



Handout #1: Alternatives Evaluation

Advisory Committee Meeting

November 10, 2016

Colchester/Riverside/Barrett/Mill Intersection Study Burlington, VT

In response to comments made at the September 22, 2015 Advisory Committee meeting, the new evaluation matrices have been developed to present a clearer picture of the alternatives analysis. The new matrices first address the elements of the alternative plans that were most discussed at the September meeting. These include:

- Traffic Operations;
- Crash Reduction;
- Pedestrian Experience;
- Bicyclist Experience;
- Intersection Complexity;
- Cost;
- Risk;
- Disruption.

Second, a new matrix is provided to measure compliance with the Purpose and Need Statement for this project. The new matrices are presented for review to help the Committee reach a consensus in support of a preferred alternative.

The first of the attached evaluation matrices is presented in two parts. The first section compares the No Build (Do Nothing) alternative to the Short-Range alternative and a new alternative, the "Mid-Range" alternative. The second section compares the three proposed long-range alternatives that were presented at the September meeting and in the draft *Alternatives Description and Evaluation* report. The matrix provides commentary and color coding, as described in greater detail below, to indicate the relative performance of each alternative for the attributes listed above. The two-part matrix is then reformatted, with limited commentary, in order to present all six alternatives side by side.

New Mid-Range Alternative

A new alternative, the Mid-Range alternative, is proposed and evaluated in response to comments received at the September 22, 2016 Advisory Committee meeting. At the meeting it was asked if any components of the long-range alternatives could be brought forward and incorporated into the Short-Range alternative. For the most part, the intersection reconfigurations and traffic control changes proposed in Alternatives 1, 2 and 3 are not compatible with the Short-Range alternative. The one



exception is the proposed widening of Colchester Avenue south of Barrett Street in Alternatives 1 and 2. This change accommodates two northbound lanes and protected bike lanes on Colchester Avenue northbound approaching Barrett Street. This improvement could be constructed independent of the realignment of Riverside Avenue proposed in Alternatives 1 and 2. The Mid-Range alternative is comprised of the Short-Range alternative plus the widening of Colchester Avenue.

Matrix Format

The first five project attributes listed in the matrix relate to potential benefits that could be realized through project implementation. The last three attributes relate to the costs and risks associated with each alternative. The findings presented in the matrix are color coded. Cells are shaded light green to indicate that the proposed alternative will perform somewhat better than the No Build or Do Nothing alternative. Darker green indicates significantly better performance than the No Build alternative. Yellow shading is offered when there is no significant difference between the proposed alternative and the No Build alternative. Orange shading indicates somewhat worse performance relative to the No Build condition. Red shading indicates significantly worse performance. The No Build or Do Nothing alternative is the baseline condition by which all other alternatives are measured. Accordingly, the No Build alternative is shaded yellow for all attributes. Since all proposed alternatives are intended to improve traffic and safety conditions, the green shading generally applies to expected project benefits and the orange and red shading generally applies to project costs. Each of the project attributes in the matrix is discussed briefly below.

Traffic Operations

Traffic operations have been evaluated in terms of intersection peak hour operating levels of service or vehicular delay and vehicle queues. The No Build analysis indicates Level of Service (LOS) E operations in the 2035 design year for the more critical of the two commuter peak hours, the PM peak hour. The calculated average delay per vehicle is 64 seconds. The Short-Range alternative modifies signal timing and phasing to enhance pedestrian safety however, the changes diminish vehicular carrying capacity. The Short-Range alternative also results in LOS E operations. Calculated delays are 69 seconds per vehicle. This attribute is coded yellow for the Short-Range alternative since the level of service does not change relative to the No Build condition. The Mid-Range alternative adds capacity relative to the No Build condition reducing delays to 43 seconds per vehicle and improving operations to LOS D. Light green shading is shown for the Mid-Range alternative. The long-range, signalized intersection alternatives, Alternatives 1 and 2, offer some added intersection capacity but no significant reduction in overall traffic delays. Yellow shading is shown for these alternatives. The roundabout alternative, Alternative 3, does significantly reduce delays, from 64 seconds per vehicle to less than 20 seconds per vehicle, relative to the No Build condition and is therefore shaded dark green. Roundabout level of service calculations do not report an overall intersection level of service however, based on the calculated delays on each roundabout approach, Stantec applied an overall rating of LOS C.

Crash Reduction

A detailed analysis was conducted to consider the potential safety impacts of the proposed reconfiguration of the existing three intersections and other proposed safety improvements. Predicted crash conditions for each long-range alternative were developed using existing crash rate data and crash modification factors published in the *Highway Safety Manual*. The net present value of predicted crashes over a 20-year time horizon was determined. The safety impacts of the Short-Range and Mid-Range alternatives were determined by examining elements of the analysis of the long-range alternatives that apply to the Short and Mid-Range alternatives. Specifically, the protected left-turn phasing proposed on southbound Colchester Avenue at Barrett Street is common to both and is expected to offer safety benefits. A calculated crash cost savings of \$2.5 million was determined relative to an estimated No Build crash value of \$12.7 million. Light green shading is associated with these alternatives. Significantly more substantial cost savings are associated with the long-range alternatives. Crash cost savings of \$5.3 and \$7.2 million were determined for Alternatives 1 and 2, respectively. The greatest savings however, are associated with the roundabout alternative as roundabouts generally experience lower crash rates and less severe crashes than signalized intersections. A savings of \$9.3 million, was calculated for Alternative 3. All three of long-range alternatives are shaded dark green.

Pedestrian Experience

Pedestrian safety is considered in the Crash Reduction analysis as motor vehicle-pedestrian crashes are included in the calculations. However, Committee members felt that the pedestrian safety and the pedestrian experience for each of the alternatives should be considered as a separate performance measure. Under No Build conditions when the traffic signals stop conflicting through vehicular traffic movements pedestrians cross the street at their discretion. However, there are no pedestrian signal heads to alert pedestrians when the conflicting through traffic volumes are stopped. The pedestrian signal heads proposed as part of the Short-Range, Mid-Range and long-range signalized intersection alternatives will provide positive guidance to pedestrians letting them know when it is the safest time to cross the street. Dark green shading is provided for the signal alternatives in the matrix reflecting the enhanced guidance for pedestrians. Studies generally indicate that roundabouts are safer for pedestrians than signalized intersections however, these studies do not make distinctions between multilane and single lane roundabouts. The pedestrian safety benefits under Alternative 3, which has two multi-lane approaches and one multi-lane departure, may be less significant. For the roundabout alternative, light green shading is provided indicating enhanced safety based on crash studies but recognizing that pedestrians must exercise proper judgement to safely cross the yield-controlled legs of the roundabout.

Bicyclist Experience

Again, similar to the pedestrian experience criterion, the bicyclist experience was examined separate from the overall crash reduction analysis. The existing traffic signal control allows bicyclists to traverse

the intersection while cross traffic is stopped. This mode of operation is maintained for the Short-Range, Mid-Range and long-range signalized intersection alternatives. These alternatives also provide extra wide crosswalks to accommodate bicyclists. The Short-Range alternative includes bike lanes on one roadway segment, Colchester Avenue. The Mid-Range and long-range signal alternatives provide enhanced (protected) bike lanes on this same segment. Since the bike lane additions do not include all intersection legs these alternatives are all shaded light green. Alternative 3 indicates a new mode of operation for bicyclists. The roundabout configuration will force bicyclists to either claim a lane and mix with vehicular traffic in the roundabout or to exit the roadway and use the sidewalk, mixing with pedestrians. Studies indicate that crash rates with bicycles and vehicles are higher in roundabouts relative to signalized intersections. This is viewed as a negative outcome for bicyclists relative to No Build conditions and orange shading is used.

Intersection Complexity

Intersection complexity is referenced in the project Purpose and Need Statement along with traffic operations and safety. Under existing conditions, three separate intersections are controlled by a single traffic signal system. The Short-Range and Mid-Range alternatives maintain this basic configuration and are shaded yellow. Alternative 1 effectively consolidates the two Barrett Street intersections with Riverside Avenue and Colchester Avenue into a single intersection. The Mill Street intersection is also simplified to a T-Type unsignalized intersection. Alternative 2 is a variation on Alternative 1 and additionally creates a new T-Type intersection where the separate right-turn lane on Colchester Avenue meets Riverside Avenue. Given the minor differences between these alternatives and their improvement over the No Build they are both shaded dark green. Roundabouts are generally considered to be easy to navigate. (All traffic from all approaches enters the roundabout and turns right.) However, the multilane components to this roundabout require decision-making by motorists regarding lane choice lending some complexity to the operation. This alternative was shaded light green.

Cost

There is a wide range of construction costs for the three long-range alternatives. Alternatives 1 and 2 will cost an estimated \$3.3 to 3.4 million. Alternative 3 is expected to cost about twice as much at \$6.7 million. The estimated cost for the Short-Range alternative is \$500,000. A detailed cost estimate was not developed for the Mid-Range alternative, however, since this alternative includes all the elements of the Short-Range alternative and approximately a third of the work associated with Alternative 1 or 2 a cost of \$1.5 million is assumed for this alternative. The Short-Range alternative is shaded yellow due to its relatively modest cost. Red shading is provided for the highest cost alternative, the roundabout. Orange shading is provided for Alternatives 1 and 2 and for the Mid-Range alternative.

Risk

There is also a significant difference in risk associated with the alternatives. Risk relates to the possibility that additional time and money is invested in an alternative that ultimately does not come to fruition.



The Short-Range alternative is the lowest risk alternative as all the proposed work would occur within the footprint of the existing roadway. The Mid-Range alternative and Alternatives 1 and 2 are considered somewhat riskier as implementation of these plans would involve expanding the edges of the existing roadway. The expansion is least significant for the Mid-Range alternative as it would be limited to a segment of Colchester Avenue south of Barrett Street. Alternatives 1 and 2 would include the Mid-Range widening of Colchester Avenue and work beyond the existing curb lines to raise the grade of Riverside Avenue. The potential need for easements or land takings to complete this work is a risk. Orange shading is shown for these alternatives to reflect this risk. There is much more substantial risk associated with Alternative 3 as the limits of work extend well beyond the existing curb line in several areas. Also, there is risk related to the need for federal approvals to take a historically significant property on the south side of the intersection. A negative determination regarding the taking would deem the roundabout proposal infeasible. The outcome of this process cannot be predicted with any certainty at this time. More certainty can only come with the investment of additional time and money. Alternative 3 was shaded red for the risk category.

Disruption

Project construction will lead to disruptions of various types. The Committee expressed concerns regarding construction related disruption to traffic flow and local businesses. Roadway construction inherently leads to reduced roadway capacity, increased traffic delays and traffic diversions to alternative routes. Also, businesses that rely on the roadways under construction for customer access generally suffer economic hardship. As such, a shorter, less disruptive construction period is better for motorists and businesses. The roundabout requires significant changes in the roadway profile and the construction of retaining walls. Consequently, it is expected that the construction period for the roundabout (Alternative 3) will be significantly longer than the construction period for the long-range signal alternatives (Alternatives 1 and 2). (This is reflected in the estimated construction costs as well.) A 1 to 1 ½ year construction period is estimated for Alternatives 1 and 2. A 2 to 2 ½ year construction period is assumed for Alternative 3. The Short-Range and Mid-Range alternatives have construction periods of 1 year or less. Longer term, a loss of five parking spaces on Colchester Avenue north of Barrett Street is associated with the Mid-Range alternative and all three long-range alternatives. In the cases of the Mid-Range alternative and Alternatives 1 and 2, the loss of parking results from the addition of a bike lane. Alternative 3 also eliminates the loading zone on the north side of Barrett Street. Alternative 3 will therefore have a more significant impact on commuters and local businesses. All alternatives were shaded the same for Disruption as they were for the previously discussed Cost and Risk categories.

Summary

As noted above, a reformatted matrix is also attached that compares all six alternatives side by side. Simply looking at the color patterns indicates what may be an unsurprising finding: greater rewards come with greater costs and risks. The more muted tones associated with both benefits and costs for

the Short-Range and Mid-Range alternatives suggest that with limited investment modest benefits can be achieved. At the other end of the spectrum is the roundabout alternative generally exhibiting bolder colors. This alternative offers the greatest safety and traffic delay reductions but is also the most costly and carries the most risk. Alternatives 1 and 2 carry more cost and risk relative to the Mid-Range alternative but they also provide greater safety benefits. The Mid-Range alternative provides greater reductions in traffic delay relative to Alternatives 1 and 2.

Purpose and Need Statement

As noted, the above discussion addresses the project attributes that were discussed most at the September meeting. Some of these attributes are also referenced in the project Purpose and Need Statement. The needs defined are to:

- Improve pedestrian safety;
- Provide a safer bicycle connectivity between Winooski and Burlington;
- Decrease the number of crashes;
- Address the intersection's complexity to create a stronger gateway;
- Formalize on-street parking; and,
- Manage peak hour congestion.

Performance of each alternative with respect to the Purpose and Need Statement is shown in a third matrix. As noted and described above, each of the alternatives will provide safer conditions for pedestrians relative to the No Build condition. The Mid-Range and long-range alternatives also add bike accommodations along Colchester Avenue improving connectivity to Winooski. Each alternative includes measures to reduce crashes. Each of the long-range alternatives address the issue of intersection complexity creating an enhanced gateway to the City of Burlington. Parking along Colchester Avenue is better organized with the Short-Range alternative addressing operational and safety concerns. These concerns are further addressed with the Mid-Range and long-range alternatives. Under these alternatives the on-street parking is eliminated to accommodate a bike lane. Finally, the added lane on Colchester Avenue northbound for the Mid-Range and long-range signal alternatives, Alternatives 1 and 2, increases intersection capacity allowing for better management of traffic congestion. Alternative 3, the roundabout alternative, also adds significant capacity to manage traffic demands. Overall, the Short and Mid-Range alternatives meet most aspects of the Purpose and Need Statement but do not address the intersection complexity issue. The three long-range alternatives meet all aspects of the Purpose and Need Statement.

EVALUATION MATRIX – SECTION 1

Attribute	Description	No Build	Short-Range	Mid-Range
Traffic Operations	How does the intersection perform with respect to peak hour intersection operating delays, queues and levels of service relative to the No Build alternative?	Delays for critical peak hour (PM) in LOS E range.	Delays for critical peak hour (PM) in LOS E range, same as No Build.	Delays for critical peak hour (PM) reduced by 33 percent. Level of service improves to LOS D.
Crash Reduction	What is the expected reduction in the value of crashes experienced over the next 20 years relative to the No Build alternative?	No change. Estimated value of crashes is \$12.7 Million.	Predicted \$2.5 Million savings vs. No Build.	Predicted \$2.5 Million savings vs. No Build.
Pedestrian Experience	How will pedestrians experience the intersection relative to the No Build alternative?	Major conflicting vehicular flows under signal control. No pedestrian signals.	Major conflicting vehicular flows under signal control. Pedestrian signals added vs. No Build. Safety Improved.	Major conflicting vehicular flows under signal control. Pedestrian signals added vs. No Build. Safety Improved.
Bicyclist Experience	How will bicyclists experience the intersection relative to the No Build alternative?	Multi use path on Riverside Avenue. No other bike accommodations.	Bike lanes added to Colchester Avenue. Wider crosswalks provided.	Protected bike lanes added to Colchester Avenue. Wider crosswalks provided.
Intersection Complexity	To what extent will the proposed changes result in a less complex intersection configuration?	No change relative to existing conditions.	No change relative to existing conditions.	No change relative to existing conditions.
Cost	How much will it cost to reconstruction the intersection?	\$0. No work proposed other than routine maintenance.	\$500,000. (Estimated range \$100,000 to \$800,000.)	\$1.5 Million vs. \$0 for No Build
Risk	How significant are the risks to project implementation, such as historic resource permitting and right-of-way acquisition, relative to the No Build condition?	No risk. No work proposed.	Nominal risk. All proposed work within existing curb lines.	Low risk. Minor change to existing roadway footprint. Change limited to Colchester Avenue.
Disruption	To what extent and for how long will project construction disrupt traffic operations and impact local businesses relative to the No Build alternative?	No disruption. No construction.	Construction period less than one year. Two parking stalls removed on Colchester Avenue north of Barrett Street.	Construction period likely one year or less. Five parking stalls removed on Colchester Avenue north of Barrett Street.

Legend				
Much Worse than No Build	Somewhat Worse than No Build	Comparable to No Build	Somewhat Better than No Build	Much Better than No Build

EVALUATION MATRIX – SECTION 2

Attribute	Description	Alt 1	Alt 2	Alt 3
Traffic Operations	How does the intersection perform with respect to peak hour intersection operating delays, queues and levels of service relative to the No Build alternative?	Delays for critical peak hour (PM) in LOS E range, same as No Build.	Delays for critical peak hour (PM) in LOS E range, same as No Build.	Delays for critical peak hour (PM) reduced by 60 percent. Rolling queues replace standing queues. Estimated LOS C during PM peak hour.
Crash Reduction	What is the expected reduction in the value of crashes experienced over the next 20 years relative to the No Build alternative?	Predicted \$5.6 Million savings vs. No Build.	Predicted \$7.2 Million savings vs. No Build.	Predicted \$9.3 Million savings vs. No Build.
Pedestrian Experience	How will pedestrians experience the intersection relative to the No Build alternative?	Major conflicting vehicular flows under signal control. Pedestrian signals added vs. No Build. Safety improved.	Major conflicting vehicular flows under signal control. Pedestrian signals added vs. No Build. Safety Improved.	Major conflicting vehicular flows from one direction only and under yield control (Build) vs. signal control and no pedestrian signals (No Build). Safety likely improved.
Bicyclist Experience	How will bicyclists experience the intersection relative to the No Build alternative?	Protected bike lanes added to Colchester Avenue. Wider crosswalks provided.	Protected bike lanes added to Colchester Avenue. Wider crosswalks provided.	Cyclists must claim a lane in roundabout or dismount and use sidewalk. Bike crashes more frequent in roundabouts.
Intersection Complexity	To what extent will the proposed changes result in a less complex intersection configuration?	Three signalized intersections become one signalized intersection and one unsignalized intersection.	Three signalized intersections become one signalized intersection and two unsignalized intersections.	Three signalized intersections become one modern roundabout (with multi-lane elements) and one unsignalized intersection.
Cost	How much will it cost to reconstruction the intersection?	\$3.3 Million vs. \$0 for No Build.	\$3.4 Million vs. \$0 for No Build.	\$6.7 Million vs. \$0 for No Build
Risk	How significant are the risks to project implementation, such as historic resource permitting and right-of-way acquisition, relative to the No Build condition?	Low risk. Minor change to existing "footprint" vs. no risk for No Build.	Low risk. Minor change to existing "footprint" vs. no risk for No Build.	High risk. Landtakings required affecting historic property vs. no risk for No Build.
Disruption	To what extent and for how long will project construction disrupt traffic operations and impact local businesses relative to the No Build alternative?	Estimated 1-1.5 years of construction based on construction cost vs. 0 years for No Build. Five parking stalls removed on Colchester Avenue north of Barrett Street.	Estimated 1-1.5 years of construction based on construction cost vs. 0 years for No Build. Five parking stalls removed on Colchester Avenue north of Barrett Street.	Estimated 2-2.5 years construction vs. 0 years for No Build. Five parking stalls removed on Colchester Avenue north of Barrett Street and loading zone lost on Barrett Street.

Legend			
Much Worse than No Build	Somewhat Worse than No Build	Comparable to No Build	Much Better than No Build

SUMMARY MATRIX

Attribute	No Build	Short-Range	Mid-Range	Alt 1	Alt 2	Alt 3
Traffic Operations	LOS E	LOS E	LOS D	LOS E	LOS E	LOS C (Estimated)
Crash Reduction	\$0 SAVINGS	\$2.5 M SAVINGS	\$2.5M SAVINGS	\$5.6M SAVINGS	\$7.2M SAVINGS	\$9.3M SAVINGS
Pedestrian Experience	NO CHANGE	PED SIGNALS TRAFFIC STOPS	PED SIGNALS TRAFFIC STOPS	PED SIGNALS TRAFFIC STOPS	PED SIGNALS TRAFFIC STOPS	TRAFFIC YIELDS
Bicyclist Experience	NO CHANGE	BIKE LANES	PROTECTED BIKE LANES	PROTECTED BIKE LANES	PROTECTED BIKE LANES	BIKES MERGE WITH TRAFFIC
Intersection Complexity	NO CHANGE	NO CHANGE	NO CHANGE	ONE 4-WAY INT ONE T-TYPE INT	ONE 4-WAY INT TWO T-TYPE INT	ROUNDBOUT WITH 2-LANE ELEMENTS
Cost	\$0	\$500,000	\$1.5M	\$3.3M	\$3.4M	\$6.7M
Risk	NONE	EXISTING "FOOTPRINT"	MINOR WIDENING	MINOR WIDENING	MINOR WIDENING	HISTORIC PROPERTY IMPACTS
Disruption	NONE	LESS THAN ONE YEAR	UP TO ONE YEAR	1.0 TO 1.5 YEARS	1.0 TO 1.5 YEARS	2.0 TO 2.5 YEARS

Legend						
Much Worse than No Build	Somewhat Worse than No Build	Comparable to No Build	Somewhat Better than No Build	Much Better than No Build		

Category	No Build	Short Range	Mid Range	Alt 1	Alt 2	Alt 3
Enhance Pedestrian Safety		◆	◆	◆	◆	◆
Safer Bike Connection to Winooski			◆	◆	◆	◆
Reduce Crashes		◆	◆	◆	◆	◆
Address Complexity				◆	◆	◆
Formalize On-Street Parking		◆	◆	◆	◆	◆
Manage Congestion			◆	◆	◆	◆
Satisfies Purpose and Need Statement	No	Partially	Partially	Yes	Yes	Yes