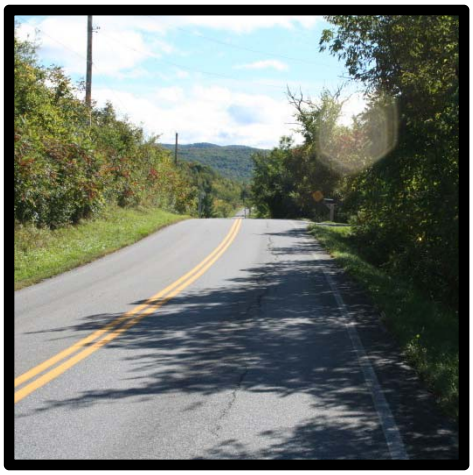

SHELBURNE FALLS ROAD SAFETY STUDY

TCE# 2012005-1
HINESBURG, VERMONT

Date:
September 29, 2014

Prepared For:
Town of Hinesburg

Prepared By:

TRUDELL CONSULTING ENGINEERS

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The purpose of this study is to provide the Town of Hinesburg with an inventory of existing roadway conditions, safety issues, and suggested roadway improvements for both short and long range planning along with approximate costs. Shelburne Falls Road has a history of crashes due to instances of excessive speeds and limited visibility on curves.

A visual safety inventory was conducted between September of 2012 and February of 2014 to observe potential hazards and identify areas for improvement. Site-reconnaissance included measurements of sight distance at various locations throughout the study corridor, geometry and side-slope observations, ball-bank indicator analysis, sign inventory, and observation of clear zone obstructions. Key areas that could benefit from improvement were identified and immediate, short, and long term improvements were outlined.

Road Crossing Culvert – mile mark 0.4-0.65

- **Observation:** Deteriorated culvert backfill and poor surface drainage
- **Immediate Actions:** Maintain 24" HDPE culvert across Shelburne Falls Road.
- **Short to Mid-Term:** Provide shoulder treatment along westbound corridor beginning at approximately mm 0.4 and continuing as needed until the culvert. Reshape and stabilize drainage ditch beginning at mm 0.4 to meet a minimum 2' depth and 2' wide flat bottom with 2:1 side slopes. Add guardrails in key locations.
- **Mid to Long Term:** Replace the 12" CMP driveway culvert under the drive 300' West of Crow Hill Rd. accessing the EB lane of the corridor with a State minimum 15" HDPE culvert. Extend the drainage ditch along the side of the WB lane between mm 0.5 and 0.575 to connect existing drainage ditch with existing Stormwater detention pond. Construct minimum 15" HDPE culvert under the dual driveway.

Taproot Farm Road and Boutin Road Intersections – mile mark 0.75-1.2

- **Observation:** Throughout this section there are four driveways and two intersections with poor visibility due to obstructed clear zone and curves. There are also steep slopes along the traveled lanes in combination with poor drainage and deteriorating shoulders.
- **Immediate Action:** Erect 25 mph advisory speed placards (W13-1P) to the existing advance warning signs. Replace the broken reverse curve warning sign for westbound traffic. Clear vegetation that is obstructing the view of signs and sight distance throughout this section of the corridor.
- **Short-Term Action:** Consider lowering speed limit to 35 mph for this stretch of corridor. Construct guardrail in both eastbound and westbound directions in key locations.

- **Mid to Long Term:** Apply access management practices to reduce quantity of access drives and consider the relocation of the Boutin Road intersection.
- **Other Considerations:** Undersized culverts and inadequate roadside drainage culvert and swale maintenance mm 0.825-0.9.

Culvert maintenance – mm 1.2 – 1.3

- **Observation:** Clogged culvert that could lead to poor drainage and result in unsafe conditions.
- **Short-Term Action:** Clean culvert during routine drainage maintenance.
- **Mid to Long Term:** Construct guardrail in key locations.

O'Neil Road Intersection – mm 1.5 – 1.8

- **Observation**: Inadequate sight distance for design speed due to vertical curve.
- **Immediate Action:** Relocate the existing advanced intersection warning sign (W2-2R) 500' west for eastbound traffic. Erect an advanced intersection warning sign (W2-2L) for westbound traffic 800' from the intersection. Add advisory speed placard to intersection warning signs for a speed of 30 mph (W13-1P).
- **Mid to Long Term:** Relocate the O'Neil Road intersection to the crest of the vertical curve to improve sight distance in both directions. Otherwise, consider lowering speed limit to 35 mph for this stretch of corridor. Adjust all signs as necessary.

Culvert and swale maintenance – mm 1.74 – 1.89

- **Observation:** Deteriorating road crossing culvert and multiple clogged driveway culverts. The deteriorating culvert backfill has caused a sinkhole to form and improper bedding for the road crossing culvert has also allowed for settling and road and shoulder deterioration. Steep side slopes create a potential hazard.
- **Immediate Action:** Backfill above 36" HDPE culvert with gravel. Compact backfill, cover with topsoil and stabilize with seed and mulch. Utilize riprap on all slopes exceeding 3:1 to stabilize the headway and prevent further erosion. Clean driveway culverts during routine drainage maintenance. Clear overhanging vegetation.
- **Short-Term Action:** Reshape westbound drainage ditch to improve drainage. Construct guardrail in key locations.
- **Mid to Long Term:** Replace bedding material around 36" HDPE culvert to prevent further settling and deterioration of the surface course. Construct a new concrete headwall to prevent future degradation of the culvert inlet.

Vertical and Horizontal Curve with multiple access drives – mm 1.91 to 2.18

- **Observation:** Inadequate sight distance for design speed due to horizontal and vertical curve. Visibility impairments are enhanced for eastbound traffic in the

morning hours due to direct sunlight. Signs are difficult to see due to bright background and overgrown vegetation. The vertical and horizontal curve reduces the ability for vehicle operators to identify traffic entering from the driveway access points on both the eastbound and westbound sides. The advanced warning curve sign with advisory speed placard was changed from 30 mph to 35 mph after recommendations from the 2007 safety report by Vermont Local Roads.

- **Immediate Action:** Install a culvert under driveway #786 using minimum 15" HDPE to improve drainage and address ponding. Clear vegetation as indicated in section **Error! Reference source not found.** part **Error! Reference source not found.**.
- **Short-Term Action:** Reshape existing drainage ditches for both directions to improve drainage. Consider lowering speed limit to 35 mph for this stretch of corridor. Adjust all signs as appropriate. Advanced warning curve speed limit advisory placards should be reduced to 25mph in both directions. This cannot be achieved without first reducing the speed limit, however based on the observed sight distances, the existing signs indicate an inappropriately high advisory speed for this curve.
- **Mid to Long Term:** Replace existing 15" CMP road culvert with minimum 18" HDPE culvert. Cut back existing bank offset from the WB lane to improve sight distance through the horizontal curve.

Vertical and Horizontal Curve with Multiple Access Drives – mm 2.58 – 2.78

- **Observation**: Inadequate sight distance for design speed due to horizontal and vertical curve. This section of the study corridor has a posted speed limit of 35 mph beginning at mm 2.78 in the eastbound direction.
- **Immediate Action:** Clear limiting vegetation.
- **Short-Term Action:** Advanced warning curve speed limit advisory placards should be reduced to 30 mph in both directions. Reshape existing drainage ditches for westbound shoulder to improve drainage
- **Mid to Long Term:** Cut back existing bank offset from the WB lane to improve sight distance through the horizontal curve. Install guardrail in key locations.

Corridor-Wide Improvements

- **Longitudinal Rumble Strips and Stripes on Two-Lane Roads** Inattentive and inexperienced drivers frequently use this corridor, which can lead to vehicles inadvertently crossing the center line and lead to serious head on collisions.
- **Fog Lines** Fog lines are the traditional single continuous white line to demarcate the edge of a travelled way. Install fog lines on the edges of Shelburne Hinesburg Road. Maintain at least a 10' travel lane width from centerline.
- **Safey Edges** Safety Edge is a technology that shapes the edge of a newly paved roadway at approximately 30 degrees from the horizontal surface. Providing an

edge treatment at this angle eliminates tire scrubbing when a vehicle leaves the roadway, which can cause loss of vehicle control.

- **Remove/Replace Utility Poles -** There is a recommended clear zone of 30' offset from the edge of traveled lane for rural roads with a speed limit of 45 mph or greater. There were two utility poles located within 3' of the edge of road that can be removed for improved safety. mm 0.07 and 1.36 on the westbound side.
- **Vegetation Removal - Periodic** maintenance of vegetation along the roadway is generally conducted in Hinesburg. Specific locations where more aggressive vegetation removal could be beneficial are noted in the report.
- **Longitudinal Roadside Barrier (Guardrail) -** Several areas in addition to the specific improvement zones noted about were observed to exceed the minimum recommended slope for consideration of longitudinal roadside barriers.
- **Shoulder Treatment -** Areas were identified as shorter sections of roadway not related to curves or intersections that could benefit from shoulder treatment.

Shelburne Falls Road has a history crashes due to excessive speeds and limited visibility on curves. Due to the presence of Chittenden Valley Union High School in Hinesburg, this route is frequently used by inexperienced student drivers. An audit of roadway conditions identified a number of specific and corridor wide areas where implementation safety measures could improve traffic safety and help to minimize crashes. This report summarizes the safety issue identified, short and long term recommendations for improvement, as well as preliminary cost figures for each item. The Hinesburg Selectboard should review and evaluate whether these improvements can be budgeted and implemented in future years.

Purpose and Need Statement

The purpose of this study is to provide the Town of Hinesburg with an inventory of existing roadway conditions, safety issues, and suggested roadway improvements for both short and long range planning along with approximate costs. Shelburne Falls Road has a history of crashes due to instances of excessive speeds and limited visibility on curves. Champlain Valley Union High School and Vermont Route 116 are located approximately 3 miles to the west of the Shelburne Town Line in Hinesburg, which makes this a popular route for school traffic and inexperienced drivers as well as a popular east-west commuter route.

1.0 Introduction

The study area encompasses an approximately 3.8 mile stretch of roadway known as Shelburne Falls Road within the limits of the Town of Shelburne (0.9 miles), and Shelburne Falls Road within the limits of Hinesburg (2.9 miles). This report will focus on the 2.9 mile road section located in Hinesburg, which for the purpose of this report shall hereafter be referred to as the "study corridor". A separate report was completed for the Shelburne section in January of 2014. A topographic survey as well as a safety audit was conducted to identify the locations and types of potential hazards. Immediate action items are recommended, including shoulder treatment, improved signage, and tree clearing, as well as long-term solutions such as guardrail additions, drainage swale and culvert maintenance and bank re-grading.

2.0 Existing Conditions

Shelburne Falls Road is considered a Class 2 Town Highway. The Agency of Transportation (VTrans) identifies the road as having a Rural Major Collector functional classification, federal aid number MC 0210. According to VTrans automatic traffic recorder (ATR) station S6D366 located 0.5 mi west of Boutin Road in Hinesburg, annual average daily traffic (AADT) on this stretch of roadway was approximately 2400 vehicles per day (vpd) in 2011.

Year	***AADT (vpd)***
2003	2600
2005	2300
2007	2700
2009	2200
2011	2400

Chittenden County Metropolitan Planning Organization (CCMPO) ATR stations collected traffic data in 2008 at two separate locations along the studied corridor. The calculated AADT for these stations was higher than the AADT reported by VTrans. See ***Appendix 1 – Overall Map*** for ATR locations.

Year	***Station ID***	***AADT (vpd)***	***Location description***
2008	HBRG-21	3,208	Between Geprag's Park and VT116
2008	HBRG-29	3,132	West of O'Neil Road

A. Route Survey

A 3.8 mile centerline survey was conducted in May of 2012, beginning on the west end of the road in Shelburne at the intersection with Dorset Street (Station 0+00) and ending in Hinesburg to the east of the Pleasant View Lane intersection near VT 116

(Sta. 201+00) to determine roadway geometry. A visual safety inventory was conducted between September of 2012 and February of 2014 to observe potential hazards and identify areas for improvement. Site-reconnaissance included measurements of sight distance at various locations throughout the study corridor to determine the visibility for multiple scenarios, including approach from multiple intersections, access drives, and stopping distance through horizontal and vertical curves for both eastbound and westbound traffic.

Review of travelled way surfaces included observing the condition of shoulders, and assessments on structural and non-structural drainage features. Poor drainage conditions were observed resulting in ponding (and ice during winter months), contributing to shoulder degradation, reducing traction, and creating potentially hazardous conditions.

Specifically, the following items were noted:

- Geometry of the corridor was a focus of site reconnaissance performed in February 2014. Measurements indicated multiple areas exceed the minimum recommended slope for consideration of longitudinal roadside barriers. See *Section 5.0 - Longitudinal Roadside Barrier (Guardrail)* for a summary of deficient locations.

- A ball-bank indicator was utilized to determine appropriate design speeds for horizontal curves throughout the study corridor. Data collected using this method did not identify any locations where the posted speed limit exceeded maximum recommendations for curve severity and is therefore not included in this report.

- A sign inventory was generated using in-field GPS data collection to document the location and condition of all the signs throughout the study corridor. Sign inventory maps are available in ***Appendix 2 - Sign Inventory***. Other observations such as visibility impairments due to the position of the sun during peak hour traffic were noted.

- Obstructions in the clear zone were identified such as utility poles in close proximity to the edge of road. Photographs of such observations can be found in *Section 3.0 – Observations and Recommendations*.

B. Speed Data

The sign inventory of Shelburne Falls Road within the study area indicates a speed limit of 45 miles per hour (mph) posted in Hinesburg in both the eastbound and

westbound direction. The CCMPO ATR data referenced above also measured traffic speed. According to the data collected, the 85th percentile speed is between 50 mph and 55 mph along the study corridor. The 85th percentile speed is used to formulate an assumed operating speed for the corridor. These data indicate the operating speed for the corridor exceeds the posted speed limit by 5-10 mph. See ***Appendix 1 – Overall Location Map*** for speed study locations.

Table 1: *Speed Summary*

Year	Station ID	85th Percentile Speed	
		Eastbound	Westbound
2006	HBRG-10	50 mph	54 mph
2008	HBRG-21	52 mph	53 mph
2008	HBRG-29	55 mph	55 mph

C. Crash Data

Crash data were analyzed from various sources to provide further justification for identifying areas of improvement. These data included General Yearly Summaries from the AOT Highway Research Department for both Federal Aid Town Highway listings for the study corridor and all intersecting town roads. Also analyzed were detailed reports from the Town of Hinesburg Police Department (HPD) summarizing all reported incidents along the study corridor. The reports provided important qualitative information regarding the circumstances of traffic incidents between 2007 and 2014.

Not all crashes are reported to the Department of Motor Vehicles to be included in the State crash database because there is a minimum threshold for qualifying incidents for State reporting that is based on the severity of the crash, determined by the value of property damage or the inclusion of an injury or fatality. All data is illustrated in ***Appendix 3 – Crash Map.***

The town highway crash listing summary for O'Neil Road reported four crashes at the intersection of O'Neil Road and Shelburne Falls Road between 2007 and 2012. The table below reports the circumstances of the crashes at the intersection.

Table 2: *O'Neil Road Crash Summary*

Date	***Location***	***Circumstance***	***Direction of Crash***
11/20/2007	O'Neil Road	Driving too fast for conditions	Single Vehicle Crash
1/27/2008	O'Neil Road	Driving too fast for conditions	Single Vehicle Crash
12/22/2008	O'Neil Road	Inattention	Single Vehicle Crash
11/11/2009	O'Neil Road	Driving too fast for conditions	Single Vehicle Crash

The federal-aid highway crash listing summary (2008-2012) reported 22 crashes throughout the study corridor. See Table 3 below for a summary of crash information, including the location, direction, circumstance of the crash and resulting quantity of injuries and fatalities.

Information from the Hinesburg Police Department includes minor crashes and other traffic-related incidents that are not represented in the state-wide crash listing summaries. These include minor crashes of insignificant property damage and no resulting injury, and other incidents that contribute to unsafe conditions on the study corridor.

Table 3: *Overall Crash Summary*

MM	*Date*	*Time*	*Weather*	*Circumstance*	*Direction of Collision*	*Injury*	*Fatal*	*Direction*
0.2	4/30/2008	7:32AM	Cloudy	Failed to yield to right of way, Driving too fast for conditions	No turns, through moves only, Broadside	2	0	N/A
0.6	10/2/2011	4:35PM	Cear	No improper driving	Rear end	1	0	N/A
0.8	5/2/2011	7:50AM	Clear	No improper driving, Driving too fast for conditions	Rear end	0	0	N/A
0.9	2/3/2009	8:25AM	Cloudy	Driving too fast for conditions	Single Vehicle Crash	1	0	E
0.9	2/13/2009	9:10AM	Cloudy	Driving too fast for conditions	Single Vehicle Crash	0	0	E
1	1/27/2012	8:04AM	Rain	Unknown	Single Vehicle Crash	2	1	N/A
1.1	10/30/2008	7:30AM	Cloudy	No improper driving	Single Vehicle Crash	0	0	E
1.7	1/13/2012	2:00PM	Snow	Driving too fast for conditions	Single Vehicle Crash	0	0	W
1.7	1/7/2009	7:55AM	Snow	Driving too fast for conditions	Single Vehicle Crash	0	0	N/A
1.7	11/21/2011	12:55PM	Clear	No improper driving, Followed too closely	Rear end	0	0	W
1.8	3/2/2009	4:00PM	Cnow	Driving too fast for conditions	Single Vehicle Crash	1	0	W
1.8	11/13/2011	5:15PM	Cloudy	No improper driving	Single Vehicle Crash	0	0	E
2	5/2/2011	7:00PM	N/A	N/A	N/A	0	0	W
2.3	12/6/2010	3:20PM	Snow	Driving too fast for conditions	Opp. direction sideswipe	0	0	E
2.4	11/18/2008	3:10PM	Snow	No improper driving, Driving too fast for conditions, Operating defective equipment	Opp. direction sideswipe	0	0	E
2.5	7/17/2008	6:33AM	Clear	Inattention	Single Vehicle Crash	1	0	N/A
2.6	1/29/2010	9:25PM	Clear	Technology Related Distraction, Failure to keep in proper lane	Single Vehicle Crash	0	0	W
2.7	1/19/2010	10:00AM	Snow	Driving too fast for conditions	Single Vehicle Crash	0	0	E
2.8	2/22/2009	8:35AM	Snow	No improper driving	Single Vehicle Crash	0	0	E
2.9	4/8/2010	5:37PM	Clear	Failed to yield right of way, No improper driving	Right Turn and Through, Same Direction Sideswipe/Angle Crash	0	0	E
2.9	4/2/2012	1:25PM	Clear	Failed to yield right of way, No improper driving	Other - Explain in Narrative	0	0	E
N/A	4/11/2008	4:12PM	Rain	No improper driving	Other - Explain in Narrative	0	0	E

D. Hinesburg Road Safety Review – Vermont Local Roads

Vermont Local Roads compiled a review performed in 2007 containing observations performed by the town administrator, highway foreman, and representatives from the CCMPO. Recommendations from the report generally include brush cutting, the addition of guardrail, signage improvements, and a culvert replacement. Many of these recommendations have been completed. See Table 4 below for a summary of the status of the recommended improvements.

Table 4: *2007 CCMPO Recommendation Implementation Status*

MM	*Direction*	*Category*	*Recommendation*	*Status*
.0	WB	Signage	Remove "Reduced Speed Ahead" Sign	Complete
.2	WB	Signage	Add Chevron (MUTCD W1-8)	Complete
.6	EB	Signage	Erect reverse curve sign (MUTCD W1-4L)	Complete
.9	WB	Signage	Add Chevron (MUTCD W1-8)	Complete
.9	EB	Signage	Erect left curve sign (MUTCD W1-2L)	Complete
1.1	WB	Intersection	Relocate Intersection to top of hill	Incomplete
1.7	EB	Signage	Erect intersection sign (MUTCD W2-2R)	Complete
1.9	EB	Signage	Upgrade left curve sign ((MUTCD W1-2L)	Complete
1.9	EB	Signage	Change 30mph to 35mph (MUTCD W13-1)	Complete
1.9	WB	Signage	Erect reverse curve sign (MUTCD W1-4R)	Complete
2.6	EB	Signage	Change 30mph to 35mph (MUTCD W13-1)	Complete
2.7	EB	Signage	Add Chevron (MUTCD W1-8)	Complete

3.0 Observations and Recommendations – Roadway Sections

A. Road Crossing Culvert near Red Wagon Plants and Family Cow Farmstand – mm 0.40-0.65

Observation: Deteriorated culvert backfill, with steep drop-off from edge of road in both the eastbound and westbound directions, and poor drainage and steep slopes in Westbound approach towards culvert across from Crow Hill Road. Poor surface drainage is causing scouring along the westbound shoulder resulting in degradation of the surface course.

Figure 1: *Steep slopes near deteriorated culvert backfill*

Figure 2: *Steep slopes and deteriorated culvert backfill*

Figure 3: *Shoulder degradation across from Crow Hill Rd. WB – September 2012*

Recommendation:

- **Immediate Actions: Culvert Maintenance** Backfill above 24" HDPE Culvert with gravel and divert surface runoff into the existing Stormwater detention pond through a lined ditch. Compact backfill, cover with topsoil and stabilize with seed and mulch. Utilize riprap on all slopes exceeding 3:1 to stabilize the headway and prevent further erosion.

- **Short to Mid-Term:** Provide shoulder treatment along westbound corridor beginning at approximately mm 0.4 and continuing as needed until the culvert. Reshape and stabilize drainage ditch beginning at mm 0.4 to meet a minimum 2' depth and 2' wide flat bottom with 2:1 side slopes. Add guardrails for both EB and WB shoulders. Extend 20' from culvert on WB side. On EB side begin guardrail at mm 0.45 and continue to approximately mm 0.55.

- **Mid to Long Term:** Replace the 12" CMP driveway culvert under the drive 300' West of Crow Hill Rd. accessing the EB lane of the corridor with a State minimum 15" HDPE culvert, improving conveyance of runoff and minimizing ponding on the traveled corridor. Extend the drainage ditch along the side of the WB lane between mm .5 and .575 to connect existing drainage ditch with existing Stormwater detention pond. Construct minimum 15" HDPE culvert under the dual driveway.

B. Taproot Farm Road and Boutin Road Intersections – mile mark 0.75-1.2

Observation: Throughout this section there are four driveways and two intersections within a ¼ mile distance. In addition to poor visibility caused by an obstructed clear zone and horizontal and vertical reverse curves, there are steep slopes along the traveled lanes in combination with poor drainage and deteriorating shoulders. Overgrown vegetation also reduces driver awareness of these hazards by reducing visibility of potential traffic hazards, as well as masking the steep slopes.

This section of the study corridor also can experience higher speeds than posted speeds in the westbound direction due to an approximately 1.0 mile straight section of road with limited peripheral obstructions resulting in an increased inferred design speed.

Sight distance measurements from intersections, driveways, within this section of corridor, indicated lower than recommended sight distance for the posted speed. Horizontal and vertical curves and overgrown vegetation reduce visibility for both EB and WB traffic. There is a recommended corner clearance of 230' for intersections

providing full access to and from town highways. Tables 5 and 6 below outline the results of the sight distance measurements.

Table 5: *Intersection Sight Distance Summary - Taproot Farm to Boutin Road*

	Recommended Intersection Sight Distance 45 mph	ISD Provided (left turn)	ISD Provided (Right Turn)
Driveway at mm 0.76	500 ft		295 ft
Taproot Farm Rd		425 ft	
Driveway at mm 0.9		340 ft	
Boutin Road			420 ft

Table 6: *Stopping Sight Distance* - Westbound Traffic

	Required Stopping Sight Distance 45 mph	Available Sight Distance
Westbound at mm 1.00	360 ft	320 ft

Adequate design speed for this section of the corridor based on the lowest measured sight distance for the existing roadway conditions is 25 mph.

Eastbound Traffic

Eastbound traffic is warned with a reverse curve sign (W1-4L) before the steep uphill approach towards the driveway intersection and a left curve sign which is subject to blockage from nearby vegetation (W1-2L).

Figure 4: *Reverse Curve Sign*
EB – September 2012

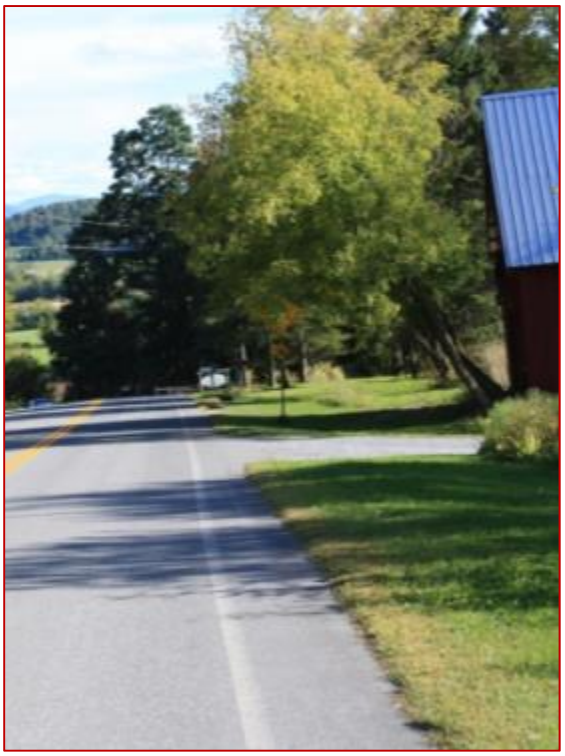

Figure 5: *Left Curve Sign*
EB – September 2012

Westbound Traffic

Westbound traffic is warned of this potentially hazardous stretch of road with a reverse curve sign, which was broken and lying horizontally on the side of the road during the site reconnaissance in February of 2014. Tire tracks leading up to the sign suggested evidence the sign was broken during a crash.

Figure 6: *Fallen reverse curve sign*
WB – February 2014

Figure 7: *View for Westbound traffic approaching Boutin Rd. Intersection WB – September 2012*

There is a recommended minimum spacing of 360' between unsignalized access drives for a town highway with a speed limit of 45 mph. The spacing between all of the driveways and intersections is below this minimum recommendation. The high density of drives and limited spacing contributes to unsafe conditions for through traffic as well as traffic entering from the access drives.

Figure 8: *View for traffic entering from Taproot Farm Rd. Intersection – September 2012*

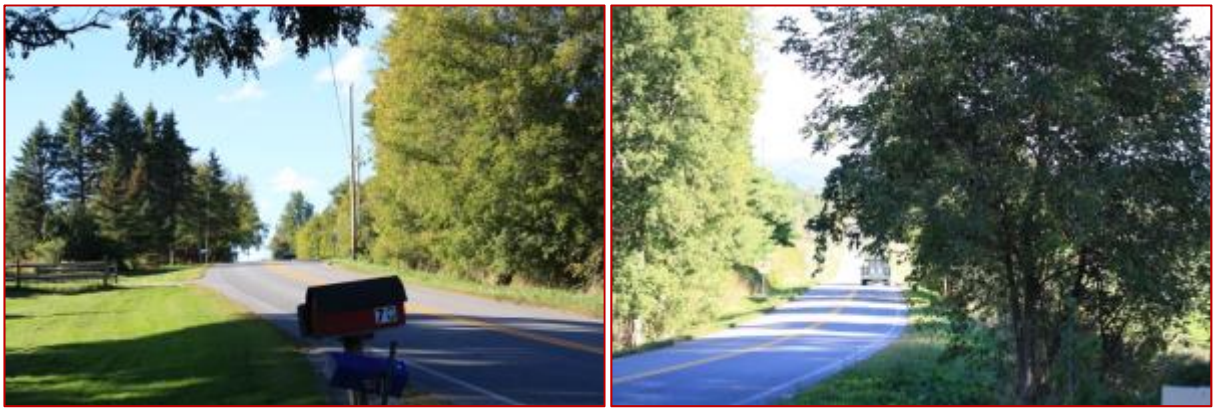

Figure 9: *View for traffic entering from Boutin Rd. Intersection – September 2012*

Figure 10: *View straight section of road for westbound traffic approaching Boutin Rd. EB – February 2014*

Recommendation:

There is a high frequency of crashes through this section of road when compared to state averages. This could correlate to the above mentioned lower than recommended intersection sight distances and lack of advance warning or posted safe curve speed. Recommendations are illustrated in Appendix 4 – Recommendations Map and Appendix 5 – Proposed Sign Inventory.

- **Immediate Action:** Erect 25 mph advisory speed placards (W13-1P) to the existing advance warning signs. See Proposed Sign Map Sheet 1 in Appendix 5. Replace the broken reverse curve warning sign for WB traffic. Clear vegetation that is obstructing the view of signs and sight distance throughout this section of the corridor.

- **Short-Term Action:** Consider lowering speed limit to 35 mph for this stretch of corridor. Erect a reduced speed ahead sign (W3-5/W3-5a) followed by a speed

limit sign (R2-1) in the westbound straight-away approach and the eastbound uphill approach.

Construct guardrail in both eastbound and westbound directions. For eastbound guardrail, begin at the Boutin Rd. intersection and continue for approximately 300' (mm.95 – 1.39). For westbound guardrail construct one section, beginning at mm 0.88 extending approximately 600' to mm 0.99. See Section 5.0 part C.

- **Mid to Long Term:** Apply access management practices to reduce quantity of access drives and consider the relocation of the Boutin Road intersection.

- **Other Considerations:** Undersized culverts and inadequate roadside drainage culvert and swale maintenance mm 0.825-0.9. VT minimum culvert size for road crossing = 18". Existing culvert size mm 1.0 = 15"

C. Culvert maintenance – mm 1.2 – 1.3

Observation: Clogged culvert that could lead to poor drainage and result in unsafe conditions.

Recommendation

- **Short-Term Action:** Clean culvert during routine drainage maintenance.

- **Mid to Long Term:** Construct guardrail as indicated in section 5.0 part C.

D. O'Neil Road Intersection – mm 1.5 – 1.8

Observation*:* Inadequate sight distance for design speed due to vertical curve. Table 7 below compares minimum recommended sight distance to the measured sight distance available.

Table 7: *O'Neil Road Sight Distance*

	Recommended Minimum (45 mph)	Available Sight Distance
Intersection Sight Distance O-Neil Rd	500 ft	385 ft
Stopping Sight Distance Eastbound	360 ft	300 ft

Adequate design speed for this section of the corridor based on the lowest measured sight distance for the existing roadway conditions is 30 mph.

Eastbound sign placement is too close to the intersection (W2-2) minimum distance is 800'; the distance provided is 300'. This section of the study corridor also can potentially experience higher speeds in the eastbound direction due to an approximately 1.0 mile straight section of road with limited peripheral obstructions resulting in an increased inferred design speed.

Figure 11: *View for traffic entering from O'Neil Rd. Intersection – September 2012*

Recommendation:

- **Immediate Action:** Relocate the existing advanced intersection warning sign (W2-2R) 500' West for eastbound traffic. Erect an advanced intersection warning sign (W2-2L) for westbound traffic 800' from the intersection. Add advisory speed placard to intersection warning signs for a speed of 30 mph (W13-1P). See proposed sign map Sheet 2 in Appendix 5– Proposed Sign Inventory.

- **Mid to Long Term:** Relocate the O'Neil Road intersection to the crest of the vertical curve to improve sight distance in both directions. Otherwise, consider lowering speed limit to 35 mph for this stretch of corridor. Adjust all signs as necessary.

E. Culvert and swale maintenance – mm 1.74 – 1.89

Observation: Deteriorating road crossing culvert and multiple clogged driveway culverts. The deteriorating culvert backfill has caused a sinkhole to form and improper bedding for the road crossing culvert has also allowed for settling and road and shoulder deterioration. Steep side slopes also create a potential hazard.

Poor drainage through the undersized and clogged driveway culverts for driveways accessing the corridor on the westbound lane has resulted in ponding on the traveled way. Existing culvert sizes (mm 1.80)= 12", VT minimum = 15". These culverts, draining to the road crossing culvert further east are not properly draining

and the ponding runoff freezes during winter months and create unsafe conditions. Shoulder degradation is also a result of poor drainage through this section of the study corridor. Saturated conditions during freeze-thaw events can disrupt the subbase and result in surface course deterioration. See photos below of ice on road at mm 1.83 to mm 1.85 (WB).

Figure 12: *Deteriorating road crossing culvert (36" HDPE) near O'Neil Rd. February 2014*

Figure 13: *Other drainage observations westbound approach to O'Neil Rd. February 2014*

Recommendation:

- **Immediate Action:** Backfill above 36" HDPE culvert with gravel. Compact backfill, cover with topsoil and stabilize with seed and mulch. Utilize riprap on all slopes exceeding 3:1 to stabilize the headway and prevent further erosion. Clean driveway culverts during routine drainage maintenance. Clear vegetation as indicated in section 5.0 part B.

- **Short-Term Action:** Reshape westbound drainage ditch to improve drainage. Construct guardrail as indicated in section 5.0 part C.

- **Mid to Long Term:** Replace bedding material around 36" HDPE culvert to prevent further settling and deterioration of the surface course. Construct a new concrete headwall to prevent future degradation of the culvert inlet.

F. Vertical and Horizontal Curve with multiple access drives – mm 1.91 to 2.18

Observation: Inadequate sight distance for design speed due to horizontal and vertical curve. Visibility impairments are enhanced for eastbound traffic in the morning hours due to direct sunlight. Signs are difficult to see due to bright background and overgrown vegetation. The vertical and horizontal curve reduces the ability for vehicle operators to identify traffic entering from the driveway access points on both the eastbound and westbound sides. The advanced warning curve sign with advisory speed placard was changed from 30 mph to 35 mph after recommendations from the 2007 safety report by Vermont Local Roads.

Table 8: *Sight Distance Summary – mm 1.91 to 2.18*

	Required Stopping Sight Distance 45 mph	Measured Sight Distance
Eastbound mm 1.94	360 ft	337 ft
Eastbound mm 1.95		275 ft
Westbound mm 1.97		315 ft
Eastbound mm 1.98		305 ft
Westbound mm 2.10		190 ft

Intersection sight distance was also measured at a driveway located at mm 2.16 at 475 ft. Minimum recommended intersection sight distance for 45 mph is 500 ft.

Adequate design speed for this section of the corridor based on the lowest measured sight distance for the existing roadway conditions is 25 mph

In addition to the limited visibility, this section of the study corridor contains narrow shoulders with close proximity to ledge and multiple locations are experiencing shoulder degradation. Poor drainage has eroded the surface course from the shoulder and contributed to degradation of the pavement. An undersized road crossing culvert at mm 2.05 (15" vs VT min. of 18") could be the cause for poor drainage. In the westbound approach towards the horizontal and vertical curves, there is a driveway with no culvert (Driveway #786 WB) which does not drain properly. Ponding occurs which freezes during winter conditions, resulting in unsafe conditions for through traffic. See photos below for documentation of these observations.

This section of the study corridor does not contain adequate signage to warn operators of the unsafe conditions. There is an old, deteriorating hidden drive sign in the eastbound direction.

Figure 14: *Inadequate signage through vertical and horizontal curve. EB – September 2012*

Figure 15: *Inadequate drainage through vertical and horizontal curve*
WB – September 2012(top left), February 2014 (top right, bottom)

Figure 16: *Poor visibility through vertical and horizontal curve and shoulder degradation WB– September 2012*

Figure 17: *Blinding morning sunlight reducing visibility EB – February 2014*

Recommendation:

- **Immediate Action:** Install a culvert under driveway #786 using minimum 15" HDPE to improve drainage and address ponding. Clear vegetation as indicated in section 5.0 part B.

- **Short-Term Action:** Reshape existing drainage ditches for both directions to improve drainage. Consider lowering speed limit to 35 mph for this stretch of corridor. Adjust all signs as appropriate. Advanced warning curve speed limit advisory placards should be reduced to 25mph in both directions. This cannot be achieved without first reducing the speed limit, however based on the observed sight distances, the existing signs indicate an inappropriately high advisory speed for this curve.

- **Mid to Long Term:** Replace existing 15" CMP road culvert with minimum 18" HDPE culvert. Cut back existing bank offset from the WB lane to improve sight distance through the horizontal curve.

G. Vertical and Horizontal Curve with Multiple Access Drives – mm 2.58 – 2.78

Observation*:* Inadequate sight distance for design speed due to horizontal and vertical curve. This section of the study corridor has a posted speed limit of 35 mph beginning at mm 2.78 in the eastbound direction.

Table 9: *Stopping Sight Distance* - Westbound Traffic

	Required Stopping Sight Distance 35 mph	Available Sight Distance
Westbound at mm 2.71	250 ft	239 ft
Westbound at mm 2.73		247 ft

Adequate design speed for this section of the corridor based on the lowest measured sight distance for the existing roadway conditions is 30 mph

In addition to poor visibility, this section of the study corridor has very narrow shoulders and poor drainage. Inadequate drainage has resulted in scouring contributing to the degradation of the shoulder surface course. There is also a steep bank in the shoulder of the westbound bank that is at risk of erosion and reduces visibility. Steep side slopes drop off from the shoulder for eastbound traffic increasing the consequence of off-road crashes.

Figure 18: *Low sign visibility and steep side slopes. EB – September 2012*

Figure 19: *Low sign visibility and shoulder degradation. WB – September 2012*

Recommendation:

- **Immediate Action:** Clear vegetation as indicated in section 5.0 part B.
- **Short-Term Action:** Advanced warning curve speed limit advisory placards should be reduced to 30 mph in both directions. Reshape existing drainage ditches for westbound shoulder to improve drainage
- **Mid to Long Term:** Cut back existing bank offset from the WB lane to improve sight distance through the horizontal curve. Install guardrail as indicated in section5.0 part C.

4.0 Recommended Improvements: Entire Corridor

The Federal Highway Administration issued a *Guidance Memorandum on Promoting the Implementation of Proven Safety Countermeasures* in January of 2012. This

guidance takes into consideration the latest research on measures intended to improve safety. The *Guidance Memorandum* lists nine different safety countermeasures, two of which could be applied on Shelburne Falls Road, including the following:

A. Longitudinal Rumble Strips and Stripes on Two-Lane Roads

Rumble strips are grooved patterns on the roadway, sometimes incorporated into the striping, that provide both an audible warning and a physical vibration to alert drivers that their vehicle is leaving its lane. They can be incorporated into centerline and/or edge line striping to increase nighttime visibility of the pavement marking. Shoulder or edge line rumble strips significantly reduce run-off-road (ROR) crashes. Centerline rumble strips reduce cross center line crashes such as head-on collisions. Similarly, maintaining the fog line (edge line) striping on rural roadways has been shown to help drivers confine their traveling path, especially at night, but has little or no effect on operating speeds.

Figure 20: *Centerline Rumble Strip*

Observation: Inattentive and inexperienced drivers frequently use this corridor, which can lead to vehicles inadvertently crossing the center line and lead to serious head on collisions.

Recommendation:

- **Immediate Action: No immediate action recommended.**

- **Short to Mid Term:** Install continuous, milled center line rumble stripes are recommended for the length of Shelburne Falls Road. Instances of noise complaints by adjacent property owners have been documented, so public input is essential prior to this form of installment.

B. Fog Lines and Safey Edges$_{SM}$

Fog lines are the traditional single continuous white line to demarcate the edge of a travelled way. Safety Edge is a technology that shapes the edge of a newly paved roadway at approximately

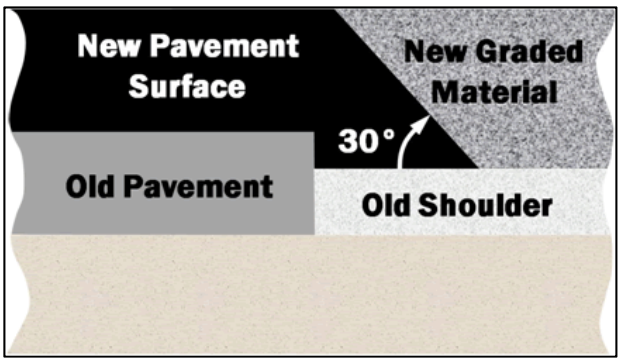

Figure 21: *Safety Edge Illustration*

30 degrees from the horizontal surface. Providing an edge treatment at this angle eliminates tire scrubbing when a vehicle leaves the roadway, which can cause loss of vehicle control. A vertical pavement edge can contribute to an increased frequency of roll-over, and research shows that crashes involving edge drop-offs are more likely to cause fatality.

Observation: Inattentive and inexperienced drivers frequently use this corridor, which can lead to vehicles inadvertently drifting into the shoulder and losing control of the vehicle leading to serious collisions with fixed obstacles within the right of way.

Recommendation:

- **Immediate Action:** Install fog lines on the edges of Shelburne Hinesburg Road. Maintain at least a 10' travel lane width from centerline.

- **Short to Mid Term:** It is recommended that the Safety Edge treatment be provided for future re-paving on Shelburne Falls Road (and other local roads). This is a treatment that the Agency of Transportation is now requiring on their paving projects.

5.0 Miscellaneous Minor Improvements: Specific Areas Throughout Corridor

A. Remove/Replace Utility Poles

There is a recommended clear zone of 30' offset from the edge of traveled lane for rural roads with a speed limit of 45 mph or greater. There were two utility poles located within 3' of the edge of road that can be removed for improved safety.

1. **mm 0.07 Westbound**
2. **mm 1.36 Westbound - #31507**

B. Vegetation Removal

Below is a summary of locations where overhanging vegetation was observed to be reducing visibility.

1. **mm 0.04 to mm 0.31 – Westbound**
2. **mm 0.74 to mm 0.80 – Westbound**
3. **mm 0.87 – Curve Warning Sign – Eastbound**
4. **mm 0.91 to 0.94 – Westbound**
5. **mm 0.97 to 0.99 – Westbound**

6. **mm 1.01 – 45 mph Speed Limit Sign – Eastbound**
7. **mm 1.63 to mm 1.73 – O'Neil Road Intersection – Eastbound**
8. **mm 1.86 – 35 mph Curve Warning Sign – Eastbound**
9. **mm 1.98 to mm 2.01 – Chevron Signs – Eastbound**
10. **mm 2.05 to mm 2.08 – Eastbound/Westbound**
11. **mm 2.15 – driveway (#786) – Westbound**
12. **mm 2.63 to mm 2.71 – Curve – Eastbound/Westbound**

C. Longitudinal Roadside Barrier (Guardrail)

Measurements indicated multiple areas exceed the minimum recommended slope for consideration of longitudinal roadside barriers. It is recommended that guardrail be installed in these deficient locations. See also Appendix 4 – Recommendations Map.

1. **mm 0.48 – Culvert – 2:1 Slopes**
   a. **mm 0.47 to mm 0.49 – 6' Vertical – Westbound**
   b. **mm 0.46 to mm 0.49 – 4.5' Vertical – Eastbound**
2. **mm 0.90 to mm 0.95 – 3:1 Slopes – Westbound**
3. **mm 0.97 to mm 1.01 – 2:1 Slopes – Eastbound**
4. **mm 1.34 to mm 1.40 – 3:1 Slopes – Westbound**
5. **mm 1.43 to mm 1.46 – 3:1 Slopes – Eastbound**
6. **mm 1.76 – Culvert – 2:1 Slopes**
   a. **mm 1.76 to mm 1.77 – Eastbound/ Westbound**
7. **mm 2.31 – Box Culvert – Vertical Drop**
   a. **mm 2.29 to mm 2.33 – Eastbound/Westbound**
8. **mm 2.61 to mm 2.74 – 3:1 Slopes – Eastbound**

D. Shoulder Treatment

The following areas were identified as shorter sections of roadway not related to curves or intersections that could benefit from shoulder treatment. These areas are identified on the Recommendations Map located in Appendix 4.

1. **mm 0.61 to mm 0.63 – Westbound**
2. **mm 2.06 to mm 2.14 – Westbound**
3. **mm 2.52 to mm 2.54 – Westbound**
4. **mm 2.61 to mm 2.73 – Westbound**

6.0 Conclusion

Shelburne Falls Road has a history crashes due to excessive speeds and limited visibility on curves. Due to the presence of Chittenden Valley Union High School in Hinesburg, this route is frequently used by inexperienced student drivers. An audit of roadway conditions has identified a number of specific and corridor wide areas where implementation safety measures could improve traffic safety and help to minimize crashes. These measures involve improved advanced warning signage at curve locations, posting advisory speeds, installation of guardrail where warranted, implementing shoulder and centerline treatments, and maintaining or improving pavement striping and intersection alignments. **Appendix 6 - Improvement Matrix** summarizes the safety issue identified, short and long term recommendations for improvement, as well as preliminary cost figures for each item. The Hinesburg Selectboard should review and evaluate whether these improvements can be budgeted and implemented in future years.

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Project Location

Legend

- Mile Mark
- Speed Count Station
- Town Boundary
- Stream

Notes

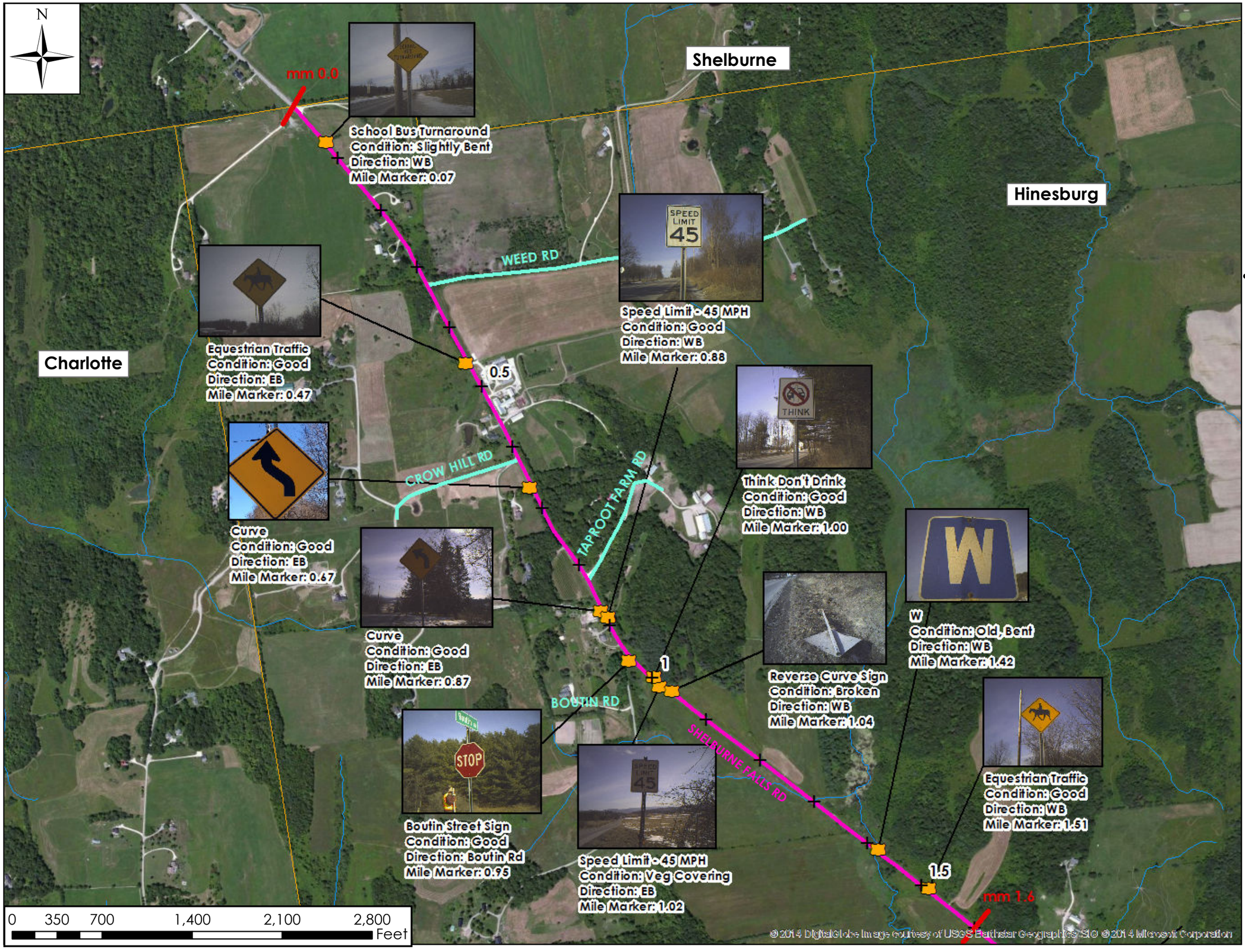
Sources: Bing aerial photography (2012); Streams by ANR (2012); Mile Mark by TCE (2014); Speed Count Station by TCE (2014).

Disclaimer: The accuracy of information presented is determined by its sources.TCE is not responsible for any errors or omissions that may exist. Questions of on-the-ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not a replacement for surveyed information or engineering studies.

Shelburne Falls Road
Hinesburg, VT

Overall Map

Project: 12-005
Prepared By: LMJ
09/17/2014
1 inch = 900 feet



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Project Location

Legend

- Mile Mark
- Signs
- Shelburne Falls Road
- Intersecting Roads
- Stream

Notes

Sources: Bing aerial photography (2012); Streams by ANR (2012); Signs by TCE (2014); Shelburne-Hinesburg Road by TCE (2014); Intersecting Roads by TCE (2014); Mile Mark by TCE (2014).

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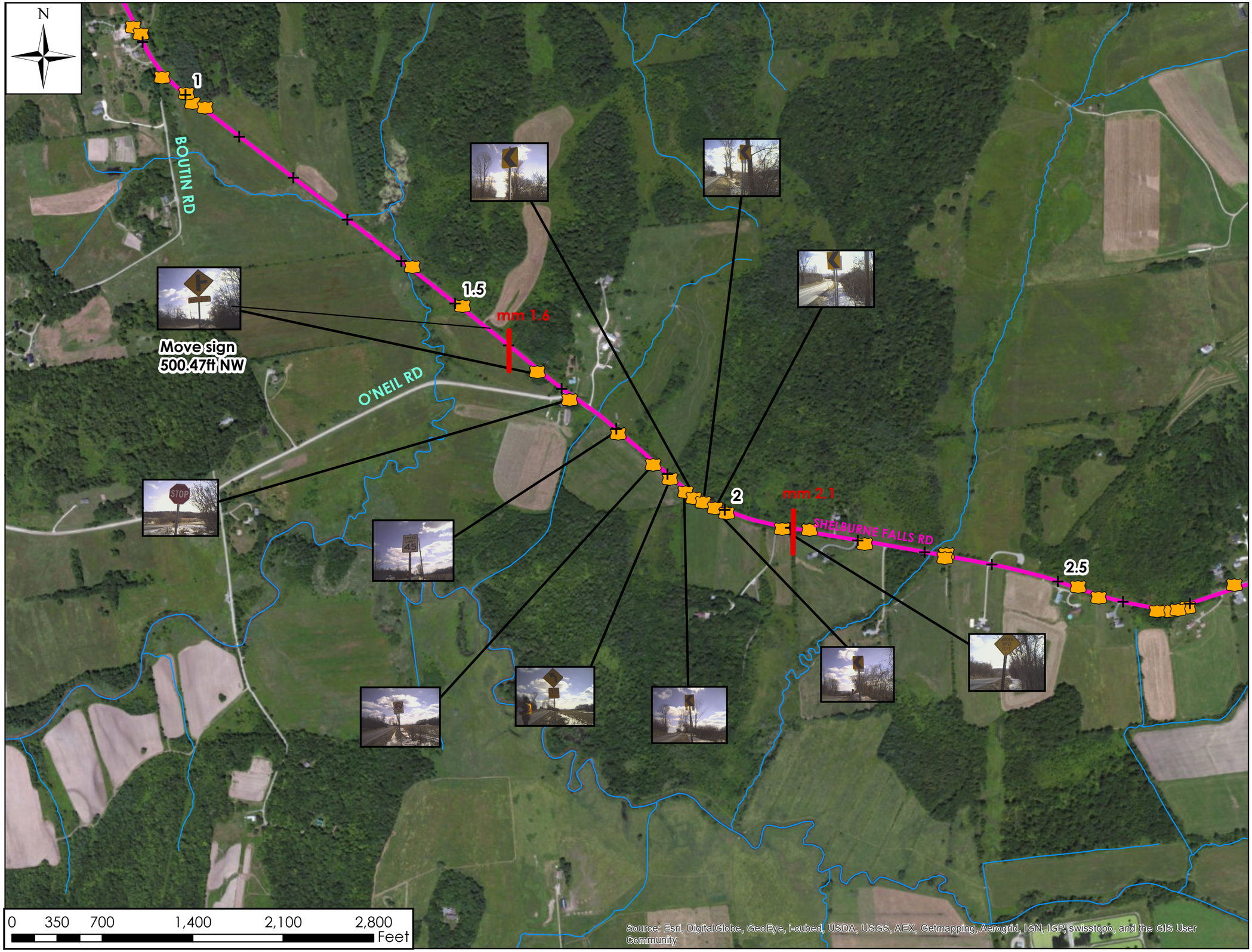
Shelburne Falls Road
Hinesburg, VT

Sign Inventory #1 of 3
mm 0.0 to 1.6

Project: 2012005
Prepared By: LMJ
09/17/2014
1 inch = 700 feet



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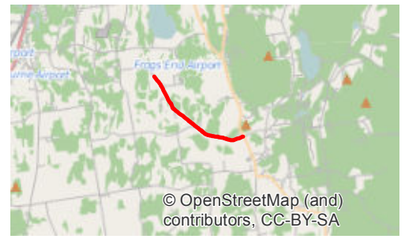
Project Location



Legend

- Mile Mark
- Signs
- Shelburne Falls Road
- Intersecting Roads
- Stream

Notes

Sources: Bing aerial photography (2012); Streams by ANR (2012); Signs by TCE (2014); Shelburne-Hinesburg Road by TCE (2014).

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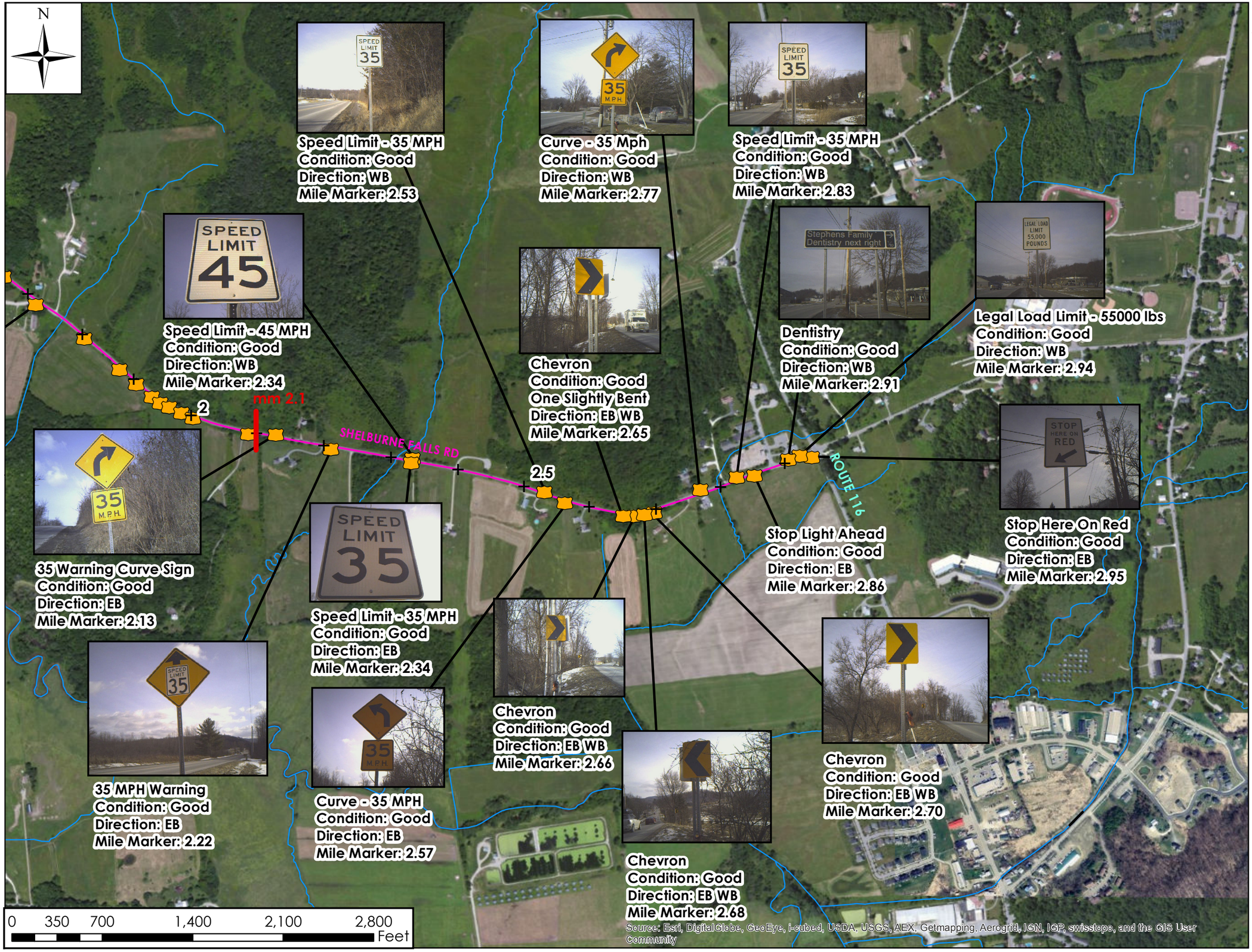
Shelburne Falls Road
Hinesburg, VT

Proposed
Sign Inventory #2 of 3
mm 1.6 to 2.1

Project: 12-005
Prepared By: LMJ
09/17/2014
1 inch = 700 feet



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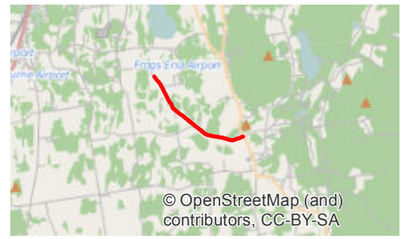
Project Location



Legend

- Mile Mark
- Signs
- Intersecting Roads
- Shelburne Falls Road
- Stream

Notes

Sources: Bing aerial photography (2012); Streams by ANR (2012); Signs by TCE (2014); Shelburne-Hinesburg Road by TCE (2014).

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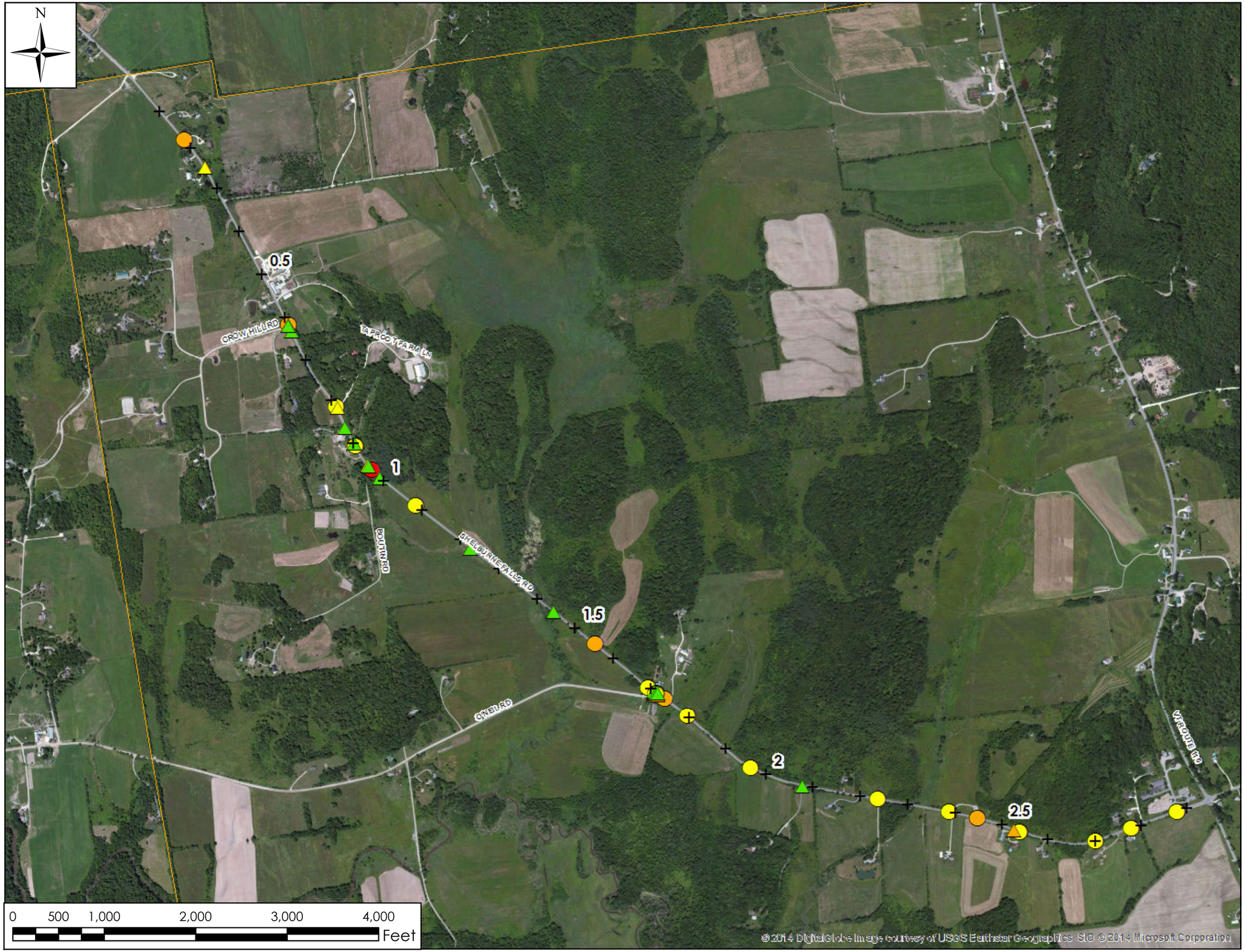
Shelburne Falls Road
Hinesburg, VT

Sign Inventory #3 of 3
mm 2.1 to Rt. 116

Project: 12-005
Prepared By: LMJ
09/17/2014
1 inch = 700 feet



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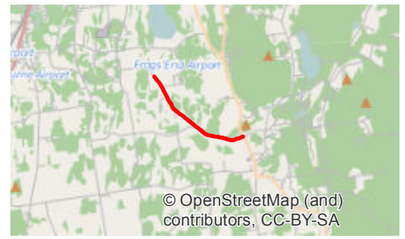
Project Location



Legend

- Mile Mark

Crash Site (Police Data)

- Fatality
- Injury
- Property
- Vehicle

Crash Site (State Data)

- Fatality
- Injury
- Property/Vehicle

Notes

Sources: Bing Aerial Photography (2012);
Crash Sites (Police Data) based on Police Records.
Crash Sites (State Data) based on shapefile from State of Vermont. Due to discrepancies in the two datasets, some duplicates or errors in exact location may exist. Any obvious duplicates were removed from Police Data.

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Shelburne Falls Road
Hinesburg, VT

Crash Map

Project: 12-005
Prepared By: LMJ
09/17/2014
1 inch = 1000 feet

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Project Location

Legend

- Remove/Replace Utility Pole
- Shoulder Treatment
- Guardrail
- Vegetation Removal
- Mile Mark
- Town Boundary
- Stream

Notes

Sources: Bing aerial photography (2012); Streams by ANR (2012); Utility Pole, Shoulder Treatment, Guardrail, Vegetation Removal and Existing Signs by TCE (2014); Mile Mark by TCE (2014).

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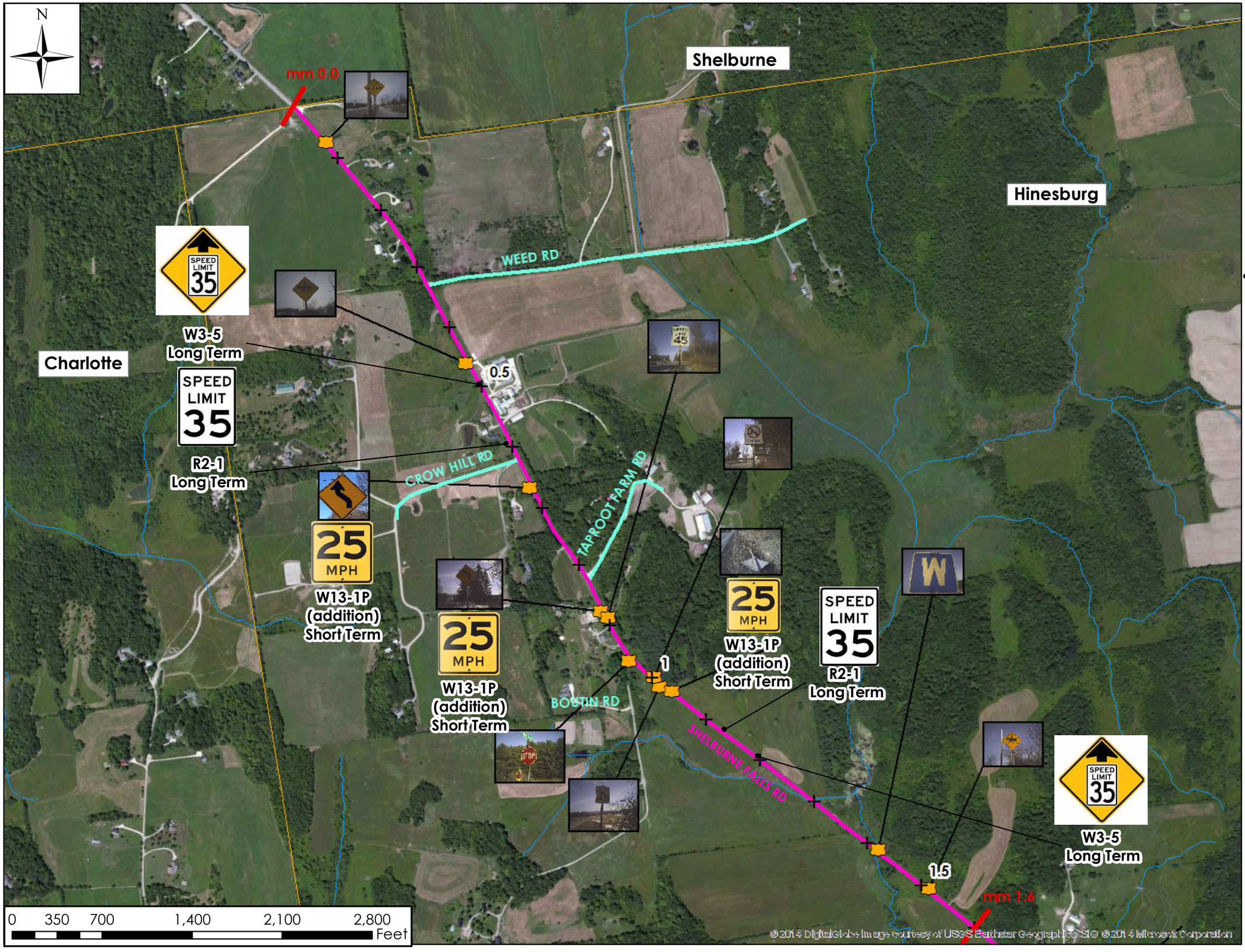
Shelburne Falls Road
Hinesburg, VT

Recommendations Map

Project: 12-005
Prepared By: LMJ
09/17/2014
1 inch = 900 feet



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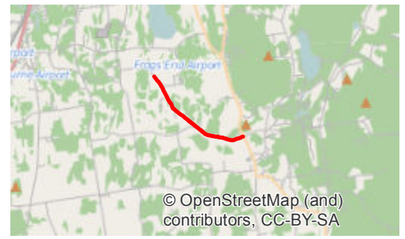
Project Location



Legend

- Mile Mark
- Signs
- Shelburne Falls Road
- Intersecting Roads
- Stream

Notes

Sources: Bing aerial photography (2012); Streams by ANR (2012); Signs by TCE (2014); Shelburne-Hinesburg Road by TCE (2014); Intersecting Roads by TCE (2014); Mile Mark by TCE (2014).

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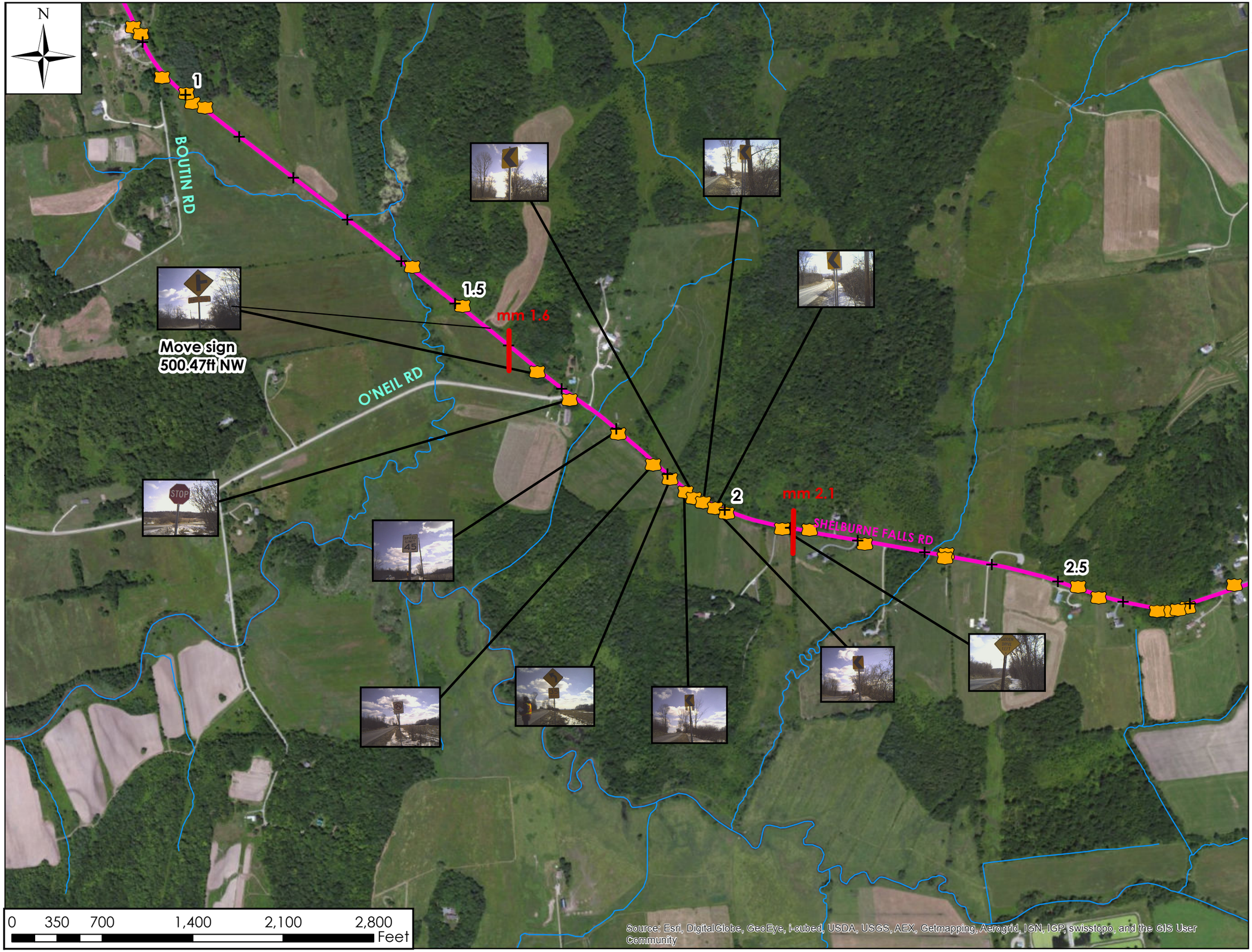
Shelburne Falls Road
Hinesburg, VT

Proposed
Sign Inventory #1 of 3
mm 0.0 to 1.6

Project: 12-005
Prepared By: LMJ
09/17/2014
1 inch = 700 feet



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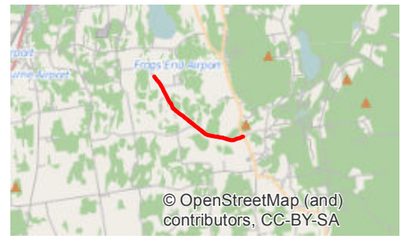
Project Location



Legend

- Mile Mark
- Signs
- Shelburne Falls Road
- Intersecting Roads
- Stream

Notes

Sources: Bing aerial photography (2012); Streams by ANR (2012); Signs by TCE (2014); Shelburne-Hinesburg Road by TCE (2014).

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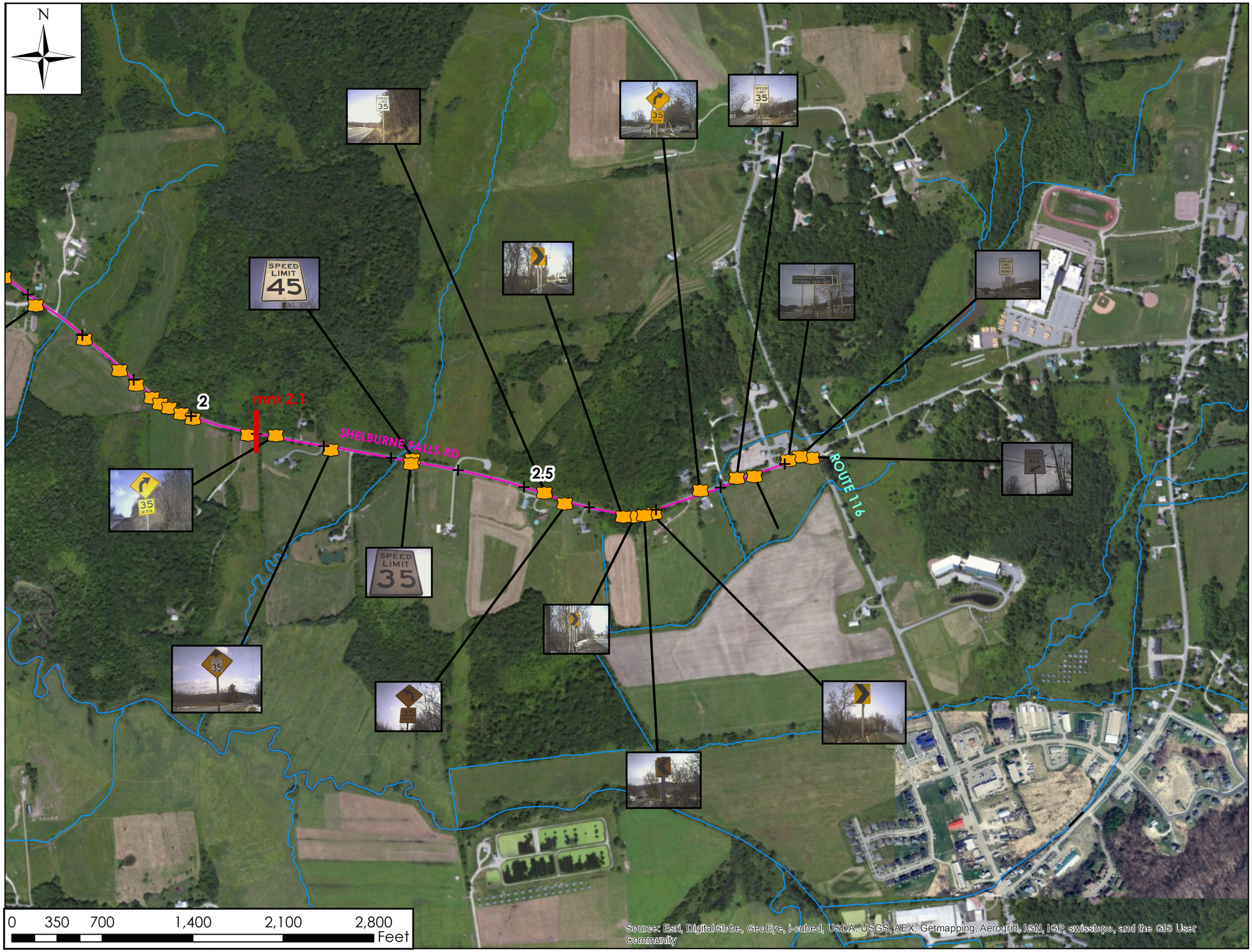
Shelburne Falls Road
Hinesburg, VT

Proposed
Sign Inventory #2 of 3
mm 1.6 to 2.1

Project: 12-005
Prepared By: LMJ
09/17/2014
1 inch = 700 feet



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Project Location

Legend

- Mile Mark
- Signs
- Intersecting Roads
- Shelburne Falls Road
- Stream

Notes

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Shelburne Falls Road
Hinesburg, VT

Proposed
Sign Inventory #3 of 3
mm 2.1 to Rt. 116

Project: 12-005
Prepared By: LMJ
09/17/2014
1 inch = 700 feet

Location (mile marker)	Observation	Short Term	Long Term
Near Red Wagon Plants 0.47-0.49	Culvert maintenance	Backfill above culvert with gravel backfill and stabilize headwall with riprap.	
Near Red Wagon Plants 0.40-0.47 EB, 0.50-057 WB	Swale maintenance		Reshape roadside swale to provide a min. depth of 2' and a min. flat bottom width of 2' with min. 2:1 side slopes.
HC and VC near Taproot Farm Rd. and Boutin Rd. Intersections 0.75-1.2	Inadequate signage, excessive speeds	Erect advisory speed placards (W13-1P) to the existing advance warning signs for a reduced speed of 25mph.	Erect a reduced speed ahead sign (W3-5/W3-5a) followed by a speed limit sign (R2-1) in both the WB and EB approach. Lower speed limit to 35 mph.
HC and VC near Taproot Farm Rd. and Boutin Rd. Intersections 0.75-1.2	Poor visibility and high driveway density	Remove access drives using access management	Relocation of Boutin Rd. Intersection
1.2-1.3	Culvert maintenance	Clean culvert	
HC and VC near O'Neil Rd. Intersection 1.5-1.8	Inadequate signage, poor visibility, excessive speeds	Relocate the existing sign (W2-2R) 500' West for EB traffic. Erect an advanced intersection warning sign (W2-2L) for WB traffic 800' from the intersection. Add 30 mph placards to the intersection warning signs (W13-1P)	Relocate the O'Neil Road intersection to the crest of the vertical curve. Lower speed limit to 35 mph.
1.74-1.89	Culvert and swale maintenance	Backfill above culvert with gravel backfill and stabilize headwall with riprap. Clean driveway culverts	Reshape WB roadside swale to provide a min. depth of 2' and a min. flat bottom width of 2' with min. 2:1 side slopes. Replace bedding material around the culvert, and construct a new concrete headwall.
VC and HC with multiple access drives 1.91-2.18	Inadequate signage, poor visibility	Reduce speed of existing placards to 25 mph (W13-1P).	Lower speed limit to 35 mph.
VC and HC with multiple access drives 1.91-2.18	Drainage improvements	Install a 15" HDPE driveway culvert for existing driveway #786.	Reshape EB & WB roadside swale to provide a min. depth of 2' and a min. flat bottom width of 2' with min. 2:1 side slopes.
VC and HC with multiple access drives	Inadequate signage, poor visibility	Reduce speed of existing placards to 30 mph (W13-1P).	Cut back existing bank offset from the WB lane to improve sight distance through the

2.58-2.78			horizontal curve.
Remove/Replace Utility Poles			
Entire Road in Hinesburg, both sides (see report)	Overgrown vegetation	Clear vegetation	
Entire Road in Hinesburg, both sides (see report)	Shoulder degradation		Shoulder treatment
Entire Road in Hinesburg, both sides (see report)	Steep side slopes		Guardrail
Entire Road in Hinesburg, both sides (see report)	Runoff/inattention		Rumble Strips