Office of Highway Safety

Road Safety Audit Review

Town:	Londonderry	**Date Reviewed:**	October 8, 2015
Route:	VT 100, Middletown Rd and Main St	**Mile points:**	Area of mm 2.99

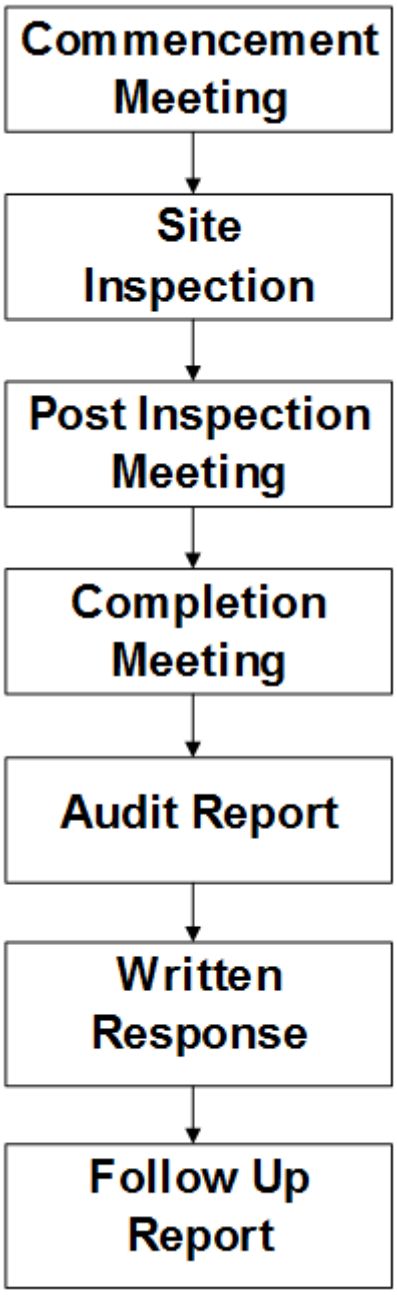
Location Map

RSAR Process

A ***Road Safety Audit Review*** (RSAR) is a formal examination of an existing road in which an independent, multi-discipline team (the Audit Team) reports on potential safety issues.

According to the Federal Highway Administration (FHWA), the purpose of a RSAR is to determine which elements of the road may present a safety concern, to what extent and under what circumstances as well as to identify opportunities to mitigate the identified safety concerns.

Figure 1 - Road Safety Audit Process



The RSAR process is composed of several steps as shown in Figure 1. The process starts with a ***Commencement Meeting*** during which the Audit Team reviews data and gathers community concerns. A ***Site Inspection*** is then performed by the Audit Team. The site visit involves the identification of safety deficiencies as seen in the field. The Audit Team will usually drive through the location of interest to “get a feel” for the area, traveling through each approach in the case of intersections. The team is to then drive at a slower speed to make observations. If needed, the team will also walk the location. Following the site inspection, the Audit Team holds a ***Post Inspection Meeting.*** It is during this meeting that the team members discuss their observations and identify safety issues. The team is to reach a consensus on the importance of each safety issue mentioned. Only those issues for which a consensus is reached are included in the RSAR findings. A RSAR report (Written Report) is prepared.

The ***Written Report*** identifies safety concerns and proposes guidance. These issues and solutions are presented in a tabular format associated to each Responsible Entity for ease of reporting. The ***Responsible Entities*** are any groups who own a roadway feature or who are responsible for making an improvement or for initiating further studies. These could include for example, the VTrans design section, the local town, the local police or the local RPC. Under a comprehensive RSAR process, the Responsible Entities are to provide a Written Response on every suggestion of the

Written Report as to its implementation. The Responsible Entity is not obliged to implement the suggestions. However, the reasons for not implementing a suggestion should be documented (e.g. physical constraints, excessive cost, environmental constraints, etc.).

Location

The location of this RSAR is the intersection of VT 100, Middletown Road and Main Street in South Londonderry.

Purpose of the RSAR

This RSAR was conducted at the request of the Windham Regional Commission (WRC) with the intent of having safety issues identified as they relate to crashes at the subject intersection.

The RSAR herein has sought to identify potential safety hazards and physical features which may affect road user safety. However, it is possible that not every deficiency has been identified. It should further be recognized that the implementation of the guidance in this report may contribute to improve the level of safety of the facility reviewed but not necessarily remove all the risks.

RSAR Participants

Mario Dupigny-Giroux,	Office of Highway Safety, VAOT
Tom Fields,	Office of Highway Safety, VAOT
Matt Mann,	Widham Regional Commission
Kevin Beattie,	Town of Londonderry
Pete Cobb,	Londonderry Volunteer Rescue Squad
George Lang,	South Londonderry Fire
Paul Gordon,	Londonderry Selectboard
Steve Prouty	Road Commissioner

Information Reviewed

Speed Limit

The posted speed limit is 30 mph on VT 100. There is a 20 mph advisory speed in both directions on VT 100 through the intersection.

There is no posted speed limit on Middletown Road or Main Street.

Traffic Volumes

On VT 100 at this intersection and between Winhall Hollow Road and VT 11, the 2012 Average Annual Daily Traffic (AADT) was 1700 vehicles per day.

The latest 12-hour turning movement count was done in 2014 and is summarized in the next figure. The previous count was done in 2012. The 2014 turning movement count indicates that the heaviest movements of travel are on VT 100 traveling from south to north and from north to south.

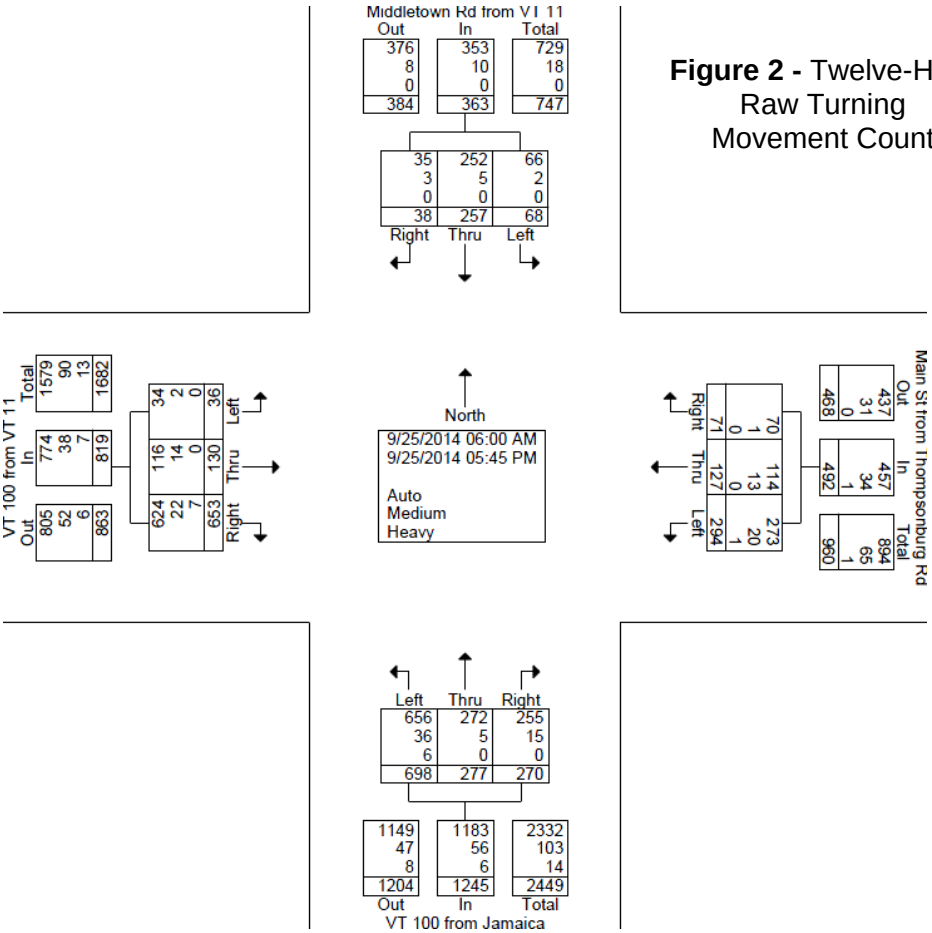


Figure 2 - Twelve-Hour Raw Turning Movement Count

The 2014 Turning Movement Report is provided at the end of this report.

Geometry

This is a four-way intersection with VT 100 through this intersection following a 31-degree curve (to the left when traveling northbound and to the right when traveling southbound on VT 100).

At this intersection, the northbound approach of VT 100 is located on the south side of the intersection while the southbound approach of VT 100 is located on the west side of the intersection. Middletown Rd is located on the north side of the intersection and Main St on the east side.

In terms of vertical alignment, the southbound approach of VT 100 has an 8.9% downgrade, Middletown Rd follows a significant downgrade as it intersects with VT 100 and the Main St approach of the intersection is slightly lower than the VT 100 northbound approach.

Signs and Markings

Approaching the intersection in both directions on VT 100, there are modified turn signs (i.e., a sign displaying both a turning arrow and an intersecting road) with a 20 mph advisory speed plaque below them. These signs are followed by a VT 100 route marker assembly with a directional arrow and a cardinal direction.

There are stop signs on Main St and Middle Town Rd.

Bridge Structure

Bridge 00090 is located on VT 100 on the south approach of the intersection. This bridge was reconstructed in 1972. This bridge was inspected in June 2015. It was found that the structure was in fair condition. The inspection report mentioned that the tear drop rail needed to be repaired.

Pavement Conditions

2011 data show that pavement conditions on VT 100 were rated as very poor by VTrans. Since 2014, pavement conditions have been rated as being good south of the intersection. The pavement conditions north of the intersections are currently rated as good.

Past Projects

The portion of VT 100 south of the “north” approach which also includes VT 100 within the intersection was paved in 2014. The portion north of the “north” approach was paved in 2015.

The traffic signs along VT 100 were installed in 2010.

Future Projects

Middletown Rd was part of a safety review by VTrans in summer 2015. Specifically concerning the intersection with VT 100, a stop a head sign will be installed along with a stop bar and the word markings “STOP”.

Crash History

The crash history was reviewed in the area of the intersection for the five-year period covering the years 2010 to 2014. Crashes that took place during 2015 up to the time of this review were also examined to provide additional insight. This intersection is not currently defined as a high crash location.

A collision diagram and the law enforcement narrative for each of the crashes are provided at the end of this report.

There were a total of three crashes at this intersection between 2010 and 2014. Three additional crashes took place in 2015.

All the crashes that took place at this intersection involved a vehicle that was traveling southbound on VT 100.

The main crash pattern at this intersection is a right angle collision (this corresponds to four of the six crashes at this intersection). Seventy-five percent of the crashes involving this type of crash occurred when a southbound vehicle on VT 100 continued straight onto Main St without yielding to oncoming traffic from the right (VT 100 northbound). In one of the crash reports, the operator at fault specifically stated that he felt that he had the right-of-way.

A second crash pattern of interest is a southbound vehicle that loses traction and control on an icy road surface. Of the six crashes investigated at this intersection, an icy road surface was the contributing factor in three crashes. These crashes were not concentrated in a particular year but happened over several years (one each in 2013, 2014 and 2015), indicating a more recurring issue.

Current Local Concerns

The following comments were obtained during the commencement meeting.

Town representatives mentioned that the intersection had a tight radius for trucks to maneuver through the intersection.

Town representatives mentioned that motorists that stop on Main St have to inch into the intersection in order to see oncoming traffic from VT 100 northbound due to the bridge railing.

Town representatives mentioned that to their knowledge, many of the locals that traveled on VT 100 southbound were slowing down or stopping before entering the intersection.

Town representatives mentioned that there were several crashes that had not been reported (mostly vehicles traveling southbound and losing control on snow or ice).

Safety Concerns Identified

This section lists the areas of safety concern identified by the audit team during the site inspection and from the analysis of available data. This section also reports the potential remedial actions identified by the audit team. The concerns are not listed in order of importance.

1st Concern

There is poor corner sight distance when stopped on the Main St approach and looking towards the VT 100 northbound approach (i.e., when looking to the left).

The following series of three pictures show what is seen by a vehicle that is stopped where the stop sign is located, where the stop bar should be located and when creeping into the road.

This poor condition is mainly caused by the presence of the bridge railing. Due to its design, it is very difficult to see oncoming traffic through it as one approaches the intersection.

It is also difficult to see oncoming traffic wen stopped at the stop sign. It is only when the nose of the vehicle is in the road that an operator can start seeing traffic.

It is questionable whether the presence of the flower boxes contributes to the limited visibility and if it is possible to see the top of a small car without them being there.

Brush in this quadrant including the vine that is growing up the sign posts is also somewhat distracting.

Approaching the Intersection

Stopped at the Stop Sign

Stopped where the Stop Bar Should Be

Creeping into the Road

Short Term Actions (up to a year)

To improve the positioning of vehicles when they stop on the Main St approach so that visibility to oncoming traffic is improved, a stop bar and the “STOP” word markings should be installed (The proper location for a stop bar is typically four feet from the edge of the road). In addition, the yellow center line should be extended up to the stop bar.

Brush in this quadrant should be trimmed.

Should the flower boxes be removed (or lowered so the top is flush with the bridge rail)?

Mid to Long Term Actions

Evaluate the possibility of designing and installing a new railing that would be less compact.

The picture on the right shows a similar type of railing but with vertical bars that are not has big.

2nd Concern

Some operators who are traveling southbound on VT 100 with the intention of continuing on Main Street are not yielding to traffic that is coming from VT 100 northbound (i.e., traffic that is coming from the right).

Immediate to Short Term Actions (up to a year)

The idea of the following short term actions is to make it more obvious to motorists who are coming from VT 100 southbound and continuing straight onto Main St that they have to yield to traffic coming from the right of the intersection.

There are currently modified turn signs on VT 100 in both directions. The size of these signs is currently 30” x 30”. The size required by the Manual on Traffic Control Devises (MUTCD) for these signs is 36” x 36”. The signs should be upgraded to the larger size.

Install a dotted white edgeline extension through the intersection. There is already an extension for the yellow centerline. Having the edgeline delineated in a similar manner would enhance the fact that the main movement is around the curve.

Install a “Main St” street name sign above the stop sign on Main St.

MUTCD sign W4-4ap is a yellow plaque that says “traffic from left does not stop” (or to the right as applicable). The Manual on Traffic Control Devises stipulates that if such a sign is to be used, that it shall be installed under a stop sign.

While its usage might not be as intended, installing this plaque along with the modified turn sign on the southbound approach would be one way to convey to motorists that they should yield to traffic that is coming from the right.

Alternatively, a warning diamond sign with the same text message (Traffic from Right Does not Stop) could be installed following the modified intersection sign.

Yet, another alternative could be to create a sign with the similar concept than MUTCD sign R10-15. For example, a design such as the one shown at the right could be explored. This sign would also be installed following the modified turn sign.

Office of Highway Safety

Road Safety Audit Review

Option A: Install the W4-4ap plaque with the existing modified turn assembly.

Option B: Various arrangements could be considered if one of the following concepts was used.

1) Install sign at location A.

2) Move the VT 100 South sign at location A and install the sign where the VT 100 South sign was.

3) Install the sign at the intersection at location B (but not to interfere with corner sight distance). Optionally Move the VT 100 South sign at location A.

Under option B and even under option A, a warning beacon could be installed above the sign to add additional emphasis.

There are currently 20 mph advisory speed plaques in both directions on VT 100. These were verified during the field inspection with a ball bank indicator. A reading of 14 degrees was obtained at 20 mph in the southbound direction and a reading of 12 degrees was obtained at 15 mph confirming that the 20 mph advisory speed in appropriate in the southbound direction.

Northbound, readings of 15 to 17 degrees were obtained at a speed of 15 mph. Maintaining a speed of 20 mph through the curve in this direction is harder to achieve and additional measurements should be taken to confirm the advisory speed in this direction.

3rd Concern

At this location, VT 100 southbound prior to the intersection is prone to icing and instances of motorists not being able to slow down and continuing across the intersection are common.

Immediate to Short Term Actions

As a first step, the Town and the District should meet to discuss winter maintenance at this intersection.

Mid Term Actions

To reduce the incidences of crashes occurring on an icy road surface, the use of an anti-icing overlay could be considered. As demonstrated by VTrans in a recent research project, the anti-icing product manufactured under the name Cargill SafeLane® HDX Overlay showed to be efficient at reducing crashes. However, due to unresolved problems with durability, the recommendation has been to halt the use of this product on Vermont roads.

It appears that the manufacturer recently developed another product that can be added to a typical asphalt mix. Although VT 100 at this location was recently resurfaced, due to the history of icy-road related crashes at this site, this location remains a candidate location that could be

considered as part of a new research project for the application of an anti-icing surface with this type of additive.

Another approach could be to warn motorists that the road surface is icy. This could be achieved by using a dynamic ice warning system.

The system would include a diamond warning sign with the text ICING MAY OCCUR WHEN FLASHING. This sign would be installed in advance of the intersection, at the top of the hill on VT 100 southbound. The sign would be flashing when ice is detected. This could be achieved by using a regular warning beacon above the sign or with a series of Light Emitting Diode units (LEDs) in the border of the sign.

Detection of icy conditions would be achieved with a non-intrusive road surface sensor capable of detecting ice on the road surface. The system could have the capabilities of being monitored remotely using a web-based application.

Other Countermeasures Considered

There were two remedial actions that were discussed and evaluated to a certain degree within this report.

The first was an overhead intersection flashing beacon. The Manual on Uniform Traffic Control Devices stipulates that the signal indications on each face of the beacon shall be circular yellow or circular red. In addition, the Manual on Uniform Traffic Control Devices also stipulates that the flashing yellow signal indication shall not face conflicting approaches.

In the current case, the main flow of traffic is on VT 100 and if an overhead intersection beacon was installed, this flow of traffic would be controlled with a yellow flashing indication on both approaches. These yellow indications would indicate that traffic on VT 100 had the right-of-way. However, VT 100 has one approach on the south side of the intersection and the other one on the west side of the intersection. Because both VT 100 approaches would face a yellow indication, this would result in a conflict and an overhead beacon would not be allowed by the Manual on Uniform Traffic Control Devices. Consequently, an intersection flashing beacon with

a circular yellow indications on VT 100 and a circular red indications on the side roads is not appropriate at this location. Given the current geometry and traffic patterns, the only way that an intersection flashing beacon could be installed is if the intersection was controlled by stop signs on all approaches and that all the indications on the beacon were red.

The second action that was evaluated is controlling the intersection with stop signs on all approaches. Clearly, stopping all traffic at this intersection from all approaches would eliminate the confusion that some VT 100 southbound motorists who want to cross the intersection onto Main St have with respect to them having the right-of-way (2nd concern previously discussed).

On the other hand, the Manual on Uniform Traffic Control Devices provides guidance as to when it is appropriate to control traffic with multi-way stop signs. One of the leading criteria is that the traffic volumes be approximately equal on all approaches. Another set of criteria are bundled into warrants. A formal warrant analysis was performed by VTrans. Based on the volumes and crash criteria, it was found that multi-way stop operation was not warranted at this location. The results of the warrants are presented at the end of this report. Based on this information alone, multi-way stop controlled for this intersection cannot be supported.

While the main warrants do not support the application of multi-way stop control, the Manual on Uniform Traffic Control Devices provides other guidance that may be considered. One of these other conditions is the need to control left-turn conflicts. Crossing over onto Main St from VT 100 southbound could possibly be considered a left turn maneuver since the continuous (through) movement is along the curve on VT 100. Another condition would be where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop. This condition could possibly describe the first concern mentioned earlier.

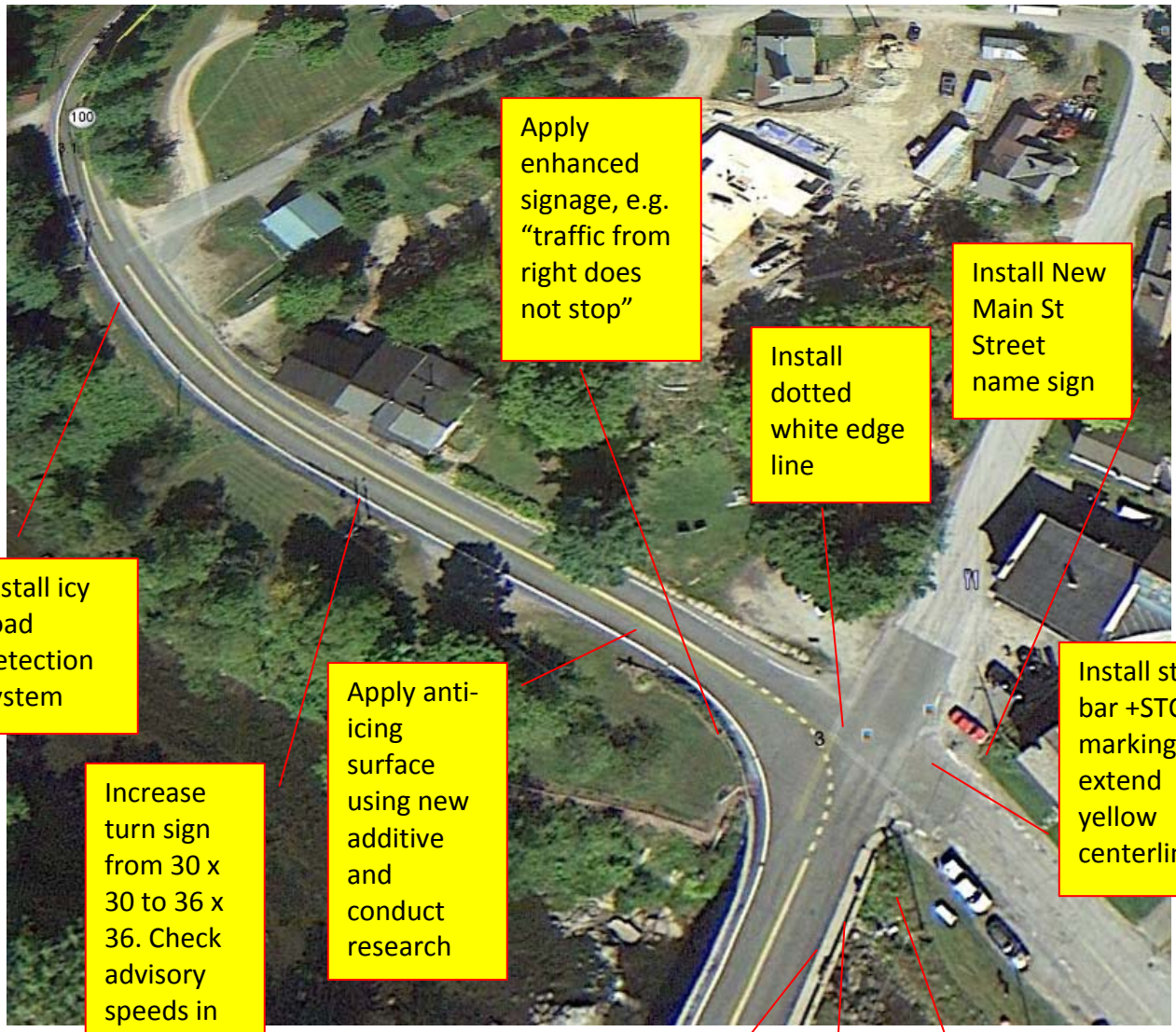
Action Plans

The safety concerns and potential actions that were identified in the previous sections are further summarized in the next table. In this table, the safety issues of concern are listed in the first column. The second set of columns identifies the groups that are most likely capable of implementing the solutions that are shown in the third column.

Office of Highway Safety

Road Safety Audit Review

Summary of Suggested Actions



Observation	AOT Traffic Design	Town of Londonderry	AOT TSMO	AOT District	AOT Office of Safety	AOT Structures	AOT Research	Strategy	Outcome Agree/ Disagree	Planned Completion Date	Comments
1ST Concern Poor corner sight distance when stopped on the Main St approach and looking towards the VT 100 northbound approach (including difficulty to see oncoming traffic when approaching the intersection due to the bridge railing).		X		X				**Short Term Actions (up to a year)** Install a stop bar (4 ft from edge of road) and the "STOP" word markings on the Main Street Approach. Extend the double yellow centerline up to the new stop bar (include the change in the annual markings plan).			
		X		X				Trim brush in southeast quadrant, including along sign posts.			
		X						Consider removing or lowering the flower boxes.			
						X		**Mid to Long Term Actions** Evaluate the possibility of designing and installing a new railing that would be less compact.			

Observation	AOT Traffic Design	Town of Londonderry	AOT TSMO	AOT District	AOT Office of Safety	AOT Structures	AOT Research	Strategy	Outcome Agree/ Disagree	Planned Completion Date	Comments
2ND Concern Southbound VT 100 vehicles that continue on Main Street are not yielding to traffic that is coming from VT 100 northbound (i.e., coming from the right).			X					**Short Term Actions (up to a year)** Increase the size of the modified turn signs which show intersecting roads from 30" x 30" to 36" x 36" (via work order).			
			X					Install a dotted white edgeline extension through the intersection to supplement the yellow extension (via work order).			
		X						Install a "Main St" street name sign above the stop sign on Main St.			

Observation	AOT Traffic Design	Town of Londonderry	AOT TSMO	AOT District	AOT Office of Safety	AOT Structures	AOT Research	Strategy	Outcome Agree/ Disagree	Planned Completion Date	Comments
			X					Evaluate the use of enhanced signage such as Traffic from Right Does not Stop. Possibly emphasize new sign by adding a flashing beacon (via work order).			
3RD Concern Due to an icy road surface on VT 100 SB, motorists are not being able to slow down and are continuing across the intersection.		X	X					**Short Term Actions** The Town and the District should meet to discuss winter maintenance at this intersection.			
			X					Evaluate the advisory speeds, especially northbound (via work order).			
					X		X	**Mid Term Actions** Conduct a new research project for the application of an anti-icing surface with the new additive developed by Cargill.			

Observation	AOT Traffic Design	Town of Londonderry	AOT TSMO	AOT District	AOT Office of Safety	AOT Structures	AOT Research	Strategy	Outcome Agree/ Disagree	Planned Completion Date	Comments
	X		X		X			Warn motorists that the road surface is icy using a dynamic ice warning system with icy conditions detected using a non-intrusive road surface sensor (via work order, HRRR project or HSIP project).			
Further consideration of 1st and 2nd concerns.			X					VT 100 SB motorists are expecting traffic from the right to stop when crossing. Traffic on Main St has a hard time seeing oncoming traffic from the left after stopping. Evaluate the extent of these conditions and the potential application of all-way stop control.			