perm	Split	NA	pt+ov	Split	NA	Perm
Protected Phases		2		1	6		8	8	8 1	4	4	
Permitted Phases	2					6						4
Detector Phase	2	2		1	6	6	8	8	8 1	4	4	4
Switch Phase												
Minimum Initial (s)	5.0	5.0		5.0	5.0	5.0	5.0	5.0		5.0	5.0	5.0
Minimum Split (s)	10.0	10.0		9.5	22.5	22.5	14.0	14.0		14.0	14.0	14.0
Total Split (s)	20.0	20.0		16.0	36.0	36.0	14.0	14.0		30.0	30.0	30.0
Total Split (%)	18.2%	18.2%		14.5%	32.7%	32.7%	12.7%	12.7%		27.3%	27.3%	27.3%
Maximum Green (s)	15.0	15.0		12.0	31.0	31.0	9.0	9.0		25.0	25.0	25.0
Yellow Time (s)	4.0	4.0		3.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	-1.0	-1.0		0.0	-1.0	-1.0		-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	4.0
Lead/Lag	Lag	Lag		Lead								
Lead-Lag Optimize?	Yes	Yes		Yes								
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Recall Mode	None	None		None	None	None	None	None		None	None	None
Walk Time (s)												
Flash Dont Walk (s)												
Pedestrian Calls (#/hr)												
v/c Ratio	0.10	0.84		0.32	0.55	0.34		0.32	0.79	0.86	0.85	0.11
Control Delay	39.6	52.1		41.5	30.7	5.4		47.6	38.9	53.1	51.1	0.4
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Total Delay	39.6	52.1		41.5	30.7	5.4		47.6	38.9	53.1	51.1	0.4
Queue Length 50th (ft)	7	132		32	130	0		28	135	196	191	0
Queue Length 95th (ft)	34	#325		75	303	58		85	#138	#547	#532	0
Internal Link Dist (ft)		766			370			242			260	
Turn Bay Length (ft)	80			350					190	125		100
Base Capacity (vph)	181	635		447	654	699		188	708	486	487	549
Starvation Cap Reductn	0	0		0	0	0		0	0	0	0	0
Spillback Cap Reductn	0	0		0	0	0		0	0	0	0	0
Storage Cap Reductn	0	0		0	0	0		0	0	0	0	0
Reduced v/c Ratio	0.10	0.84		0.32	0.55	0.34		0.32	0.79	0.86	0.85	0.11

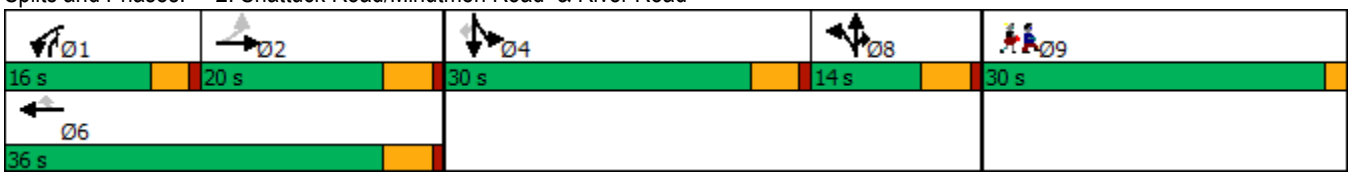
Intersection Summary
Cycle Length: 110

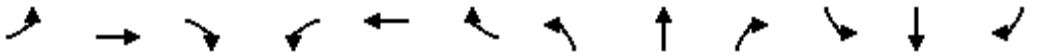
Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Lane Util. Factor	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Adj. Flow (vph)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	30.0
Total Split (s)	30.0
Total Split (%)	27%
Maximum Green (s)	28.0
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Vehicle Extension (s)	3.0
Recall Mode	None
Walk Time (s)	7.0
Flash Dont Walk (s)	21.0
Pedestrian Calls (#/hr)	16
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 92
Natural Cycle: 115
Control Type: Actuated-Uncoordinated
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 2: Shattuck Road/Minutmen Road & River Road





Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	17	464	24	120	304	219	36	6	374	757	8	54
Future Volume (vph)	17	464	24	120	304	219	36	6	374	757	8	54
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	12	12	12	11	11	11	10	10	11	12	12	12
Total Lost time (s)	4.0	4.0		4.0	4.0	4.0		4.0	5.0	4.0	4.0	4.0
Lane Util. Factor	1.00	0.95		0.97	1.00	1.00		1.00	0.88	0.95	0.95	1.00
Frt	1.00	0.99		1.00	1.00	0.85		1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00	1.00		0.96	1.00	0.95	0.95	1.00
Satd. Flow (prot)	1770	3550		3351	1837	1531		1694	2720	1681	1687	1583
Flt Permitted	0.55	1.00		0.95	1.00	1.00		0.96	1.00	0.95	0.95	1.00
Satd. Flow (perm)	1019	3550		3351	1837	1531		1694	2720	1681	1687	1583
Peak-hour factor, PHF	0.92	0.91	0.91	0.85	0.85	0.92	0.67	0.92	0.67	0.92	0.92	0.92
Adj. Flow (vph)	18	510	26	141	358	238	54	7	558	823	9	59
RTOR Reduction (vph)	0	3	0	0	0	154	0	0	0	0	0	42
Lane Group Flow (vph)	18	533	0	141	358	84	0	61	558	420	412	17
Heavy Vehicles (%)	2%	1%	0%	1%	0%	2%	0%	2%	1%	2%	2%	2%
Turn Type	Perm	NA		Prot	NA	Perm	Split	NA	pt+ov	Split	NA	Perm
Protected Phases		2		1	6		8	8	8 1	4	4	
Permitted Phases	2					6						4
Actuated Green, G (s)	15.5	15.5		12.3	31.8	31.8		9.2	21.5	25.6	25.6	25.6
Effective Green, g (s)	16.5	16.5		12.3	32.8	32.8		10.2	21.5	26.6	26.6	26.6
Actuated g/C Ratio	0.18	0.18		0.13	0.35	0.35		0.11	0.23	0.29	0.29	0.29
Clearance Time (s)	5.0	5.0		4.0	5.0	5.0		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	3.0
Lane Grp Cap (vph)	180	629		443	647	539		185	628	480	482	452
v/s Ratio Prot		c0.15		0.04	0.19			0.04	c0.21	c0.25	0.24	
v/s Ratio Perm	0.02					0.05						0.01
v/c Ratio	0.10	0.85		0.32	0.55	0.16		0.33	0.89	0.88	0.85	0.04
Uniform Delay, d1	32.0	37.0		36.6	24.2	20.6		38.2	34.6	31.6	31.4	24.0
Progression Factor	1.00	1.00		1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	10.3		0.4	1.0	0.1		1.0	14.4	16.2	13.8	0.0
Delay (s)	32.3	47.3		37.0	25.2	20.8		39.3	48.9	47.8	45.2	24.0
Level of Service	C	D		D	C	C		D	D	D	D	C
Approach Delay (s)		46.8			26.0			48.0			45.0	
Approach LOS		D			C			D			D	

Intersection Summary			
HCM 2000 Control Delay	41.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	93.0	Sum of lost time (s)	19.0
Intersection Capacity Utilization	58.7%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group