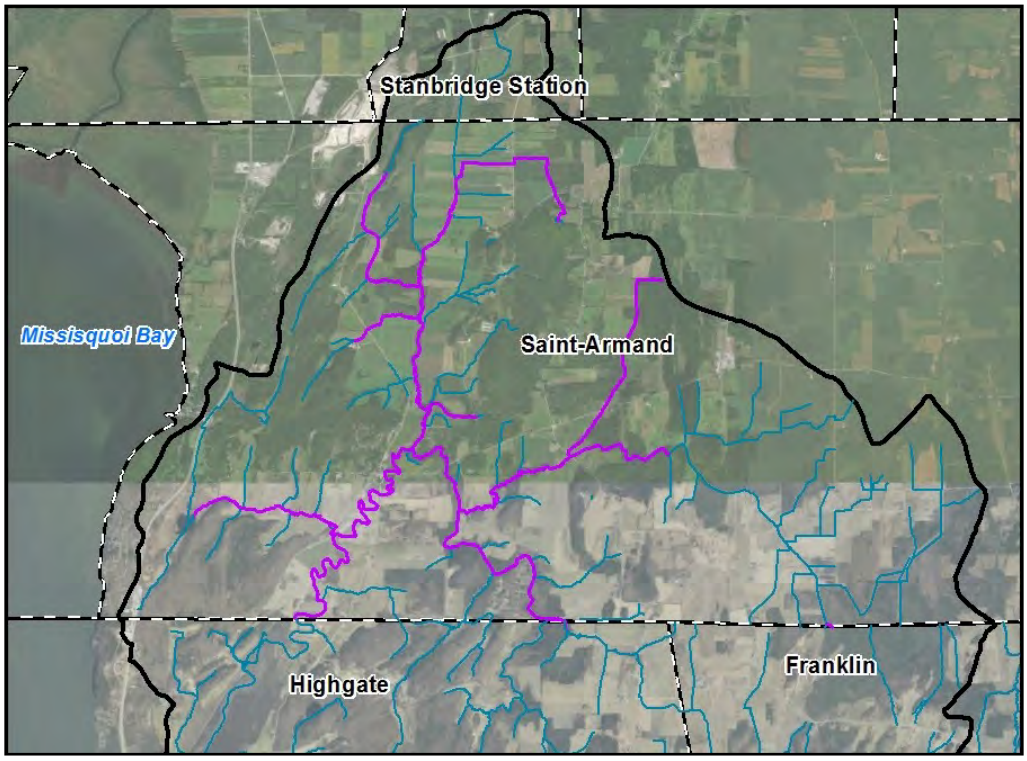
Québec Portion of the Rock River Watershed:
Phase 1 Stream Geomorphic Assessment Report

March 13, 2020



Prepared by:

Fitzgerald Environmental Associates, LLC.
18 Severance Green, Suite 203
Colchester, VT 05446

Fitzgerald Environmental Associates, LLC.
Applied Watershed Science & Ecology

Prepared under contract to:

Lake Champlain Basin Program
54 West Shore Road
Grand Isle, VT 05458

Lake Champlain Basin Program

List of Figures

List of Tables

Executive Summary

The Rock River is an important drainage within the Missisquoi Bay watershed spanning the Vermont/Québec border. Numerous river assessments have been completed within the Missisquoi and Rock River watersheds utilizing the science of fluvial geomorphology to increase our understanding of the process of streams' geomorphic evolution. Stream geomorphic assessments (SGA) were completed on 27 kilometers of the Vermont portion of the watershed in 2007. Several river segments in Québec have also been assessed following similar protocols. Fitzgerald Environmental Associates, LLC (FEA) was hired by the Lake Champlain Basin Program (LCBP) in 2019 to complete a Phase 1 SGA study for the Québec portion of the Rock River watershed and to complete a Phase 2 SGA study for entire watershed (Québec and Vermont). This report will describe the Phase 1 study, incorporating the Québec portion of the watershed into the Vermont Stream Geomorphic Assessment methodology. The next step of the project will be to complete Phase 2 assessments on the prioritized reaches identified in this report, and to re-assess the Phase 2 reaches in Vermont (previously completed in 2007).

Water quality is the primary concern within the Rock River and the greater Missisquoi Bay watershed. The watershed is dominated by agricultural land uses and is known to contribute high loading of P into Lake Champlain (USEPA, 2016). The Missisquoi Bay watershed is a critical focus area for water quality improvement work in the Lake Champlain Basin. The Bay's watershed, which includes the Rock River watershed, has been the subject of several studies and mitigation projects to reduce P loading and improve water quality. The Lake Champlain Basin Program's (LCBP) Opportunities for Action lists the Missisquoi Bay watershed as a focus area for 1) better understanding nutrient loading to the Bay by assisting partners in monitoring and assessment work; 2) supporting partners in the protection of riparian areas in the Bay; and 3) facilitating education and outreach among partners in the Missisquoi River watershed (LCBP, 2017).

The Vermont Stream Geomorphic Assessment (SGA) Protocols provide sound and scientifically defensible methods for identifying stressors on channel stability (VTANR, 2010). Restoration projects identified during these assessments present important opportunities to improve water quality, geomorphic stability, and stream habitat features. The Phase 1 SGA approach generates watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), providing a basis for understanding the natural and human-impacted conditions within the watershed. The Phase 1 assessment ultimately helps to guide planners in selecting reaches for more detailed field analysis. The objectives of the Phase 1 study are described below.

1) Develop baseline watershed and reach-scale data for the study reaches.
2) Identify river reaches where more detailed field data collection (i.e., Phase 2 SGA) is needed.
3) Develop a basis for understanding the overall causes of channel instability, flood/erosion hazards, and habitat degradation along the river corridor in the watershed.

Below is a summary of key findings from the Phase 1 SGA study on the Rock River:

- A total of 36 reaches along 42.8 river kilometers in Québec were delineated during the Phase 1 analysis. Full Phase 1 data and windshield survey data was collected by FEA for the Québec portion of the Rock River, three (3) tributary watersheds, and 4 (four) sub-tributary watersheds.

- The Phase 1 SGA approach resulted in watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), providing a basis for understanding the natural and human-impacted conditions within the watershed. The Phase 1 data will also aid in future identification of specific stressors affecting the physical conditions of the stream channels and structures (e.g., bridges and culverts, bank armoring, etc.).
- Approximately 20% of the assessed reaches (8 reaches) are found in a confined valley setting that would normally support sediment transport channels with A or B-type geometry. The remaining 28 reaches are found in an unconfined valley setting with meandering, depositional, C or E-type channel geometry (Rosgen 1994).
- Over 50% of the land cover within the study watersheds is mapped as agricultural with forested lands representing approximately 40%. Developed lands and wetlands and other surface waters are typically 1-2% of the land cover within the study watersheds.
- Impact ratings were developed for each reach using the Phase 1 parameters representing four classes of watershed and reach-scale impacts: 1) Land Cover and Reach Hydrology; 2) Channel Modifications; 3) Floodplain Modifications and Planform Changes; 4) Bed and Bank Conditions.
- Based on the Phase 1 impact ratings, a total of 27 high priority reaches in Québec are recommended for Phase 2 assessment. In addition, 19 previously assessed Phase 2 reaches/segments in Vermont will be re-assessed to provide an up-to-date and complete assessment of the watershed. The selected reaches have a total channel length of approximately 39 miles (63 kilometers).

1.0 Project Background

In 2018 the Lake Champlain Basin Program (LCBP) identified reaches within the Rock River watershed in Québec for assessment of fluvial geomorphic conditions. The Rock River is an important drainage within the Missisquoi Bay watershed and is known to produce a disproportionately high load of phosphorus (P). Numerous river assessments have been completed within the Missisquoi and Rock River watersheds utilizing the science of fluvial geomorphology to increase our understanding of the process of streams' geomorphic evolution. Geomorphic assessments were completed on 27 kilometers of the Vermont portion of the watershed in 2007. Several river segments in Québec have also been assessed following similar protocols. Fitzgerald Environmental Associates, LLC. (FEA) was retained by LCBP in 2018 to complete Phase 1 assessments of the Québec portion of the watershed and Phase 2 assessments of select reaches within Vermont and Québec. These assessments will follow the Phase 1 and Phase 2 SGA protocols developed by VTDEC (VTDEC 2009).

Watershed restoration projects are most successful when carried out within a context for understanding how reach and watershed-scale stressors cause channel instability. The VTDEC SGA Protocols and River Corridor Planning Guide provides sound, scientifically defensible methods for identifying stressors on channel stability and restoration projects that will address them appropriately (VTANR, 2010). The overall goal of the VTDEC Rivers Program is to "manage toward, protect, and restore the fluvial geomorphic equilibrium condition of Vermont rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner," (VTANR, 2010) achieved through:

- Fluvial erosion hazard mitigation;
- Sediment and nutrient load reduction; and
- Aquatic and riparian protection and restoration

The Phase 1 SGA approach results in watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), providing a basis for understanding the natural and human-impacted conditions within the watershed. The SGA data also aids in the identification of specific stressors affecting the physical conditions of the stream channels and structures (e.g., bridges and culverts).

FEA used the Stream Geomorphic Assessment Tool (SGAT) to develop the baseline GIS data for the watershed in 2019. A total of 36 reaches along 27 river miles (43.2 kilometers) in Québec were assessed during the Phase 1 analysis. Full Phase 1 data, FIT, and windshield survey data were collected by FEA for the Rock River, three (3) tributaries, and four (4) sub-tributaries.

2.0 Watershed Background

2.1 Geographic Setting and Land Use History

The Rock River watershed is located in the Champlain Valley in northwestern Vermont and southern Québec (Figure 1). The headwaters of the Rock River watershed are in Vermont in the towns of Highgate and Franklin (Franklin County). From its headwaters in Vermont, the Rock River travels west and north to cross the border approximately 3.75 mi east of Lake Champlain (Missisquoi Bay). It then runs through Canada for several miles receiving waters from multiple tributaries before turning south to re-enter the

USA approximately 1.6 mi east of Lake Champlain. It eventually discharges into Missisquoi Bay 1.8 mi south of the border.

The total watershed area of the Rock River is approximately 56.5 square miles. Of that, the portion that includes the river's headwaters in Vermont and its main stem before it crosses the border for the first time amounts to approximately 24.3 square miles. The watershed area from the main stem portion within Canada is approximately 26.1 square miles and encompasses areas in both the USA and Canada, but mostly in Canada. Another 6.1 square miles in the USA contributes to the total watershed area after the river crosses the border for the second time and re-enters the USA.

This report covers the Canadian portion of the Rock River (Riviere de la Roche) watershed (Figure 2). Within Canada, the watershed is basically defined by the main stem of the Rock River (QM.01-QM.06) with a total channel length of 6.5 mi (from the USA-Canada border), a tributary called Brandy Brook (Ruisseau Brandy) entering the main stem from the east at mile 4.6 (QT3.01-QT3.09 and 1 sub tributary), another tributary called Swennen Brook (Ruisseau Swennen) entering from the north at mile 3.7 (QT2.01-QT2.07 and 3 sub tributaries), and one final tributary called Menes Brook (Ruisseau aux Menes) entering from the west at mile 1.7 (QT1.01-QT1.03).

Land cover data for land within Canada are summarized in Table 1. The Rock River drains rural watersheds, with agricultural land usually representing the dominant cover type. Agricultural land is broadly distributed across the subwatersheds, with an aggregation around waterways and their flood plains, active or inactive. Agricultural land cover ranges from 28 to 61 % in the different sub watersheds which is high. The second most dominant land cover is forest, ranging from 36 to 59%. There is limited developed land within the subwatersheds ranging from 0 to 7%. The town of Philipsburg on Missisquoi Bay, accounts for the higher percentage for the Menes Brook sub watershed. The town of St Armand similarly contributes towards the percentage of developed land for the Rock River main stem sub watershed. The headwaters of the Menes Brook originate in a wetland system which includes "Streit" pond. This watershed is relatively less farmed compared to the other watersheds, due to the previously mentioned wetland system and more expansive non-prime soils which have remained forested (stony soils in till).

Table 1: Percent Land Cover for Rock River watershed and tributaries.

Watershed	Drainage Area (mi^2) Total / Canada only	Agriculture	Development	Forest	Wetland
Brandy Brook*	9.4 / 8.0	51%	1%	46%	2%
Swennen Brook*	6.8 / 6.8	57%	0%	43%	0%
Menes Brook	2.5 / 2.4	28%	7%	59%	7%
Rock River Main Stem	7.3 / 3.3	61%	3%	36%	0%

*Land cover data for tributaries are included.

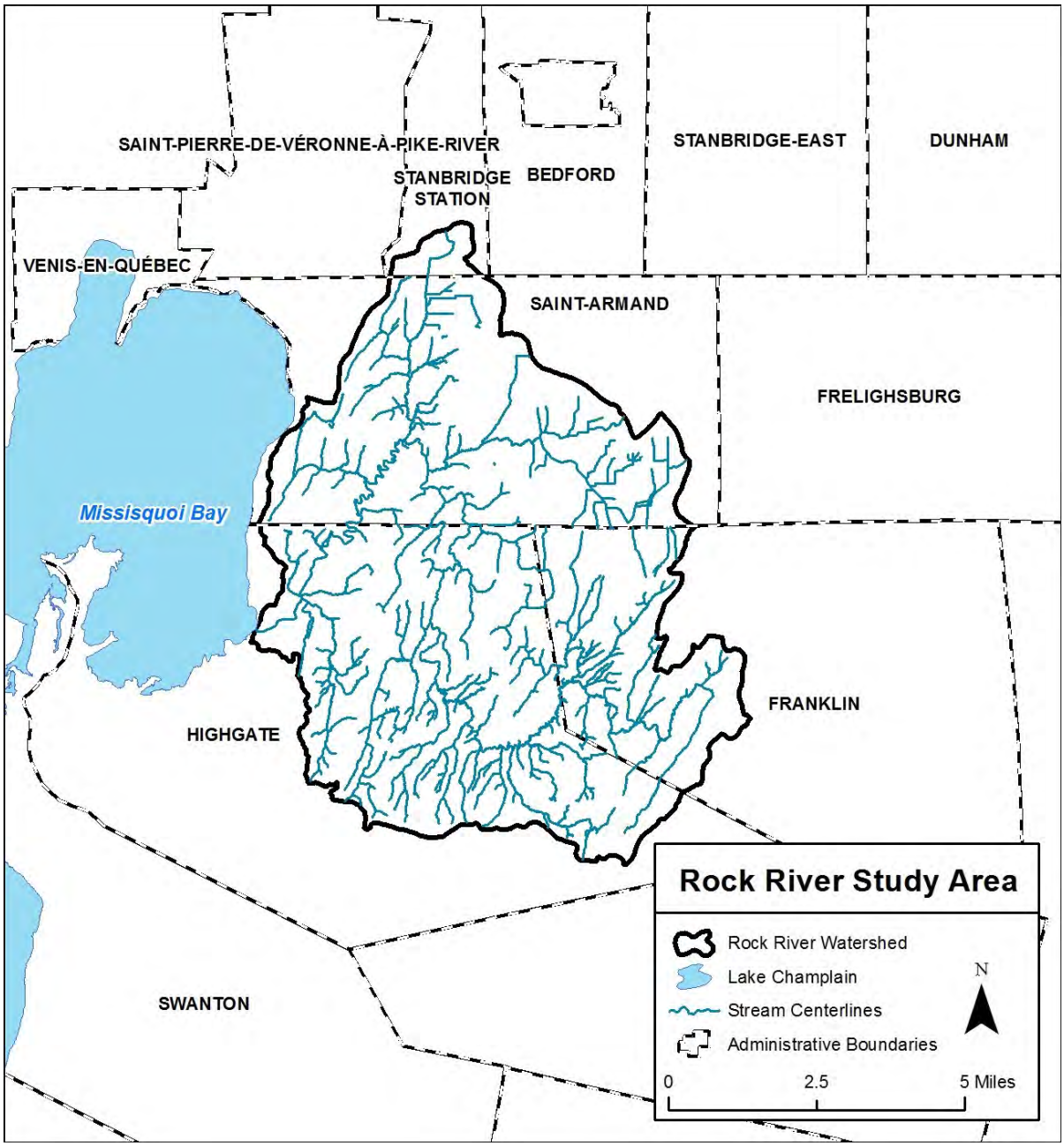


Figure 1: Location map for the Rock River watershed.

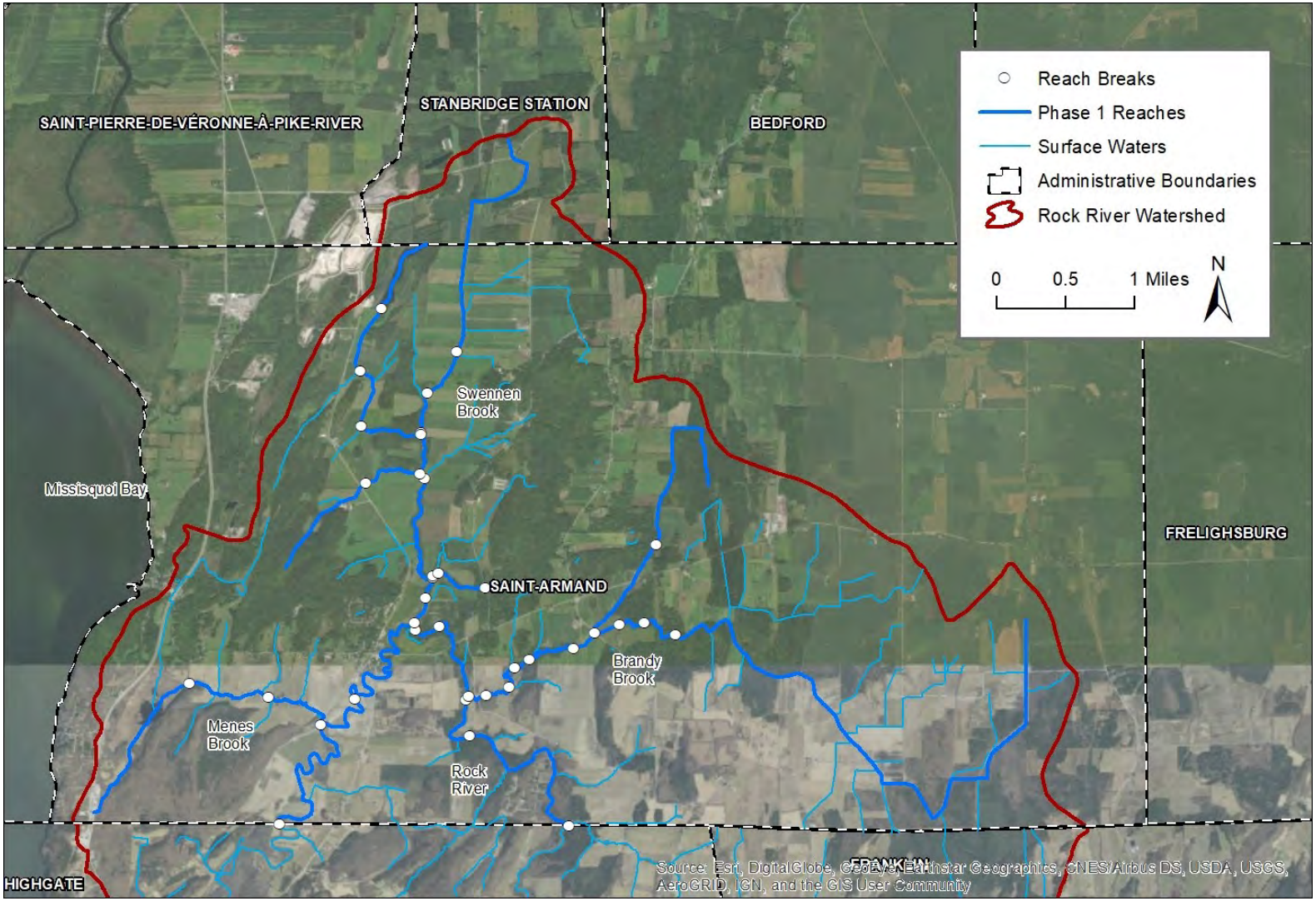


Figure 2: Phase 1 study reaches in Québec.

Historical Land Uses

The Champlain valley has a long history of human settlement, starting with native American people and later with European settlers in the late 18th century. Because of its rich, relatively stone free soils in many areas and its warmer climate, the area has been farmed almost continuously for almost two centuries. The original pre-settlement forests were cleared, and crops planted. Today, agriculture is still a dominant land use in the Champlain valley, especially within the Rock River watershed in both Québec and Vermont.

2.2 Geologic and Geomorphic Setting

Geologic Setting

The geology of the Rock River watershed is typical to that of the Champlain valley. It includes rocks dating back to the pre-Cambrian, Cambrian and Ordovician periods. Some of these rocks are carbonate rich such as limestones, dolomites and marbles, others less so such as shales, slates and schists. The landforms of the Champlain valley were created during the Taconic orogeny, the same continental plate movement that gave rise to the Green Mountain Range (Thompson and Sorenson, 2000).

In more recent times, geologically speaking, the presence and eventual retreat of glaciers had a significant effect on the surficial geology of the Champlain valley. After the retreat of the glaciers from Vermont approximately 14,000 years ago, the Champlain Valley was first filled with a freshwater lake (Figure 3, Glacial Lake Vermont) and later as the glaciers retreated further north a saltwater inland sea (Champlain Sea). Lake Vermont was at an elevation of approximately 620' (current Lake Champlain elevation is approx. 100') and extended over a large portion of the current Lake Champlain basin. The great size of the lake combined with the forces of the glacier moving over bedrock surfaces caused large amounts of erosion and deposition throughout the basin. It allowed for the development of annual layering of fine sediments (e.g., varves) throughout the areas affected by glacial lakes (Ridge and Larson, 1990). Some of this fine sediment, in the form of glacio-lacustrine deposits, has a strong influence on both the stability of the valley side slopes and the channel and floodplain morphology. Later, when sea water entered the Champlain basin via the Saint Lawrence valley and the Champlain Sea was formed, the same processes of erosion and deposition occurred, with the largest and heaviest materials depositing first and the finest materials depositing last on their transport downstream. Today, deposits of clays and sands populate the valley floors of the Champlain valley while till (stony, gravelly sandy loams) makes up a large fraction of the soil in the uplands.

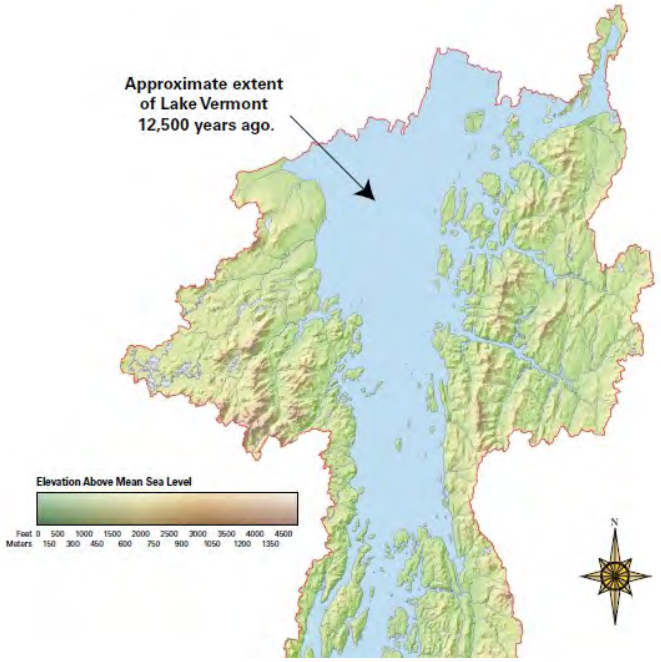


Figure 3. Lake Vermont

Geomorphic Setting

Figure 4 below illustrates the Rock River main stem within Québec and its tributaries in longitudinal profiles. The highest elevation is 335 ft at the upstream limit of Brandy Brook to the east. The lowest elevation is 97 ft where the Rock River re-enters the USA, slightly higher than Lake Champlain. Below Table 2 lists the average channel slope of the main stem of the Rock River and its tributaries within the Canadian portion of the watershed. Channel slopes were calculated from LiDAR elevation data.

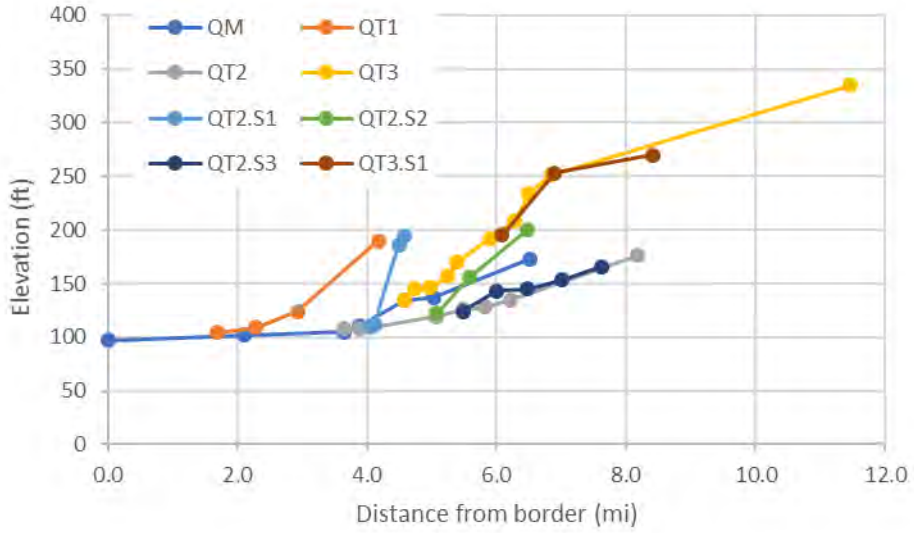


Figure 4. Elevation profiles of the Rock River and its tributaries

Table 2. Average slopes of the Rock River and its tributaries

Channel (SGA Reaches)	Average Slope
Rock River main stem (QM.01 – QM.06)	0.22%
Brandy Brook (QT3.01 – QT3.09)	0.55%
QT3S1.01-QT3S1.02	0.61%
Swennen Brook (QT2.01 – QT2.07)	0.29%
QT2S1.01-QT2S1.03	3.07%
QT2S2.01-QT2S2.02	1.05%
QT2S3.01-QT2S3.04	0.37%
Menes Brook (QT1.01-QT1.03)	0.65%

2.3 Hydrology and Flood History

The United States Geological Survey (USGS) currently operates a real-time flow monitoring gage along Cassidy Road (#04294140) in the upper portion of the Rock River watershed. The watershed area of 11.3 square miles represents roughly half of the drainage area when the River enters Québec (QM.06). USGS also operates a stream gage on the Pike River (#04294300) approximately 1 mile south of the Canadian border. The Rock River gage has been operation since 2010 and the Pike River gage since 2001. The highest

flows for Rock River (597cfs) were recorded following Tropical Storm Irene in August of 2011. This discharge is approximately a 10-year recurrence interval flow based on a simplified hydrology analysis using the USGS StreamStats interface. The highest flows for the Pike River were recorded in June 2006 (3,010cfs), April 2011 (2,400cfs), and June 2002 (2,120cfs). These flows represent significant flood events of greater than a 100-year flood, greater than 50-year flood, and a 25-year flood respectively (Table 3). These estimated recurrence intervals appear high for the Pike River, possible due to limitations with the Streamstats analysis for watershed that extend outside of the US.

The portions of the Rock River watershed observed during the windshield survey typically had a deeply incised and oversized channel with very limited floodplain access. Based on these observations, we do not expect that overbank flooding is a significant threat within the Québec portion of the watershed. Localized ice jam flooding is likely the primary concern.

Table 3: Frequency and magnitude of flow events in the Rock River and Pike River watersheds based on USGS Streamstats analysis.

	Discharge (cfs)	
Return Frequency	Rock River (11.3sqmi)	Pike River (34.6sqmi)
2 year	280	762
5 year	434	1,170
10 year	552	1,470
25 year	722	1,910
50 year	567	2,280
100 year	1,020	2,670
500 year	1,140	3,730

2.4 Ecological Setting

The Rock River watershed is in the Champlain valley biophysical region (Thompson and Sorenson, 2000). The topography of the area is gentle to rolling. As previously noted, the surface geology of the area consists largely in a mix of glacial-lacustrine deposits and till of varying soil texture and coarse fragment content.

The climate of the Champlain valley is relatively warm. The growing season approaches 150 days in the valley (Thompson and Sorenson, 2000) with relatively high temperatures in the summer due to the low elevation (July average ≈ 70°F) and temperatures staying mild well into the fall due to the tempering effect of nearby Lake Champlain. Average annual precipitation in the Champlain valley is about 30 inches (Thompson and Sorenson, 2000).

It is difficult to know precisely what the natural vegetation was in this part of the Rock River watershed because of its early settlement and subsequent continuous farming. However, it is likely that northern hardwood forests were once abundant (Thompson and Sorenson, 2000). Oak-pine forests likely dominated lower and warmer areas in the landscape with well drained coarse soils whose parent material is outwash and shallow till. Typical northern hardwood forests dominated by birch, beech and sugar maples (or sometimes red maples), were probably more common at the higher elevations where temperatures are slightly cooler, in soils that hold more moisture and whose parent material is mostly glacial till.

Small areas of wetland are scattered throughout the watershed. The Menes Brook sub watershed contains a relatively large wetland system. This wetland system and areas surrounding it are part of the Philipsburg Migratory Bird Sanctuary (link). Additional small wetlands are found along streams and small tributaries throughout the watershed.

3.0 Data Collection

3.1 Data Collection Methods

The Vermont River Management Program (RMP) has invested many person-years of effort into developing a state-of-the-art system of Stream Geomorphic Assessment (SGA) protocols. The SGA protocols are intended to be used by resource managers, community watershed groups, municipalities and others to identify how changes to land use affect hydro-geomorphic processes at the landscape and reach scale, and how these changes alter the physical structure and biological habitat of streams. The SGA protocols have become a key tool in the prioritization of restoration projects that will 1) reduce sediment and nutrient loading to downstream receiving waters such as Lake Champlain and the Connecticut River, 2) reduce the risk of property damage from flooding and erosion, and 3) enhance the quality of in-stream biological habitat. The protocols are based on defensible scientific principles and have been tested widely in many watersheds throughout the state. Data collected for the Rock River watershed using the protocols will form the basis for preliminary project identification carried out during future Phase 2 SGA and River Corridor Planning efforts.

The SGA protocols include three phases (VTDEC, 2009):

- **Phase 1**: The Phase 1 SGA approach utilizes the Stream Geomorphic Assessment Tool (SGAT), a GIS extension developed by RMP for the collection of reach and watershed scale data. In addition to the GIS and remote sensing effort, a cursory field assessment ("windshield survey") is included for the verification of stream and valley forms, significant channel features and the location of man-made infrastructure. The Phase 1 SGA approach results in watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), which provides a basis for understanding the natural and human-impacted conditions within the watershed. The SGA data also aids in the identification of specific stressors affecting the physical conditions of the stream channels and structures (e.g., bridges and culverts). Table 4 summarizes the parameters collected in Phase 1 using the Feature Indexing Tool (FIT), which include those utilized to develop the final impact ratings.
- **Phase 2**: The Phase 2 approach builds upon Phase 1 data through the collection of reach-specific data about the current physical conditions. Characterization of reach conditions utilizes a suite of quantitative (e.g., channel geometry, pebble counts) and qualitative (e.g., pool-riffle habitat) measurements to calculate two indices: Rapid Geomorphic Assessment (RGA) Score; Rapid Habitat Assessment (RHA) score. Using the RGA scores in conjunction with knowledge about the background or "reference" conditions, a sensitivity rating is developed to predict the degree to which the channel will adjust to human and natural impacts in the future.

Table 4: Parameters collected with FIT

Phase 1 Step	Phase 2 Step	Data Type	Impact	Sub-Impact
3.1	**1.2**	Point	Alluvial Fan	NA
3.2	**1.6**	Point	Grade Control	Dam Ledge Waterfall Weir
NA	**3.3**	Point	Mass Failure	NA
5.5	**5.5**	Point	Dredging	Dredging Gravel Mining Commercial Mining
NA	**4.4**	Point	Debris Jam	NA
NA	**4.6**	Point	Stormwater Input	NA
NA	**4.9**	Point	Beaver Dam	NA
NA	**5.2**	Point	Migration	Neck Cut Off Flood chute Avulsion Braiding
NA	**5.3**	Point	Steep Riffle or Head Cut	Head Cut Steep Riffle
NA	**5.4**	Point	Stream Crossing	Stream Ford Animal Crossing
NA	**3.3**	Point	Gully	NA
6.2	**1.3**	Line	Development	NA
6.1	**1.3**	Line	Encroachment	Berm Improved Path Road Railroad
5.3	**3.1**	Line	Bank Armoring or Revetment	Rip-Rap Hard Bank Other
7.2	**3.1**	Line	Erosion	NA
5.4	**5.5**	Line	Straightening	Straightening With Windrowing

Phase 1 and 2 "Steps" are correspond to the VTANR SGA methodology and the organization of the DMS database.

- **Phase 3**: Phase 3 surveys involve the collection of detailed, reach-scale survey data to verify or build upon Phase 2 data. These surveys are typically carried out prior to project development for an "active" channel management approach (e.g., floodplain restoration), or for long-term monitoring purposes.

Prior to running SGAT, FEA developed subwatershed, valley wall, and meander centerline themes for the study reaches. FEA ran SGAT in the fall of 2019, and the remaining Phase 1 data was collected remotely by FEA and through windshield surveys for reaches along 27 river miles (43.2 kilometers). All major human impacts and natural features were indexed in a GIS using the Feature Indexing Tool (FIT; VTDEC, 2009).

3.2 Quality Assurance

The VTDEC Quality Assurance (QA) protocols outlined in the SGA protocols (VTDEC, 2009) were followed in order to ensure a complete and accurate dataset. FEA and VTDEC shared responsibility for QA for the SGAT shapefiles and the finalized Phase 1 datasets. All metadata describing the data sources were entered in the Data Management System (DMS), with extraordinary sources noted in the comments section in Phase 1 Step 5. The DMS database for all assessed reaches in the watershed was finalized in September 2019.

4.0 Phase 1 Results

4.1 Reach Delineations

The 26.8 miles of surface waters within the Canadian portion of the Rock River watershed were divided into 36 reaches during the SGAT analysis. Reach divisions were based on changes in valley geometry, channel slope, and the size and influence of tributaries entering the mainstem channel (VTDEC, 2009). The Rock River mainstem, three tributaries and four sub-tributaries were included in the SGAT analysis. Table 5 summarizes data for the study watersheds. Detailed information about each reach location is found in the reach reports in Appendix A, and a reach map is provided in Appendix B.

Table 5: Tributary and sub-tributary summary data

DMS ID	Name	Watershed Area (square miles)	Assessed River Length (mi)	Number of Assessed Reaches
QM	Rock River	26.1 (QC main stem)	6.5	6
QT1	Brandy Brook	2.5	2.5	3
QT2	Swennen Brook	6.8	4.5	7
QT2.S1	Unnamed Sub-Tributary	1.2	0.5	3
QT2.S2	Unnamed Sub-Tributary	0.5	1.4	2
QT2.S3	Unnamed Sub-Tributary	1.2	2.2	4
QT3	Menes Brook	9.4	6.9	9
QT3.S1	Unnamed Sub-Tributary	1.2	2.3	2
		Total	**26.8**	**36**

4.2 Reference Stream Types

Windshield survey measurements and observations as well as remotely collected data of valley confinement, channel slope, and sinuosity were used to develop reference stream types for the assessed reaches according to the Rosgen (1994) and Montgomery and Buffington (1997) classification systems. Characterization of reference stream types is based on the channel forms and processes we would expect in a particular geologic and geomorphic setting without human influences. Detailed information about each reach reference stream type is found in the reach reports in Appendix A. Table 6 presents general valley and channel characteristics associated with reference stream types found in the Rock River and tributary watersheds. Table 7 describes the reference stream conditions for each study reach. Note: The upper portion (approximately 0.5km) or QT3S1.02 has an error in the stream centerline mapping. The upper portion of the stream channel should be mapped as flowing south joining a different unnamed tributary to Brandy Brook.

Table 6: Reference stream type characteristics

Stream Type	Valley Confinement	Channel Slope	Sinuosity	Bedform	Number of Study Reaches*
A	Confined	> 4%	Low	Cascade or Step-pool	0 (0%)
B	Confined	2 – 4%	Low	Step-pool or Plane bed	8 (22%)
C	Unconfined	< 2%	Moderate	Riffle Pool	15 (42%)
D	Unconfined	<4%	Variable	Variable	0 (0%)
E	Unconfined	<2%	Highly	Dune Ripple	13(36%)

* Number of reaches and percentage of total reaches represented by type.

Table 7: Phase 1 reach and watershed conditions

Surface Water	Reach ID	Watershed Area (Mi^2)	Channel Length (Mi)	Channel Width (ft)	Channel Slope (%)	Sinuosity	Valley Type*	Reference Stream Type†	Bedform‡
Rock River (QC Main stem)	QM.01	50.3	2.1	73.4	0.04	2.04	VB	E	Dune-Ripple
	QM.02	46.7	1.5	71.1	0.04	2.16	VB	E	Dune-Ripple
	QM.03	39.5	0.2	66.0	0.41	1.25	BD	C	Riffle-Pool
	QM.04	39.4	0.7	66.0	0.64	1.09	SC	B	Riffle-Pool
	QM.05	29.7	0.5	58.3	0.13	1.12	SC	B	Riffle-Pool
	QM.06	29.5	1.5	58.0	0.47	1.10	SC	B	Riffle-Pool
Menes Brook	QT1.01	2.5	0.6	19.6	0.15	1.21	VB	E	Dune-Ripple
	QT1.02	1.9	0.6	17.5	0.45	1.03	VB	C	Riffle-Pool
	QT1.03	1.1	1.2	13.9	1.00	1.02	VB	E	Dune-Ripple
Swennen Brook	QT2.01	6.8	0.2	30.5	0.03	1.02	VB	E	Dune-Ripple
	QT2.02	6.7	0.2	30.3	0.07	1.20	BD	C	Riffle-Pool
	QT2.03	6.7	1.0	30.2	0.20	1.24	BD	C	Riffle-Pool
	QT2.04	4.3	0.4	24.8	0.29	1.12	BD	C	Riffle-Pool
	QT2.05	2.6	0.3	19.8	0.11	1.13	BD	E	Dune-Ripple
	QT2.06	2.3	0.4	18.8	0.33	1.04	BD	C	Riffle-Pool
	QT2.07	2.1	1.9	18.1	0.40	1.05	VB	E	Dune-Ripple
Unnamed Tributary	QT2S1.01	1.2	0.1	14.4	0.91	1.01	BD	C	Riffle-Pool
	QT2S1.02	0.1	0.4	5.4	3.65	1.00	BD	B	Step-Pool
	QT2S1.03	0.1	0.1	4.1	1.82	1.00	VB	C	Riffle-Pool
Unnamed Tributary	QT2S2.01	0.5	0.5	9.5	1.27	1.11	BD	E	Dune-Ripple
	QT2S2.02	0.4	0.9	8.4	0.93	1.00	VB	C	Riffle-Pool
Unnamed Tributary	QT2S3.01	1.2	0.5	13.9	0.69	1.14	BD	C	Riffle-Pool
	QT2S3.02	0.9	0.5	12.7	0.08	1.02	BD	E	Dune-Ripple
	QT2S3.03	0.5	0.5	9.5	0.30	1.03	VB	E	Dune-Ripple
	QT2S3.04	0.3	0.6	7.2	0.38	1.04	VB	E	Dune-Ripple

Table 7: Phase 1 reach and watershed conditions

Surface Water	Reach ID	Watershed Area (Mi^2)	Channel Length (Mi)	Channel Width (ft)	Channel Slope (%)	Sinuosity	Valley Type*	Reference Stream Type†	Bedform‡
Brandy Brook	QT3.01	9.4	0.2	35.1	1.25	1.01	SC	B	Riffle-Pool
	QT3.02	9.4	0.2	35.0	0.04	1.48	BD	E	Dune-Ripple
	QT3.03	9.1	0.3	34.6	0.80	1.79	BD	C	Riffle-Pool
	QT3.04	9.0	0.1	34.4	1.62	1.11	SC	B	Riffle-Pool
	QT3.05	8.9	0.5	34.4	0.84	1.41	NW	C	Riffle-Pool
	QT3.06	8.8	0.4	34.1	0.83	1.00	NW	C	Riffle-Pool
	QT3.07	7.5	0.2	31.8	2.20	1.00	NW	B	Riffle-Pool
	QT3.08	7.4	0.3	31.5	0.90	1.00	SC	B	Riffle-Pool
	QT3.09	7.2	4.6	31.1	0.34	1.05	VB	C	Riffle-Pool
Unnamed Tributary	QT3S1.01	1.2	0.8	14.1	1.36	1.00	BD	C	Riffle-Pool
	QT3S1.02	0.7	1.5	11.0	0.20	1.03	BD	E	Dune-Ripple

* NC= Narrowly-confined; SC= Semi-confined; NW= Narrow; BD=Broad; VB=Very Broad † per Rosgen, 1994
‡ per Montgomery and Buffington, 1997

Figure 5 presents the location of the reference stream types developed for the Rock River watershed. Reaches of the C-type, E-type, and B-type were mapped under reference conditions (42%, 36% and 22% respectively). C-type streams are typically characterized by a moderately sinuous channel found in a broad, unconfined valley setting with a balance between the upslope sediment supply and the transport capacity. E-type reaches are typically found in broad valleys with low slope and depositional environments. B-type streams are typically characterized by a low to moderately sinuous channel in a confined valley that is dominated by sediment transport processes. Data from the reaches covered in the full Phase 1 analysis are shown in Table 7. B-type was generally mapped in reaches with relatively confined valleys and steep slopes. E-type was mapped in reaches with relatively wide unconfined valleys and very gentle slopes. C-type was mapped in reaches with unconfined valleys. but slightly steeper slopes compared to E-type.

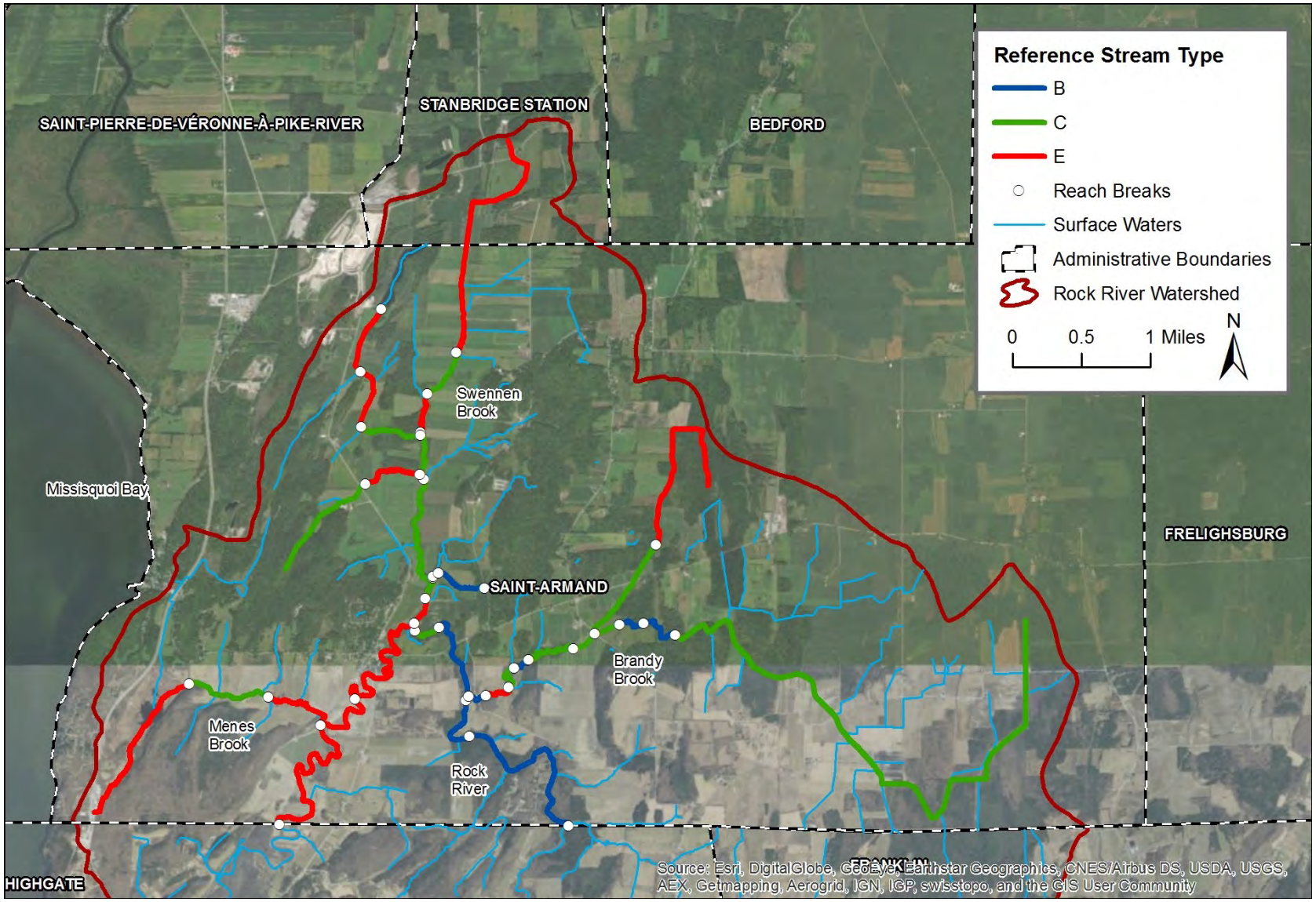


Figure 5: Reference stream types per Rosgen (1994) for the Rock River watershed.

4.3 Watershed Geology and Soils

Soils maps covering the Rock River watershed in Canada are available online from the "Institut de Recherche et de Développement en Agro-environment". (link) These maps were downloaded as pdf documents and imported into Arcmap where they were georeferenced and digitized. The results are shown in Figure 8 which offers an overview of the parent material throughout the watershed.

One natural bedrock grade control was identified during the windshield surveys on the main stem of the Rock River on reach QM.06. Figures 6 and 7 illustrates this large bedrock cascade.

Figure 6: Start of bedrock grade control on the Rock River, north of bridge on Chemin Pelletier S.

Figure 7: View upstream of bedrock grade control, south of bridge on Chemin Pelletier S.

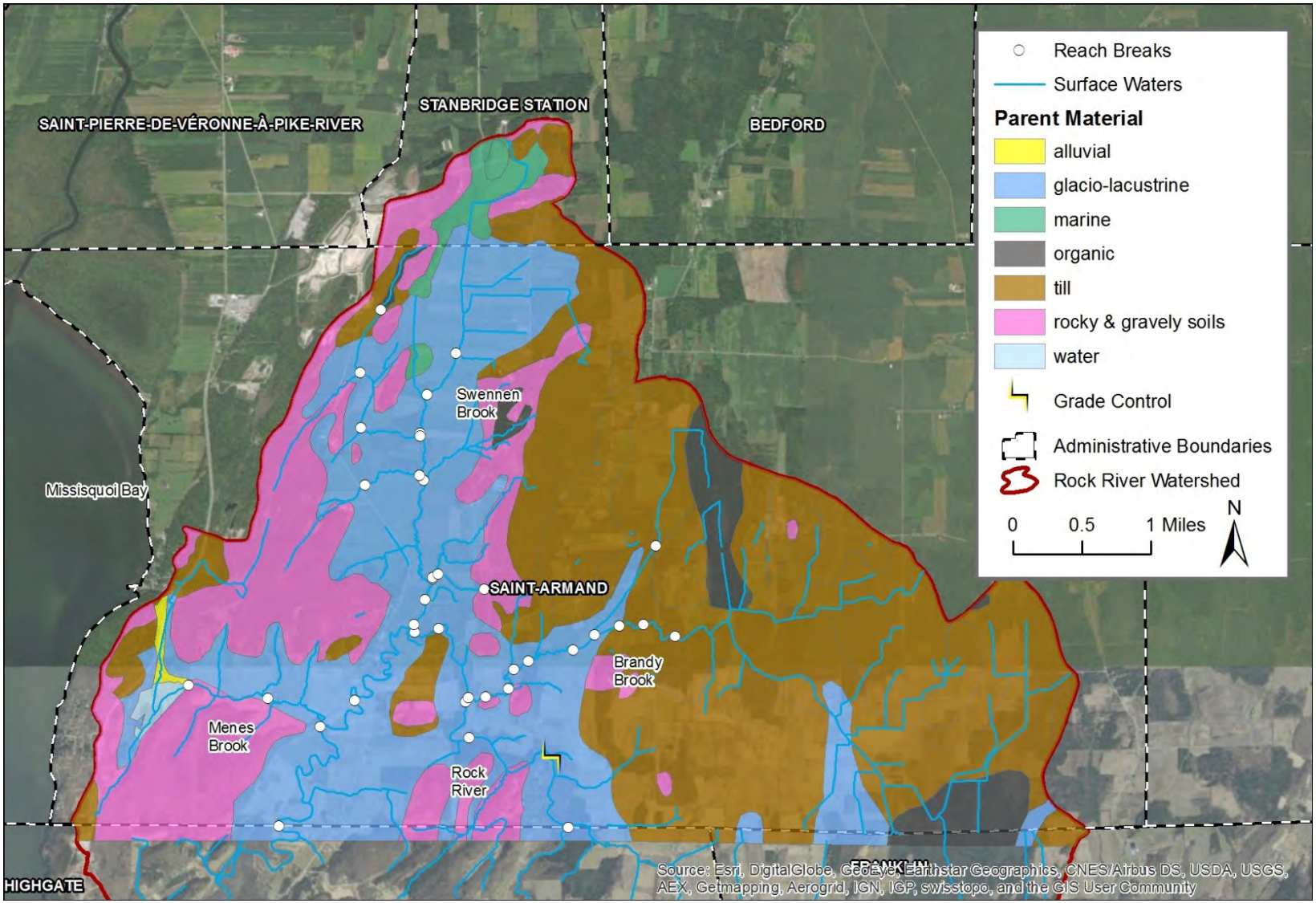


Figure 8: Parent surficial materials and grade controls in the Rock River Watershed

4.4 Land Cover and Reach Hydrology

Step 4 of the Phase 1 protocols evaluates the impacts of watershed land use, riparian vegetative cover, and other reach-scale controls on hydrologic processes. Conversion of natural forest cover to urban and agricultural land uses in a watershed, even at low levels (e.g., 10% of watershed area), has been shown to have measurable impacts on channel stability and aquatic biota (Paul and Meyer, 2001; CWP, 2003). Loss of forest cover reduces the infiltration capacity of soils, and typically results in increased runoff during infrequent storm events and reduced baseflow during the dry periods of the year. In addition, direct impacts to riparian cover along the river bank and within the corridor are also known to have negative impacts on channel stability (e.g., loss of boundary resistance) and available habitat for biota (e.g., canopy shading, large woody debris, etc.). Other local-scale influences on reach hydrology include adjacent wetlands, small tributaries, and other sources of groundwater inputs. These areas provide important inputs of cooler waters that are critical for microhabitats, especially during the late summer and fall months when water temperatures can become elevated to levels that are harmful to native cold water fish.

Land cover data for the Rock River watershed were downloaded from a public online data bank covering Québec and several municipalities within it (link). The downloaded landcover data is the product of a study conducted by the "Institut de la statistique du Québec" comparing land cover in the southern portion of Québec between 1990 and 2000 (Institut de la statistique du Québec, 2017). The most recent 2000 map was used in this report. The downloaded .tif image was imported into ArcMap, georeferenced and digitized (Figure 9). This dataset was clipped to the local watershed (e.g., area draining directly to reach) and stream corridor to understand the impacts to each reach at each scale. Impact ratings were computed from our landcover data based on the rankings provided in Table 8. Almost all the reaches in the Rock River watershed have a combined urban and crop subwatershed landcover exceeding 10% and are therefore given an impact rating of high.

Table 8: SGA land use impact ratings.

Impact Rating	Land Cover Value
High	10% or more of reach watershed is crop and/or urban
Low	Between 2 - 10% of reach watershed is crop and/or urban
Not Significant	Less than 2% of reach watershed is crop and/or urban

We were unable to find historical imagery covering the Québec portion of the Rock River watershed; therefore, we were not able to map changes in land cover. However, it is unlikely that major changes in land cover have taken place in the last several decades. We expect that agricultural use has been the dominant land use in the watershed for a long time.

Riparian buffer widths were estimated remotely and verified in the field where possible during the windshield surveys. Areas where the buffer widths were less than 25 feet were mapped remotely and indexed using the FIT. Areas that received high impact scores for the lack of a healthy riparian buffer were

due to roadway encroachment or were alluvial valleys where adjacent lands have been intensively used for agricultural or residential uses for many years. 18 reaches, out of a total of 35, have a "high" impact from reduced buffer width (Figure 10). Several reaches approached 100% buffer impact along both the main stem and within the tributaries and sub-tributaries. The loss of overhanging bank vegetation directly reduces shading of the stream and is well documented as a threat to cold water fish and macroinvertebrate communities (Herb et al., 2008).

Groundwater and small tributary inputs were reviewed for each reach using available wetland and surface water mapping, as well as aerial imagery review. Important wetland areas were described in Section 2.4. Additional detailed information about each Step 4 parameter for all reaches is found in the reach reports found in Appendix A.

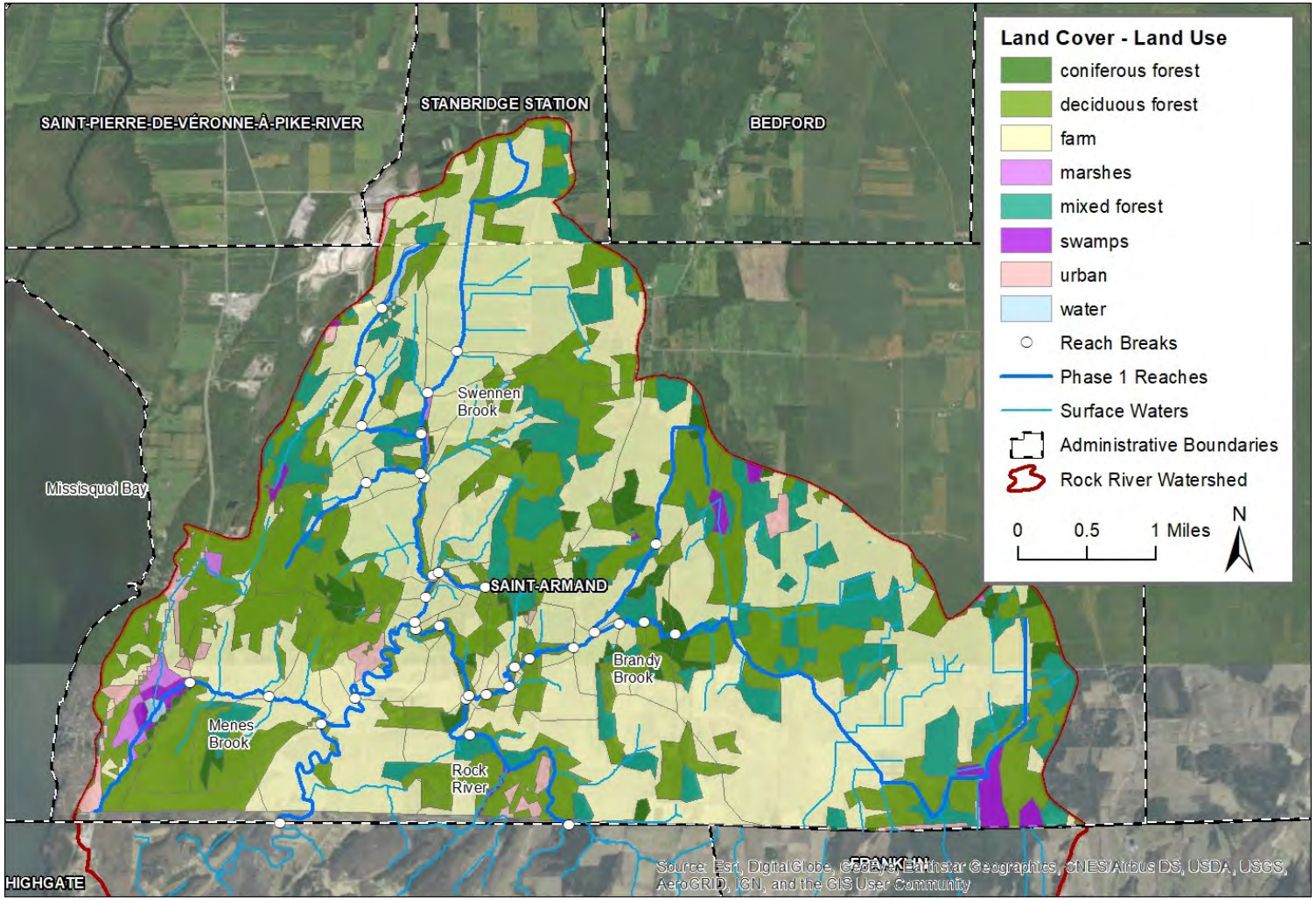


Figure 9: Land cover data for the Rock River watershed.

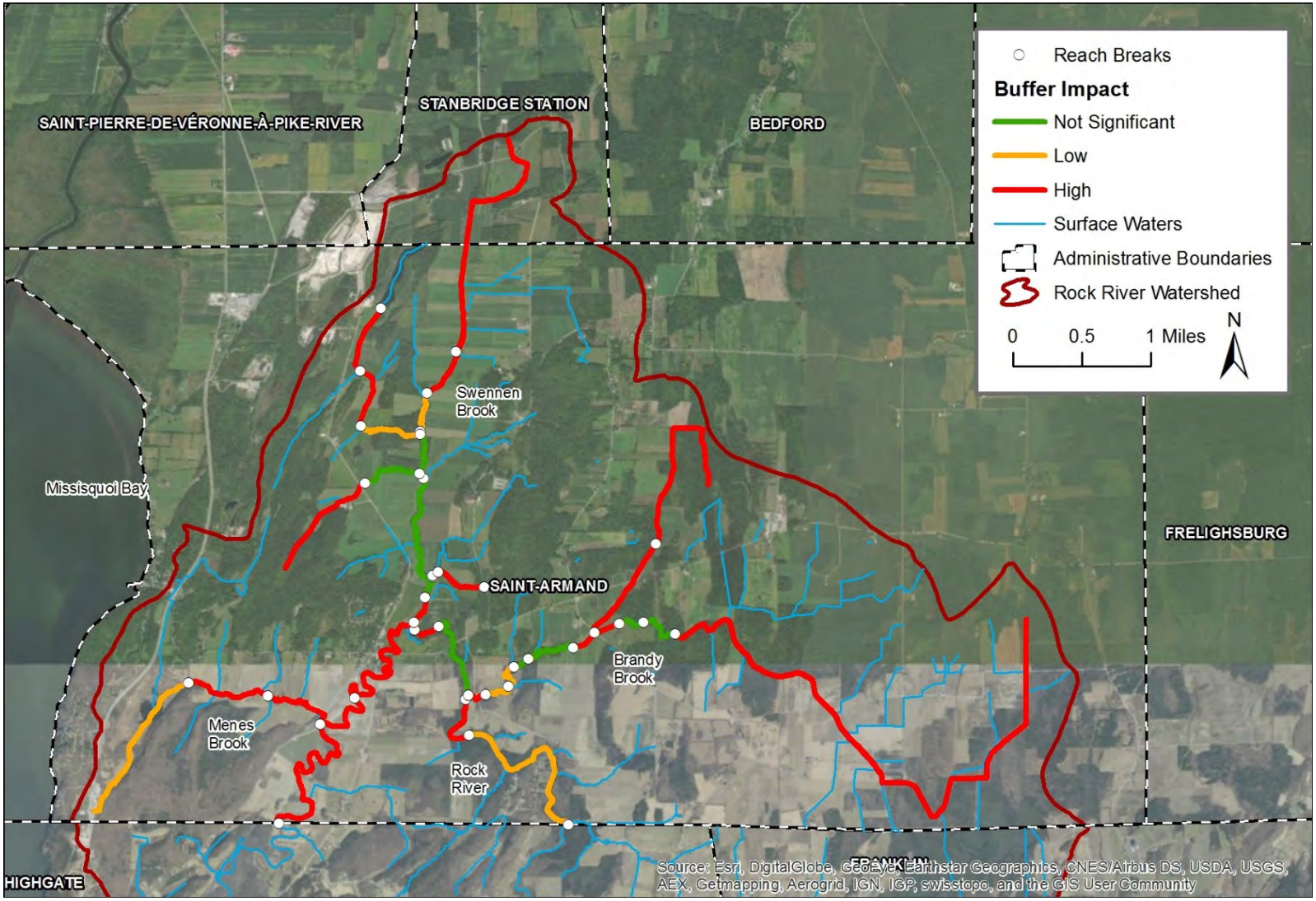


Figure 10: Impacts from buffer width in the Rock River watershed.

4.5 In-stream Channel Modifications

Data collected as part of SGA Step 5 aids in the understanding of how direct impacts to the channel boundaries have altered the sediment supply and transport regimes at the reach scale. Flow-regulating structures that span the channel impact the natural flow variability in downstream reaches and interrupt the sediment supply along the channel network. These features often result in reduced in-stream habitat as well as channel incision in downstream areas where the sediment transport capacity exceeds the limited supply from upslope. Bridges and culverts that are inadequately sized to accommodate channel forming flows have similar impacts to habitat and sediment transport as flow-regulating structures. In addition, culverts that have severely "perched" outlets create a discontinuity in habitat along the channel by preventing fish passage. Bank armoring, channel straightening, and dredging are human impacts that increase the sediment transport capacity of the channel through the increase of 1) resistance to lateral migration, and 2) channel slope. Further discussion of the impacts of in-stream channel modifications is provided in the SGA Phase 1 Handbook (VTDEC, 2009). Reaches with significant impacts from these features are summarized below. Additional detailed information about each Step 5 parameter for all reaches is found in the reach reports found in Appendix A.

Impoundments and Flow Regulations

Flow regulations were reviewed and mapped based on aerial imagery and observations during the windshield survey. Two impoundments were observed and mapped, additional impoundment and flow regulations will likely be observed during the Phase 2 surveys. A large berm was observed along Chemin Pelletier N. Aerial imagery shows an approximately 4.5-acre impoundment upstream of the road (reach QT2S1.03). This was mapped as a "small store and release" feature, however we did not observe the impoundment or the outlet structure. An additional 20-acre impoundment is shown in aerial imagery along reach QT2S3.04. This impoundment may be associated with the adjacent rock quarry and was not observed during the windshield survey. Both reaches were fully impacted by the impoundments and were removed from the Phase 1 analysis.

Bridges and Culverts

The locations and lengths of bridge and culvert crossings were mapped remotely and were verified in the field where possible (Figure 11). A total of 4 bridges and 18 culverts were noted on the Phase 1 reaches. A long culvert on a short reach (T3.01) produced a "Low" impact score, all other bridges and culverts were a "Not Significant" impact.

Figure 11: Road culvert on QT3S1.01.

Bank Armoring

Bank armoring and revetments were observed on two reaches (QM.02 and QT3.01) during the windshield survey and were entered through FIT. Approximately 130 feet of bank armoring along a short reach produced a "Low" impact for QT3.01 (Figure 12).

Figure 12: Bank armoring upstream of the new culvert at Chemin Pelletier S (T3.01).

Channel Straightening and Dredging

Extensive channel straightening was observed during windshield surveys and from aerial imagery (Figure 13). Twelve (12) reaches were assigned a "high" impact rating and three (3) reaches were assigned a "low" impact (Figure 14). Channel straightening was primarily observed between agricultural fields to effectively ditch the streams. Ten (10) reaches were straightened for over 50% of the length.

No dredging locations were observed during the windshield survey.

Figure 13: Extensive straightening between large agricultural fields along T3.09.

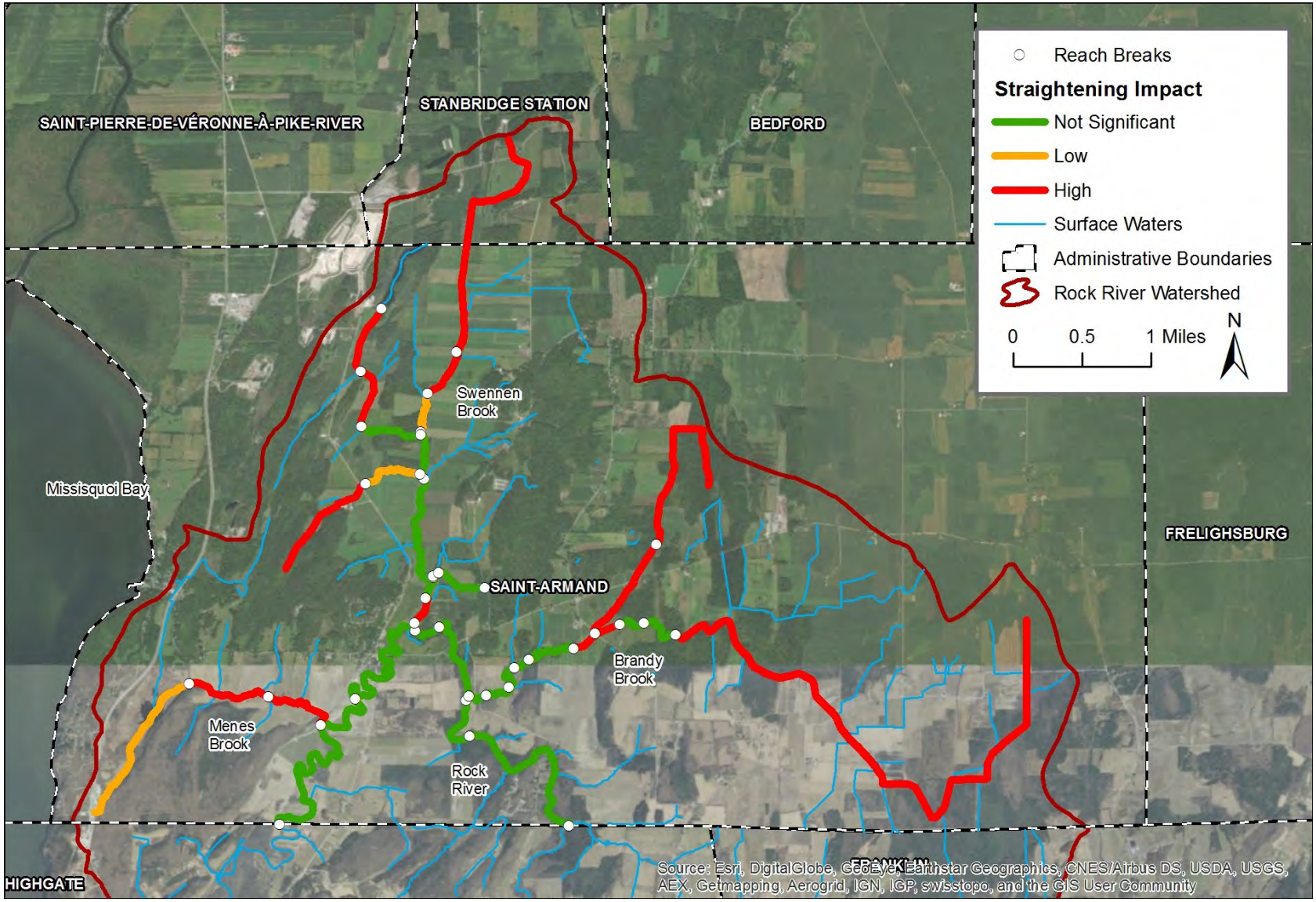


Figure 14: Straightening impacts.

4.6 Floodplain Modifications and Planform Changes

Due to the historical development of road networks and settlement patterns in the lowland areas of the Champlain basin, many alluvial rivers in the area have been encroached upon by roads and development over the years. As discussed in the previous section, many of these areas have also been historically manipulated and straightened to maintain an unnaturally steep slope in a state of sediment transport, allowing for a short-term sense of security from flooding and subsequent encroachment of infrastructure in the floodplain. In addition to historic alterations to channel slope in alluvial rivers, the lowering of stream beds (e.g., dredging) and the raising of floodplains (e.g., berming) has resulted in an increase in channel depth (VTANR, 2010). Channel depths have typically been increased through the encroachment on the floodplain by roads, development and railroads and subsequent filling and armoring required to construct and maintain this infrastructure. Increases in impervious cover have also led to the deepening and eventual widening of channels throughout urbanized areas of the region (Fitzgerald, 2007). These human impacts tend to induce a series of channel adjustments that begin with channel incision and leads to widening and eventually a redevelopment of a sinuous planform in alluvial reaches.

Reaches with significant impacts associated with the above-described human impacts are summarized below according to the SGA impact ratings listed in Table 9. Reaches affected by an increase in depositional or migrational features are also summarized below. Additional detailed information about each Step 6 parameter for all reaches is found in the reach reports found in Appendix A.

Table 9: Impact ratings for corridor encroachments and development

Impact Rating	Impact Criteria
High	Greater than 20% of reach length affected.
Low	Between 5 - 20% of reach length affected.
Not Significant	Less than 5% of reach length affected.

Encroachments

Following the Phase 1 protocol, any berms, roads, driveways, railroads and/or improved paths found within the stream corridor were indexed using the FIT. These areas were identified using current aerial imagery and were confirmed and/or refined during the windshield survey. Figure 15 depicts the reaches where encroachment has significantly impacted the stream corridor, with ratings based on the percentage of the reach length that was impacted as indicated in Table 9. Impacts classified as “high” from corridor encroachment were found on reach QT3.09 where an improved farm road closely followed the channel in multiple locations. Four (4) reaches have "low" impacts, primarily from roads within the corridor. No berm encroachments were mapped during Phase 1 analysis.

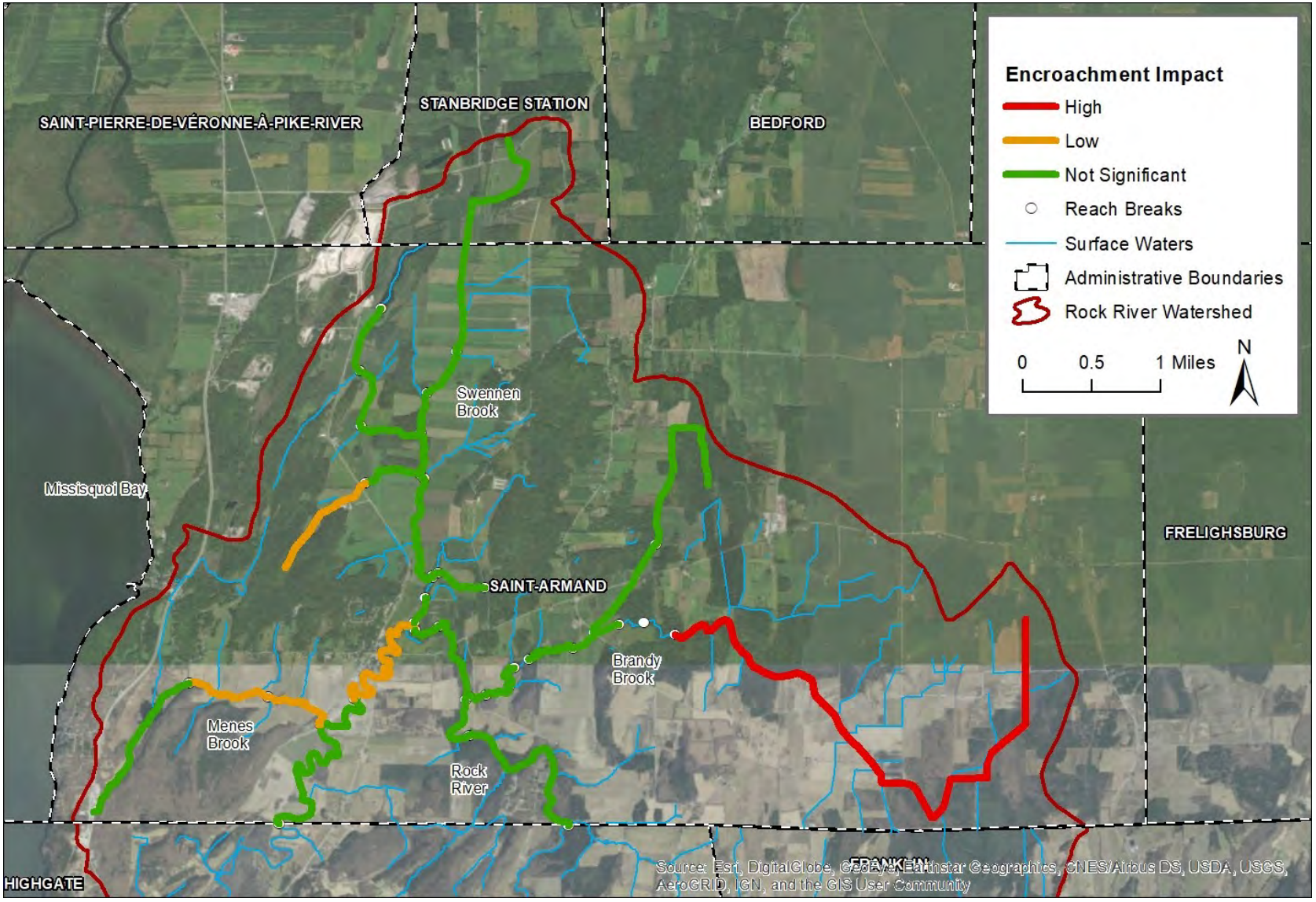


Figure 15: Impacts from corridor encroachments in the Rock River watershed.

Development

The impact of development within the stream corridor was evaluated using current aerial imagery and was confirmed and/or refined during the field observations (Figure 16). The presence of development was indexed using the FIT, and impact ratings for each reach were developed based on SGA criteria presented in Table 11. Two (2) reaches were assigned "low" impacts for corridor development (QM.02 and QT2S2.02).

Figure 16: Development impacts on the Rock River on reach QM.02.

Depositional Features

Sediment depositional features (e.g., point bars, mid channel bars, etc.) were evaluated using current aerial imagery, and were confirmed and/or refined during the field observations. Reaches with multiple types of depositional features indicated where upslope sediment supply exceeded the transport capacity. These areas represent conditions that are favorable for increased lateral channel migration that could endanger adjacent infrastructure and properties. A total of seven (7) reaches were identified as having "low" depositional impacts. The high degree of straightening through much of the Québec study area reduces the opportunity for bar formation. Additional detailed data about the types of depositional features and their relative impacts for all reaches are found in the reach reports found in Appendix A.

Meander Migration

Recent and historic aerial photographs and imagery were reviewed to identify areas of channel migration in the Rock River watershed. Aerial photos (1:5K) from the 1990's were compared to 2017 imagery from Google Earth and ESRI Imagery webservices. Six reaches were characterized as having "low" migration impact (QT1.01, QT2.03, QT2.04, QT2.05, QT2.07, and QT3.05).

For reaches characterized within unconfined valley settings (C-type or E-type channels), meander geometry was reviewed following the Phase 1 protocols; 24 reaches had valley settings suitable for assessment of meander width and wavelength. Of these reaches, 13 had visible meander features where GIS shapefiles were developed to indicate the areas where meander width and wavelength was measured (Figure 17). Where the meander wavelengths and widths fell outside of the range of expected values relative to the predicted channel width, impact ratings of high or low were assigned according to the degree of departure (VTDEC, 2009). Only one reach had no significant impacts for either meander width or wavelength (QM.01); 13 reaches and "high" impacts for both meander width and wavelength; 4 reaches had "high" impacts for either width or wavelength. The remaining 6 reaches had low impacts for width and/or wavelength.

Figure 17: Meander geometry assessment on Reach QM.01

4.7 Bed and Bank Windshield Surveys

Windshield surveys were completed following the initial classification of stream type and substrate based on remotely sensed data. Surveys were completed in June 2019 on all reaches accessible by public roads; 16 of the 34 reaches in the study area were at least partially accessible by roads and were viewed. The Phase 1 parameters verified and/or evaluated during the field surveys included:

- General stream and valley geometry, including valley width and confinement, bed substrate, and bedform features (Step 2).
- Grade controls and areas of known or potential alluvial fans (Step 3).
- Impacts on the buffer and stream corridor, including areas of reduced buffer vegetation, road encroachments, and the presence of development within the stream corridor (Steps 4 and 6).
- Types of stream crossing structures (e.g., bridges and culverts), and their potential for causing ice and debris jams (Steps 5 and 7).
- Areas of bank erosion and armoring (Steps 5 and 7).
- Areas of increased sediment deposition and meander migration (Step 6).

Particular attention was paid to recording bank erosion and ice/debris jam potential at the stream crossings. Due to limited direct accessibility on most reaches, bank erosion assessment along the entire channel length was not practical; rather, bank erosion plainly visible along roads or at stream crossings was indexed using the FIT. Therefore, the relative length of the reach impacted by bank erosion was likely underestimated compared to typical Phase 2 field observations (Figure 18). Bank erosion was observed on 2 reaches, and mass failures were observed on an additional 1 reach (Figure 19).

Debris and ice jam potential at points of channel constrictions associated with stream crossings and sharp channel bends were recorded in the field. Qualitative ratings of the impact of these areas on sediment and debris continuity were developed and entered into the DMS. Ice and debris jam potential was observed on three reaches (QM.06, QT1.01, and QT3.01).

Figure 18: Bank erosion on QM.05.

Figure 19: Small mass failure on QT3.01.

5.0 Phase 1 Data Analysis

5.1 Final Impact Ratings and Geomorphic Condition

Phase 1 impact scores are shown in Table 10 and Figure 20. Based on the Phase 1 impact scores, the DMS also develops predictions for channel adjustment processes (VTDEC, 2009). These predictions are based on the dominant impacts recorded for each reach, and are categorized based on the impacts typically associated with the following four channel adjustment processes: 1) Degradation (e.g., channel incision); 2) Aggradation (e.g., increased sediment deposition); 3) Channel widening (e.g., increased bank erosion); 4) Planform Changes (e.g., irregular meander patterns). Using the channel adjustment process ratings, a provisional geomorphic rating is developed for each reach based on the methods outlined in the SGA Phase 1 protocols (VTDEC, 2009). It is important to note that the local and corridor watershed land cover/land use impacts (steps 4.1 and 4.2) were not included for the Quebec study area. The available land cover data was not compatible with the SGAT tool. Table 11 outlines the four possible geomorphic ratings based on the SGA methods. These impacts would have been applicable to most of the study reaches, likely increases the scores by 2-4 points. Due to difficulties with integrating some of the required data inputs for the Québec reaches, the automated geomorphic ratings do not appropriately reflect conditions within the study area.

Table 10: Final Impact Score Parameters for Phase 1 Dataset. Each category is scored from 0 (no data or no impact) to 2 (high impact)

Phase 1 Step	Phase 1 Parameter	Impact Category
4.1	Local Watershed Land Cover/Land Use	Land Use
4.2	Corridor Watershed Land Cover/Land Use	
4.3	Riparian Buffer Width	
5.1	Flow Regulations	Channel Modifications
5.2	Bridges and Culverts	
5.3	Bank Armoring	
5.4	Channel Straightening	
5.5	Dredging and Gravel Mining	
6.1	River Corridor Encroachments	Floodplain Modifications and Planform Changes
6.2	River Corridor Development	
6.3	Depositional Features	
6.4	Meander Migration	
6.5	Meander Belt Width Departure	
6.6	Meander Wavelength Departure	
7.2	Bank Erosion	Bed and Bank Conditions
7.3	Debris and Ice Jam Potential	

Table 11: SGA Reach Condition Ratings

SGA Rating	Predicted Conditions and Processes
Reference	In Equilibrium – no apparent or significant channel, floodplain, or land cover modifications; channel geometry is likely to be in balance with the flow and sediment produced in its watershed.
Good	In Equilibrium but may be in transition into or out of the range of natural variability – minor erosion or lateral adjustment but adequate floodplain function; any adjustment from historic modifications nearly complete.
Fair	In Adjustment – moderate loss of floodplain function; or moderate to major planform adjustments that could lead to channel avulsions.
Poor	In Adjustment and Stream Type Departure - may have changed to a new stream type or central tendency of fluvial processes – significant channel and floodplain modifications may have altered the channel geometry such that the stream is not in balance with the flow and sediment produced in its watershed.

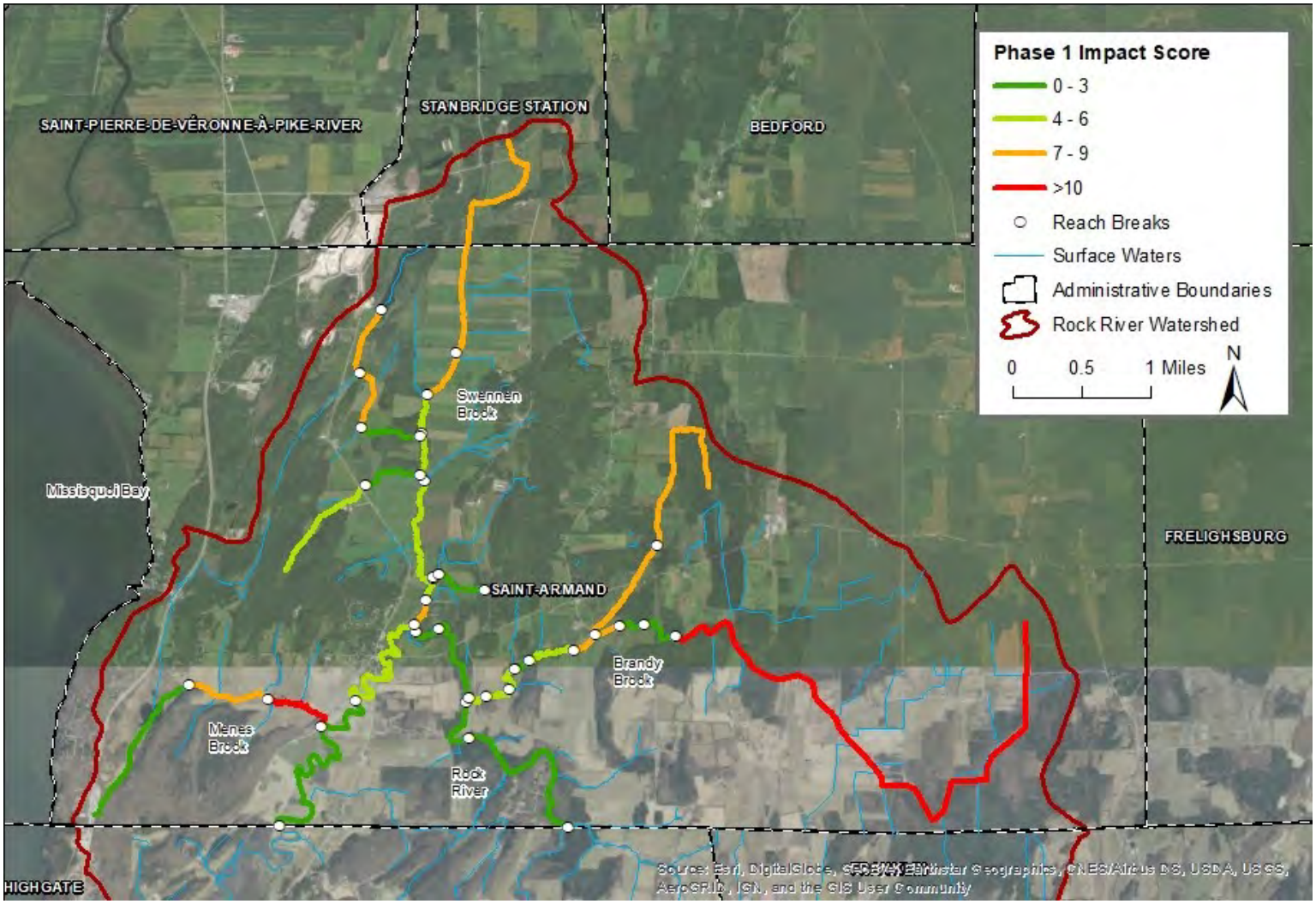


Figure 20. Phase 1 impact scores for the Rock River watershed.

5.2 Phase 2 Reach Recommendations

Channel conditions observed during the windshield surveys and the Phase 1 impact ratings were used to identify and prioritize appropriate reaches for Phase 2 field surveys within the Québec portion of the Rock River watershed. Three of the Phase 1 reaches had no measured impact and were scored with a "0". The exclusion of the land cover/land use impacts from this assessment likely reduced the impact score for all reaches by 2-4 points. This is an important consideration when comparing the Québec study area to other geomorphic assessments in Vermont.

Phase 1 reaches with drainage areas under 1 square mile were not recommended for Phase 2 assessment (7 reaches). Several of these reaches were observed during the windshield survey and were under management as agricultural swales/ditches with no discernable channel or geomorphic processes. Table 12 summarizes the 34 reaches included in the Phase 1 assessment. The seven highlighted reaches have drainage areas under 1 square mile and are not recommended for Phase 2 assessment. The remaining 28 reaches are recommended for Phase 2 assessment and have a total channel length of 22.4mi (35.8 km). The 19 Phase 2 segments previously assessed in Vermont will be re-assessed as part of this project, totaling 17.4mi (27.8km) (Figure 21).

Table 12: Phase 2 reach recommendations and Phase 1 Impact Ratings (highlighted reaches are not recommended for Phase 2 assessment)

Surface Water	Reach ID	Channel Length (Mi)	Channel Slope (%)	Valley Type*	Reference Stream Type†	Bedform‡	Impact Score
Rock River	QM.01	2.1	0.04	VB	E	Dune-Ripple	2
	QM.02	1.6	0.04	VB	E	Dune-Ripple	2
	QM.03	0.2	0.41	BD	C	Riffle-Pool	5
	QM.04	0.7	0.64	SC	B	Riffle-Pool	3
	QM.05	0.5	0.13	SC	B	Riffle-Pool	0
	QM.06	1.5	0.47	SC	B	Riffle-Pool	2
Menes Brook	QT1.01	0.6	0.15	VB	E	Dune-Ripple	2
	QT1.02	0.6	0.45	VB	C	Riffle-Pool	12
	QT1.03	1.3	1	VB	E	Dune-Ripple	9
Swennen Brook	QT2.01	0.2	0.03	VB	E	Dune-Ripple	2
	QT2.02	0.2	0.07	BD	C	Riffle-Pool	8
	QT2.03	1.0	0.2	BD	C	Riffle-Pool	4
	QT2.04	0.4	0.29	BD	C	Riffle-Pool	5
	QT2.05	0.3	0.11	BD	E	Dune-Ripple	5
	QT2.06	0.4	0.33	BD	C	Riffle-Pool	6
	QT2.07	2.0	0.4	VB	E	Dune-Ripple	8
Unnamed Tributary	QT2S1.01	0.1	0.91	BD	C	Riffle-Pool	9
	QT2S1.02	0.4	3.65	BD	B	Step-Pool	0
Unnamed Tributary	QT2S2.01	0.5	1.27	BD	E	Dune-Ripple	2
	QT2S2.02	0.9	0.93	VB	C	Riffle-Pool	3
Unnamed Tributary	QT2S3.01	0.5	0.69	BD	C	Riffle-Pool	5
	QT2S3.02	0.5	0.08	BD	E	Dune-Ripple	3
	QT2S3.03	0.5	0.3	VB	E	Dune-Ripple	8

Surface Water	Reach ID	Channel Length (Mi)	Channel Slope (%)	Valley Type*	Reference Stream Type†	Bedform‡	Impact Score
Brandy Brook	QT3.01	0.2	1.25	SC	B	Riffle-Pool	6
	QT3.02	0.2	0.04	BD	E	Dune-Ripple	5
	QT3.03	0.3	0.8	BD	C	Riffle-Pool	4
	QT3.04	0.1	1.62	SC	B	Riffle-Pool	1
	QT3.05	0.5	0.84	NW	C	Riffle-Pool	5
	QT3.06	0.4	0.83	NW	C	Riffle-Pool	9
	QT3.07	0.2	2.2	NW	B	Riffle-Pool	2
	QT3.08	0.3	0.9	SC	B	Riffle-Pool	0
	QT3.09	4.6	0.34	VB	C	Riffle-Pool	10
Unnamed Tributary	QT3S1.01	0.8	1.36	BD	C	Riffle-Pool	8
	QT3S1.02	1.5	0.2	BD	E	Dune-Ripple	8

* SC= Semi-confined; NW= Narrow; BD=Broad; VB=Very Broad, NC=No Confinement; † per Rosgen, 1994

‡ per Montgomery and Buffington, 1997

6.0 Conclusions

This project presents a unique opportunity to work in a watershed spanning an international boundary with important water quality considerations for Missisquoi Bay and Lake Champlain. This Phase 1 assessment includes study reaches within the Québec portion of the Rock River watershed which are impacted by extensive land conversion to agriculture. Historic channel straightening impacts were recorded on over 10 miles (16km) of the study reaches, representing approximately 40% of the channel length. Reduced buffer widths were observed throughout the study area, with over 23 miles (40km) of buffer impacts recorded. The tributaries and sub-tributaries are more affected by these impacts than the Rock River mainstem. Several reaches along the mainstem had forested buffers and accessible floodplain benches along the meandering channel. The portions of the watershed observed during the windshield survey suggest that the straightened and deeply incised channels are relatively stable. We did not observe significant erosion or indications of widening or bar formation. The very low channel slopes observed through most of the study area likely mitigate some of the channel adjustment processes that would otherwise be expected in channels with a high degree of geomorphic impact.

The comprehensive SGA data collection and planning effort initiated by LCBP will assist the municipalities within the watershed with identifying and prioritizing water quality improvement opportunities within the study area. Collection of additional Phase 2 data for the priority reaches in both Québec and Vermont will be begin in the spring of 2020. Specifically, this data will aid in understanding of channel geomorphic processes, floodplain accessibility, and buffer width and quality. In addition, the Phase 2 data will assist municipalities in Vermont and Québec to prioritize water quality improvement efforts including buffer plantings, channel restorations, and floodplain protection/enhancement.

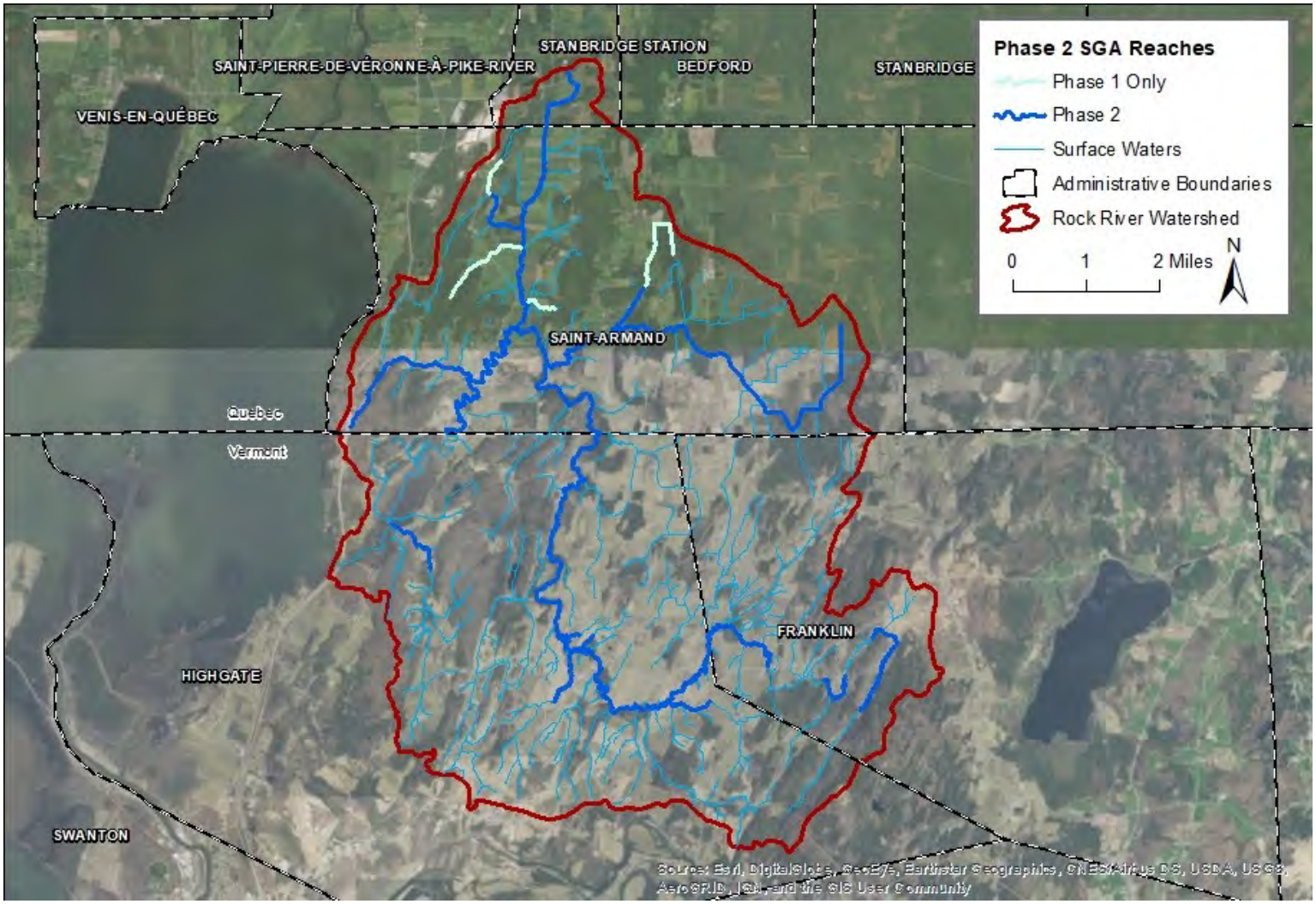


Figure 21: Rock River watershed reaches recommended for phase 2 stream geomorphic assessment.

7.0 References

CWP (Center for Watershed Protection), 2003, Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph: 39-49.

Fitzgerald, E. P., 2007, Linking urbanization to stream geomorphology and biotic integrity in the Lake Champlain Basin, Vermont [M.S. Thesis]: Burlington, Vermont, University of Vermont, 121 p.

Herb, W. R., B. Janke, O. Mohseni, and H. G. Stefan, 2008, Thermal Pollution of Streams by Runoff from Paved Surfaces. Hydrological Processes, 22, 987-999.

Institut de la statistique du Québec. Octobre 2017. Données de couverture terrestre issues du projet des comptes des terres du Québec meridional.

Lake Champlain Basin Program (LCBP), 2017, Opportunities for Action - An Evolving Plan for the Future of the Lake Champlain Basin. Updated 2017. Available at: http://www.lcbp.org/wp-content/uploads/2016/11/Opportunities-for-Action_2017.pdf

Montgomery, D. R., and J. M. Buffington, 1997, Channel-reach morphology in mountain drainage basins, *Geological Society of America Bulletin*, 109(5), 596-611.

Paul, M. J., and J. L. Meyer, 2001, Streams in the urban landscape. Annual Review of Ecology and Systematics 32:333-365.

Ridge, J.C. and Larsen, F.D., 1990, Re-evaluation of Antevs' New England varve chronology and new radiocarbon dates of sediments from Glacial Lake Hitchcock: Geological Society of America, v. 102, p. 889-899

Rosgen, D. L., 1994, A classification of natural rivers, Catena, 22(3), 169 - 199.

Thompson, E.H., and E.R. Sorenson, 2000, Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont, Vermont Department of Fish and Wildlife and The Nature Conservancy.

U. S. Environmental Protection Agency (USEPA), 2016, Phosphorus TDMLs for Vermont Segments of Lake Champlain. USEPA Region 1, New England, Boston, MA.

USGS (Untied States Geological Survey), 2008, Real-time Flow Monitoring Data for Vermont Rivers, available at: http://waterdata.usgs.gov/nwis

VTANR, 2010, Vermont Agency of Natural Resources River Corridor Planning Guide. April, 2010. Available at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_restoration.htm

VTANR, 2014, Vermont Agency of Natural Resources - Natural Resource Atlas, available at: http://anrmaps.vermont.gov/websites/anra/

VTDEC (Vermont Department of Environmental Conservation), 2009, Stream Geomorphic Assessment Handbook - Phase 1 & 2 Protocols. Vermont Agency of Natural Resources Publication. Available at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm.

8.0 Glossary of Terms

Adapted from:
Restoration Terms, by Craig Fischenich, February, 2000, USAE Research and Development Center, Environmental Laboratory, 3909 Halls Ferry Rd., Vicksburg, MS 39180
And
Vermont Stream Geomorphic Assessment Handbook, 2007, Vermont Agency of Natural Resources, Waterbury, VT http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm

Acre -- A measure of area equal to 43,560 ft ^{2} (4,046.87 m^2). One square mile equals 640 acres.
Adjustment process --or type of change, that is underway due to natural causes or human activity that has or will result in a change to the valley, floodplain, and/or channel condition (e.g., vertical, lateral, or channel plan form adjustment processes)
Aggradation -- A progressive buildup or raising of the channel bed and floodplain due to sediment deposition. The geologic process by which streambeds are raised in elevation and floodplains are formed. Aggradation indicates that stream discharge and/or bed-load characteristics are changing. Opposite of degradation.
Algae -- Microscopic plants that grow in sunlit water containing phosphates, nitrates, and other nutrients. Algae, like all aquatic plants, add oxygen to the water and are important in the fish food chain.
Alluvial -- Deposited by running water.
Alluvium -- A general term for detrital deposits make by streams on riverbeds, floodplains, and alluvial fans; esp. a deposit of silt or silty clay laid down during time of flood. The term applies to stream deposits of recent time. It does not include subaqueous sediments of seas or lakes.
Anadromous -- Pertaining to fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn.
Aquatic ecosystem -- Any body of water, such as a stream, lake, or estuary, and all organisms and nonliving components within it, functioning as a natural system.
Armoring -- A natural process where an erosion-resistant layer of relatively large particles is established on the surface of the streambed through removal of finer particles by stream flow. A properly armored streambed generally resists movement of bed material at discharges up to approximately 3/4 bank-full depth. Augmentation (of stream flow) – Increasing flow under normal conditions, by releasing storage water from reservoirs.
Avulsion -- A change in channel course that occurs when a stream suddenly breaks through its banks, typically bisecting an overextended meander arc.
Backwater -- (1) A small, generally shallow body of water attached to the main channel, with little or no current of its own, or (2) A condition in subcritical flow where the water surface elevation is raised by downstream flow impediments.
Backwater pool -- A pool that formed as a result of an obstruction like a large tree, weir, dam, or boulder.
Bank stability -- The ability of a streambank to counteract erosion or gravity forces.
Bankfull channel depth -- The maximum depth of a channel within a riffle segment when flowing at a bank-full discharge.
Bankfull channel width -- The top surface width of a stream channel when flowing at a bank-full discharge.
Bankfull discharge -- The stream discharge corresponding to the water stage that overtops the natural banks. This flow occurs, on average, about once every 1 to 2 years and given its frequency and magnitude is responsible for the shaping of most stream or river channels.
Bankfull width -- The width of a river or stream channel between the highest banks on either side of a stream.
Bar -- An accumulation of alluvium (usually gravel or sand) caused by a decrease in sediment transport capacity on the inside of meander bends or in the center of an overwide channel.
Barrier -- A physical block or impediment to the movement or migration of fish, such as a waterfall (natural barrier) or a dam (man-made barrier).
Base flow -- The sustained portion of stream discharge that is drawn from natural storage sources, and not affected by human activity or regulation.
Bed load -- Sediment moving on or near the streambed and transported by jumping, rolling, or sliding on the bed layer of a stream. See also suspended load.
Bed material -- The sediment mixture that a streambed is composed of.
Bed material load -- That portion of the total sediment load with sediments of a size found in the streambed.
Bed roughness -- A measure of the irregularity of the streambed as it contributes to flow resistance. Commonly expressed as a Manning "n" value.
Bed slope -- The inclination of the channel bottom, measured as the elevation drop per unit length of channel.

Bedform -- Individual patterns which streams follow that characterize the condition of the stream bed into several categories. (*See*: braided, dune-ripple, plane bed, riffle-pool, step-pool, and cascade)
Benthic invertebrates -- Aquatic animals without backbones that dwell on or in the bottom sediments of fresh or salt water. Examples: clams, crayfish, and a wide variety of worms.
Berms -- mounds of dirt, earth, gravel, or other fill built parallel to the stream banks designed to keep flood flows from entering the adjacent floodplain.
Biota -- All living organisms of a region, as in a stream or other body of water.
Boulder -- A large substrate particle that is larger than cobble, between 10 and 160 inches in diameter.
Boundary resistance -- The ability a stream bank has to withstand the erosional forces of the flowing water at varying intensities. Under natural conditions boundary resistance is increased due to stream bank vegetation (roots), cohesive clays, large boulder substrate, etc.
Braided -- A stream channel characterized by flow within several channels, which successively meet and divide. Braiding often occurs when sediment loading is too large to be carried by a single channel.
Braiding (of river channels) -- Successive division and rejoining of riverflow with accompanying islands.
Buffer strip -- A barrier of permanent vegetation, either forest or other vegetation, between waterways and land uses such as agriculture or urban development, designed to intercept and filter out pollution before it reaches the surface water resource.
Canopy -- A layer of foliage in a forest stand. This most often refers to the uppermost layer of foliage, but it can be used to describe lower layers in a multistoried stand. Leaves, branches and vegetation that are above ground and/or water that provide shade and cover for fish and wildlife.
Cascade -- A short, steep drop in streambed elevation often marked by boulders and agitated white water.
Catchment -- (1) The catching or collecting of water, especially rainfall. (2) A reservoir or other basin for catching water. (3) The water thus caught. (4) A watershed.
Channel -- An area that contains continuously or periodically flowing water that is confined by banks and a streambed.
Channelization -- The process of changing (usually straightening) the natural path of a waterway.
Channel evolution model (CEM) -- A series of stages used to describe the erosional or depositional processes that occur within a stream or river in order to regain a dynamic equilibrium following a disturbance.
Clay -- Substrate particles that are smaller than silt and generally less than 0.0001 inches in diameter.
Coarse gravel -- Substrate that is smaller than cobble, but larger than fine gravel. The diameter of this stream-bottom particulate is between 0.63 and 2.5 inches.
Cobble -- Substrate particles that are smaller than boulders and larger than gravels, and are generally between 2.5 and 10 inches in diameter.
Confinement -- *see* Valley confinement
Confluence -- (1) The act of flowing together; the meeting or junction of two or more streams; also, the place where these streams meet. (2) The stream or body of water formed by the junction of two or more streams; a combined flood.
Conifer -- A tree belonging to the order Gymnospermae, comprising a wide range of trees that are mostly evergreens. Conifers bear cones (hence, coniferous) and have needle-shaped or scalelike leaves.
Conservation -- The process or means of achieving recovery of viable populations.
Contiguous habitat -- Habitat suitable to support the life needs of a species that is distributed continuously or nearly continuously across the landscape.
Cover -- "cover" is the general term used to describe any structure that provides refuge for fish, reptiles or amphibians. These animals seek cover to hide from predators, to avoid warm water temperatures, and to rest, by avoiding higher velocity water. These animals come in all sizes, so even cobbles on the stream bottom that are not sedimented in with fine sands and silt can serve as cover for small fish and salamanders. Larger fish and reptiles often use large boulders, undercut banks, submerged logs, and snags for cover.
Critical shear stress -- The minimum amount of shear stress exerted by stream currents required to initiate soil particle motion. Because gravity also contributes to streambank particle movement but not on streambeds, critical shear stress along streambanks is less than for streambeds.]
Cross-section -- A series of measurements, relative to bankfull, that are taken across a stream channel that are representative of the geomorphic condition and stream type of the reach.
Crown -- The upper part of a tree or other woody plant that carries the main system of branches and the foliage.
Crown cover -- The degree to which the crowns of trees are nearing general contact with one another.
Cubic feet per second (cfs) -- A unit used to measure water flow. One cubic foot per second is equal to 449 gallons per minute.
Culvert -- A buried pipe that allows flows to pass under a road.

Debris flow -- A rapidly moving mass of rock fragments, soil, and mud, with more than half of the particles being larger than sand size.
Deciduous -- Trees and plants that shed their leaves at the end of the growing season.
Degradation -- (1) A progressive lowering of the channel bed due to scour. Degradation is an indicator that the stream's discharge and/or sediment load is changing. The opposite of aggradation. (2) A decrease in value for a designated use.
Detritus -- is organic material, such as leaves, twigs, and other dead plant matter, that collects on the stream bottom. It may occur in clumps, such as leaf packs at the bottom of a pool, or as single pieces, such as a fallen tree branch.
Dike -- (1) (Engineering) An embankment to confine or control water, especially one built along the banks of a river to prevent overflow of lowlands; a levee. (2) A low wall that can act as a barrier to prevent a spill from spreading. (3) (Geology) A tabular body of igneous (formed by volcanic action) rock that cuts across the structure of adjacent rocks or cuts massive rocks.
Dissolved oxygen (DO) -- The amount of free (not chemically combined) oxygen dissolved in water, wastewater, or other liquid, usually expressed in milligrams per liter, parts per million, or percent of saturation.
Ditch -- A long narrow trench or furrow dug in the ground, as for irrigation, drainage, or a boundary line.
Drainage area -- The total surface area upstream of a point on a stream that drains toward that point. Not to be confused with watershed. The drainage area may include one or more watersheds.
Drainage basin -- The total area of land from which water drains into a specific river.
Dredging -- Removing material (usually sediments) from wetlands or waterways, usually to make them deeper or wider.
Dune-ripple -- A bedform associated with low-gradient, sand-bed channels; the low gradient nature of the channel causes the sand to form a sequence of dunes and small ripples; significant sediment transport typically occurs at most stream stages.
Ecology -- The study of the interrelationships of living organisms to one another and to their surroundings.
Ecosystem -- Recognizable, relatively homogeneous units, including the organisms they contain, their environment, and all the interactions among them.
Embankment -- An artificial deposit of material that is raised above the natural surface of the land and used to contain, divert, or store water, support roads or railways, or for other similar purposes.
Embeddedness -- is a measure of the amount of surface area of cobbles, boulders, snags and other stream bottom structures that is covered with sand and silt. An embedded streambed may be packed hard with sand and silt such that rocks in the stream bottom are difficult or impossible to pick up. The spaces between the rocks are filled with fine sediments, leaving little room for fish, amphibians, and bugs to use the structures for cover, resting, spawning, and feeding. A streambed that is not embedded has loose rocks that are easily removed from the stream bottom, and may even "roll" on one another when you walk on them.
Entrenchment ratio --The width of the flood-prone area divided by the bankfull width.
Epifaunal – "epi" means surface, and "fauna" means animals. Thus, "epifaunal substrate" is structures in the stream (on the stream bed) that provide surfaces on which animals can live. In this case, the animals are aquatic invertebrates (such as aquatic insects and other "bugs"). These bugs live on or under cobbles, boulders, logs, and snags, and the many cracks and crevices found in these structures. In general, older decaying logs are better suited for bugs to live on/in than newly fallen "green" logs and trees.
Ephemeral streams -- Streams that flow only in direct response to precipitation and whose channel is at all times above the water table.
Equilibrium Condition -- The state of a river reach in which the upstream input of energy (flow of water) and materials (sediment and debris) is equal to its output to downstream reaches. Natural river reaches without human impacts tend towards a "stable" state where predictable channel forms are maintained over the long term under varying flow conditions.
Erosion -- Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces.
Eutrophic -- Usually refers to a nutrient-enriched, highly productive body of water.
Eutrophication -- The process of enrichment of water bodies by nutrients.
Fine gravel -- Is substrate which is larger than sand, but smaller than coarse gravel. It is between 0.08 and 0.63 inches in diameter.
Flash flood -- A sudden flood of great volume, usually caused by a heavy rain. Also, a flood that crests in a short length of time and is often characterized by high velocity flows.
Floodplain -- Land built of fine particulate organic matter and small substrate that is regularly covered with water as a result of the flooding of a nearby stream.
Floodplain (100-year) -- The area adjacent to a stream that is on average inundated once a century.

Floodplain Function – Flood water access of floodplain which effects the velocity, depth, and slope (stream power) of the flood flow thereby influencing the sediment transport characteristics of the flood (i.e., loss of floodplain access and function may lead to higher stream power and erosion during flood).
Flow -- The amount of water passing a particular point in a stream or river, usually expressed in cubic feet per second (cfs).
Fluvial -- Migrating between main rivers and tributaries. Of or pertaining to streams or rivers.
Fluvial Geomorphology—The study of how rivers and their landforms interact over time through different climatic conditions.
Ford -- A shallow place in a body of water, such as a river, where one can cross by walking or riding on an animal or in a vehicle.
Fry -- A recently hatched fish.
Gabion -- A wire basket or cage that is filled with gravel or cobble and generally used to stabilize streambanks.
Gaging station -- A particular site in a stream, lake, reservoir, etc., where hydrologic data are obtained.
Gallons per minute (gpm) -- A unit used to measure water flow.
Geographic information system (GIS) -- A computer system capable of storing and manipulating spatial data.
Geomorphology -- A branch of both physiography and geology that deals with the form of the earth, the general configuration of its surface, and the changes that take place due to erosion of the primary elements and the buildup of erosional debris.
Glide -- A section of stream that has little or no turbulence.
Grade control -- A fixed feature on the streambed that controls the bed elevation at that point, effectively fixing the bed elevation from potential incision; typically bedrock, dams. or culverts.
Gradient -- Vertical drop per unit of horizontal distance.
Grass/forb -- Herbaceous vegetation.
Gravel -- An unconsolidated natural accumulation of rounded rock fragments, mostly of particles larger than sand (diameter greater than 2 mm), such as boulders, cobbles, pebbles, granules, or any combination of these.
Groundwater -- Subsurface water and underground streams that can be collected with wells, or that flow naturally to the earth's surface through springs.
Groundwater basin -- A groundwater reservoir, defined by an overlying land surface and the underlying aquifers that contain water stored in the reservoir. In some cases, the boundaries of successively deeper aquifers may differ and make it difficult to define the limits of the basin.
Groundwater recharge -- Increases in groundwater storage by natural conditions or by human activity. See also artificial recharge.
Groundwater Table -- The upper surface of the zone of saturation, except where the surface is formed by an impermeable body.
Habitat -- The local environment in which organisms normally live and grow.
Habitat diversity -- The number of different types of habitat within a given area.
Habitat fragmentation -- The breaking up of habitat into discrete islands through modification or conversion of habitat by management activities.
Headcut -- A sharp change in slope, almost vertical, where the streambed is being eroded from downstream to upstream.
Headwater -- Referring to the source of a stream or river.
High gradient streams -- typically appear as steep cascading streams, step/pool streams, or streams that exhibit riffle/pool sequences. Most of the streams in Vermont are high gradient streams.
Hydraulic gradient -- The slope of the water surface. See also streambed gradient.
Hydraulic radius -- The cross-sectional area of a stream divided by the wetted perimeter.
Hydric -- oil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper horizon.
Hydrograph -- A curve showing stream discharge over time.
Hydrologic balance -- An accounting of all water inflow to, water outflow from, and changes in water storage within a hydrologic unit over a specified period of time. Hydrologic region -- A study area, consisting of one or more planning subareas, that has a common hydrologic character.
Hydrologic unit Code (HUC) -- A distinct watershed or river basin defined by an 8-digit code.
Hydrology -- The scientific study of the water of the earth, its occurrence, circulation and distribution, its chemical and physical properties, and its interaction with its environment, including its relationship to living things.
Hyporheic zone -- The area under the stream channel and floodplain where groundwater and the surface waters of the stream are exchanged freely.

Impoundment -- An area where the natural flow of the river has been disrupted by the presence of human-made or natural structure (e.g. weir or beaver dam). The impoundment backwater extends upstream causing sediment to be deposited on the stream bottom.
Improved paths – Paths that are maintained and typically involve paved, gravel or macadam surfaces.
Incised river -- A river that erodes its channel by the process of degradation to a lower base level than existed previously or is consistent with the current hydrology.
Incision ratio -- The low bank height divided by the bankfull maximum depth.
Infiltration (soil) -- The movement of water through the soil surface into the soil.
Inflow -- Water that flows into a stream, lake,
In-stream cover -- The layers of vegetation, like trees, shrubs, and overhanging vegetation, that are in the stream or immediately adjacent to the wetted channel.
In-stream flows -- (1) Portion of a flood flow that is contained by the channel. (2) A minimum flow requirement to maintain ecological health in a stream.
In-stream use -- Use of water that does not require diversion from its natural watercourse. For example, the use of water for navigation, recreation, fish and wildlife, aesthetics, and scenic enjoyment.
Intermittent stream -- Any nonpermanent flowing drainage feature having a definable channel and evidence of scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two criteria.
Irrigation diversion -- Generally, a ditch or channel that deflects water from a stream channel for irrigation purposes.
Islands -- mid-channel bars that are above the average water level and have established woody vegetation.
Kame – a deposit of stratified glacial drift in isolated mounds or steep-sided hills.
Lake -- An inland body of standing water deeper than a pond, an expanded part of a river, a reservoir behind a dam
Landslide -- A movement of earth mass down a steep slope.
Large woody debris (LWD) -- Pieces of wood at least 6 ft. long and 1 ft. in diameter (at the large end) contained, at least partially, within the bankfull area of a channel.
Levee -- An embankment constructed to prevent a river from overflowing (flooding).
Limiting factor -- A requirement such as food, cover, or another physical, chemical, or biological factor that is in shortest supply with respect to all resources necessary to sustain life and thus "limits" the size or retards production of a population.
Low gradient -- streams typically appear slow moving and winding, and have poorly defined riffles and pools.
Macroinvertebrate -- Invertebrates visible to the naked eye, such as insect larvae and crayfish.
Macrophytes -- Aquatic plants that are large enough to be seen with the naked eye.
Main Stem -- The principal channel of a drainage system into which other smaller streams or rivers flow.
Mass movement -- The downslope movement of earth caused by gravity. Includes but is not limited to landslides, rock falls, debris avalanches, and creep. It does not however, include surface erosion by running water. It may be caused by natural erosional processes, or by natural disturbances (e.g., earthquakes or fire events) or human disturbances (e.g., mining or road construction).
Mean annual discharge -- Daily mean discharge averaged over a period of years. Mean annual discharge generally fills a channel to about one-third of its bank-full depth.
Mean velocity -- The average cross-sectional velocity of water in a stream channel. Surface values typically are much higher than bottom velocities. May be approximated in the field by multiplying the surface velocity, as determined with a float, times 0.8.
Meander -- The winding of a stream channel, usually in an erodible alluvial valley. A series of sine-generated curves characterized by curved flow and alternating banks and shoals.
Meander amplitude -- The distance between points of maximum curvature of successive meanders of opposite phase in a direction normal to the general course of the meander belt, measured between center lines of channels.
Meander belt width -- the distance between lines drawn tangential to the extreme limits of fully developed meanders. Not to be confused with meander amplitude.
Meander length -- The lineal distance down valley between two corresponding points of successive meanders of the same phase.
Mid-channel Bars – bars located in the channel away from the banks, generally found in areas where the channel runs straight. Mid-channel bars caused by recent channel instability are unvegetated.
Milligrams per liter (mg/l) -- The weight in milligrams of any substance dissolved in 1 liter of liquid; nearly the same as parts per million by weight.
Moraine – a mass of till either carried by an active glacier or deposited on the land after a glacier recedes.
Natural flow -- The flow past a specified point on a natural stream that is unaffected by stream diversion, storage, import, export, return flow, or change in use caused by modifications in land use.
Neck cutoff -- A channel migration feature where the land that separates a meander bend is cut off by the lateral migration of the channel. This process may be part of the equilibrium regime or associated with channel instability.

Outfall -- The mouth or outlet of a river, stream, lake, drain or sewer.
Outwash – water-transported material carried away from the ablation zone of a melting glacier.
Oxbow -- An abandoned meander in a river or stream, caused by cutoff. Used to describe the U-shaped bend in the river or the land within such a bend of a river.
Peat -- Partially decomposed plants and other organic material that build up in poorly drained wetland habitats.
Perched groundwater -- Groundwater supported by a zone of material of low permeability located above an underlying main body of groundwater with which it is not hydrostatically connected.
Perennial streams -- Streams that flow continuously.
Permeability -- The capability of soil or other geologic formations to transmit water.
pH -- The negative logarithm of the molar concentration of the hydrogen ion, or, more simply acidity.
Planform -- The channel shape as if observed from the air. Changes in planform often involve shifts in large amount of sediment, bank erosion, or the migration of the channel. A channel straightened for agricultural purposes has a highly impacted planform.
Point bar -- The convex side of a meander bend that is built up due to sediment deposition.
Pond -- A body of water smaller than a lake, often artificially formed.
Pool -- A reach of stream that is characterized by deep, low-velocity water and a smooth surface.
Potential plant height -- the height to which a plant, shrub or tree would grow if undisturbed.
Probability of exceedence -- The probability that a random flood will exceed a specified magnitude in a given period of time.
Railroads – Used or unused railroad infrastructure.
Rapids -- A reach of stream that is characterized by small falls and turbulent, high-velocity water.
Reach -- A section of stream having relatively uniform physical attributes, such as valley confinement, valley slope, sinuosity, dominant bed material, and bed form, as determined in the Phase 1 assessment.
Rearing habitat -- Areas in rivers or streams where juvenile fish find food and shelter to live and grow.
Reference stream type --Uses preliminary observations to determine the natural channel form and process that would be present in the absence of anthropogenic impacts to the channel and the surrounding watershed.
Refuge area -- An area within a stream that provides protection to aquatic species during very low and/or high flows.
Regime theory -- A theory of channel formation that applies to streams that make a part of their boundaries from their transported sediment load and a portion of their transported sediment load from their boundaries. Channels are considered in regime or equilibrium when bank erosion and bank formation are equal.
Restoration -- The return of an ecosystem to a close approximation of its condition prior to disturbance.
Riffle -- A reach of stream that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.
Riffle-pool ratio -- The ratio of surface area or length of pools to the surface area or length of riffles in a given stream reach; frequently expressed as the relative percentage of each category. Used to describe fish habitat rearing quality.
Riffle-step ratio-- ratio of the distance between riffles to the stream width.
Riparian area -- An area of land and vegetation adjacent to a stream that has a direct effect on the stream. This includes woodlands, vegetation, and floodplains. Riparian buffer is the width of naturally vegetated land adjacent to the stream between the top of the bank (or top of slope, depending on site characteristics) and the edge of other land uses. A buffer is largely undisturbed and consists of the trees, shrubs, groundcover plants, duff layer, and naturally uneven ground surface. The buffer serves to protect the water body from the impacts of adjacent land uses. Riparian corridor includes lands defined by the lateral extent of a stream's meanders necessary to maintain a stable stream dimension, pattern, profile, and sediment regime. For instance, in stable pool-riffle streams, riparian corridors may be as wide as 10-12 times the channel's bankfull width. In addition the riparian corridor typically corresponds to the land area surrounding and including the stream that supports (or could support if unimpacted) a distinct ecosystem, generally with abundant and diverse plant and animal communities (as compared with upland communities).
Riparian habitat -- The aquatic and terrestrial habitat adjacent to streams, lakes, estuaries, or other waterways.
Riparian -- Located on the banks of a stream or other body of water.
Riparian vegetation -- The plants that grow adjacent to a wetland area such as a river, stream, reservoir, pond, spring, marsh, bog, meadow, etc., and that rely upon the hydrology of the associated water body.
Ripple -- (1) A specific undulated bed form found in sand bed streams. (2) Undulations or waves on the surface of flowing water.
Riprap -- Rock or other material with a specific mixture of sizes referred to as a "gradation," used to stabilize streambanks or riverbanks from erosion or to create habitat features in a stream.
River channels --Large natural or artificial open streams that continuously or periodically contain moving water, or which form a connection between two bodies of water.
River miles --Generally, miles from the mouth of a river to a specific destination or, for upstream tributaries, from the confluence with the main river to a specific destination.

River reach -- Any defined length of a river.
River stage -- The elevation of the water surface at a specified station above some arbitrary zero datum (level).
Riverine -- Relating to, formed by, or resembling a river including tributaries, streams, brooks, etc.
Riverine habitat -- The aquatic habitat within streams and rivers.
Roads -- Transportation infrastructure. Includes private, town, state roads, and roads that are dirt, gravel, or paved.
Rock -- A naturally formed mass of minerals.
Rootwad -- The mass of roots associated with a tree adjacent to or in a stream that provides refuge for fish and other aquatic life.
Run (in stream or river) -- A reach of stream characterized by fast-flowing, low-turbulence water.
Runoff -- Water that flows over the ground and reaches a stream as a result of rainfall or snowmelt.
Sand -- Small substrate particles, generally from 0.002 to 0.08 in diameter. Sand is larger than silt and smaller than gravel.
Scour -- The erosive action of running water in streams, which excavates and carries away material from the bed and banks. Scour may occur in both earth and solid rock material and can be classed as general, contraction, or local scour.
Sediment -- Soil or mineral material transported by water or wind and deposited in streams or other bodies of water.
Sedimentation -- (1) The combined processes of soil erosion, entrainment, transport, deposition, and consolidation. (2) Deposition of sediment.
Seepage -- The gradual movement of a fluid into, through, or from a porous medium. Segment: A relatively homogenous section of stream contained within a reach that has the same reference stream characteristics but is distinct from other segments in the reach in one or more of the following parameters: degree of floodplain encroachment, presence/absence of grade controls, bankfull channel dimensions (W/D ratio, entrenchment), channel sinuosity and slope, riparian buffer and corridor conditions, abundance of springs/seeps/adjacent wetlands/stormwater inputs, and degree of channel alterations.
Sensitivity -- of the valley, floodplain, and/or channel condition to change due to natural causes and/or anticipated human activity.
Shoals -- unvegetated deposits of gravels and cobbles adjacent to the banks that have a height less than the average water level. In channels that are over-widened, the stream does not have the power to transport these larger sediments, and thus they are deposited throughout the channel as shoals.
Silt -- Substrate particles smaller than sand and larger than clay; between 0.0001 and 0.002 inches in diameter.
Siltation -- The deposition or accumulation of fine soil particles.
Sinuosity -- The ratio of channel length to direct down-valley distance. Also may be expressed as the ratio of down-valley slope to channel slope.
Slope -- The ratio of the change in elevation over distance.
Slope stability -- The resistance of a natural or artificial slope or other inclined surface to failure by mass movement.
Snag -- Any standing dead, partially dead, or defective (cull) tree at least 10 in. in diameter at breast height and at least 6 ft tall. Snags are important riparian habitat features.
Spawning -- The depositing and fertilizing of eggs (or roe) by fish and other aquatic life.
Spillway -- A channel for reservoir overflow.
Stable channel -- A stream channel with the right balance of slope, planform, and cross section to transport both the water and sediment load without net long-term bed or bank sediment deposition or erosion throughout the stream segment.
Stone -- Rock or rock fragments used for construction.
Straightening -- the removal of meander bends, often done in towns and along roadways, railroads, and agricultural fields.
Stream -- A general term for a body of water flowing by gravity; natural watercourse containing water at least part of the year. In hydrology, the term is generally applied to the water flowing in a natural narrow channel as distinct from a canal. Stream banks are features that define the channel sides and contain stream flow within the channel; this is the portion of the channel bank that is between the toe of the bank slope and the bankfull elevation. The banks are distinct from the streambed, which is normally wetted and provides a substrate that supports aquatic organisms. The top of bank is the point where an abrupt change in slope is evident, and where the stream is generally able to overflow the banks and enter the adjacent floodplain during flows at or exceeding the average annual high water.
Stream channel -- A long narrow depression shaped by the concentrated flow of a stream and covered continuously or periodically by water.
Stream condition -- Given the land use, channel and floodplain modifications documented at the assessment sites, the current degree of change in the channel and floodplain from the reference condition for parameters such as dimension, pattern, profile, sediment regime, and vegetation.

Stream gradient -- A general slope or rate of change in vertical elevation per unit of horizontal distance of the bed, water surface, or energy grade of a stream.
Stream morphology -- The form and structure of streams.
Stream order -- A hydrologic system of stream classification. Each small unbranched tributary is a first-order stream. Two first-order streams join to make a second-order stream. A third-order stream has only first-and second-order tributaries, and so forth.
Stream reach -- An individual segment of stream that has beginning and ending points defined by identifiable features such as where a tributary confluence changes the channel character or order.
Stream type -- Gives the overall physical characteristics of the channel and helps predict the reference or stable condition of the reach.
Stream type departure -- When the current stream type differs from the reference stream type as a response to anthropogenic or severe natural disturbances. These departures are often characterized by large-scale incision, deposition, or changes in planform.
Streambank armoring – The installation of concrete walls, gabions, stone riprap, and other large erosion resistant material along stream banks.
Streambank erosion -- The removal of soil from streambanks by flowing water.
Streambank stabilization -- The lining of streambanks with riprap, matting, etc., or other measures intended to control erosion.
Streambed -- (1) The unvegetated portion of a channel boundary below the baseflow level. (2) The channel through which a natural stream of water runs or used to run, as a dry streambed.
Streamflow -- The rate at which water passes a given point in a stream or river, usually expressed in cubic feet per second (cfs).
Step (in a river system) --A step is a steep, step-like feature in a high gradient stream (> 2%). Steps are composed of large boulders lines across the stream. Steps are important for providing grade-control, and for dissipating energy. As fast-shallow water flows over the steps it takes various flow paths thus dissipating energy during high flow events.
Substrate -- (1) The composition of a streambed, including either mineral or organic materials. (2) Material that forms an attachment medium for organisms.
Surface erosion -- The detachment and transport of soil particles by wind, water, or gravity. Or a group of processes whereby soil materials are removed by running water, waves and currents, moving ice, or wind.
Surface water -- All waters whose surface is naturally exposed to the atmosphere, for example, rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc., and all springs, wells, or other collectors directly influenced by surface water.
Suspended sediment -- Sediment suspended in a fluid by the upward components of turbulent currents, moving ice, or wind.
Suspended sediment load -- That portion of a stream's total sediment load that is transported within the body of water and has very little contact with the streambed.
Tailwater -- (1) The area immediately downstream of a spillway. (2) Applied irrigation water that runs off the end of a field.
Thalweg -- (1) The lowest thread along the axial part of a valley or stream channel. (2) A subsurface, groundwater stream percolating beneath and in the general direction of a surface stream course or valley. (3) The middle, chief, or deepest part of a navigable channel or waterway.
Tractive Force --The drag on a streambed or bank caused by passing water, which tends to pull soil particles along with the streamflow.
Transpiration -- An essential physiological process in which plant tissues give off water vapor to the atmosphere.
Tributary -- A stream that flows into another stream, river, or lake.
Turbidity -- A measure of the content of suspended matter that interferes with the passage of light through the water or in which visual depth is restricted. Suspended sediments are only one component of turbidity.
Urban runoff -- Storm water from city streets and gutters that usually carries a great deal of litter and organic and bacterial wastes into the sewer systems and receiving waters.
Valley confinement -- Referring to the ratio of valley width to channel width. Unconfined channels (confinement of 4 or greater) flow through broader valleys and typically have higher sinuosity and area for floodplain. Confined channels (confinement of less than 4) typically flow through narrower valleys.
Valley wall -- The side slope of a valley, which begins where the topography transitions from the gentle-sloped valley floor. The distance between valley walls is used to calculate the valley confinement.
Variable-stage stream -- Stream flows perennially but water level rises and falls significantly with storm and runoff events.
Velocity -- In this concept, the speed of water flowing in a watercourse, such as a river.

Washout -- (1) Erosion of a relatively soft surface, such as a roadbed, by a sudden gush of water, as from a downpour or floods. (2) A channel produced by such erosion.
Water quality -- A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Waterfall -- A sudden, nearly vertical drop in a stream, as it flows over rock.
Watershed -- An area of land whose total surface drainage flows to a single point in a stream.
Watershed management -- The analysis, protection, development, operation, or maintenance of the land, vegetation, and water resources of a drainage basin for the conservation of all its resources for the benefit of its residents.
Watershed project -- A comprehensive program of structural and nonstructural measures to preserve or restore a watershed to good hydrologic condition. These measures may include detention reservoirs, dikes, channels, contour trenches, terraces, furrows, gully plugs, revegetation, and possibly other practices to reduce flood peaks and sediment production.
Watershed restoration -- Improving current conditions of watersheds to restore degraded habitat and provide long-term protection to aquatic and riparian resources.
Weir -- A structure to control water levels in a stream. Depending upon the configuration, weirs can provide a specific "rating" for discharge as a function of the upstream water level.
Wetland -- Areas adjacent to, or within the stream, with sufficient surface/groundwater influence to have present hydric soils and aquatic vegetation (e.g. cattails, sedges, rushes, willows or alders).
Width/depth ratio -- The ratio of channel bankfull width to the average bankfull depth. An indicator of channel widening or aggradation, and used for stream type classification.

Rock River

Phase 1 - Reach Summary Report

Basin:	**Missisquoi**	Reach ID:	**QM.01**
Stream Name:	**Rock River**	SGAT Version:	**4.56**
Topo Maps:	**Reach flowing southwest, with mostly farmland adjacent to banks. Vegetated buffers are limited on edge of farmland. Reach includes meanders and the outside extent of one such meander is close to Chemin Luke to the west.**	Date Last Edited:	**October, 18 2019**
Watershed:	**Lewis Creek, Little Otter, Lake Champlain**	QA Status:	**Step 7 done**
Sub-watershed:	**Lake Champlain direct drainage -- Northeast Arm**	Is Reach An Impoundment?:	**#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing southwest, with mostly farmland adjacent to banks. Vegetated buffers are limited on edge of farmland. Reach includes meanders and the outside extent of one such meander is close to Chemin Luke to the west.**

1.2 Towns:

1.3 Downstream Latitude: **45.01470**

1.3 Downstream Longitude: **-73.05692**

Step 2. Stream Type

2.1 Elevation Upstream: **102**

2.1 Elevation Downstream: **97**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **5,440.0** ft. **1.03** Miles

2.3 Valley Slope: **0.1**

2.4 Channel Length: **11,122.8** ft. **2.11** Miles

2.5 Channel Slope: **0.04 %**

2.6 Sinuosity: **2.04**

2.7 Watershed Area: **50.3** Square Miles

2.8 Channel Width: **73.4** feet

2.9 Valley Width: **1,864.0** feet

2.10 Confinement Ratio: **25.4**

2.10 Confinement Type: **Very Broad**

2.11 Reference Stream Type: **E**

Bedform: **Dune-Ripple**

Sub-Class Slope: **None**

Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Steep**

3.4 Valley Slope Right: **Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Crop**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Crop**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**0-25**
Sub-dominant:	**26-50**	**26-50**
Length w / less than 25 ft.:	**7,679.0** ft.	**6,503.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **0** **0.0** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **0.0** **0.0** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **397.6** ft. **3.6**

	One Side	Both Sides
Road:	**397.6** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **Side**

6.4 Meander Migration:

6.5 Meander Width: **554 ft.** Rato: **7.5**

6.6 Wavelength: **802 ft.** Ratio: **10.9**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **None**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	2

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Rock River**

Topo Maps: **Reach flowing west - southwest, with mostly farmland and development (Town of St Armand) adjacent to banks. Vegetated buffers are generally narrow. Reach includes meanders and crosses Chemin Bradly and then Chemin Luke in the middle of the reach.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QM.02**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing west - southwest, with mostly farmland and development (Town of St Armand) adjacent to banks. Vegetated buffers are generally narrow. Reach includes meanders and crosses Chemin Bradly and then Chemin Luke in the middle of the reach.**

1.2 Towns:

1.3 Downstream Latitude: **45.02791**

1.3 Downstream Longitude: **-73.04585**

Step 2. Stream Type

2.1 Elevation Upstream: **105**

2.1 Elevation Downstream: **102**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **3,778.0** ft. **0.72** Miles

2.3 Valley Slope: **0.1**

2.4 Channel Length: **8,166.9** ft. **1.55** Miles

2.5 Channel Slope: **0.04 %**

2.6 Sinuosity: **2.16**

2.7 Watershed Area: **46.7** Square Miles

2.8 Channel Width: **71.1** feet

2.9 Valley Width: **1,230.0** feet

2.10 Confinement Ratio: **17.3**

2.10 Confinement Type: **Very Broad**

2.11 Reference Stream Type: **E**

Bedform: **Dune-Ripple**

Sub-Class Slope: **None**

Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Steep**

3.4 Valley Slope Right: **Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Field**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Field**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**0-25**
Sub-dominant:	**26-50**	**26-50**
Length w / less than 25 ft.:	**3,749.0** ft.	**7,236.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **2** **1.5** %

5.3 Bank Armoring: **66.5** **0.8** %

Left: **0.0** ft. Right: **66.5** ft.

5.4 Channel Straightening: **0.0** **0.0** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **700.4** ft. **8.6**

	One Side	Both Sides
Road:	**700.4** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **1,493.6** ft. **0.0** ft.

6.3 Channel Bars: **Side**

6.4 Meander Migration:

6.5 Meander Width: **585 ft.** Rato: **8.2**

6.6 Wavelength: **610 ft.** Ratio: **8.6**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **None**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	1 Low	1 Low	0 N.S.	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	5

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Rock River**
Topo Maps: **Short reach flowing west, with forested buffers adjacent to banks and farmland further out. Vegetated buffers are wide on left bank and narrower on right bank.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QM.03**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Short reach flowing west, with forested buffers adjacent to banks and farmland further out. Vegetated buffers are wide on left bank and narrower on right bank.**

1.2 Towns:

1.3 Downstream Latitude: **45.03517**

1.3 Downstream Longitude: **-73.03698**

Step 2. Stream Type

2.1 Elevation Upstream: **110**
2.1 Elevation Downstream: **105**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **930.0** ft. **0.18** Miles
2.3 Valley Slope: **0.5**
2.4 Channel Length: **1,162.2** ft. **0.22** Miles
2.5 Channel Slope: **0.41 %**
2.6 Sinuosity: **1.25**
2.7 Watershed Area: **39.5** Square Miles
2.8 Channel Width: **66.0** feet
2.9 Valley Width: **607.0** feet
2.10 Confinement Ratio: **9.2**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Very Steep**
3.4 Valley Slope Right: **Very Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Crop**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**51-100**
Sub-dominant:	**None**	**26-50**
Length w / less than 25 ft.:	**0.0** ft.	**297.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **Side**
6.4 Meander Migration:
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	1 Low	0 N.S.	0 N/A	0 N/A	0 N.S.	0 N.S.	3

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Rock River**
Topo Maps: **Reach flowing north, with forested buffers adjacent to banks and extensive farmland further out. Vegetated buffers vary in width but are relatively wide. Reach crosses Chemin de St Armand 2/3 of the way down the reach.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QM.04**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing north, with forested buffers adjacent to banks and extensive farmland further out. Vegetated buffers vary in width but are relatively wide. Reach crosses Chemin de St Armand 2/3 of the way down the reach.**

1.2 Towns:

1.3 Downstream Latitude: **45.03555**

1.3 Downstream Longitude: **-73.03348**

Step 2. Stream Type

2.1 Elevation Upstream: **134**
2.1 Elevation Downstream: **110**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **3,362.0** ft. **0.64** Miles
2.3 Valley Slope: **0.7**
2.4 Channel Length: **3,676.7** ft. **0.70** Miles
2.5 Channel Slope: **0.64 %**
2.6 Sinuosity: **1.09**
2.7 Watershed Area: **39.4** Square Miles
2.8 Channel Width: **66.0** feet
2.9 Valley Width: **197.0** feet
2.10 Confinement Ratio: **3.0**
2.10 Confinement Type: **Semi-confined**
2.11 Reference Stream Type: **B**
Bedform: **Riffle-Pool**
Sub-Class Slope: **c**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**51-100**	**51-100**
Length w / less than 25 ft.:	**0.0** ft.	**0.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **1** **1.6** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **Side**
6.4 Meander Migration:
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **None**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	0 N/A	0 N/A	0 N.S.	0 N.S.	0

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Rock River**

Topo Maps: **Short reach flowing north with mix of forest and farmland adjacent to banks. Vegetated buffers on edge of farmland of limited extent and mostly on right bank.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QM.05**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Short reach flowing north with mix of forest and farmland adjacent to banks. Vegetated buffers on edge of farmland of limited extent and mostly on right bank.**

1.2 Towns:

1.3 Downstream Latitude: **45.02784**

1.3 Downstream Longitude: **-73.02941**

Step 2. Stream Type

2.1 Elevation Upstream: **137**

2.1 Elevation Downstream: **134**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **2,196.0** ft. **0.42** Miles

2.3 Valley Slope: **0.2**

2.4 Channel Length: **2,459.1** ft. **0.47** Miles

2.5 Channel Slope: **0.13 %**

2.6 Sinuosity: **1.12**

2.7 Watershed Area: **29.7** Square Miles

2.8 Channel Width: **58.3** feet

2.9 Valley Width: **150.0** feet

2.10 Confinement Ratio: **2.6**

2.10 Confinement Type: **Semi-confined**

2.11 Reference Stream Type: **B**

Bedform: **Riffle-Pool**

Sub-Class Slope: **c**

Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Ext. Steep**

3.4 Valley Slope Right: **Ext. Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**0-25**
Sub-dominant:	**51-100**	**26-50**
Length w / less than 25 ft.:	**0.0** ft.	**1,180.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **0** **0.0** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **0.0** **0.0** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration:

6.5 Meander Width: **N/A** Rato: **0.0**

6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	0 N/A	0 N/A	0 N.S.	0 N.S.	2

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Rock River**

Topo Maps: **Long reach flowing northwest with extensive forests and buffers adjacent to banks. Farmland and some development is present further out but vegetated buffers are wide for the most part. Reach crosses Chemin Pelletier S near midpoint.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QM.06**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Long reach flowing northwest with extensive forests and buffers adjacent to banks. Farmland and some development is present further out but vegetated buffers are wide for the most part. Reach crosses Chemin Pelletier S near midpoint.**

1.2 Towns:

1.3 Downstream Latitude: **45.02412**

1.3 Downstream Longitude: **-73.02888**

Step 2. Stream Type

2.1 Elevation Upstream: **173**

2.1 Elevation Downstream: **137**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **7,134.0** ft. **1.35** Miles

2.3 Valley Slope: **0.5**

2.4 Channel Length: **7,827.2** ft. **1.48** Miles

2.5 Channel Slope: **0.47 %**

2.6 Sinuosity: **1.10**

2.7 Watershed Area: **29.5** Square Miles

2.8 Channel Width: **58.0** feet

2.9 Valley Width: **204.0** feet

2.10 Confinement Ratio: **3.5**

2.10 Confinement Type: **Semi-confined**

2.11 Reference Stream Type: **B**

Bedform: **Riffle-Pool**

Sub-Class Slope: **c**

Bed Material:

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **Waterfall**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Ext. Steep**

3.4 Valley Slope Right: **Ext. Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Long flat run leading to a bedrock cascade starting at the bridge

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**51-100**	**51-100**
Length w / less than 25 ft.:	**270.0** ft.	**415.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **1** **0.8** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **0.0** **0.0** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration:

6.5 Meander Width: **N/A** Rato: **0.0**

6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **112.0310898** ft

7.2 Bank Height: **3** ft

7.3 Ice/Debris Jam Potential: **Multiple**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	0 N/A	0 N/A	0 N.S.	1 Low	2

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Menes Brook**

Topo Maps: **Short reach flowing east with land cover dominated by farmland. Vegetated buffers relatively wide in first half of reach. Buffers more limited and channel straightening significant in second half of reach. Reach follows then crosses Chemin Luke.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT1.01**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Short reach flowing east with land cover dominated by farmland. Vegetated buffers relatively wide in first half of reach. Buffers more limited and channel straightening significant in second half of reach. Reach follows then crosses Chemin Luke.**

1.2 Towns:

1.3 Downstream Latitude: **45.02512**

1.3 Downstream Longitude: **-73.05091**

Step 2. Stream Type

2.1 Elevation Upstream: **109**

2.1 Elevation Downstream: **104**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **2,632.0** ft. **0.50** Miles

2.3 Valley Slope: **0.2**

2.4 Channel Length: **3,185.4** ft. **0.60** Miles

2.5 Channel Slope: **0.15 %**

2.6 Sinuosity: **1.21**

2.7 Watershed Area: **2.5** Square Miles

2.8 Channel Width: **19.6** feet

2.9 Valley Width: **429.0** feet

2.10 Confinement Ratio: **21.9**

2.10 Confinement Type: **Very Broad**

2.11 Reference Stream Type: **E**

Bedform: **Dune-Ripple**

Sub-Class Slope: **None**

Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Ext. Steep**

3.4 Valley Slope Right: **Ext. Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Crop**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**26-50**
Sub-dominant:	**26-50**	**0-25**
Length w / less than 25 ft.:	**1,954.0** ft.	**591.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **2** **2.2** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **1,233.0** **38.7** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **382.2** ft. **12.0**

	One Side	Both Sides
Road:	**382.2** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration: **Migration**

6.5 Meander Width: **19 ft.** Rato: **1.0**

6.6 Wavelength: **19 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **374.6412659** ft

7.2 Bank Height: **2** ft

7.3 Ice/Debris Jam Potential: **Culvert**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	1 Low	0 N.S.	0 N.S.	1 Low	2 High	2 High	1 Low	1 Low	12

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Menes Brook**

Topo Maps: **Reach flowing east with land-cover dominated by farmland. Vegetated buffers limited in width and channel straightening significant.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT1.02**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing east with land-cover dominated by farmland. Vegetated buffers limited in width and channel straightening significant.**

1.2 Towns:

1.3 Downstream Latitude: **45.02806**

1.3 Downstream Longitude: **-73.05867**

Step 2. Stream Type

2.1 Elevation Upstream: **124**

2.1 Elevation Downstream: **109**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **3,285.0** ft. **0.62** Miles

2.3 Valley Slope: **0.5**

2.4 Channel Length: **3,388.3** ft. **0.64** Miles

2.5 Channel Slope: **0.45 %**

2.6 Sinuosity: **1.03**

2.7 Watershed Area: **1.9** Square Miles

2.8 Channel Width: **17.5** feet

2.9 Valley Width: **250.0** feet

2.10 Confinement Ratio: **14.3**

2.10 Confinement Type: **Very Broad**

2.11 Reference Stream Type: **C**

Bedform: **Riffle-Pool**

Sub-Class Slope: **None**

Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Steep**

3.4 Valley Slope Right: **Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Crop**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**26-50**	**0-25**
Sub-dominant:	**0-25**	**26-50**
Length w / less than 25 ft.:	**1,802.0** ft.	**2,680.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **1** **0.6** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **1,914.6** **56.5** %

5.5 Dredging History: **Not Evaluated**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **629.5** ft. **18.6**

	One Side	Both Sides
Road:	**629.5** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **147.9** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration:

6.5 Meander Width: **17 ft.** Rato: **1.0**

6.6 Wavelength: **17 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **None**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	9

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Menes Brook**
Topo Maps: **Long reach, consisting mostly of a large wetland system that includes Streit pond.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT1.03**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Long reach, consisting mostly of a large wetland system that includes Streit pond.**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.02938**
1.3 Downstream Longitude: **-73.07043**

Step 2. Stream Type

2.1 Elevation Upstream: **190**
2.1 Elevation Downstream: **124**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **6,445.0** ft. **1.22** Miles
2.3 Valley Slope: **1.0**
2.4 Channel Length: **6,581.7** ft. **1.25** Miles
2.5 Channel Slope: **1.00 %**
2.6 Sinuosity: **1.02**
2.7 Watershed Area: **1.1** Square Miles
2.8 Channel Width: **13.9** feet
2.9 Valley Width: **884.0** feet
2.10 Confinement Ratio: **63.5**
2.10 Confinement Type: **Very Broad**
2.11 Reference Stream Type: **E**
Bedform: **Dune-Ripple**
Sub-Class Slope: **None**
Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Wetland**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**None**	**0-25**
Length w / less than 25 ft.:	**0.0** ft.	**375.0** ft.

4.4 Ground Water Inputs: **Abundant**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **1,161.9** **17.7** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **126.9** ft. **1.9**

	One Side	Both Sides
Road:	**126.9** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **None**
6.4 Meander Migration:
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N/A	0 N/A	0 N.S.	0 N.S.	2

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Swennen Brook**
Topo Maps: **Short reach flowing south with landcover dominated by farmland. Vegetated buffers are limited on both banks.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2.01**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Short reach flowing south with landcover dominated by farmland. Vegetated buffers are limited on both banks.**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.03596**
1.3 Downstream Longitude: **-73.03711**

Step 2. Stream Type

2.1 Elevation Upstream: **108**
2.1 Elevation Downstream: **108**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **1,141.0** ft. **0.22** Miles
2.3 Valley Slope: **0.0**
2.4 Channel Length: **1,169.3** ft. **0.22** Miles
2.5 Channel Slope: **0.03 %**
2.6 Sinuosity: **1.02**
2.7 Watershed Area: **6.8** Square Miles
2.8 Channel Width: **30.5** feet
2.9 Valley Width: **435.0** feet
2.10 Confinement Ratio: **14.3**
2.10 Confinement Type: **Very Broad**
2.11 Reference Stream Type: **E**
Bedform: **Dune-Ripple**
Sub-Class Slope: **None**
Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Hilly**
3.4 Valley Slope Right: **Hilly**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Field**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Field**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**0-25**
Sub-dominant:	**None**	**None**
Length w / less than 25 ft.:	**1,010.0** ft.	**1,012.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **1,025.6** **87.7** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **None**
6.4 Meander Migration:
6.5 Meander Width: **30 ft.** Rato: **1.0**
6.6 Wavelength: **30 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	8

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Swennen Brook**
Topo Maps: **Short reach flowing south with relatively wide forested buffers adjacent to banks and farmland further out.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2.02**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Short reach flowing south with relatively wide forested buffers adjacent to banks and farmland further out.**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.03858**
1.3 Downstream Longitude: **-73.03548**

Step 2. Stream Type

2.1 Elevation Upstream: **109**
2.1 Elevation Downstream: **108**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **819.0** ft. **0.16** Miles
2.3 Valley Slope: **0.1**
2.4 Channel Length: **979.9** ft. **0.19** Miles
2.5 Channel Slope: **0.07 %**
2.6 Sinuosity: **1.20**
2.7 Watershed Area: **6.7** Square Miles
2.8 Channel Width: **30.3** feet
2.9 Valley Width: **204.0** feet
2.10 Confinement Ratio: **6.7**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**51-100**	**51-100**
Length w / less than 25 ft.:	ft.	ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type:
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: ft. Right: ft.
5.4 Channel Straightening: **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	ft.	ft.
Railroad:	ft.	ft.
Berm:	ft.	ft.
Improved Path:	ft.	ft.

6.2 Development: ft. ft.
6.3 Channel Bars: **None**
6.4 Meander Migration:
6.5 Meander Width: **56 ft.** Rato: **1.8**
6.6 Wavelength: **120 ft.** Ratio: **4.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **0** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.D.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 Unk.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	4

Rock River

Phase 1 - Reach Summary Report

Basin:	**Missisquoi**	Reach ID:	**QT2.03**
Stream Name:	**Swennen Brook**	SGAT Version:	**4.56**
Topo Maps:	**Reach flowing south with relatively wide forested buffers adjacent to banks and extensive farmland further out.**	Date Last Edited:	**October, 18 2019**
Watershed:	**Lewis Creek, Little Otter, Lake Champlain**	QA Status:	**Step 7 done**
Sub-watershed:	**Lake Champlain direct drainage -- Northeast Arm**	Is Reach An Impoundment?:	**#Error**

Step 1. Reach Location **Reach flowing south with relatively wide forested buffers adjacent to banks and extensive farmland further out.**

1.1 Reach Description:

1.2 Towns:

1.3 Downstream Latitude: **45.04071**

1.3 Downstream Longitude: **-73.03442**

Step 2. Stream Type

2.1 Elevation Upstream: **119**
2.1 Elevation Downstream: **109**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **4,322.0** ft. **0.82** Miles

2.3 Valley Slope: **0.2**

2.4 Channel Length: **5,348.4** ft. **1.01** Miles

2.5 Channel Slope: **0.20 %**

2.6 Sinuosity: **1.24**

2.7 Watershed Area: **6.7** Square Miles

2.8 Channel Width: **30.2** feet

2.9 Valley Width: **187.0** feet

2.10 Confinement Ratio: **6.2**

2.10 Confinement Type: **Broad**

2.11 Reference Stream Type: **C**

Bedform: **Riffle-Pool**

Sub-Class Slope: **None**

Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Ext. Steep**

3.4 Valley Slope Right: **Ext. Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**51-100**	**51-100**
Length w / less than 25 ft.:	**0.0** ft.	**0.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts:	**1**	**0.4** %
5.3 Bank Armoring:	**0.0**	**0.0** %
Left:	**0.0** ft.	Right: **0.0** ft.
5.4 Channel Straightening:	**0.0**	**0.0** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **Multiple**

6.4 Meander Migration: **Migration**

6.5 Meander Width: **90 ft.** Rato: **3.0**

6.6 Wavelength: **239 ft.** Ratio: **7.9**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	1 Low	1 Low	2 High	1 Low	0 N.S.	0 N.S.	5

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Swennen Brook**
Topo Maps: **Reach flowing south with wide vegetated buffers adjacent to banks and farmland further out.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2.04**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Reach flowing south with wide vegetated buffers adjacent to banks and farmland further out.**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.05107**
1.3 Downstream Longitude: **-73.03583**

Step 2. Stream Type

2.1 Elevation Upstream: **126**
2.1 Elevation Downstream: **119**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **1,905.0** ft. **0.36** Miles
2.3 Valley Slope: **0.3**
2.4 Channel Length: **2,134.4** ft. **0.40** Miles
2.5 Channel Slope: **0.29 %**
2.6 Sinuosity: **1.12**
2.7 Watershed Area: **4.3** Square Miles
2.8 Channel Width: **24.8** feet
2.9 Valley Width: **156.0** feet
2.10 Confinement Ratio: **6.3**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**26-50**	**51-100**
Length w / less than 25 ft.:	**0.0** ft.	**0.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Migration**
6.5 Meander Width: **51 ft.** Rato: **2.1**
6.6 Wavelength: **162 ft.** Ratio: **6.5**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	1 Low	1 Low	2 High	1 Low	0 N.S.	0 N.S.	5

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Swennen Brook**
Topo Maps: **Reach flowing south with mostly wide vegetated buffers adjacent to banks and farmland further out.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2.05**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Reach flowing south with mostly wide vegetated buffers adjacent to banks and farmland further out.**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.05596**
1.3 Downstream Longitude: **-73.03635**

Step 2. Stream Type

2.1 Elevation Upstream: **128**
2.1 Elevation Downstream: **126**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **1,624.0** ft. **0.31** Miles
2.3 Valley Slope: **0.1**
2.4 Channel Length: **1,828.1** ft. **0.35** Miles
2.5 Channel Slope: **0.11 %**
2.6 Sinuosity: **1.13**
2.7 Watershed Area: **2.6** Square Miles
2.8 Channel Width: **19.8** feet
2.9 Valley Width: **166.0** feet
2.10 Confinement Ratio: **8.4**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **E**
Bedform: **Dune-Ripple**
Sub-Class Slope: **None**
Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Crop**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Wetland**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**51-100**	**>100**
Sub-dominant:	**0-25**	**51-100**
Length w / less than 25 ft.:	**299.0** ft.	**0.0** ft.

4.4 Ground Water Inputs: **Abundant**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **305.7** **16.7** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Migration**
6.5 Meander Width: **72 ft.** Rato: **3.6**
6.6 Wavelength: **120 ft.** Ratio: **6.1**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	1 Low	0 N.S.	0 Unk.	0 N.S.	1 Low	1 Low	1 Low	1 Low	0 N.S.	0 N.S.	6

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Swennen Brook**
Topo Maps: **Reach flowing south with land cover dominated by farmland. Straightening is significant and vegetated buffers are limited adjacent to banks.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2.06**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing south with land cover dominated by farmland. Straightening is significant and vegetated buffers are limited adjacent to banks.**
1.2 Towns:
1.3 Downstream Latitude: **45.06008**
1.3 Downstream Longitude: **-73.03541**

Step 2. Stream Type

2.1 Elevation Upstream: **135**
2.1 Elevation Downstream: **128**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **2,042.0** ft. **0.39** Miles
2.3 Valley Slope: **0.3**
2.4 Channel Length: **2,123.0** ft. **0.40** Miles
2.5 Channel Slope: **0.33 %**
2.6 Sinuosity: **1.04**
2.7 Watershed Area: **2.3** Square Miles
2.8 Channel Width: **18.8** feet
2.9 Valley Width: **168.0** feet
2.10 Confinement Ratio: **9.0**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Steep**
3.4 Valley Slope Right: **Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Crop**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Crop**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**0-25**
Sub-dominant:	**None**	**None**
Length w / less than 25 ft.:	**2,122.0** ft.	**1,796.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **1,822.4** **85.8** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **None**
6.4 Meander Migration:
6.5 Meander Width: **18 ft.** Rato: **1.0**
6.6 Wavelength: **18 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	8

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Swennen Brook**
Topo Maps: **Long reach flowing south with land cover dominated by farmland. Straightening is significant and vegetated buffers are limited adjacent to banks. The reach crosses Chemin de Philipsburg in the northern part of the reach.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2.07**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Long reach flowing south with land cover dominated by farmland. Straightening is significant and vegetated buffers are limited adjacent to banks. The reach crosses Chemin de Philipsburg in the northern part of the reach.**

1.2 Towns:

1.3 Downstream Latitude: **45.06441**

1.3 Downstream Longitude: **-73.03119**

Step 2. Stream Type

2.1 Elevation Upstream: **176**
2.1 Elevation Downstream: **135**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **9,793.0** ft. **1.85** Miles
2.3 Valley Slope: **0.4**
2.4 Channel Length: **10,238.1** ft. **1.94** Miles
2.5 Channel Slope: **0.40 %**
2.6 Sinuosity: **1.05**
2.7 Watershed Area: **2.1** Square Miles
2.8 Channel Width: **18.1** feet
2.9 Valley Width: **686.0** feet
2.10 Confinement Ratio: **38.0**
2.10 Confinement Type: **Very Broad**
2.11 Reference Stream Type: **E**
Bedform: **Dune-Ripple**
Sub-Class Slope: **None**
Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Hilly**
3.4 Valley Slope Right: **Hilly**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Field**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Field**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**0-25**
Sub-dominant:	**26-50**	**26-50**
Length w / less than 25 ft.:	**9,329.0** ft.	**8,292.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **3** **0.8** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **9,152.0** **89.4** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **179.7** ft. **1.8**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**179.7** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **None**
6.4 Meander Migration: **Migration**
6.5 Meander Width: **18 ft.** Rato: **1.0**
6.6 Wavelength: **18 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential:

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	0 N.S.	1 Low	2 High	2 High	0 N.S.	0 N.S.	9

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **QT2S1 - Unnamed-1 to Sween Brook**
Topo Maps: **Very short reach flowing west. Wide forested buffers adjacent to banks and farmland present further out.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2S1.01**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Very short reach flowing west. Wide forested buffers adjacent to banks and farmland present further out.**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.04085**
1.3 Downstream Longitude: **-73.03445**

Step 2. Stream Type

2.1 Elevation Upstream: **112**
2.1 Elevation Downstream: **110**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **272.0** ft. **0.05** Miles
2.3 Valley Slope: **0.9**
2.4 Channel Length: **275.4** ft. **0.05** Miles
2.5 Channel Slope: **0.91 %**
2.6 Sinuosity: **1.01**
2.7 Watershed Area: **1.2** Square Miles
2.8 Channel Width: **14.4** feet
2.9 Valley Width: **94.0** feet
2.10 Confinement Ratio: **6.5**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**None**	**None**
Length w / less than 25 ft.:	ft.	ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type:
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: ft. Right: ft.
5.4 Channel Straightening: **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	ft.	ft.
Railroad:	ft.	ft.
Berm:	ft.	ft.
Improved Path:	ft.	ft.

6.2 Development: ft. ft.
6.3 Channel Bars: **None**
6.4 Meander Migration:
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **0** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.D.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N/A	0 N/A	0 N.S.	0 N.S.	0

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **QT2S1 - Unnamed-1 to Sween Brook**
Topo Maps: **Reach flowing west. Forested buffers of varying width adjacent to banks and farmland present further out.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2S1.02**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Reach flowing west. Forested buffers of varying width adjacent to banks and farmland present further out.**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.04120**
1.3 Downstream Longitude: **-73.03359**

Step 2. Stream Type

2.1 Elevation Upstream: **186**
2.1 Elevation Downstream: **112**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **2,020.0** ft. **0.38** Miles
2.3 Valley Slope: **3.7**
2.4 Channel Length: **2,024.8** ft. **0.38** Miles
2.5 Channel Slope: **3.65 %**
2.6 Sinuosity: **1.00**
2.7 Watershed Area: **0.1** Square Miles
2.8 Channel Width: **5.4** feet
2.9 Valley Width: **52.0** feet
2.10 Confinement Ratio: **9.7**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **B**
Bedform: **Step-Pool**
Sub-Class Slope: **None**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**51-100**	**51-100**
Sub-dominant:	**>100**	**0-25**
Length w / less than 25 ft.:	**0.0** ft.	**432.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **None**
6.4 Meander Migration:
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	0 N/A	0 N/A	0 N.S.	0 N.S.	2

Rock River

Phase 1 - Reach Summary Report

Basin:	**Missisquoi**	Reach ID:	**QT2S2.01**
Stream Name:	**Unnamed-2 to Sween Brook**	SGAT Version:	**4.56**
Topo Maps:	**Reach flowing east with land cover a mix of forest and farmland. Vegetated buffers adjacent to banks somewhat narrow on edge of fields.**	Date Last Edited:	**October, 18 2019**
Watershed:	**Lewis Creek, Little Otter, Lake Champlain**	QA Status:	**Step 7 done**
Sub-watershed:	**Lake Champlain direct drainage -- Northeast Arm**	Is Reach An Impoundment?:	**#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing east with land cover a mix of forest and farmland. Vegetated buffers adjacent to banks somewhat narrow on edge of fields.**

1.2 Towns:

1.3 Downstream Latitude: **45.05158**

1.3 Downstream Longitude: **-73.03648**

Step 2. Stream Type

2.1 Elevation Upstream: **156**

2.1 Elevation Downstream: **122**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **2,448.0** ft. **0.46** Miles

2.3 Valley Slope: **1.4**

2.4 Channel Length: **2,711.6** ft. **0.51** Miles

2.5 Channel Slope: **1.27 %**

2.6 Sinuosity: **1.11**

2.7 Watershed Area: **0.5** Square Miles

2.8 Channel Width: **9.5** feet

2.9 Valley Width: **80.0** feet

2.10 Confinement Ratio: **8.4**

2.10 Confinement Type: **Broad**

2.11 Reference Stream Type: **E**

Bedform: **Dune-Ripple**

Sub-Class Slope: **None**

Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Ext. Steep**

3.4 Valley Slope Right: **Ext. Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Crop**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**51-100**
Sub-dominant:	**26-50**	**26-50**
Length w / less than 25 ft.:	**0.0** ft.	**0.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts:	**0**	**0.0** %
5.3 Bank Armoring:	**0.0**	**0.0** %
Left:	**0.0** ft.	Right: **0.0** ft.
5.4 Channel Straightening:	**146.9**	**5.4** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration:

6.5 Meander Width: **35 ft.** Rato: **3.7**

6.6 Wavelength: **59 ft.** Ratio: **6.2**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **None**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	1 Low	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	1 Low	1 Low	0 N.S.	0 N.S.	3

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Unnamed-2 to Sween Brook**

Topo Maps: **Reach flowing north - northeast with land cover dominated by extensive forests in first half and farmland in second half of reach. Channel straightening significant and vegetated buffers limited in second half. Reach crosses Chemin de St Henri.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2S2.02**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing north - northeast with land cover dominated by extensive forests in first half and farmland in second half of reach. Channel straightening significant and vegetated buffers limited in second half. Reach crosses Chemin de St Henri.**

1.2 Towns:

1.3 Downstream Latitude: **45.05054**

1.3 Downstream Longitude: **-73.04447**

Step 2. Stream Type

2.1 Elevation Upstream: **200**

2.1 Elevation Downstream: **156**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **4,680.0** ft. **0.89** Miles

2.3 Valley Slope: **0.9**

2.4 Channel Length: **4,681.5** ft. **0.89** Miles

2.5 Channel Slope: **0.93 %**

2.6 Sinuosity: **1.00**

2.7 Watershed Area: **0.4** Square Miles

2.8 Channel Width: **8.4** feet

2.9 Valley Width: **161.0** feet

2.10 Confinement Ratio: **19.1**

2.10 Confinement Type: **Very Broad**

2.11 Reference Stream Type: **C**

Bedform: **Riffle-Pool**

Sub-Class Slope: **None**

Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Hilly**

3.4 Valley Slope Right: **Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**0-25**
Sub-dominant:	**>100**	**>100**
Length w / less than 25 ft.:	**2,091.0** ft.	**2,691.0** ft.

4.4 Ground Water Inputs: **Abundant**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **4** **2.5** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **2,148.0** **45.9** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **603.2** ft. **0.0** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration:

6.5 Meander Width: **N/A** Rato: **0.0**

6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	0 Unk.	1 Low	0 N.S.	0 N.S.	0 N/A	0 N/A	0 N.S.	0 N.S.	5

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Unnamed-3 to Sween Brook**

Topo Maps: **Reach flowing east. First half of reach dominated by farmland with vegetated buffers varying in width. Second half of reach is extensively forested.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2S3.01**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing east. First half of reach dominated by farmland with vegetated buffers varying in width. Second half of reach is extensively forested.**

1.2 Towns:

1.3 Downstream Latitude: **45.05570**

1.3 Downstream Longitude: **-73.03640**

Step 2. Stream Type

2.1 Elevation Upstream: **143**

2.1 Elevation Downstream: **124**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **2,439.0** ft. **0.46** Miles

2.3 Valley Slope: **0.8**

2.4 Channel Length: **2,786.0** ft. **0.53** Miles

2.5 Channel Slope: **0.69 %**

2.6 Sinuosity: **1.14**

2.7 Watershed Area: **1.2** Square Miles

2.8 Channel Width: **13.9** feet

2.9 Valley Width: **101.0** feet

2.10 Confinement Ratio: **7.2**

2.10 Confinement Type: **Broad**

2.11 Reference Stream Type: **C**

Bedform: **Riffle-Pool**

Sub-Class Slope: **None**

Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Ext. Steep**

3.4 Valley Slope Right: **Ext. Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**51-100**	**0-25**
Length w / less than 25 ft.:	**0.0** ft.	**223.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **0** **0.0** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **0.0** **0.0** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration:

6.5 Meander Width: **47 ft.** Rato: **3.4**

6.6 Wavelength: **100 ft.** Ratio: **7.2**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	1 Low	1 Low	0 N.S.	0 N.S.	3

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Unnamed-3 to Sween Brook**

Topo Maps: **Reach flowing south with land cover dominated by farmland. Straightening in the reach is significant and vegetated buffers adjacent to banks are narrow.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT2S3.02**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing south with land cover dominated by farmland. Straightening in the reach is significant and vegetated buffers adjacent to banks are narrow.**

1.2 Towns:

1.3 Downstream Latitude: **45.05651**

1.3 Downstream Longitude: **-73.04520**

Step 2. Stream Type

2.1 Elevation Upstream: **145**

2.1 Elevation Downstream: **143**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **2,465.0** ft. **0.47** Miles

2.3 Valley Slope: **0.1**

2.4 Channel Length: **2,526.2** ft. **0.48** Miles

2.5 Channel Slope: **0.08 %**

2.6 Sinuosity: **1.02**

2.7 Watershed Area: **0.9** Square Miles

2.8 Channel Width: **12.7** feet

2.9 Valley Width: **117.0** feet

2.10 Confinement Ratio: **9.2**

2.10 Confinement Type: **Broad**

2.11 Reference Stream Type: **E**

Bedform: **Dune-Ripple**

Sub-Class Slope: **None**

Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Hilly**

3.4 Valley Slope Right: **Hilly**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Field**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**0-25**
Sub-dominant:	**None**	**None**
Length w / less than 25 ft.:	**2,511.0** ft.	**2,526.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **1** **0.8** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **2,497.7** **98.9** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration:

6.5 Meander Width: **12 ft.** Rato: **1.0**

6.6 Wavelength: **12 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	8

Rock River

Phase 1 - Reach Summary Report

Basin:	**Missisquoi**	Reach ID:	**QT2S3.03**
Stream Name:	**Unnamed-3 to Sween Brook**	SGAT Version:	**4.56**
Topo Maps:	**Reach flowing south with land cover dominated by farmland. Straightening in the reach is significant and vegetated buffers adjacent to banks are usually narrow. Reach runs parallel to Chemin de St Henri to the west.**	Date Last Edited:	**October, 18 2019**
Watershed:	**Lewis Creek, Little Otter, Lake Champlain**	QA Status:	**Step 7 done**
Sub-watershed:	**Lake Champlain direct drainage -- Northeast Arm**	Is Reach An Impoundment?:	**#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing south with land cover dominated by farmland. Straightening in the reach is significant and vegetated buffers adjacent to banks are usually narrow. Reach runs parallel to Chemin de St Henri to the west.**

1.2 Towns:

1.3 Downstream Latitude: **45.06236**

1.3 Downstream Longitude: **-73.04539**

Step 2. Stream Type

2.1 Elevation Upstream: **153**

2.1 Elevation Downstream: **145**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **2,650.0** ft. **0.50** Miles

2.3 Valley Slope: **0.3**

2.4 Channel Length: **2,722.6** ft. **0.52** Miles

2.5 Channel Slope: **0.30 %**

2.6 Sinuosity: **1.03**

2.7 Watershed Area: **0.5** Square Miles

2.8 Channel Width: **9.5** feet

2.9 Valley Width: **177.0** feet

2.10 Confinement Ratio: **18.7**

2.10 Confinement Type: **Very Broad**

2.11 Reference Stream Type: **E**

Bedform: **Dune-Ripple**

Sub-Class Slope: **None**

Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Steep**

3.4 Valley Slope Right: **Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Crop**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Crop**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**0-25**
Sub-dominant:	**>100**	**None**
Length w / less than 25 ft.:	**2,485.0** ft.	**2,701.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **2** **1.3** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **2,686.4** **98.7** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration:

6.5 Meander Width: **9 ft.** Rato: **1.0**

6.6 Wavelength: **9 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	8

Rock River

Phase 1 - Reach Summary Report

Basin:	**Missisquoi**	Reach ID:	**QT3.01**
Stream Name:	**Brandy Brook**	SGAT Version:	**4.56**
Topo Maps:	**Short reach flowing west to the confluence with the Rock River. Stream crosses Chemin Pelletier S near midpoint of reach.**	Date Last Edited:	**October, 18 2019**
Watershed:	**Lewis Creek, Little Otter, Lake Champlain**	QA Status:	**Step 7 done**
Sub-watershed:	**Lake Champlain direct drainage -- Northeast Arm**	Is Reach An Impoundment?:	**#Error**

Step 1. Reach Location

1.1 Reach Description: **Short reach flowing west to the confluence with the Rock River. Stream crosses Chemin Pelletier S near midpoint of reach.**

1.2 Towns:

1.3 Downstream Latitude: **45.02830**

1.3 Downstream Longitude: **-73.02897**

Step 2. Stream Type

2.1 Elevation Upstream: **145**

2.1 Elevation Downstream: **135**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **812.0** ft. **0.15** Miles

2.3 Valley Slope: **1.3**

2.4 Channel Length: **818.6** ft. **0.16** Miles

2.5 Channel Slope: **1.25 %**

2.6 Sinuosity: **1.01**

2.7 Watershed Area: **9.4** Square Miles

2.8 Channel Width: **35.1** feet

2.9 Valley Width: **71.0** feet

2.10 Confinement Ratio: **2.0**

2.10 Confinement Type: **Semi-confined**

2.11 Reference Stream Type: **B**

Bedform: **Riffle-Pool**

Sub-Class Slope: **c**

Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Ext. Steep**

3.4 Valley Slope Right: **Ext. Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Crop**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**0-25**
Sub-dominant:	**51-100**	**26-50**
Length w / less than 25 ft.:	**0.0** ft.	**337.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **1** **6.1** %

5.3 Bank Armoring: **132.4** **16.2** %

Left: **67.5** ft. Right: **64.8** ft.

5.4 Channel Straightening: **0.0** **0.0** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **Multiple**

6.4 Meander Migration: **Migration**

6.5 Meander Width: **N/A** Rato: **0.0**

6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **Multiple**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	1 Low	1 Low	0 N.S.	0 N.S.	0 Unk.	0 N.S.	1 Low	0 N.S.	0 N/A	0 N/A	0 N.S.	1 Low	6

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Brandy Brook**
Topo Maps: **Short reach flowing west, with farmland and forests adjacent to banks**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT3.02**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Short reach flowing west, with farmland and forests adjacent to banks**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.02839**
1.3 Downstream Longitude: **-73.02645**

Step 2. Stream Type

2.1 Elevation Upstream: **146**
2.1 Elevation Downstream: **145**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **876.0** ft. **0.17** Miles
2.3 Valley Slope: **0.1**
2.4 Channel Length: **1,296.2** ft. **0.25** Miles
2.5 Channel Slope: **0.04 %**
2.6 Sinuosity: **1.48**
2.7 Watershed Area: **9.4** Square Miles
2.8 Channel Width: **35.0** feet
2.9 Valley Width: **245.0** feet
2.10 Confinement Ratio: **7.0**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **E**
Bedform: **Dune-Ripple**
Sub-Class Slope: **None**
Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Very Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Crop**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**51-100**	**26-50**
Sub-dominant:	**>100**	**26-50**
Length w / less than 25 ft.:	**0.0** ft.	**158.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **No Data**
6.4 Meander Migration:
6.5 Meander Width: **79 ft.** Rato: **2.3**
6.6 Wavelength: **207 ft.** Ratio: **5.9**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	5

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Brandy Brook**
Topo Maps: **Short reach flowing south, with forests adjacent to banks and farmland further out**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT3.03**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Short reach flowing south, with forests adjacent to banks and farmland further out**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.02927**
1.3 Downstream Longitude: **-73.02310**

Step 2. Stream Type

2.1 Elevation Upstream: **157**
2.1 Elevation Downstream: **146**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **832.0** ft. **0.16** Miles
2.3 Valley Slope: **1.4**
2.4 Channel Length: **1,489.2** ft. **0.28** Miles
2.5 Channel Slope: **0.80 %**
2.6 Sinuosity: **1.79**
2.7 Watershed Area: **9.1** Square Miles
2.8 Channel Width: **34.6** feet
2.9 Valley Width: **243.0** feet
2.10 Confinement Ratio: **7.0**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**0-25**	**0-25**
Length w / less than 25 ft.:	**133.0** ft.	**91.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **No Data**
6.4 Meander Migration:
6.5 Meander Width: **80 ft.** Rato: **2.3**
6.6 Wavelength: **260 ft.** Ratio: **7.5**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	2 High	1 Low	0 N.S.	0 N.S.	4

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Brandy Brook**
Topo Maps: **Short reach flowing southwest, with extensive forests adjacent to banks and some farmland further out**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT3.04**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Short reach flowing southwest, with extensive forests adjacent to banks and some farmland further out**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.03127**
1.3 Downstream Longitude: **-73.02226**

Step 2. Stream Type

2.1 Elevation Upstream: **170**
2.1 Elevation Downstream: **157**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **679.0** ft. **0.13** Miles
2.3 Valley Slope: **1.8**
2.4 Channel Length: **755.1** ft. **0.14** Miles
2.5 Channel Slope: **1.62 %**
2.6 Sinuosity: **1.11**
2.7 Watershed Area: **9.0** Square Miles
2.8 Channel Width: **34.4** feet
2.9 Valley Width: **102.0** feet
2.10 Confinement Ratio: **3.0**
2.10 Confinement Type: **Semi-confined**
2.11 Reference Stream Type: **B**
Bedform: **Riffle-Pool**
Sub-Class Slope: **c**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**None**	**51-100**
Length w / less than 25 ft.:	ft.	ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type:
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: ft. Right: ft.
5.4 Channel Straightening: **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	ft.	ft.
Railroad:	ft.	ft.
Berm:	ft.	ft.
Improved Path:	ft.	ft.

6.2 Development: ft. ft.
6.3 Channel Bars: **None**
6.4 Meander Migration:
6.5 Meander Width: **117 ft.** Ratio: **3.4**
6.6 Wavelength: **306 ft.** Ratio: **8.9**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **0** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.D.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 Unk.	0 N.S.	0 N.S.	1 Low	0 N.S.	0 N.S.	0 N.S.	1

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Brandy Brook**
Topo Maps: **Reach flowing west, with forests adjacent to banks and farmland further out**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT3.05**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Reach flowing west, with forests adjacent to banks and farmland further out**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.03219**
1.3 Downstream Longitude: **-73.02010**

Step 2. Stream Type

2.1 Elevation Upstream: **192**
2.1 Elevation Downstream: **170**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **1,853.0** ft. **0.35** Miles
2.3 Valley Slope: **1.2**
2.4 Channel Length: **2,613.5** ft. **0.49** Miles
2.5 Channel Slope: **0.84 %**
2.6 Sinuosity: **1.41**
2.7 Watershed Area: **8.9** Square Miles
2.8 Channel Width: **34.4** feet
2.9 Valley Width: **196.0** feet
2.10 Confinement Ratio: **5.7**
2.10 Confinement Type: **Narrow**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Field**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**26-50**	**51-100**
Length w / less than 25 ft.:	**116.0** ft.	**0.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Migration**
6.5 Meander Width: **110 ft.** Rato: **3.2**
6.6 Wavelength: **195 ft.** Ratio: **5.7**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 N.S.	1 Low	1 Low	1 Low	2 High	0 N.S.	0 N.S.	5

Rock River

Phase 1 - Reach Summary Report

Basin:	**Missisquoi**	Reach ID:	**QT3.06**
Stream Name:	**Brandy Brook**	SGAT Version:	**4.56**
Topo Maps:	**Reach flowing west - southwest, with limited vegetated buffers adjacent to banks and extensive farmland further out. Reach is straightened and crosses road Chemin Dutch (Route 235) near midpoint.**	Date Last Edited:	**October, 18 2019**
Watershed:	**Lewis Creek, Little Otter, Lake Champlain**	QA Status:	**Step 7 done**
Sub-watershed:	**Lake Champlain direct drainage -- Northeast Arm**	Is Reach An Impoundment?:	**#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing west - southwest, with limited vegetated buffers adjacent to banks and extensive farmland further out. Reach is straightened and crosses road Chemin Dutch (Route 235) near midpoint.**

1.2 Towns:

1.3 Downstream Latitude: **45.03339**

1.3 Downstream Longitude: **-73.01352**

Step 2. Stream Type

2.1 Elevation Upstream: **208**

2.1 Elevation Downstream: **192**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **2,037.0** ft. **0.39** Miles

2.3 Valley Slope: **0.8**

2.4 Channel Length: **2,038.7** ft. **0.39** Miles

2.5 Channel Slope: **0.83 %**

2.6 Sinuosity: **1.00**

2.7 Watershed Area: **8.8** Square Miles

2.8 Channel Width: **34.1** feet

2.9 Valley Width: **173.0** feet

2.10 Confinement Ratio: **5.1**

2.10 Confinement Type: **Narrow**

2.11 Reference Stream Type: **C**

Bedform: **Riffle-Pool**

Sub-Class Slope: **None**

Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Hilly**

3.4 Valley Slope Right: **Hilly**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Field**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Field**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**0-25**
Sub-dominant:	**26-50**	**26-50**
Length w / less than 25 ft.:	**1,280.0** ft.	**1,456.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **2** **4.4** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **1,924.1** **94.4** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **Multiple**

6.4 Meander Migration:

6.5 Meander Width: **34 ft.** Rato: **1.0**

6.6 Wavelength: **34 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **None**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	0 Unk.	0 N.S.	1 Low	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	9

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Brandy Brook**
Topo Maps: **Short reach flowing west, with forests adjacent to banks and farmland a short distance from left bank.**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT3.07**
SGAT Version: **4.56**
Date Last Edited: **September, 16 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location **Short reach flowing west, with forests adjacent to banks and farmland a short distance from left bank.**

1.1 Reach Description:
1.2 Towns:
1.3 Downstream Latitude: **45.03590**
1.3 Downstream Longitude: **-73.00672**

Step 2. Stream Type

2.1 Elevation Upstream: **234**
2.1 Elevation Downstream: **208**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **1,170.0** ft. **0.22** Miles
2.3 Valley Slope: **2.2**
2.4 Channel Length: **1,171.9** ft. **0.22** Miles
2.5 Channel Slope: **2.20 %**
2.6 Sinuosity: **1.00**
2.7 Watershed Area: **7.5** Square Miles
2.8 Channel Width: **31.8** feet
2.9 Valley Width: **171.0** feet
2.10 Confinement Ratio: **5.4**
2.10 Confinement Type: **Narrow**
2.11 Reference Stream Type: **B**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**51-100**	**None**
Length w / less than 25 ft.:	ft.	ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type:
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: ft. Right: ft.
5.4 Channel Straightening: **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	ft.	ft.
Railroad:	ft.	ft.
Berm:	ft.	ft.
Improved Path:	ft.	ft.

6.2 Development: ft. ft.
6.3 Channel Bars: **None**
6.4 Meander Migration:
6.5 Meander Width: **107 ft.** Ratio: **3.4**
6.6 Wavelength: **194 ft.** Ratio: **6.1**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **0** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.D.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 Unk.	0 N.S.	0 N.S.	1 Low	1 Low	0 N.S.	0 N.S.	2

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Brandy Brook**
Topo Maps: **Short reach flowing west, with moderately extensive forests adjacent to both banks and some farmland further out**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT3.08**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Short reach flowing west, with moderately extensive forests adjacent to both banks and some farmland further out**

1.2 Towns:

1.3 Downstream Latitude: **45.03609**

1.3 Downstream Longitude: **-73.00313**

Step 2. Stream Type

2.1 Elevation Upstream: **251**
2.1 Elevation Downstream: **234**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **1,827.0** ft. **0.35** Miles
2.3 Valley Slope: **0.9**
2.4 Channel Length: **1,828.2** ft. **0.35** Miles
2.5 Channel Slope: **0.90 %**
2.6 Sinuosity: **1.00**
2.7 Watershed Area: **7.4** Square Miles
2.8 Channel Width: **31.5** feet
2.9 Valley Width: **70.0** feet
2.10 Confinement Ratio: **2.2**
2.10 Confinement Type: **Semi-confined**
2.11 Reference Stream Type: **B**
Bedform: **Riffle-Pool**
Sub-Class Slope: **c**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**51-100**	**26-50**
Length w / less than 25 ft.:	ft.	ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type:
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: ft. Right: ft.
5.4 Channel Straightening: **0.0** %
5.5 Dredging History: **No Data**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	ft.	ft.
Railroad:	ft.	ft.
Berm:	ft.	ft.
Improved Path:	ft.	ft.

6.2 Development: ft. ft.
6.3 Channel Bars: **None**
6.4 Meander Migration:
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **0** ft
7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	0 N.D.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 Unk.	0 Unk.	0 N.S.	0 N.S.	0 N/A	0 N/A	0 N.S.	0 N.S.	0

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**
Stream Name: **Brandy Brook**
Topo Maps: **Very long reach with significant straightening and limited vegetated buffers. Land cover includes some forest but is dominated by farmland. The reach crosses two roads: Chemin Dutch 2/3 of the way down and Chemin Beaulac early in the reach**
Watershed: **Lewis Creek, Little Otter, Lake Champlain**
Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT3.09**
SGAT Version: **4.56**
Date Last Edited: **October, 18 2019**
QA Status: **Step 7 done**
Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Very long reach with significant straightening and limited vegetated buffers. Land cover includes some forest but is dominated by farmland. The reach crosses two roads: Chemin Dutch 2/3 of the way down and Chemin Beaulac early in the reach**

1.2 Towns:

1.3 Downstream Latitude: **45.03489**

1.3 Downstream Longitude: **-72.99846**

Step 2. Stream Type

2.1 Elevation Upstream: **335**
2.1 Elevation Downstream: **251**
2.1 Is Gradient Gentle?: **#Error**
2.2 Valley Length: **23,323.0** ft. **4.42** Miles
2.3 Valley Slope: **0.4**
2.4 Channel Length: **24,402.9** ft. **4.62** Miles
2.5 Channel Slope: **0.34 %**
2.6 Sinuosity: **1.05**
2.7 Watershed Area: **7.2** Square Miles
2.8 Channel Width: **31.1** feet
2.9 Valley Width: **477.0** feet
2.10 Confinement Ratio: **15.3**
2.10 Confinement Type: **Very Broad**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: %
3.3 Sub-dom. Geological Mat.:
3.4 Valley Slope Left: **Flat**
3.4 Valley Slope Right: **Flat**
3.5 Soils
Hydrologic Group: %
Flooding: %
Water Table Deep: %
Water Table Shallow: %
Erodibility: **slight** %
7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:
4.2 Corridor
Historic Land Cover:: **Forest**
Current Dominant Land Cover: %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**0-25**
Sub-dominant:	**0-25**	**>100**
Length w / less than 25 ft.:	**9,891.0** ft.	**24,595.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**
Type: **None**
Use:
5.2 Bridges and Culverts: **2** **0.5** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **23,667.9** **97.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **9,877.0** ft. **40.5**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**9,877.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.
6.3 Channel Bars: **No Data**
6.4 Meander Migration:
6.5 Meander Width: **31 ft.** Rato: **1.0**
6.6 Wavelength: **31 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **None**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	10

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Unnamed-1 to Brady Brook**

Topo Maps: **Reach flowing southwest, with mix of forests and farmland adjacent to banks. Vegetated buffers are limited on edge of fields. Reach is straightened and crosses Chemin St Armand near midpoint.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT3S1.01**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing southwest, with mix of forests and farmland adjacent to banks. Vegetated buffers are limited on edge of fields. Reach is straightened and crosses Chemin St Armand near midpoint.**

1.2 Towns:

1.3 Downstream Latitude: **45.03497**

1.3 Downstream Longitude: **-73.01037**

Step 2. Stream Type

2.1 Elevation Upstream: **253**

2.1 Elevation Downstream: **195**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **4,282.0** ft. **0.81** Miles

2.3 Valley Slope: **1.4**

2.4 Channel Length: **4,283.3** ft. **0.81** Miles

2.5 Channel Slope: **1.36 %**

2.6 Sinuosity: **1.00**

2.7 Watershed Area: **1.2** Square Miles

2.8 Channel Width: **14.1** feet

2.9 Valley Width: **98.0** feet

2.10 Confinement Ratio: **6.9**

2.10 Confinement Type: **Broad**

2.11 Reference Stream Type: **C**

Bedform: **Riffle-Pool**

Sub-Class Slope: **None**

Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Ext. Steep**

3.4 Valley Slope Right: **Ext. Steep**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**0-25**
Sub-dominant:	**0-25**	**>100**
Length w / less than 25 ft.:	**953.0** ft.	**1,889.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **3** **3.3** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **4,040.3** **94.3** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **None**

6.4 Meander Migration:

6.5 Meander Width: **14 ft.** Rato: **1.0**

6.6 Wavelength: **14 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **None**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	8

Rock River

Phase 1 - Reach Summary Report

Basin: **Missisquoi**

Stream Name: **Unnamed-1 to Brady Brook**

Topo Maps: **Reach flowing south with mix of forests and farmland adjacent to banks. Vegetated buffers are limited on edge of fields. Reach is heavily straightened.**

Watershed: **Lewis Creek, Little Otter, Lake Champlain**

Sub-watershed: **Lake Champlain direct drainage -- Northeast Arm**

Reach ID: **QT3S1.02**

SGAT Version: **4.56**

Date Last Edited: **October, 18 2019**

QA Status: **Step 7 done**

Is Reach An Impoundment?: **#Error**

Step 1. Reach Location

1.1 Reach Description: **Reach flowing south with mix of forests and farmland adjacent to banks. Vegetated buffers are limited on edge of fields. Reach is heavily straightened.**

1.2 Towns:

1.3 Downstream Latitude: **45.04434**

1.3 Downstream Longitude: **-73.00134**

Step 2. Stream Type

2.1 Elevation Upstream: **270**

2.1 Elevation Downstream: **253**

2.1 Is Gradient Gentle?: **#Error**

2.2 Valley Length: **7,775.0** ft. **1.47** Miles

2.3 Valley Slope: **0.2**

2.4 Channel Length: **7,982.6** ft. **1.51** Miles

2.5 Channel Slope: **0.20 %**

2.6 Sinuosity: **1.03**

2.7 Watershed Area: **0.7** Square Miles

2.8 Channel Width: **11.0** feet

2.9 Valley Width: **109.0** feet

2.10 Confinement Ratio: **9.9**

2.10 Confinement Type: **Broad**

2.11 Reference Stream Type: **E**

Bedform: **Dune-Ripple**

Sub-Class Slope: **None**

Bed Material: **Sand**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**

3.2 Grade Control: **None**

3.3 Dominant Geological Mat.: %

3.3 Sub-dom. Geological Mat.:

3.4 Valley Slope Left: **Flat**

3.4 Valley Slope Right: **Flat**

3.5 Soils

Hydrologic Group: %

Flooding: %

Water Table Deep: %

Water Table Shallow: %

Erodibility: **slight** %

7.4 Comments:

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.2 Corridor

Historic Land Cover:: **Forest**

Current Dominant Land Cover: %

Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**0-25**
Sub-dominant:	**0-25**	**>100**
Length w / less than 25 ft.:	**1,492.0** ft.	**3,935.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old): **None**

Type: **None**

Use:

5.2 Bridges and Culverts: **0** **0.0** %

5.3 Bank Armoring: **0.0** **0.0** %

Left: **0.0** ft. Right: **0.0** ft.

5.4 Channel Straightening: **4,327.5** **54.2** %

5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **0.0** ft.

6.3 Channel Bars: **No Data**

6.4 Meander Migration:

6.5 Meander Width: **11 ft.** Rato: **1.0**

6.6 Wavelength: **11 ft.** Ratio: **1.0**

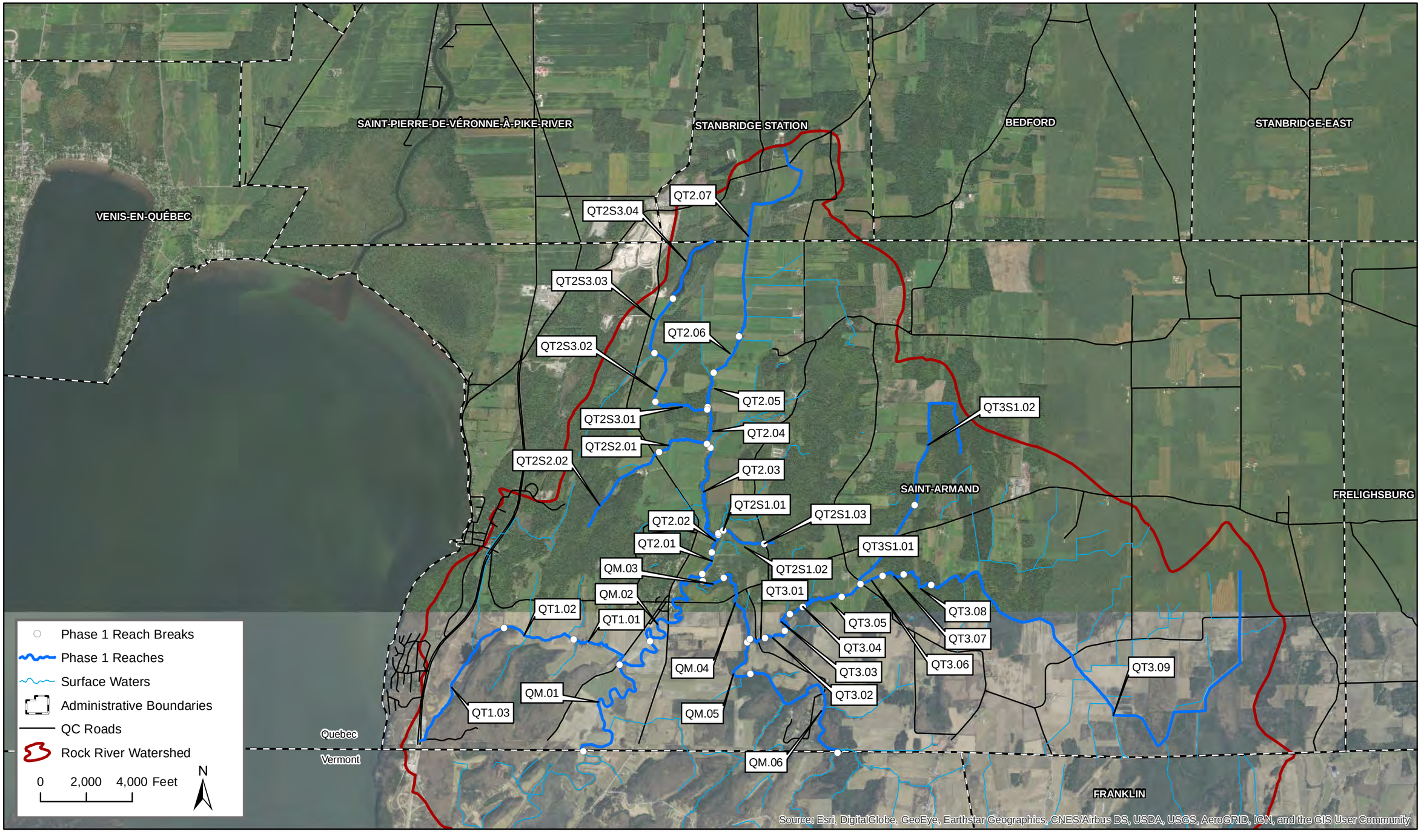
Step 7. Windshield Survey

7.1 Bank Erosion: **0.0000000** ft

7.2 Bank Height: **No Data** ft

7.3 Ice/Debris Jam Potential: **Not Evaluated**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	0 Unk.	0 N.S.	0 N.S.	0 N.S.	2 High	2 High	0 N.S.	0 N.S.	8



Appendix B: Phase 1 Reach Map