

3.0 PURPOSE & NEED

To focus the direction of this project and with input from the project steering committee, the following purpose and need statement was developed.

3.1 Purpose

The purpose of the VT 15/Ethan Allen Avenue project is to identify transportation alternatives proximate to the intersection of VT 15/Ethan Allen Avenue that will improve the performance of CCTA's Essex Route, which has the highest average weekday boardings within the CCTA service system.

Supporting this purpose are the following objectives: improve traffic flow on VT 15, a principal arterial; preserve the historic and aesthetic integrity of the entrance to the Fort; support economic development within the Fort and, improve the safety of traffic operations at this location.

3.2 Need

- The existing intersection configuration prohibits southbound left turns, a prohibition that was established due to safety concerns resulting from a crash occurring over ten years ago. Enabling exiting left turns at Ethan Allen Avenue would create operational efficiencies for CCTA's Essex Route, as well as all other roadway users.
- During the peak hours, CCTA has recently reduced bus headways for the Essex Route from one half-hour to fifteen minutes. The absence of a safe left turning exit at the Ethan Allen Avenue approach to VT 15 requires that the bus double back to Barnes Avenue adding four to five minutes to the overall route service time.

4.0 ALTERNATIVE INVESTIGATION

4.1 Development of Alternatives

Through the course of the scoping process, input is gathered from the public, the project Steering Committee and VTrans. Some suggestions that have come about due to this process as potential alternatives include:

- No Change
- Permit southbound left turns exiting at VT 15/Ethan Allen Avenue
- Re-route bus; enter Fort via eastbound left turn at Ethan Allen Avenue
- New bridge over Sunderland Brook
- Roundabout at VT 15/Ethan Allen Avenue intersection
- Feeder bus serving Fort Ethan Allen via CCTA bus stop at St. Michael's College
- Traffic Signal options
 - Signal Lite
 - Signal Plus
 - Transit Only

These potential alternatives were considered for analysis in the memorandum Potential Alternatives for the VT 15/Ethan Allen Avenue Scoping Study (July 2008), which is attached to this report as Appendix G. Based on this memo, four alternatives were selected for further investigation. They are:



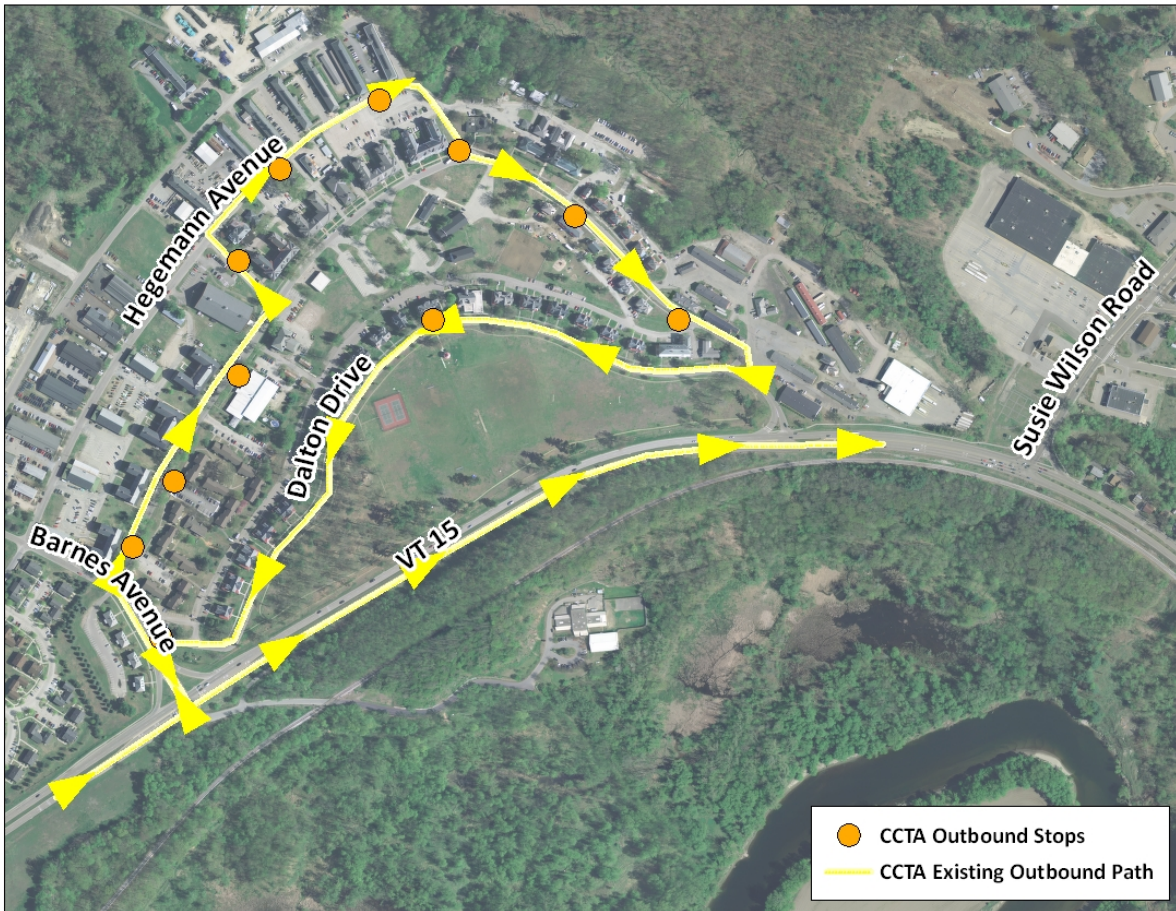
- No Build
- Signal Lite
- Signal Plus
- Transit Only

4.2 Description of Alternatives

4.2.1 Alternative 1: No Build

The No Build scenario assumes that no changes would be made to the existing intersection configuration. As a result, existing roadway and circulation conditions continue, subject to increased background traffic. No change to CCTA operations is proposed. If this alternative is chosen as the preferred alternative, further investigation in this study area would come to an end. The existing intersection configuration is shown in Figure 41.

Figure 41: No Build Alternative Showing the Outbound Routing of CCTA's Essex Route



4.2.2 Alternative 2: Signal Lite

Alternative 2 involves introducing a traffic signal to the VT 15/Ethan Allen Avenue intersection. The traffic signal would enable CCTA buses, and other vehicles, to exit Fort Ethan Allen as a southbound left



turn at this intersection and would thus eliminate the backtracking this bus currently has to do to exit via Barnes Avenue.

The “Lite” part of the alternative’s title implies that little or no change to the intersection’s geometry is considered. The Signal Lite Alternative will utilize the existing geometry (minimal impact to approach lanes, no changes to deceleration lanes or storage lanes). The existing right turn slip lane exiting Ethan Allen Avenue is considered as an option to consolidating the southbound approach to one approach lane designed to allow for right turning trucks (WB50). The two intersection configurations, with and without the existing slip lane, are shown in Figure 42 and Figure 43, below.



A project option for Alternative 2 would be the provision of transit signal priority capability for the Ethan Allen Avenue approach to the intersection. This capability would enable a CCTA bus driver to hold the southbound approach in green as the bus approached the intersection. Line of sight operation is necessary for the priority to work, so a CCTA bus would need to be approaching the traffic signal during the southbound green phase (<20% of the time). Because of this it is anticipated that the signal would be triggered to hold green for transit less than 5 times during a typical day.

Bus Shelters Serving the Essex Route at Fort Ethan Allen

For each of the Build alternatives, bus shelters would be installed to serve both the inbound (westbound) and outbound (eastbound) Essex Route. CCTA prefers to place bus shelters in pairs to reinforce public perception of route permanency and to maximize convenience.

The potential bus shelter placements along Ethan Allen Avenue are shown on all scenario graphics; located within the public right-of-way, approximately 200 feet from VT 15 and 15' from the street curb. To connect these shelters to the existing pedestrian network, sidewalks would extend from the shelters to the edge of pavement, and the two would be connected via a crosswalk. Since traffic along Ethan Allen Avenue is relatively light, buses serving these shelters would stop within the travel way to board and disembark passengers.

The westbound CCTA Essex Route is currently served by a shelter located off of VT 15 (approximately 250 feet from Susie Wilson Road and approximately 650 feet from Fort Ethan Allen). If the two bus shelters were to be installed along Fort Ethan Allen Drive as depicted in the scenario graphics, CCTA could choose to remove or maintain the westbound bus shelter on VT 15. In the event CCTA were to maintain the existing VT 15 shelter they would prefer not to improve the stop with a bus pull-off as it creates a challenge for buses merging back on to VT 15 after stopping.

4.2.3 Alternative 3: Signal Plus

Alternative 3 also involves introducing a traffic signal to the VT 15/Ethan Allen Avenue intersection, but would involve changes to the intersection approach geometry. Specifically, Signal Plus includes a westbound right turn deceleration lane so that vehicles entering Fort Ethan Allen at this location can move out of the through traffic lane and safely enter a dedicated right turn lane. The Signal Plus alternative also seeks to improve the eastbound left turn lane to bring it into conformance with VTrans design standards.

As with "Signal Lite" the existing southbound right turn slip lane is considered an option. In other words, both Alternatives 2 and 3 can be designed with or without the right turn slip lane. Two bus shelters with accompanying sidewalks and crosswalk will also be installed in both scenarios. These geometries are shown in Figure 44 and Figure 45.



Transit signal priority is also recommended as an option for this alternative.

4.2.4 Alternative 4: Transit Only

Alternative 4 isolates the principle of signal priority and installs a signal for the exclusive use of the CCTA bus. Southbound right turns will continue to be permitted for all other vehicles via the existing slip lane; however only the bus will be permitted to make a southbound left at the study intersection. Each bus will be equipped with signal priority equipment such that the bus will actuate the signal at the intersection to stop traffic on VT 15 and allow the bus to perform a southbound left turn. As a result, traffic on VT 15 will be free-flowing until the bus arrives, at which point traffic will stop for the length of time necessary for the bus to make the turn. This is expected to occur at the frequency with which the bus arrives, which is once every fifteen minutes during peak hours and once per half hour on off-peak hours. Signage and/or traffic gates will be required to alert all other traffic of this left-turn prohibition. Two bus shelters with accompanying sidewalks and crosswalk will also be installed in this scenario.

Similar to Alternatives 2 and 3, this alternative could be implemented with either the “Lite” or “Plus” options. Further, this alternative would be designed to include the existing slip lane, and therefore only minor intersection modifications will be required to appropriately accommodate the bus.

4.3 Evaluation of Alternatives

Each alternative is evaluated across a matrix of performance measures. Many performance measures are suggested by VTrans as part of a typical Local Transportation Facilities (LTF) project, and include such things as project cost, environmental impact, and permitting requirements. For this project, additional performance measures pertaining to bus and traffic operations are also considered. They are:

- **Impact on Bus Operations** – how does the proposed alternative affect the efficiency of CCTA’s Essex Route?
- **Impact on Bus Ridership** – how will the proposed alternative affect ridership on CCTA’s Essex Route?
- **Impact on Arterial Traffic Flow (VT 15)** – how does the proposed alternative enhance or impede the smooth flow of traffic on VT 15, a regional principal arterial?
- **Traffic Signal Spacing** – does the introduction of a new traffic signal conform to recommended signal spacing guidelines?
- **Safety** – how will the proposed alternative impact travel safety in the project area? Three aspects of safety are considered: 1) conformance with turn lane design standards; 2) safety impacts of traffic signals; and, 3) impact on pedestrian safety.
- **Aesthetics** – how will the proposed alternative affect historic amenities in the area, specifically the historic Fort Ethan Allen gates situated at the approach to VT 15 at Ethan Allen Avenue?
- **Economic Development Impacts** – how will the proposed alternative enable re-development and encourage growth within Fort Ethan Allen?

4.3.1 Bus Operations

In the No Build scenario, the Essex Junction outbound bus will continue to backtrack through Fort Ethan Allen via Dalton Drive due to the left-turn prohibition at Ethan Allen Avenue. This prohibition will be unchanged in the No Build alternative.

In alternatives 2, 3, and 4, the bus will be allowed to perform a southbound left turn at Ethan Allen Avenue, which will result in a gain of 1.1 miles or 4 minutes per trip, which results in an annual direct cost of \$50,000 per year. The bus will not incur any additional delay due to the signal, given that the bus



is currently delayed by the signal at Barnes Avenue for a similar amount of time. The one bus stop located on Dalton Drive will be eliminated; however two bus shelters will be installed on Ethan Allen Avenue just north of the study intersection which displaced passengers can use. Also, there are many alternate stop locations on Ethan Allen Avenue and Hegeman Avenue to serve the varied customer needs.

4.3.2 Ridership

Ridership, which is roughly 1,736 daily boardings, is anticipated to be unchanged in the No Build alternative.¹ At present, the public continuously voices their dissatisfaction with the current routing – specifically the backtracking – and this, too, is expected to continue. The perception of delay due to the backtracking remains in the public’s mind, which inhibits potential future growth in the area. Passenger lost time – another impediment to growth – accumulates indefinitely.

For all three other alternatives, the CCMPO’s Mode Share model was used to estimate the expected level of ridership based on travel times, cost, and frequency of departures. Considering the reduction in travel times due to signalization of the VT 15-Ethan Allen Avenue intersection, this model forecasted that of 1.2% of travelers would shift from other modes (personal vehicle, carpool, bicycle, etc.) to using the bus during an average weekday. The model also predicts a 0.6% shift on the weekends. This percentage increase results in a daily gain of roughly 40 passengers daily.

Based on CCTA model calculations, the time savings is anticipated to increase ridership on the Essex route by 5.9%, or roughly 50 passengers per day. Additionally, feedback from public meetings to discuss the topic of increased headways on the Essex Route shows consistent support for the elimination of backtracking from this route. This and other anecdotal evidence further indicates that with faster travel times and the elimination of so-called backtracking, ridership would increase along the route with every signalized alternative.

4.3.3 Arterial Flow

The Highway Capacity Reports from Synchro (v7) were used to estimate the average delays at the three study intersections under the four alternatives (Figure 46 and Figure 47).

In addition to the four alternatives assuming existing lane geometries at Susie Wilson Road (2010 AM & PM, 2020 AM & PM), overall AM peak hour intersection delays were also calculated assuming a change in geometry to the southbound approach of Susie Wilson Road at VT 15. Currently, there are two left turn lanes and one right turn lane. The additional scenarios assume one of the left turn lanes is converted to a right turn lane. Thus, the assumed geometry of this approach in these scenarios is two right turn lanes and one left turn lane.

The results can be summarized as follows:




- The VT 15/Barnes Avenue intersection operates acceptably at LOS A/B during both peak hours (AM/PM) in both study years (2010/2020) in all scenarios.
- The VT 15/Ethan Allen Avenue intersection operates acceptably at LOS A during both peak hours (AM/PM) in both study years (2010/2020) in all scenarios.
- The Susie Wilson Road intersection operates at LOS F in all existing and future AM scenarios with the existing intersection configuration. However, in the PM scenarios the intersection improves from LOS E/F in the No Build to LOS D in all Build scenarios. This improvement is due primarily to optimized signal timings.
- Figure 48 shows the results from the two right turn lane scenario in the AM peak hour. In this scenario, Barnes Avenue and Ethan Allen Avenue continue to operate acceptably at LOS A/B.

¹ CCTA fare box data, September 2008.






Susie Wilson Road operates at LOS C in all Build scenarios with the change in geometry.¹ The No Build results in Figure 48 represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.

Figure 46: Signalized LOS Results – AM Peak Hour

Signalized Intersections	2010 AM Peak Hour								2020 AM Peak Hour							
	No Build		Build - Signal Lite		Build - Signal Plus		Build - Transit Only		No Build		Build - Signal Lite		Build - Signal Plus		Build - Transit Only	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
 VT 15/Barnes Ave Overall EB, from Winooski WB, from Essex Junction NB, from Woodside Drive SB, from Barnes Avenue	B	15	A	9	A	8	B	13	B	16	B	10	A	9	B	15
	A	9	A	10	A	10	B	12	A	9	B	11	B	11	B	12
	B	17	A	7	A	6	B	13	B	19	A	9	A	8	B	15
	D	35	D	43	D	43	D	39	D	35	D	44	D	44	D	40
	B	15	B	13	B	13	C	21	B	16	B	12	B	12	C	24
 VT 15/Ethan Allen Ave* Overall EB, from Winooski WB, from Essex Junction SB, from Ethan Allen Avenue	-	-	A	4	A	4	A	3	-	-	A	4	A	4	A	3
	-	-	A	2	A	2	A	1	-	-	A	2	A	2	A	3
	-	-	A	4	A	4	A	3	-	-	A	3	A	4	A	2
	-	-	D	47	D	44	D	46	-	-	D	52	D	47	D	49
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
 VT 15/Susie Wilson Rd Overall EB, from Winooski WB, from Essex Junction SB, from Susie Wilson Road	F	84	F	82	F	82	F	82	F	100	F	91	F	91	F	92
	D	40	F	93	F	93	F	95	D	43	F	93	F	92	F	94
	F	>100	D	49	D	49	D	49	F	>100	E	58	E	58	E	58
	E	57	F	98	F	98	F	98	E	73	F	>100	F	>100	F	>100
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Intersection is unsignalized in the No Build scenario and signalized in the Build scenarios.

Figure 47: Signalized LOS Results – PM Peak Hour




Signalized Intersections	2010 PM Peak Hour								2020 PM Peak Hour							
	No Build		Build - Signal Lite		Build - Signal Plus		Build - Transit Only		No Build		Build - Signal Lite		Build - Signal Plus		Build - Transit Only	
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
 VT 15/Barnes Ave Overall EB, from Winooski WB, from Essex Junction NB, from Woodside Drive SB, from Barnes Avenue	B	14	B	11	B	11	B	16	B	15	B	12	B	12	B	17
	B	14	B	12	B	12	B	16	B	15	B	13	B	13	B	17
	B	11	A	8	A	8	B	10	B	11	A	8	A	8	B	11
	C	33	D	40	D	40	C	35	C	32	D	42	D	42	D	37
	C	27	B	19	B	19	C	30	C	29	C	22	C	22	D	38
 VT 15/Ethan Allen Ave* Overall EB, from Winooski WB, from Essex Junction SB, from Ethan Allen Avenue	-	-	A	6	A	6	A	4	-	-	A	6	A	6	A	4
	-	-	A	6	A	6	A	5	-	-	A	6	A	6	A	4
	-	-	A	2	A	1	A	1	-	-	A	2	A	1	A	1
	-	-	D	44	D	44	D	44	-	-	D	47	D	47	D	47
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
 VT 15/Susie Wilson Rd Overall EB, from Winooski WB, from Essex Junction SB, from Susie Wilson Road	E	71	D	40	D	40	D	40	F	>100	D	53	D	53	D	53
	C	21	C	34	C	34	C	32	C	21	D	37	D	37	D	36
	F	>100	D	44	D	44	D	44	F	>100	E	72	E	72	E	72
	F	84	D	49	D	49	D	49	F	>100	E	61	E	61	E	61
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Intersection is unsignalized in the No Build scenario and signalized in the Build scenarios.

¹ During the PM peak hour, the southbound left turn volume is significantly higher than in the AM. Thus, while this geometric change significantly improves delays during the AM peak hour, it would likely increase average delays during the PM peak hour.



Figure 48: Signalized LOS Results – AM Peak Hour – 2 Southbound Right Turn Lanes at Susie Wilson Rd¹

Signalized Intersections	2010 AM Peak Hour - 2 SBR Lanes on Susie Wilson Rd								2020 AM Peak Hour - 2 SBR Lanes on Susie Wilson Rd								
	No Build		Lite		Plus		Only		No Build		Lite		Plus		Only		
	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	
 VT 15/Barnes Ave	Overall	B	15	B	10	B	11	B	16	B	16	B	11	B	12	B	17
	EB, from Winooski	A	9	A	10	A	10	A	9	A	9	B	10	B	10	B	13
	WB, from Essex Junction	B	17	B	11	B	11	B	17	B	19	B	12	B	13	B	17
	NB, from Woodside Drive	D	35	D	36	D	36	C	32	D	35	D	36	D	36	D	35
	SB, from Barnes Avenue	B	15	A	9	A	9	C	31	B	16	A	9	A	9	C	27
 VT 15/Ethan Allen Ave*	Overall	-	-	A	4	A	4	A	3	-	-	A	4	A	4	A	3
	EB, from Winooski	-	-	A	2	A	2	A	1	-	-	A	2	A	2	A	3
	WB, from Essex Junction	-	-	A	4	A	3	A	3	-	-	A	4	A	3	A	3
	SB, from Ethan Allen Avenue	-	-	D	44	D	44	D	36	-	-	D	46	D	46	D	41
	Overall	F	84	C	23	C	23	C	23	F	100	C	25	C	25	C	25
 VT 15/Susie Wilson Rd	Overall	F	84	C	23	C	23	C	23	F	100	C	25	C	25	C	25
	EB, from Winooski	D	40	C	21	C	21	C	23	D	43	C	24	C	24	C	24
	WB, from Essex Junction	F	>100	C	28	C	28	C	26	F	>100	C	30	C	30	C	30
	SB, from Susie Wilson Road	E	57	C	21	C	21	C	21	E	73	C	22	C	22	C	22

SimTraffic (v7) generates 3 network-wide indicators of arterial flow, which are presented below. These are:

- ◆ Total Delay—the cumulative travel time of each vehicle in the network over the hour minus the free flow time for each vehicle.
- ◆ Total Stops—a count of vehicle stops over the course of the 1 hour simulation
- ◆ Total Travel Time—the total time of each vehicle present within the network over the 1 hour simulation

These 3 network indicators of arterial flow are compared for each Alternative (and scenario) to the No Build. The No Build indicators for Total Delay, Total Stops, and Total Travel Time are constructed as an index (=1.0) so that the performance of each alternative relative to the No Build can be quickly gauged. Note that the No Build is based on existing, installed signal timings where each alternative assumes optimized timings for each of the 3 traffic signals in a coordinated system.

4.3.3.1 Total Delay Index

SimTraffic (v7), the traffic simulation module paired with Synchro, was used to determine a total delay index for the three intersections in the various alternatives. To build the index, the total delay in the No Build scenario is considered equal to 1.00² and the total delay index number of each of the other three alternatives is measured in proportion to the No Build index number (i.e., a number less than 1.0 indicates less delay than in the No Build).

Figure 49 and Figure 50 show how the three Build alternatives result in a reduction in overall delay during both peak hours. The improvement in total delay is more significant during the PM peak hour than the AM peak hour.

Figure 51 shows that having two southbound right turn lanes at Susie Wilson Road results in a greater reduction in delay than with the existing geometry. The No Build results in Figure 51 represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.

¹ The No Build results represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.

² All reporting for the 2010 and 2020 No Build scenarios is based on existing, installed signal timings for the 2 signalized intersections, which currently do not operate in coordination.



Figure 49: AM Peak Hour Total Delay Index

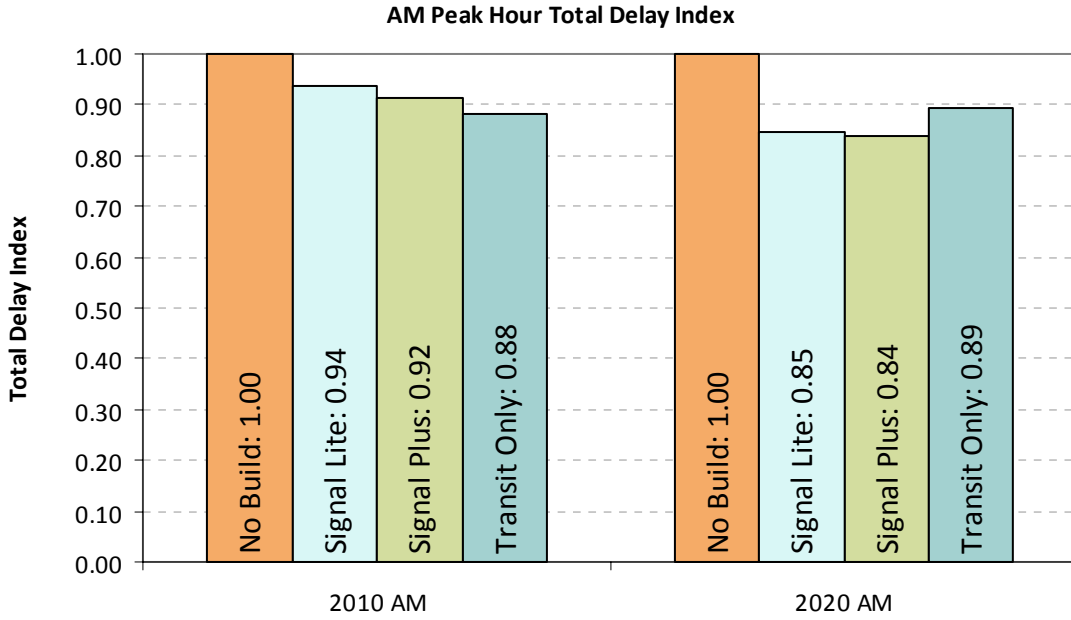


Figure 50: PM Peak Hour Total Delay Index

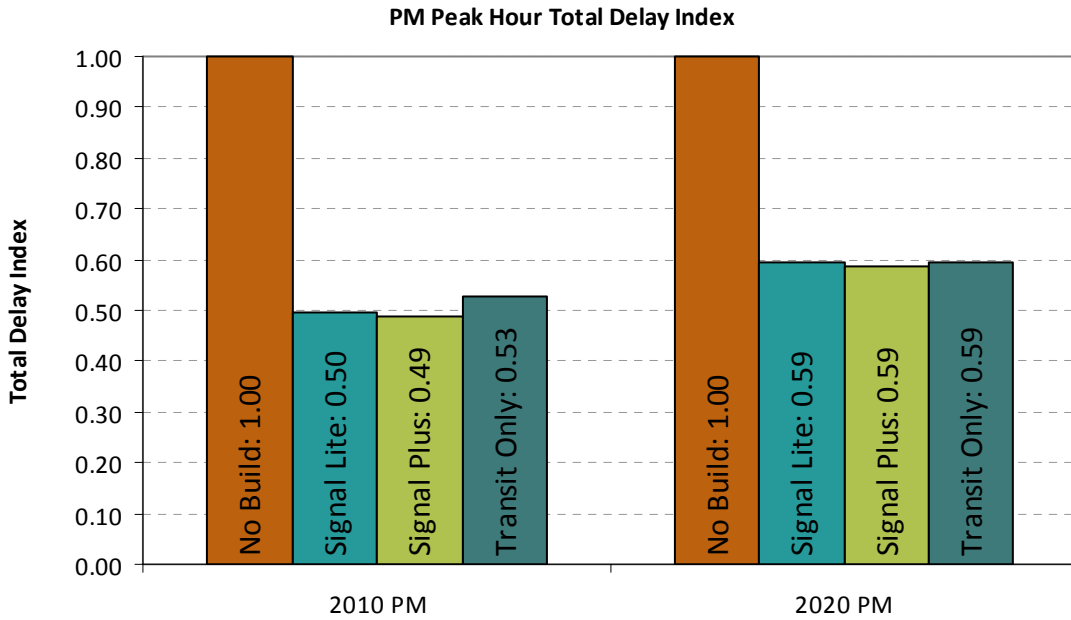
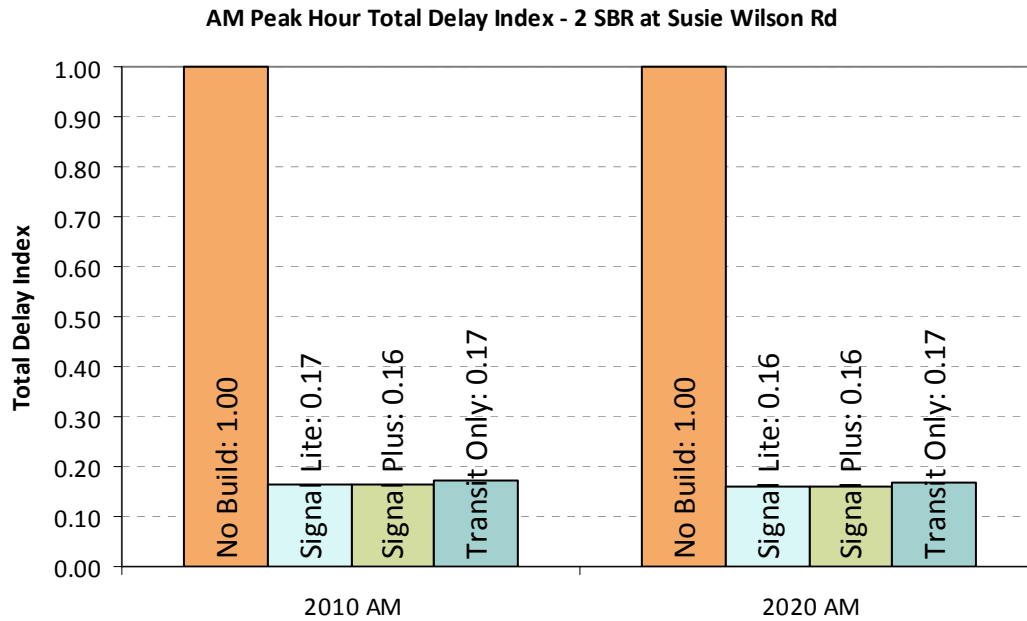


Figure 51: AM Peak Hour Total Delay Index - 2 Southbound Right Turn Lanes at Susie Wilson Rd¹



4.3.3.2 Total Stops Index

Similar to the Total Delay Index, RSG calculated a Total Stops Index. Again, the number of stops made by vehicles traveling in the study area in the No Build simulations is considered equal to an index number of 1.00, and the Build alternatives are measured against the No Build.

Similar to the Total Delay results, the Total Stops Index shown in Figure 52 and Figure 53 indicates the Build scenarios result in fewer stops in both peak hours but with greater gains during the PM peak hour.

When there are two southbound right turn lanes, the Build scenarios result in a greater reduction to stops similar to the reduction in total delay (Figure 54). The No Build results in Figure 54 represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.

¹ The No Build results represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.



Figure 52: AM Peak Hour Total Stops Index

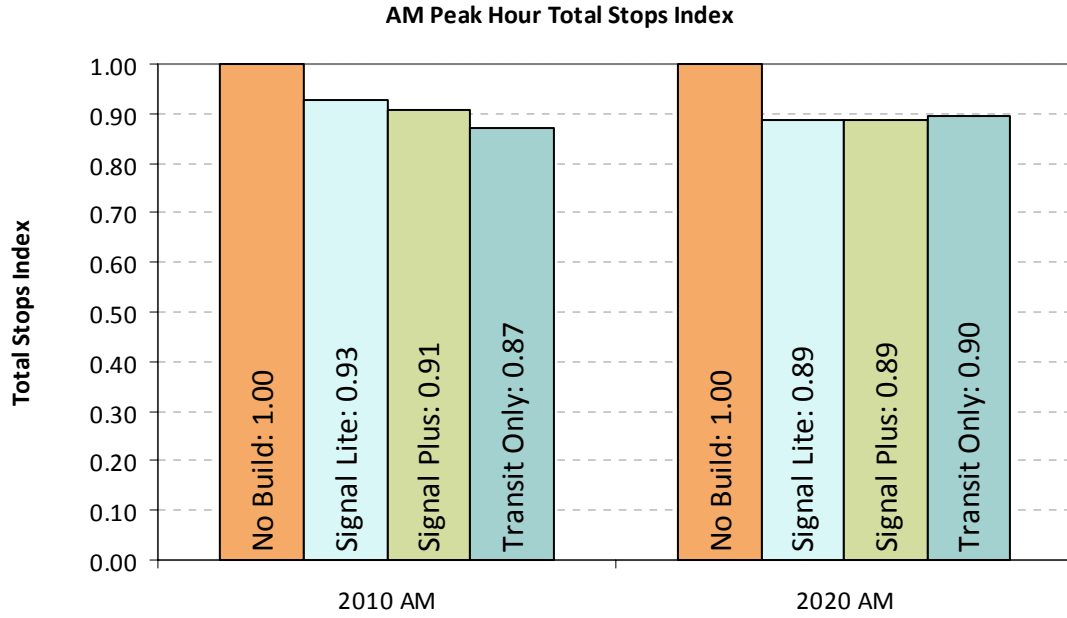


Figure 53: PM Peak Hour Total Stops Index

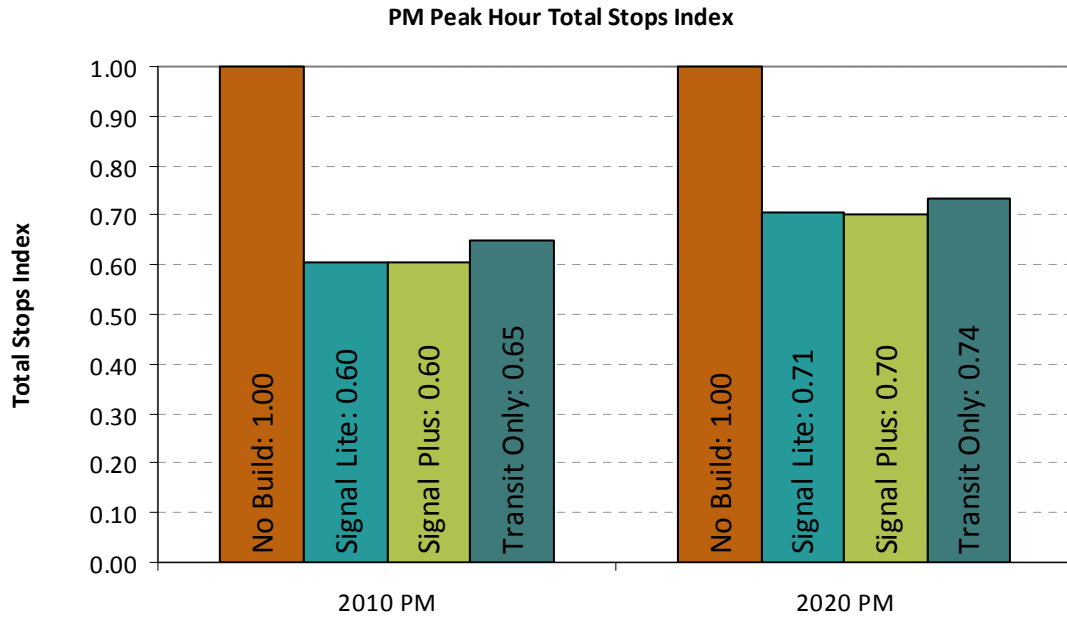
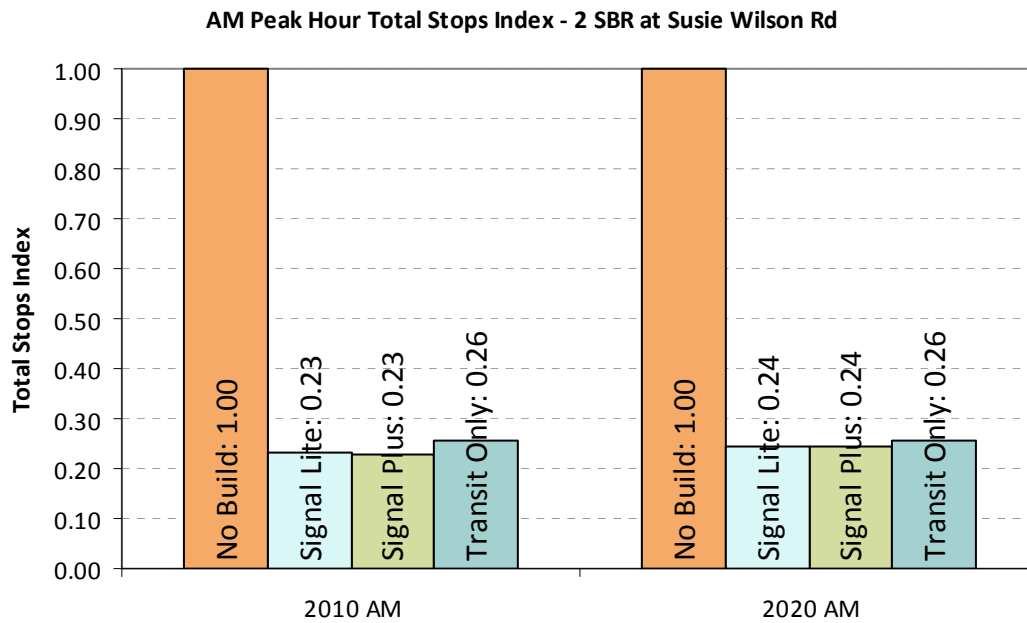


Figure 54: AM Peak Hour Total Delay Index - 2 Southbound Right Turn Lanes at Susie Wilson Rd¹



4.3.3.3 Total Travel Time Index

A total travel time index was also calculated for the various alternatives. The combined eastbound and westbound travel times were added together to yield the total travel time. Again, the travel time in the No Build scenario is given an index number of 1.00, and the three Build alternatives are indexed against that number.

Figure 55 and Figure 56 indicate significant gains in travel time are achieved in the Build scenarios. However, during the AM peak hour the reduction in travel time is primarily in the westbound direction. During the PM peak hour, the reduction in travel time is roughly the same in both directions.

When there are two southbound right turn lanes, the Build scenarios result in a greater reduction to stops similar to the reduction in total delay and stops (Figure 57). The No Build results in Figure 57 represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.

¹ The No Build results represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.



Figure 55: AM Peak Hour Total Travel Time Index

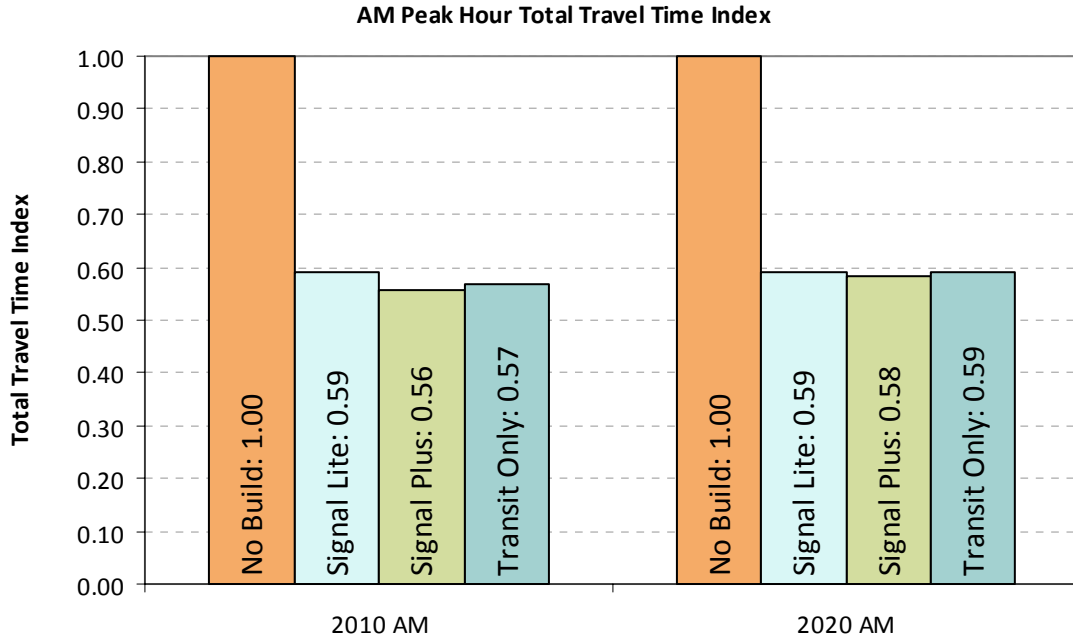


Figure 56: PM Peak Hour Total Travel Time Index

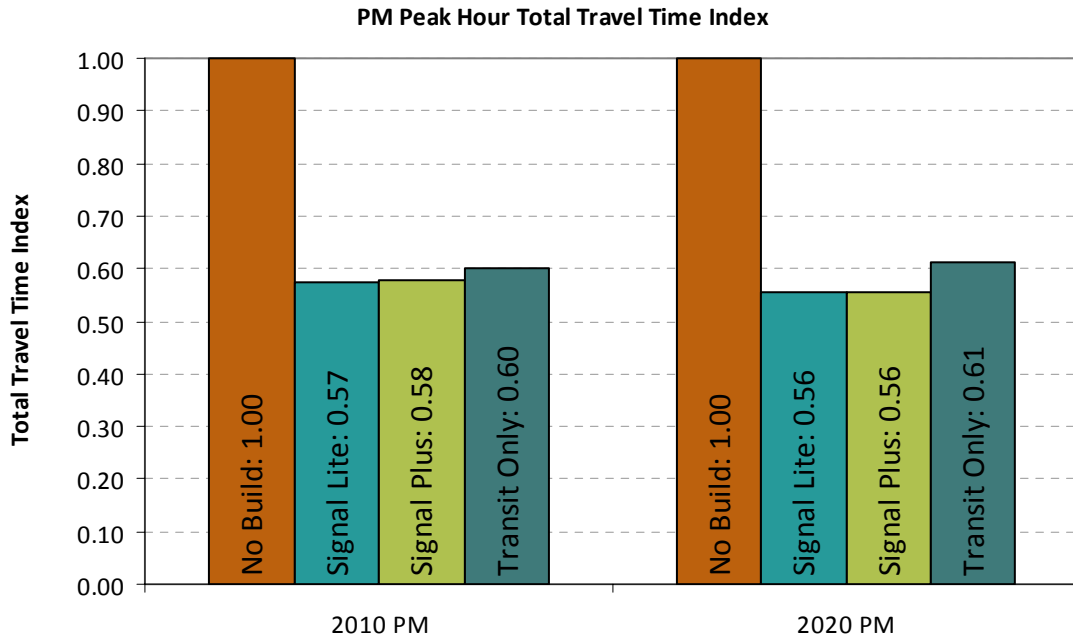
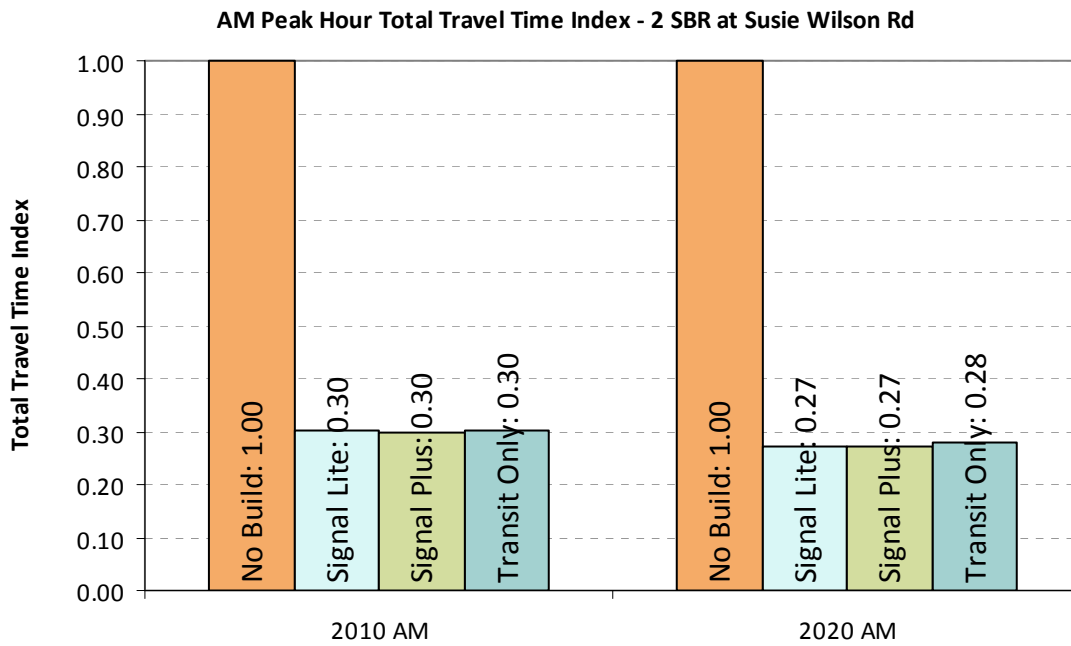


Figure 57: AM Peak Hour Total Travel Time Index - 2 Southbound Right Turn Lanes at Susie Wilson Rd¹



4.3.3.4 Queues

SimTraffic (v7) was also used to determine average queue lengths. The average maximum queue (in cars) from five simulation runs, each one-hour in length, are shown in Figure 58 and Figure 59.² The average maximum queue represents the longest queue for each approach for the hour. The results when two southbound right turn lanes at Susie Wilson Road are shown in Figure 60. The No Build results in Figure 60 represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.

The key queue results are as follows:

- VT 15/Barnes Avenue
 - The VT 15/Barnes Avenue intersection does not have significant queuing during either peak hour, as all queues are approximately 10 vehicles or less in length.
- VT 15/Ethan Allen Avenue
 - During the AM peak hour, the VT 15/Ethan Allen Avenue intersection has no significant queues.
 - During the PM peak hour, the eastbound queue is approximately 12-14 vehicles in length in the 2010 Build scenarios and 23-24 vehicles in length in the 2020 Build scenarios. Much of this queuing is due to spillback queues from the downstream intersection (VT 15/Susie Wilson Road).

¹ The No Build results represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.

² Estimated queues are the average of the maximum queue for every 2-minute period.



- During the PM peak hour, the southbound approach at the VT 15/Ethan Allen Avenue intersection experience queues of approximately 10 vehicles in 2010 and 15 vehicles in 2020.
- VT 15/Susie Wilson Road
 - During the AM peak hour, the southbound queues are severe in all scenarios.¹ During the PM peak hour, the southbound queues are reduced by about 35 vehicles in the Build versus No Build scenarios.
 - During both peak hours, westbound queues along VT 15 are significantly reduced by approximately 65-75 vehicles.
 - During both peak hours, eastbound queues along VT 15 increase and spill back into the upstream intersection (Ethan Allen Avenue).
 - When there are two southbound right turn lanes, queues are reduced by about 100-110 vehicles at the westbound approach and 130-150 vehicles at the southbound approach.

Figure 58: AM Peak Hour Queues (# cars)²

	2010 AM				2020 AM			
	No Build	Build - Signal Lite	Build - Signal Plus	Build - Transit Only	No Build	Build - Signal Lite	Build - Signal Plus	Build - Transit Only
VT 15/Barnes Ave								
EB, from Winooski	4	4	4	5	5	5	5	5
WB, from Essex Junction	10	8	8	11	10	7	8	12
NB, from Woodside Drive	0	0	0	0	0	0	0	0
SB, from Barnes Avenue	4	2	2	4	4	3	3	4
VT 15/Ethan Allen Ave								
EB, from Winooski	0	2	2	0	0	2	2	2
WB, from Essex Junction	0	3	3	0	0	3	3	0
SB, from Ethan Allen Avenue	0	2	2	0	0	2	2	0
VT 15/Susie Wilson Rd								
EB, from Winooski	8	15	15	13	8	>22	>22	>20
WB, from Essex Junction	>118	63	58	59	>130	82	82	80
SB, from Susie Wilson Road	>148	>165	>165	>159	>153	>155	>155	>160

¹ The study area does not include the intersections along Susie Wilson Road, which would impact the queue lengths for the southbound approach at the VT 15/Susie Wilson Road intersection.

² Queues that are approaching or exceeding the available storage length are shown with a ">" sign.



Figure 59: PM Peak Hour Queues (# cars)¹

	2010 AM				2020 AM			
	No Build	Build - Signal Lite	Build - Signal Plus	Build - Transit Only	No Build	Build - Signal Lite	Build - Signal Plus	Build - Transit Only
VT 15/Barnes Ave								
EB, from Winooski	6	5	5	7	7	6	6	8
WB, from Essex Junction	5	7	7	7	6	7	7	8
NB, from Woodside Drive	0	0	0	0	0	0	0	0
SB, from Barnes Avenue	6	3	3	5	6	4	4	6
VT 15/Ethan Allen Ave								
EB, from Winooski	0	13	14	12	1	24	24	23
WB, from Essex Junction	0	2	2	0	0	3	3	1
SB, from Ethan Allen Avenue	0	9	8	0	0	14	15	0
VT 15/Susie Wilson Rd								
EB, from Winooski	14	>29	>30	>27	17	>34	>35	>33
WB, from Essex Junction	>98	19	20	30	>119	42	42	53
SB, from Susie Wilson Road	56	18	17	22	63	29	25	25

Figure 60: AM Peak Hour Queues Assuming Two Southbound Right Turn Lanes at Susie Wilson Road (cars)²³

	2010 AM				2020 AM			
	No Build	Build - Signal Lite	Build - Signal Plus	Build - Transit Only	No Build	Build - Signal Lite	Build - Signal Plus	Build - Transit Only
VT 15/Barnes Ave								
EB, from Winooski	4	4	4	4	5	5	5	5
WB, from Essex Junction	10	11	11	18	10	12	12	16
NB, from Woodside Drive	0	0	0	0	0	0	0	0
SB, from Barnes Avenue	4	3	3	3	4	3	3	4
VT 15/Ethan Allen Ave								
EB, from Winooski	0	1	1	0	0	1	1	0
WB, from Essex Junction	0	5	4	0	0	5	4	0
SB, from Ethan Allen Avenue	0	2	2	0	0	2	2	0
VT 15/Susie Wilson Rd								
EB, from Winooski	8	5	5	5	8	6	6	6
WB, from Essex Junction	>118	15	15	12	>130	18	18	19
SB, from Susie Wilson Road	>148	11	12	10	>153	12	13	12

The foregoing analysis suggests that all of the signal alternatives can provide improvements to vehicle flow in the corridor over No Build conditions (using existing signal timings). When all 4 measures of network performance are evaluated – Total Delay, Total Stops, Total Travel Time, and Queues – the differences between each alternative are minimal. Generally, however, the analysis supports the installation of a traffic signal at this location. When combined with the signal warrant analysis provided earlier in this report this present analysis supports the installation of a traffic signal at this location.

Detailed SimTraffic reports can be found in Appendix D.

¹ Queues that are approaching or exceeding the available storage length are shown with a ">" sign.

² Queues that are approaching or exceeding the available storage length are shown with a ">" sign.

³ The No Build results represent existing conditions with one southbound right turn lane on Susie Wilson Road while all the Build scenarios represent proposed conditions with two southbound right turn lanes.



4.3.4 Safety

Owing to the fact that no changes are made to the existing intersection configuration in the No Build alternative, the relative safety of this intersection is expected to remain unchanged. The eastbound left turn lane is insufficient in length based on AASHTO standards, and the westbound right turn lane – although warranted – will not be installed (Figure 61).¹ Collisions at the intersection are anticipated to continue at the current rate of one crash per year.

Figure 61: Turn Lane Warrant for Westbound Right at Ethan Allen Avenue

VT 15/Ethan Allen Avenue		WBR Warranted?
AM Peak Hour	2010 No Build	Y
	2010 Build	Y
	2020 No Build	Y
	2020 Build	Y
PM Peak Hour	2010 No Build	Y
	2010 Build	Y
	2020 No Build	Y
	2020 Build	Y

In the Signal Lite alternative, no modifications will be made to existing roadway and intersection geometry. For instance, the current eastbound left turn lane on VT 15 is insufficient in length to meet AASHTO standards based on their 2004 Geometric Design of Highways and Streets.² Similar to the No Build alternative, although the warrants are met for a westbound right turn lane in the No Build and Build scenarios, no turn lane will be installed in this scenario.

With regard to collisions and as noted in section 2.9.1, the Transportation Research Board’s Access Management Manual has indicated that there are typically more collisions at signalized intersections than at unsignalized intersections. AASHTO’s Strategic Highway Safety Plan agrees with this statement, however goes on to say that the severity of these crashes is expected to lessen due to the change in the nature of the collisions – fewer angle and turning collisions and more rear-end collisions.³

In the Signal Plus alternative, safety will be addressed from multiple approaches. First, the existing eastbound left turn lane will be modified to comply with VTrans standards – specifically, the lane length and taper will be extended. Secondly, because the turn lane warrants are met in all scenarios (Figure 61), a westbound right turn lane will be installed to provide refuge for right turning vehicles from VT 15. In short, the intersection will be designed to meet all Vermont State Standards, which will vehicle safety.

The FHWA performed a safety analysis in 2002 called the Safety Effectiveness of Intersection Left- and Right-Turn Lanes. Based on these analyses, it was found that installation of a right-turn lane on major road approaches reduced crash rates at the study intersection, regardless of approach or signalization (Figure 62).

Conformance to Standards

Currently the eastbound left turn lane does not comply with Vermont State Standards. Additionally, a westbound right turn lane is warranted but not installed. The No Build, Signal Lite and Transit Only alternatives do not address either of these issues.

¹ The existing auxiliary lane is roughly 210’ in length, whereas the minimum standard as outlined by AASHTO is 341’.

² The existing auxiliary lane is roughly 216’ in length, whereas the minimum standard as outlined by VTrans is 295’.

³ The American Association of State Highway and Transportation Officials *Strategic Highway Safety Plan*, 2004.



	AASHTO Green Book (2004)	VTrans	Existing
Storage + Deceleration Length	197	115	129
Taper Length	220	180	87
Total Length	417	295	216

In the Signal Plus alternative, the eastbound left turn lane will be modified to comply with VTrans standards – specifically, the taper will be lengthened – and the westbound right turn lane will be designed to conform to the same standards.

Figure 62: Excerpt from FHWA’s Safety Effectiveness of Intersection Left- and Right-Turn Lanes (2002)

Recommended Accident Modification Factors for Installation of Right-Turn Lanes on the Major-Road Approaches to Rural and Urban Intersections

Intersection Traffic Control	Number of major-road approaches on which right-turn lanes are installed	
	One approach	Both Approaches
STOP sign ^a	0.86 ^b	0.74 ^b
Traffic signal	0.96 ^c	0.92 ^c

^aSTOP signs on minor-road approach(es)

^bBased on rural unsignalized intersection results

^cBased on urban signalized intersection results

4.3.5 Aesthetics

The No Build alternative will not alter the state of any historic elements of the entrance to Ethan Allen Avenue; the entrance gates will remain in-tact and in-place, and the historic manhole cover will not be disturbed.

All of the signalized alternatives dictate that the approach of Ethan Allen Avenue be realigned to squarely interface with VT 15. Due to this necessity, the western gate post at the entrance to Ethan Allen Avenue will have to be moved to allow room for the southbound left-turning movement. Because of this impact, the eastern gate will also be moved so that the gates properly align at the Fort entrance. (In the signal plus alternative, the eastern gates will be forced to move regardless due to the westbound right deceleration lane installation).

4.3.6 Economic Development Potential

The No Build alternative will not change the potential for economic development in Fort Ethan Allen; existing land uses are anticipated to be unchanged.

Alternatives 2 and 3, Signal Lite and Signal Plus, will enhance the opportunities for redevelopment in the Fort due to improved access for all modes of transportation. This is particularly true for the portion of the Fort in Essex, as it is closest to the study intersection and thus more likely to benefit.

The fourth alternative – Transit Only – will improve the opportunities for redevelopment slightly as well. Due to improved transit service to the Fort, there will be an increase in transit and pedestrian traffic, which will likely have a modest economic impact in the Fort.

4.4 Evaluation Matrices

The previous sections have been summarized into two evaluation matrices; the first is a summary of study-specific performance measures, and the second is derived from VTrans’ LTF process.



Figure 63: Evaluation Matrix – Study Measures

	Alternative 1: No Change	Alternative 2: Signal Lite	Alternative 3: Signal Plus	Alternative 4: Transit Only
Bus Operations				
Re-Route Delay	Redundant 1.1 miles or 4 minutes per outbound trip	No re-route	No re-route	No re-route
Signal Delay	Delay @ Barnes Ave	Delay @ Ethan Allen Avenue	Delay @ Ethan Allen Avenue	Delay @ Ethan Allen Avenue
Ridership				
Existing Ridership	1,736 average weekday ridership	1,736 average weekday ridership	1,736 average weekday ridership	1,736 average weekday ridership
New Ridership	None	+40-50 passengers daily*	+40-50 passengers daily*	+40-50 passengers daily*
Traffic Flow				
VT 15 Arterial Flow	No Change AM & PM Delay Index of 1.00	AM Delay Index: 0.94 PM Delay Index: 0.50	AM Delay Index: 0.92 PM Delay Index: 0.49	AM Delay Index: 0.88 PM Delay Index: 0.53
Signal Warrants	No Warrants Met	4 Warrants Met	4 Warrants Met	No Warrants Met
Traffic Signal Spacing	N/A	Does not meet ideal separation criteria	Does not meet ideal separation criteria	Does not meet ideal separation criteria
Safety				
Turn Lane Design/Conformance to Standards	Insufficient EB LTL, Will not be addressed; WB RTL Warranted, Not installed	Insufficient EB LTL, Will not be addressed; WB RTL Warranted, Not installed	Insufficient EB LTL, Will be addressed; WB RTL Warranted, Will be installed	Insufficient EB LTL, Could be addressed; WB RTL Warranted, Could be installed
Traffic Signal Impacts	No Change	More rear-end collisions; Typically less severe	More rear-end collisions; Typically less severe	Potential Vehicular Confusion
Pedestrian	Inconsistent Bus Routes and Stops	Consistent Bus Routes and Stops	Consistent Bus Routes and Stops	Consistent Bus Routes and Stops
Aesthetics				
Historic Gate Location	No Change	Relocate Gates	Relocate Gates	Relocate Gates
Economic Development				
Redevelopment Potential	No Change	Improved access to Commercial/Industrial areas for all users	Improved access to Commercial/Industrial areas for all users	Improved access to Commercial/Industrial areas for CCTA bus users

*based on CCMPO Modeshare model with 4 minute decrease in travel time and CCTA model



Figure 64: Evaluation Matrix – VTrans

	VT 15 - Ethan Allen Avenue Intersection Scoping Analysis	Alt 1 - No Build	Alt 2 - Signal Lite (Remove Slip Lane)	Alt 2 - Signal Lite (With Slip Lane)	Alt 3 - Signal Plus (Remove Slip Lane)	Alt 3 - Signal Plus (With Slip Lane)	Alt 4 - Transit Only
COST	Cost Estimate (construction cost + contingency)	\$0	\$414,400	\$351,700	\$442,400	\$400,200	\$376,700
	Annual CCTA Operating Cost (Essex Route)	\$936,200	\$886,200	\$886,200	\$886,200	\$886,200	\$886,200
ENGINEERING	Typical Section (total width)	65'	65'	65'	76'	76'	65' or 76'
	Utility Impacts	No	Yes	Yes	Yes	Yes	Yes
	ADA Compliance	Yes	Yes	Yes	Yes	Yes	Yes
	Right of Way Impacts	No	Yes	No	Yes	Yes	Potential
ENVIRONMENTAL IMPACTS	Prime Soils	No	No	No	No	No	No
	Archaeological	No	No	No	No	No	No
	Historic Structures/Sites	No	Yes	Yes	Yes	Yes	Yes
	Floodplain	No	No	No	No	No	No
	Fish and Wildlife	No	No	No	No	No	No
	Rare, Threatened & Endangered	No	No	No	No	No	No
	Public Lands	No	Yes	No	Yes	No	No
	Noise	No	No	No	No	No	No
TRANSPORTATION IMPACTS	Wetlands	No	No	No	No	No	No
	Bus Travel Time Savings	0	4 min/ outbound trip	4 min/ outbound trip	4 min/ outbound trip	4 min/ outbound trip	4 min/ outbound trip
	Ridership (Annual)	0	+10,000	+10,000	+10,000	+10,000	+10,000
	Arterial Traffic Flow Impact (Composite Index)	1.00	0.54	0.54	0.53	0.53	0.54
	Safety	No	Improved	Improved	Improved	Improved	Improved
LOCAL & REGIONAL ISSUES	Level of Service (Ethan Allen Ave)	LOS A	LOS A	LOS A	LOS A	LOS A	LOS A
	Community Character	No	Yes	Yes	Yes	Yes	Yes
PERMITS	Economic Impacts	No	Yes	Yes	Yes	Yes	Yes
	Act 250	No	No	No	No	No	No
	401 Water Quality	No	No	No	No	No	No
	404 Corps of Engineers Permit	No	No	No	No	No	No
	Stream Alteration	No	No	No	No	No	No
	Conditional Use Determination	No	No	No	No	No	No
	Storm Water Discharge	No	Potential	Likely	Likely	Likely	Potential
	Shoreland Encroachment	No	No	No	No	No	No
	Endangered & Threatened Species	No	No	No	No	No	No
	VTrans ROW Permit	No	Yes	Yes	Yes	Yes	Yes
	SHPO Clearance	No	Potential	Potential	Potential	Potential	Potential
	NEPA Process Required	No	No	No	No	No	No

4.5 Preferred Alternative

The VT 15/Ethan Allen Avenue intersection has demonstrated a need for change in order to improve ridership for CCTA, create economic development opportunities within Fort Ethan Allen, and to improve safety at the intersection. Based on the analysis and evaluation described in this report, and based upon input from the general public and from the key stakeholders of the CCTA and the Town of Essex, the preferred alternative is a combination of Signal Lite and Signal Plus. The following elements are deemed necessary for the preferred alternative:

- ◆ Signalization;
- ◆ Elimination of the southbound right turn slip lane;



- ◆ Construction of a westbound right turn deceleration Lane;
- ◆ Installation of CCTA bus shelters and crosswalk.

The Preferred Alternative will require the relocation of the Historic Gates to accommodate the right turn deceleration lane.

The reconfiguration of the eastbound left turn lane does not currently comply with current VTrans standards. However, this improvement is deemed to be of lesser importance and is considered discretionary.

4.6 Historic Assessment

As a follow-up to this study, the University of Vermont Consulting Archaeology Program conducted a historic assessment for the alternatives presented in this report. The report found that this project would cause *No Adverse Effect* to historic resources within the Fort Ethan Allen Historic District, as long as these guidelines are followed:

- The gates should be rebuilt at the location specified by this report;
- The slate sidewalk should be realigned with the original materials;

Although not required, the report also indicated a preference for the alternatives that eliminate the sliplane. Other recommendations include:

- Measure and record the existing entrance gates, so that they can be reconstructed in their original form;
- Replace brick in poor condition in kind;
- Mortar should be compatible in hardness and tinted the same color as existing;
- Iron elements should be further assessed after removal, and repaired and painted as needed; and
- If possible, the swinging iron gates should be reinstalled on the piers and locked in the open position.

These findings do not conflict with the preferred alternative, which has been outlined in the previous section of this report.

The full report can be found in Appendix I.

