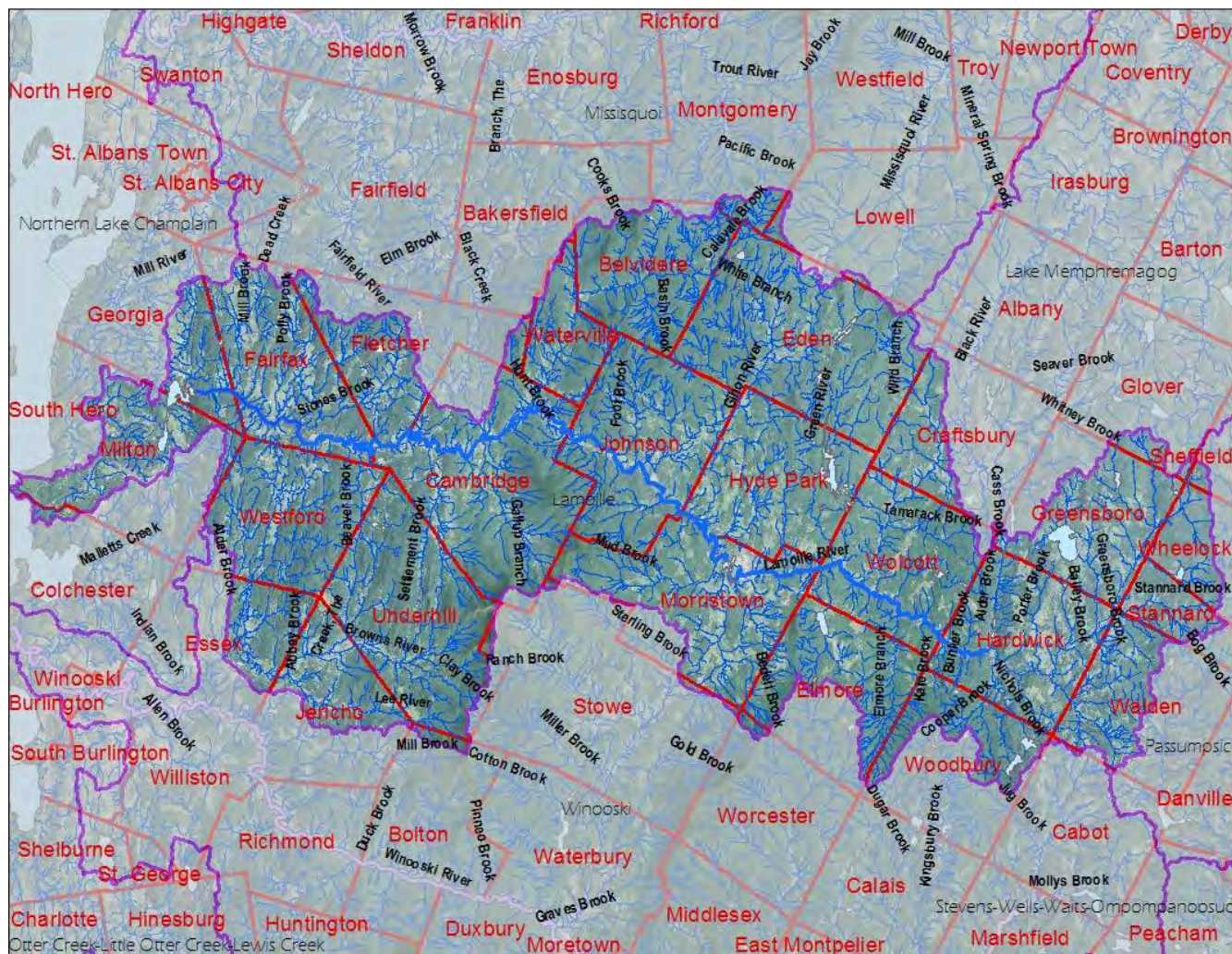


Lamoille River Watershed

Updated Water Quality/Aquatic Habitat

Assessment Report

February 2016



The Lamoille River watershed with towns and some tributaries

Vermont Agency of Natural Resources
Department of Environmental Conservation
Watershed Management Division
Monitoring, Assessment, and Planning Program

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Earlier Information on the Lamoille River Watershed

The last time that a formal [assessment report](#) was done on the Lamoille River was in 2001 and at that time, the report included the following information that is not repeated here:

- Sites described in the *Whitewater Rivers of Vermont* (1989) report
- Sites described in the *Waterfalls, Cascades, and Gorges of Vermont* (1985) report
- Sites described in the *The Vermont Swimming Hole Study* (1992) report
- Fishery and angling information
- Descriptions of the significant wetlands by biophysical region

A basin plan for the Lamoille River was then produced in 2009 and can be found [here](#). And now, this February 2016 assessment report is an update of monitoring information in preparation for the Basin 7 plan and is divided into three sections – the upper, middle, and lower watershed with the Browns River watershed included with the lower watershed.

General Description of the Lamoille River Watershed

The Lamoille River mainstem is recognized and named as beginning in the northwest corner of Wheelock, along the east side of Vermont Route 16, at the outlet of Horse Pond. It flows 84.9 miles in a generally westerly direction until it empties into outer Malletts Bay of Lake Champlain ten miles north of Burlington.

From its headwaters to the mouth, the river descends approximately 1,200 feet and drains a 706 square mile watershed, about 7.5 percent of Vermont's land area. The basin occupies the major part of the Lamoille and lesser parts of Franklin, Chittenden, Orleans, Washington, and Caledonia Counties. A longer description of the course of the Lamoille is given in the assessment report at the link above.

The watershed will be broken up as shown below for discussion purposes:

The Upper Lamoille consists of the watershed from Hardwick upstream and includes parts of the towns of Greensboro, Wheelock, Stannard, Walden, and Hardwick with a tip of Sheffield.

The Middle Lamoille is the part of the Lamoille that is in the Northern Green Mountains biophysical region primarily. It includes waterbodies that are the mainstem and sub-watersheds draining to the mainstem.

The Lower Lamoille is from the Brewster River confluence down to Lake Champlain including the Browns River watershed.

Basin-wide Illicit Discharge Detection and Elimination Study

An illicit discharge detection and elimination project took place in eleven municipalities and at Johnson State College in the Lamoille watershed. The project seeks to find and then eliminate contaminated, non-stormwater discharges that are getting to stormwater systems. A total of 305 stormwater drainage systems were investigated and of these 80 were dripping or flowing when inspected. Of these 80, there were 26 that were suspected illicit discharges, however, only 11 were finally confirmed as illicit discharges.

The Upper Lamoille Subwatershed

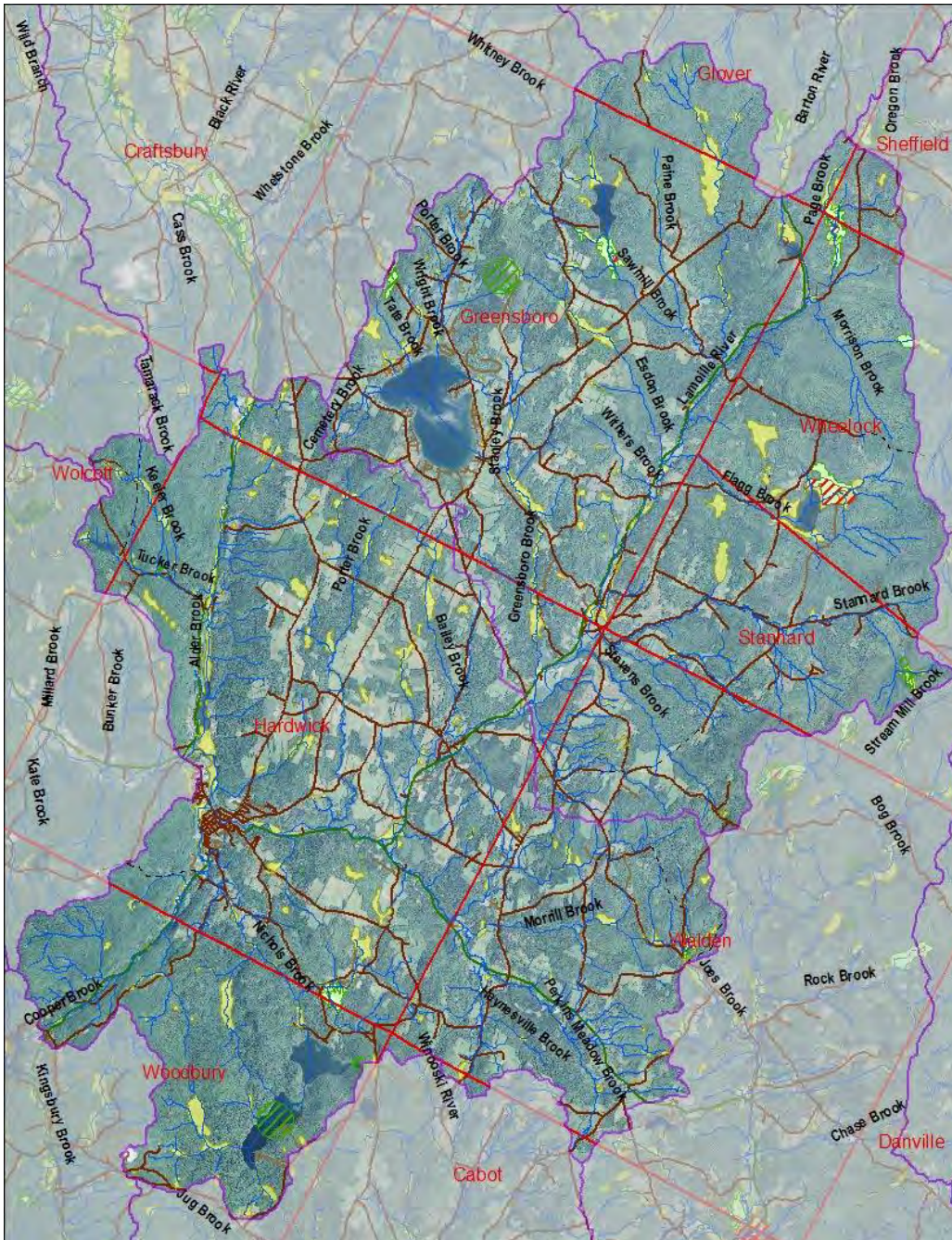


Figure 1. Upper Lamoille with wetlands, RTE & significant natural communities

Special Features of the Upper Lamoille subwatershed

Flagg Pond in Wheelock is in the top 10% of “Best Lakes” and has an northern white cedar swamp with two state-threatened plants found in the wetland. East Long Pond is also in the top 10% of Best Lakes. Caspian Lake and Horse Pond are in the top 20% of Best Lakes. Long Pond in Greensboro and Nichols Pond are in the top 25% of the Best Lakes.

Upper Lamoille River Watershed Summary of Segments with Impacts

There were seven waterbodies in Table 1 below at the beginning of this report's construction, but two will be removed in the 2016 impaired waters and other priority waters listing process underway and Caspian Lake has gone from altered to stressed status. Nichols Brook that was below the dam of East Long Pond and East Long Pond itself are no longer used for hydro-electric power and so those impacts are removed.

Table 1. Stream segments or lake sections with impacts

Stream or Lake Segment	Mileage & Status	Pollutant	Source	Use affected & other information
VT07-21L05 Hardwick Lake	145 acres Altered Part F list	water level fluctuation		no longer managed for hydro, lake drained in fall for ice control
Haynesville Brook	3.5 miles Stressed	sediment, physical alterations	post flood work, bank erosion	
Tucker Brook	1.5 miles Stressed	siltation, turbidity, physical alt.	post flood work, bank erosion	
Stannard Brook	5.0 miles Stressed	sediment	flood & post flood work	macroinvertebrates good-fair in 2013
VT07-22L04 Caspian Lake	789 acres Stressed	water level fluctuation		

Assessment Information for the Upper Lamoille

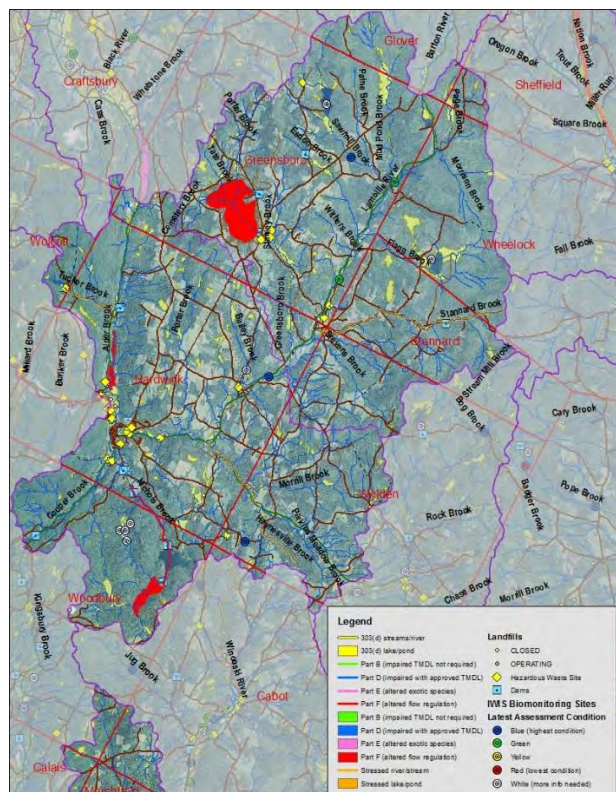


Figure 2. Upper Lamoille with assessment information

Biological Monitoring on the Upper Lamoille

Table 2. Biological community sampling results for the Upper Lamoille - 2008 to 2014

Wbid	River/Stream	Town	Station	Date	Assessment - macroinvertebrates	Assessment-fish
VT07-22	Sawmill Brook	Greensboro	1.8	09/13/2011	exc-vgood	----
VT07-22	Sawmill Brook	Greensboro	1.8	09/26/2013	excellent	----
VT07-22	Stannard Brook	Stannard	0.3	09/26/2013	good-fair	----
VT07-22	Lamoille River	Greensboro	80.8	09/26/2013	vgood-good	----

Table 3. Biological sampling sites locations

WBID	Stream or River	Station	Description
VT07-22	Sawmill Brook	1.8	Below Hillcrest Road culvert 100 meters (Greensboro)
VT07-22	Stannard Brook	0.3	Above Orton Road which is just above the RR tressle
VT07-22	Lamoille River	80.8	Below first bridge crossing north of Greensboro Bend

Table 4. Biological monitoring needed in the Upper Lamoille watershed

Waterbody id	Stream or river name	Location/number of sites	Comments
VT07-22	Greensboro Brook	at least one site	most of its length through a forested small valley
VT07-22	Stannard Brook	sample rm 0.3 again	was "fair" in 2002 and "good-fair" in 2013 – this stream has been dredged a number of times and gets sand from the adjacent road
VT07-21	Tucker Brook	one site	this brook has not been sampled – affected by floods at various times
VT07-21	Haynesville Brook	one site	this brook has not been sampled – affected by floods at various times
VT07-21	Porter Brook	one site	no samples from this brook to date

Physical Assessments on the Upper Lamoille

A Phase 2 Upper Lamoille River stream geomorphic assessment report was done in February 2009 by the Caledonia County Natural Resources Conservation District. It can be found among the reports located here:

<https://anrweb.vt.gov/DEC/SGA/finalReports.aspx>

Middle Lamoille River Subwatershed

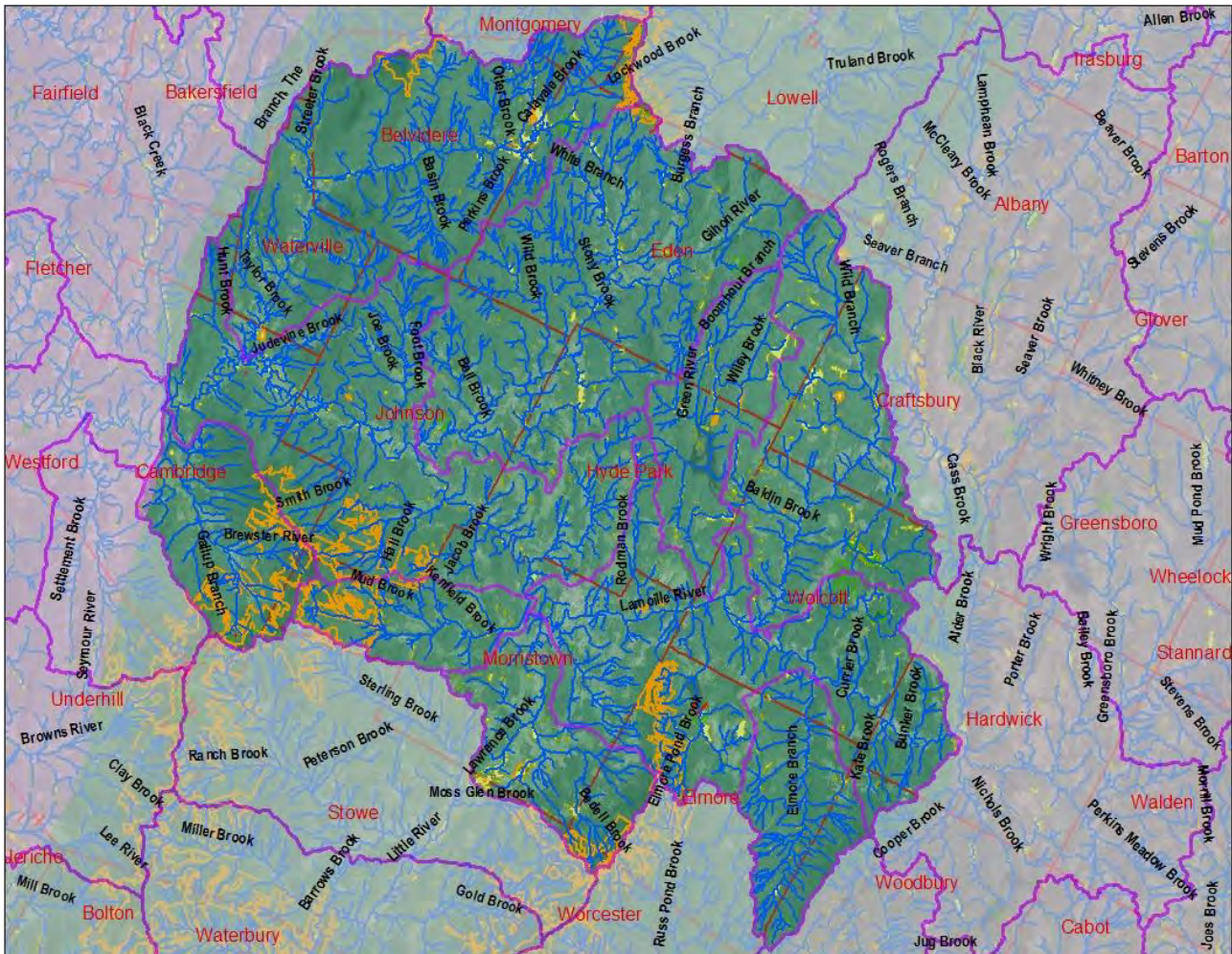
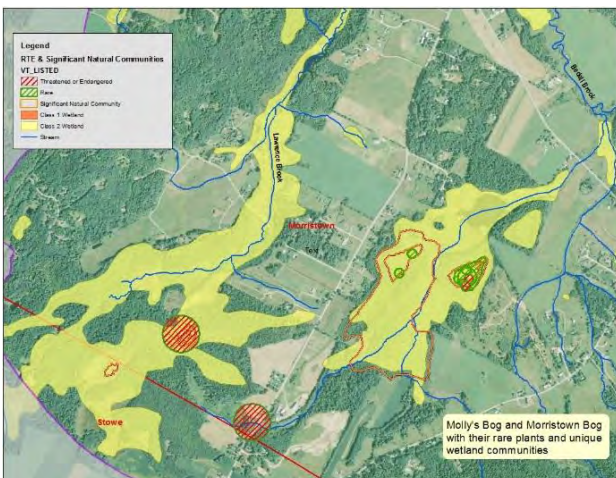


Figure 3. Mid Lamoille watershed largely within the Green Mountains biophysical region (green shading) with wetlands yellow & significant natural communities orange outline

Special Features of the Mid Lamoille subwatershed



The [original assessment report](#) for the Lamoille River watershed described many special features of this watershed including significant wetland communities, swimming holes, fishing and whitewater stretches. One wetland complex that was not described in that report was the Morristown Bog with its associated rare and endangered species that lies east of the Molly's Bog complex and in Morristown also.

Mid Lamoille River Watershed Summary of Segments with Impacts

Following are the stream segments or lake sections that are impaired, altered, or stressed and appear on one of the various 2016 lists that the Watershed Management Division maintains to track waters that have some impact. Those lists can be found [here](#).

Table 5. Stream segments or lake sections with impacts

Stream or Lake Segment	Mileage & Status	Pollutant	Source	Other information
Rodman Brook, mouth to rm 0.6	0.6 miles Impaired Part A list	iron	Lamoille Landfill	Past 20 year post closure monitoring period. Biomonitoring showing improvements.
Hutchins Brook, from rm 2.0 to rm 3.0	1.0 miles Impaired Part A list	sediment, asbestos	asbestos mine tailings erosion	
Hutchins Brook, Trib 4, mouth to rm 0.3	0.3 miles Impaired Part A list	sediment, asbestos	asbestos mine tailings erosion	
Trib to Brewster River	1.0 miles Impaired Part A list	iron	ski area development	
Lake of the Clouds (Cambridge)	1 acres Impaired Part D list	pH	acid deposition	EPA approved a TMDL on Sept 30, 2003.
Lamoille River, Hardwick Lake to Lake Lamoille in Morrisville	15.7 miles Altered Part F list	artificial flow regime	downstream of Hardwick Lake dam	Hardwick Electric, unlicensed facility
		impoundment water level fluctuation	above Wolcott dam	Hardwick Electric, unlicensed facility
		poor flow regime	below Wolcott dam	Hardwick Electric, unlicensed facility
		no flow in bypass	below Morrisville hydro project dam	FERC license expires in 2015, in FERC re-licensing.
Lake Elmore	17 acres Altered Part E list	Eurasian watermilfoil		Population was discovered in 2002. Non-chemical control.
Lake Elmore	219 acres Altered Part F list	water level fluctuations	above Lake Elmore dam	Morrisville Hydro-electric Project. FERC license expires in 2015, in FERC re-licensing.
Elmore Pond brook, from dam to 2.2 miles downstream	2.2 miles Altered Part F list	artificial flow regulation	below Lake Elmore dam	Morrisville Hydro-electric Project. FERC license expires in 2015, in FERC re-licensing.
Lake Lamoille	148 acres Altered Part F list	water level fluctuation	above Cady's Falls dam	Morrisville Hydro-electric Project. FERC license expires in 2015, in FERC re-licensing.

Mid-Lamoille River immediately below Cady's Falls dam	0.3 miles Altered Part F list	lack of flow, de-watering of falls	Cady's Falls dam & hydro facility.	Morrisville Hydro-electric Project. FERC license expires in 2015, in FERC re-licensing.
Tributary to Brewster River	1.0 miles Altered Part F list	insufficient flow	water withdrawal for domestic water	Smugglers Notch is operating under a new permit with a FMF condition for snow-making but not for domestic water use
Bunker Brook	1.5 miles Stressed	physical alterations	rip-rap, channelization	
Kate Brook	2.0 miles Stressed	physical alterations	rip-rap, channelization	
Browns River, from west of Jericho/Essex line up 7.5 miles	7.5 miles Stressed	sediment, physical alterations, temperature	former large scale gravel mining	streambank de-stabilization
Stevensville Brook, from rm 2.0 up to headwaters	3.0 miles Stressed	low pH, flood scour	acid deposition, flashy stream	
Seymour River, mouth upstream	3.5 miles Stressed	sediments, nutrients	bank erosion, instability, ag encroachment	
Brewster River, from ski area to mouth	5.9 miles Stressed	sediment, stormwater	construction erosion, road & parking lot runoff	macroinvertebrates have been good to excellent last two sample sets so this off in 2016?
North Branch Lamoille River, Route 109 to mouth	1.0 miles Stressed	sediment	bank erosion, channel instability	
Dark Branch	3.3 miles Stressed	asbestos, sediment	asbestos mine erosion	
Gihon River	0.4 miles Stressed	organics	underground storage tank leak & spills	close to surface water but no surface water data-needs investigation
Mud Brook	0.5 miles Stressed	iron	state-owned dam & culvert	FPR & watershed coordinator to follow-up
Ryder Brook	3.5 miles Stressed	sediment, physical alterations	loss of riparian vegetation, development	
Wild Branch	15.0 miles Stressed	sediment, turbidity	channel alterations, encroachments, bank erosion	
Elmore Branch	4.0 miles Stressed	sediment, turbidity,	channel alterations	

Assessment Information for the Mid Lamoille

Biological Monitoring on the Mid Lamoille

Following are the assessment results from biological monitoring that occurred from 2008 through 2014 on this section of the Lamoille River and tributaries to it. Conditions assessed from earlier sampling for some of the streams is given in short stream paragraphs below.

Table 6. Biological sampling results for the Mid Lamoille subwatershed 2008-2014

Wbid	River/Stream	Station	Date	Assessment - macroinvertebrates	Assessment - fish
VT07-04	Lamoille River	rm 45.0	09/19/2011	excellent	-----
VT07-04	Lamoille River	rm 53.6	09/18/2013	very good	-----
VT07-06	Foot Brook	rm 2.6	09/10/2013	exc-vgood	-----
VT07-06	Waterman Brook	rm 1.2	09/18/2013	exc-vgood	poor ¹
VT07-06	Jacob Brook	rm 0.6	09/19/2011	exc-vgood	poor
VT07-06	Jacob Brook	rm 0.6	09/16/2013	very good	good
VT07-06	Smith Brook	rm 0.9	09/18/2013	very good	very good
VT07-08	Rodman Brook	rm 0.6	09/20/2013	vgood-good	fair
VT07-08	Rodman Brook	rm 0.6	10/02/2014	excellent	-----
VT07-08	Rodman Brook	rm 1.1	10/02/2014	excellent	-----
VT07-13	Brewster River	rm 4.2	09/19/2014	very good	-----
VT07-13	Brewster River	rm 4.5	09/19/2014	very good	-----
VT07-13	Brewster River	rm 5.0	09/19/2010	vgood-good	-----
VT07-13	Brewster River	rm 5.0	09/13/2012	exc-vgood	-----
VT07-13	Brewster River	rm 5.0	09/18/2014	very good	-----
VT07-13	Brewster River	rm 5.3	09/19/2010	vgood-good	-----
VT07-13	Brewster River	rm 5.3	09/13/2012	excellent	-----
VT07-13	Brewster River	rm 5.3	09/18/2014	vgood-good	-----
VT07-13	Brewster River Trib 10	rm 0.4	09/23/2013	fair	-----
VT07-13	Stream A	rm 0.2	09/19/2010	good	-----
VT07-13	Stream A	rm 0.2	09/13/2012	good	-----
VT07-13	Stream A	rm 0.2	09/18/2014	fair	-----
VT07-13	Stream A	rm 0.4	09/19/2010	vgood-good	-----
VT07-13	Stream A	rm 0.4	09/13/2012	fair	-----
VT07-13	Stream A	rm 0.4	09/28/2014	good-fair	-----
VT07-14	North Branch Lamoille River	rm 2.0	09/26/2013	excellent	-----
VT07-14	North Branch Lamoille River	Rm 14.0	09/19/2013	excellent	-----
VT07-15	Dark Branch	rm 3.3	09/10/2013	fair	very good
VT07-15	Gihon River	rm 0.1	09/09/2013	very good	-----
VT07-15	Gihon River	rm 7.4	09/19/2011	very good	good
VT07-15	Gihon River	rm 10.3	09/26/2013	excellent	-----
VT07-15	Gihon River	rm 14.5	09/09/2013	good	very good
VT07-16	Kenfield Brook	rm 0.2	09/16/2013	exc-vgood	-----
VT07-16	Kenfield Brook	rm 1.5	09/16/2013	-----	poor
VT07-17	Ryder Brook	rm 0.8	09/16/2013	very good	fair
VT07-18	Green River	rm 2.9	09/20/2013	excellent	-----
VT07-19	Wild Branch	rm 0.1	09/19/2011	good	fair
VT07-20	Elmore Branch	rm 1.7	09/03/2013	exc-vgood	good

¹ this was "very good" earlier as the low density is likely a localized habitat issue. A reach above needs to be sampled.

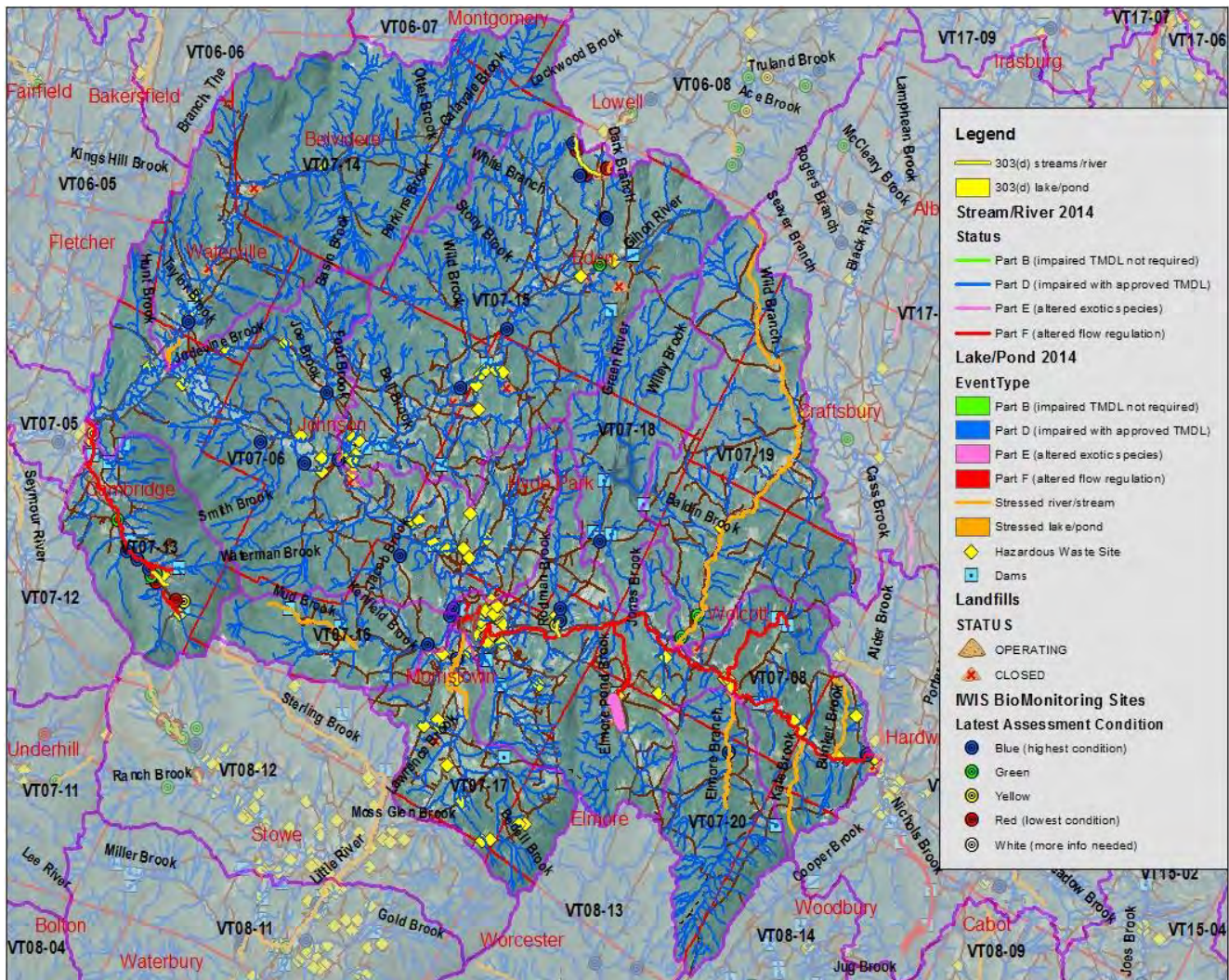


Figure 4. Mid Lamoille with assessment information

Rodman Brook

Rodman Brook has been monitored since 2005 both above and below the Lamoille Landfill. The macroinvertebrate community below the landfill went from fair and poor in 2005 and 2006 respectively to very good-good in 2007, very good-good in 2013 and excellent in 2014. Above the landfill at rm 1.1, the community has been from very good-good to excellent since 2005. The assessment notes included the following summary:

Early assessments in 2005 and 2006 showed very high percentage of Oligochaeta and in 2006, low EPT richness. The bio index is low and EPT/EPTc ratio is high showing enrichment is not a stressor. Past assessments determined iron precipitate was the probable reason for the fair condition. Iron precipitate continues to be high coating the substrate, however, the macroinvertebrate and fish communities are in very good condition. Water quality samples do show that a number of metals that were elevated especially in 2006 (the year of very low macroinvertebrate EPT and richness) are now below ALS criteria. Metals, which were present in 2005/2006 but not detected in the last 2 years or are well below ALS, include: arsenic, iron, and copper. Also TN which was 1.0-1.7 in past is now 0.75 mg/l. It appears that the metals stressors have decreased, and the ALS has been maintained over the last 3

assessments including 2013 and 2014 for the macroinvertebrate community integrity. This stream should be considered for delisting for non- support of ALS.

Rodman Brook was proposed for de-listing the impairment of aquatic life use in the 2016 305(b)/303(d) cycle but due to the slope failure incident at the landfill in summer 2015, the brook will remain on the list until another biological sample below the landfill can be obtained. The impairment for aesthetics due to the iron in the stream and on the stream banks has not changed at this time.

Brewster River, Tributary to Brewster River, and Sterling Brook

For the 2016 revisions to Vermont's Lists of Priority Waters, these streams will be removed from the Part F list – flow-altered waters. The Smugglers Notch snowmaking water withdrawal is operating under a new permit that has site specific February Median Flow (FMF) conditions that protect aquatic life.

Brewster River Trib 10

Assessment notes for this stream that has been sampled often include:

The reach of Tributary 10 to the Brewster River has been sampled 11 times since 1986 and has been rated poor 9 of the 11 samples and and fair 2 of the 11 times. It was last found to be fair in 2004, but then was poor in 2005-2007. In 2013, it is rated as fair with a very low density keeping it from rating good. Observations of the stream habitat show it continues to be coated in iron precipitate, and in 2013, we also observed a significant increase in sand/silt and greater cobble embeddedness (>40%)... These data indicate that habitat sand-embeddedness maybe partly responsible for the fair condition due to low abundance.

The field observations when sampling in 2013 include that there was a lot of iron percipitate and that the water was turbid from rain in the previous night. The biologists also noted a black layer of oily goo on rocks but no oily smell. A means to restore this long-impaired stream needs to be found.

Gihon River

The Gihon River drains a substantial watershed of 66 square miles. Four sites were sampled between 2011 and 2013 (rm 0.1, rm 7.4, rm 10.3, rm 14.5) and the biological monitoring results showed a macroinvertebrate community from good to excellent.

At the rm 14.5 site, which was sampled in 2007 and 2013, “the community assessment has declined from excellent to good due to a loss of taxa especially EPT. Habitat observations do show an increase in percent sand 2-8% and embeddedness 5-10% at the reach but still these are generally not high enough to cause such a dramatic loss of taxa. Water quality data show no significant changes. Other sites in the area including the Gihon River at rm 10.3 saw an increase in richness metrics in 2013.” Assessment of this generally excellent or very good aquatic community of this river should occur fairly regularly to insure no loss of the very high quality conditions.

Table 7. Biological sampling sites locations for the Mid Lamoille area

WBID	Stream or River	Station	Town	Description
VT07-04	Lamoille River	45.0	Johnson	Alongside River Road off of Railroad Street
VT07-04	Lamoille River	53.6	Morristown	Below Lake Lamoille Cady's Falls bridge about 0.4 miles, off of Duhamel Road
VT07-06	Foot Brook	2.6	Johnson	Below Plot Road culvert 50 meters.
VT07-06	Waterman Brook	rm 1.2	Johnson	Off Waterman Road below first bridge crossing but above falls.
VT07-06	Jacob Brook	rm 0.6	Morristown	Downstream of Tyndall Road and "bedrock slider"
VT07-06	Smith Brook	rm 0.9	Johnson	Above VAST trail, railroad bridge, and power line crossing
VT07-08	Rodman Brook	rm 0.6	Morristown	Below old landfill and transfer station off Garfield Road
VT07-08	Rodman Brook	rm 1.1	Morristown	Above old landfill and transfer site off Garfield Road, below first bridge
VT07-13	Brewster River	rm 4.2	Cambridge	Above confluence with Gallup Branch, below proposed spray site for Smugglers Notch
VT07-13	Brewster River	rm 4.5	Cambridge	Below Edwards Road (old Rte 108), upstream of proposed spray field
VT07-13	Brewster River	rm 5.0	Cambridge	Below Route 108 and Unnamed Brook at Smugglers Notch Ski area about 50m.
VT07-13	Brewster River	rm 5.3	Cambridge	Above Route 108 and Unnamed Brook at Smugglers Notch Ski area about 50m, upstream of covered bridge.
VT07-13	Brewster River Trib 10	rm 0.4	Cambridge	About 50 meters below old leachfield discharge pipe.
VT07-13	Stream A	rm 0.2	Cambridge	Below new spray field for Smugglers Notch Ski area, immediately above route 108.
VT07-13	Stream A	rm 0.4	Cambridge	Above new spray field for Smugglers Notch Ski area.
VT07-14	North Branch Lamoille River	rm 2.0	Waterville	Below covered bridge west of town about 100 meters.
VT07-14	North Branch Lamoille River	rm 14.0	Belvidere	20 meters above first bridge crossing on west edge of the alder wetland
VT07-15	Dark Branch	rm 3.3	Eden	Below first beaver pond wetland below asbestos mine
VT07-15	Gihon River	rm 0.1	Johnson	Below WWTF outfall about 75m at first riffle along riprap bank
VT07-15	Gihon River	rm 7.4	Johnson	Just off Route 100C below confluence with Wild Brook

VT07-15	Gihon River	rm 10.3	Eden	Off Route 100 north of North Hyde Park about 1.2 miles
VT07-15	Gihon River	rm 14.5	Eden	Above Route 100 crossing next to the town garage, just below Dark Branch confluence
VT07-16	Kenfield Brook	rm 0.2	Morristown	Upstream from bridge on Cady's Falls Rd about 150m
VT07-16	Kenfield Brook	rm 1.5	Morristown	Above Cote Hill or Tyndol Road about 200m, above a skidoo bridge.
VT07-17	Ryder Brook	rm 0.8	Morristown	Located just upstream of a power station, above a bridge
VT07-18	Green River	rm 2.9	Hyde Park	Below Garfield Rd about 100m
VT07-19	Wild Branch	rm 0.1	Wolcott	Below abandoned metal bridge off the West Wolcott Road
VT07-20	Elmore Branch	rm 1.7	Elmore	About 0.7 miles from northerly bend in road from Route 12 to Wolcott

Table 8. Biological monitoring needed in the Mid Lamoille watershed

Water-body id	Stream or river name	Location/number of sites	Comments
VT07-06	Centerville Brook	at least one site	This stream has never been sampled. An SGA has been done.
VT07-06	Waterman Brook	rm 1.2 sampled again	Re-sample to confirm vhf or A1?
VT07-06	Foote Brook	rm 2.6	Bugs were sampled in 2013 and were exc-very good. Confirm vhf?
VT07-14	Rattling Brook	a site or two	Not been sampled ever. Trib to the North Branch.
VT07-14	Calavale Brook	a site or two	Not been sampled ever. Trib to the North Branch.
VT07-14	Basin Brook	re-sample rm 0.5	Last sampled in 1992. Density and richness metrics not meeting.
VT07-14	North Branch Lamoille River	rm 2.0	Need second year of bugs (exc in 2013) and also fish data.
VT07-15	Wild Brook (to Gihon R)	1 site – upstream from confluence with Gihon	Never sampled –looks like a well-forested watershed
VT07-15	White Branch (to Gihon R)	1 site – upstream from confluence with Gihon	Never sampled
VT07-15	Gihon River	above or below where Rocky Road crosses	Need some information in this lower stretch (but above the mouth)
VT07-16	Kenfield Brook	two sites – rm 0.2 and rm 1.5	It would be great to have fish data from the bug site and vice versa.
VT07-18	Green River	rm 2.9	Bugs were sampled in 2013 and were excellent – confirmation of this with another sample would be great.
VT07-19	Wild Branch	rm 0.1 again and one site upstream more	A lot going on in this stream - more bug and fish sampling would be very helpful

Physical Assessments on Mid Lamoille Streams

Brewster River

Phase 2 geomorphic assessments were done on only four reaches of the 19 reaches for which there were Phase 1 assessments. The four reaches were segmented into five stretches for the Phase 2 evaluations. The segment or reach M02 is primarily a “bedrock gorge” and wasn’t fully assessed.

Of the four Phase 2 assessed reaches, all had a rapid habitat assessment condition of “fair”; all had a rapid geomorphic assessment of “fair”; and two had a “very high” sensitivity and two had a “high” stream sensitivity.

Centerville Brook

In the Centerville Brook Phase 2 assessment, the rapid habitat assessment found that five of the 18 segments were “fair”; three of the segments were “good”; and ten of the segments were not assessed because they were wetland communities or bedrock stretches. The sensitivity analysis found that of the eight segments assessed, two segments had “extreme” sensitivity, three had “very high” sensitivity, and three had “high” sensitivity.

Elmore Branch

The rapid habitat assessment was done on thirteen segments as part of a Phase 2 stream geomorphic assessment. Four segments were bedrock controlled and not evaluated. Of the other nine segments, six were in “fair” habitat condition and three were in “good” condition.

Sensitivity ratings were also done on these nine segments with four segments having a “very high” sensitivity to stressors or disturbance; four having a “high sensitivity”; and one having a “moderate” sensitivity.

The segment labelled T04 has a “large waterfall” and segment T07-A has a 1031 foot bedrock gorge both of which sound like they are significant aesthetic features.

Gihon River

In the Gihon River Phase 2 assessment, the rapid habitat assessment (RHA) found that 13 of the 24 segments were “fair” for habitat and 11 of the 24 segments were “good”. The sensitivity analysis done for the Gihon River found that two segments had “extreme” sensitivity to stressors or disturbance; 14 segments had “very high” sensitivity; 7 segments had “high” sensitivity; and only one had “moderate” sensitivity.

Lamoille River mainstem from Hardwick to Johnson

The Lamoille River from Hardwick down to Johnson was physically assessed and the information reported in a 2010 corridor plan. Of the 15 segments on this stretch, ten of them had a “fair” habitat condition and three of them were not assessed because they were an impounded reach. Two segments were not assessed because of bedrock. Of the ten segments evaluated for their sensitivity, two segments had “extreme” sensitivity, seven had “very high” sensitivity, and one had “high” sensitivity.

Rodman Branch

A Phase 2 geomorphic assessment was only done on the lower portion of Rodman Brook although a Phase 1 assessment was done on the whole length. The Phase 2 assessment

evaluated five segments but a habitat assessment was not conducted only a geomorphic assessment and a sensitivity analysis. Of the five segments, one had “very high” sensitivity, three had “high” sensitivity, and one had “moderate” sensitivity.

Wild Branch

Phase 2 geomorphic assessments were done on 19 stream reaches on the mainstem of the Wild Branch and one on a lower reach of an unnamed tributary. These 19 reaches were divided into 28 segments for evaluation. There were 12.2 miles of stream assessed.

Major flood events affected the Wild Branch in 1912, 1936, 1973, 1984, 1995, 1997, 1998, and 2008. In addition, channelization adjacent to roads, floodplain encroachments, gravel mining, bank armoring, road stream crossings, and woody vegetation removal have all had impacts on the Wild Branch and its stability. *All of the segments assessed on the Wild Branch were in fair or poor geomorphic condition.*

Landfills and Hazardous Waste Sites in the Mid Lamoille

Lamoille Landfill and Salvage Depot

The Lamoille Landfill and Salvage Center is located north of Route 15 and west of Garfield Road and Rodman Brook in Morristown. The landfill was closed in 1992. Groundwater and surface water monitoring for both organics and inorganics occurred in May and October each year from 1992 until 2010 and were reported to the landfill owner as well as Vermont DEC. The landfill owner ran out of monitoring and maintenance funds before the end of the 20 year post-closure monitoring period, which was to be in 2013.

Rodman Brook biological monitoring in recent years has shown a healthy macroinvertebrate community and declining levels of metals. The brook has been considered for de-listing from the impaired waters list in 2016.

However, a gully erosion and slope failure incident at the landfill in summer of 2015 led to “exposed underlying waste, allowing waste constituents to be in contact with surface runoff, and increasing leachate generation through the waste mass into groundwater.” The eroded area was repaired and stabilized and certified as complete by a professional engineer in fall of 2015.

The site was visited by Vermont DEC Waste Management Division staff on December 28, 2015 to check if the site was adequately stabilized because of the late fall repairs and unfortunately, the staff observed further issues:

“that cap repair materials (sand and/or Omya material) had been washed out from under the stone and had accumulated adjacent to Garfield Rd around an open drop inlet (+/-2’ diameter vertical culvert) to the road culvert. Silt fence left in the same area also showed an accumulation of sediment. Crossing the road to the brook that parallels the road in that location, we observed discoloration of the streambed from sedimentation on the landfill side of the brook, extending at least 75’ downstream of the culvert outlet. There was none of this light colored sediment in the stream above the culvert outlet (i.e., it was not from a source further upstream). There was also none of this sediment on the roadside above the culvert inlet (i.e., it was not from road/ditch sediment). There was also iron staining above the culvert inlet, and iron bacteria in the brook by the culvert outlet.”

Another Notice of Alleged Violation (NOAV) was issued and a site visit took place in January 2016 with DEC staff, the engineer, the contractor, and the land owner. Temporary erosion control is being put into place with more permanent repairs being designed for spring 2016.

It is not known what, if any, impact there has been to the biological community of Rodman Brook downstream of the landfill culvert.

Vermont Asbestos Group (VAG) Mine

An excellent background and history of the VAG mine site is given in the Weston Solutions Sampling and Analysis Plan cited in the Information Sources section at the end of this report. Some of the information below is taken from that report and some comes from Vermont DEC Waste Management Division reports and correspondence.

The 1500 acre VAG site with asbestos quarries and the associated tailings piles are found in both Lowell and Eden with part of the mine draining to the Missisquoi River watershed and part draining to the Lamoille River watershed (Hutchins Brook, Dark Branch, Gihon River). The Eden Quarry and associated tailings pile, the oldest part of the mine, is estimated at more than 5 million tons and it is this area that is impairing streams and wetlands in the Lamoille watershed.

In 2004, ANR DEC Wetlands Office received a complaint about a property owner's wetland being filled in by eroding asbestos tailings. In 2005, Vermont ANR, Vermont Department of Health, VAG, and USGS began collecting data to look into environmental impacts and potential human health impacts. In 2007, Vermont DEC and USGS collected water, tailing, sediment, and macroinvertebrate data. Also in 2007, EPA began to control the tailings runoff in several areas by constructing berms and creating waterbars and diversion channels to keep runoff from reaching off-site streams and wetlands. That specific work was completed in 2008.

Funding for operations and maintenance, which includes cleaning sediment basins, checking erosion on the site, and insuring that warning signs and gates and other security is in place, comes from the G-1 Holdings Trust, the successor to the past owner/operator of the mine. The towns of Eden and Lowell were opposed to Superfund listing and thus, the Governor did not support the listing and so there is not the federal money to study, design, and implement remediation at this site. There are some experimental vegetation plots on the site but the focus of the efforts at the site are primarily maintenance of erosion control practices put in by EPA.

Wetland and stream monitoring off site will need to be done on a regular basis to document what is likely to be ongoing impact until the proper resources are brought to bear to stabilize and remediate the site.

Waterville F.D. #1 Site

A Supplemental Site Investigation Report and Corrective Action Feasibility Investigation was completed in January 2016 for the Waterville F.D. #1 site (#2014-4485) that encompasses three former gasoline locations in Waterville village near the North Branch Lamoille River. The report thoroughly details the various investigations to date of the site and all of the monitoring results so far.

Initial identification of a problem, and investigation into it, began in 2013 when people at #814 Route 9 noticed fuel oil odor in their water. The water system operator sampled the water in September 2013 and confirmed the presence of volatile organic compounds (VOCs). Samples were collected from other Route 109 locations and VOCs were found in these two samples as well.

Environmental Compliance Services (ECS), a consulting firm from Waterbury, was brought in to do more sampling and an inspection of the area. They produced a report in December 2013 and identified six potential sources of contamination. They then conducted further historical reviews of the properties that were potential sources; conducted a subsurface investigation along the water distribution lines via soil borings and photoionization detector screenings of the soil samples taken; and collected water system samples from seven locations along Route 109. They concluded that the contamination is likely entering the Waterville Fire District #1 water distribution system between #598 and #634 Route 109 where there once were underground storage tanks for gasoline and old gasoline stations.

In July 2014, ECS inspected the banks of the North Branch of the Lamoille and found seven seeps along 100 feet of riverbank. There was “orange iron-staining, a strong gasoline odor, and sheen on the water seeping from the bank.” Groundwater, soil, and surface water samples were all taken. Benzene was in the groundwater of all three seep locations well above the Vermont Groundwater Enforcement Standards (VGES). Trimethylbenzene and naphthalene were above the VGES at the upstream seep. The surface water sample near the upstream seep had benzene at 34.0 ug/liter(L) exceeding the Vermont Water Quality Standard for consumption of water and organisms of 1.2 ug/liter.

A subsurface VOC investigation report in December 2014 used the results of 29 soil borings to identify “two significant zones of contamination extending from the Waterville Garage towards the North Branch of the Lamoille River...”. One zone of contamination is shallow and the other deep, presumably just above the bedrock.

The seeps were again inspected and sampled in December 2015. The same orange staining, strong gasoline odor, and sheens on the water discharging from the bank were present. There are booms in place along the river shoreline where these seeps are located. The samples from the seeps have high concentrations of benzene and two of the seeps have high naphthalene. Other VOCs were detected but below VGES.

Surface water samples were also collected in December 2015 at three sites – the Church Street Bridge near a popular swimming hole, near the upstream seep, and further upstream on the North Branch. Benzene was found in the “Near Upstream Seep” surface water sample at 2.0 ug/L. No sheens were seen on the flowing surface water at the time of sampling.

ESC recommends several remediation technologies to clean up the petroleum contaminants in the vicinity of the water supply distribution lines and the plume that is migrating towards the North Branch.

Lower Lamoille River Subwatershed

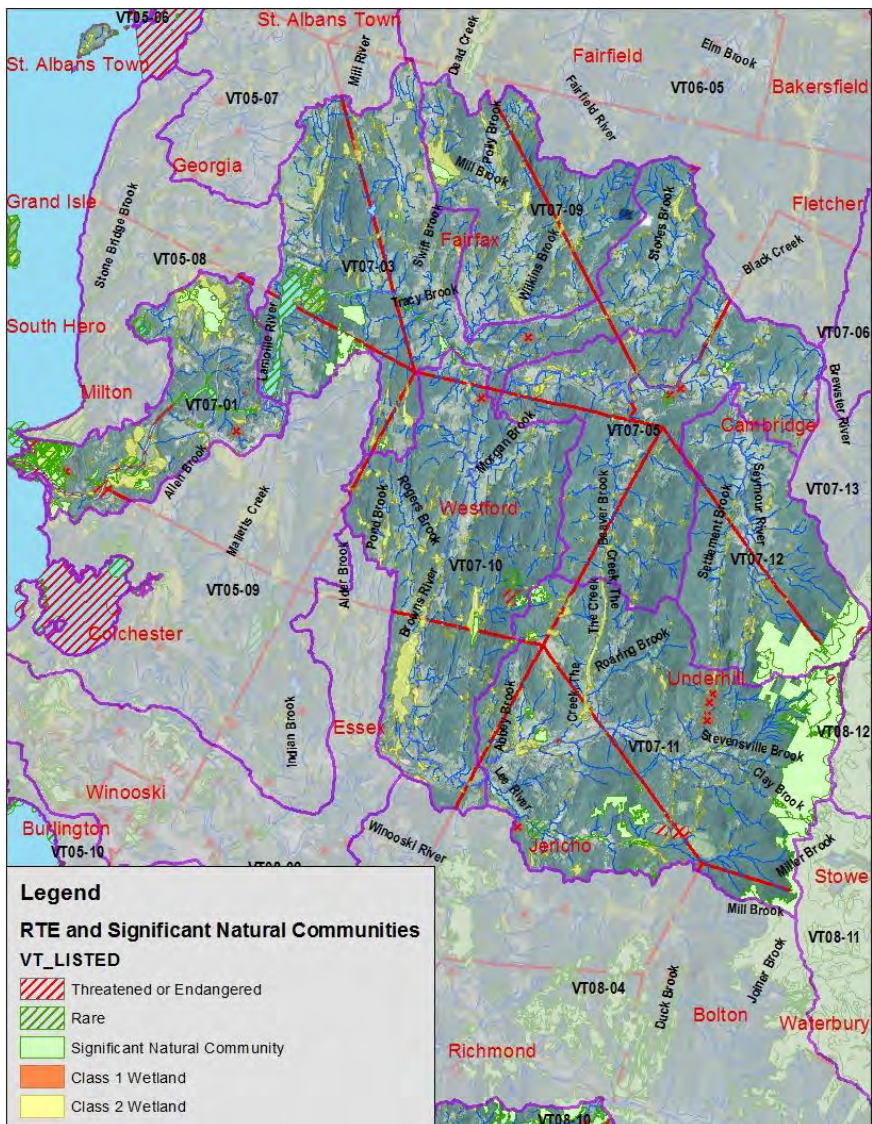


Figure 5. Lower Lamoille River

Special Features of the Lower Lamoille subwatershed

The lower Lamoille River, like all tributaries to Lake Champlain, supports a wide variety of fish species, a few rare and state-listed. Lake Sturgeon, nearly fished to extinction, should slowly recover in the Lamoille River due to closing of the fishery in the 1960s and a soon to be implemented Sturgeon Restoration Plan. Recovery will be limited however due to the reduction in spawning area created by the Peterson Dam, which was built on the Sturgeon Hole where sturgeon once gathered to continue their trek upstream to more abundant spawning grounds. Other rare fish include the threatened Eastern Sanddarter, the uncommon Mottled Sculpin, and two species of Redhorse Sucker, which are limited to lower reaches of large tributaries to Lake Champlain. The diverse fish community numbers over 25 species, rare and otherwise, downstream from the Peterson Dam.

Lower Lamoille River Watershed Summary of Segments with Impacts

Table 15. Stream segments or lake sections with impacts

Stream or Lake Segment	Mileage & Status	Pollutant/ problem	Source	Use affected & other information
Deer Brook, mouth upstream 2.5 miles	2.5 miles Impaired Part A list	sediment	stormwater discharges, road culverts	some BMPs have been implemented
Lower Lamoille, from Clarks Falls dam to Route 2 Bridge	6.0 miles Impaired Part B list	low D.O.	three dams	Clarks, Milton, Peterson dams
Lower Lamoille, mouth to Clarks Falls Dam	8.5 miles Impaired Part D list	mercury		EPA approved a regional mercury TMDL December 20, 2007
Arrowhead Mountain Lake	646 acres Impaired Part D list	mercury		EPA approved a regional mercury TMDL December 20, 2007
Arrowhead Mountain Lake	114 acres Altered Part E list	Eurasian watermilfoil		
Streeter Brook	0.6 miles Stressed	stormwater possible	sample site is below some roads and subdivisions	Macroinvertebrate community results have ranged over the last 10 years
Lower Mid Lamoille, from Arrowhead Mtn Lake to Fairfax Falls dam	5.0 miles Stressed	mercury		Elevated levels of mercury in walleye

Assessment Information for the Lower Lamoille

Biological Monitoring on the Lower Lamoille

Table 16. Biological sampling results for the lower Lamoille subwatershed 2008-2014

Wbid	River/Stream	Station	Date	Assessment-macroinvertebrates	Assessment - fish
VT07-01	Lamoille R Trib #4	0.3	9/29/2015	good	---
VT07-01	Lamoille R Trib #4	0.5	9/29/2015	fair	----
VT07-01	Lamoille R Trib #4	1.0	9/29/2015	good	---
VT07-01	Streeter Brook	0.6	10/07/2013	very good-good	----
VT07-02	Lamoille River	15.7	10/07/2013	exc-very good	----
VT07-02	Lamoille River	19.3	9/19/2011	very good-good	----
VT07-02	Lamoille River	20.9	9/19/2011	very good	----
VT07-04 ¹	Lamoille River	33.5	9/18/2013	very good	----
VT07-03	Deer Brook	1.4	10/09/2013	good	----
VT07-03	Deer Brook	2.1	9/27/2011	fair	----
VT07-10 ²	Abbey Brook	0.4	10/09/2013	exc-very good	fair
VT07-10	Rogers Brook	0.5	10/06/2014	very good-good	----

Wbid	River/Stream	Station	Date	Assessment- macroinvertebrates	Assessment - fish
VT07-11	The Creek	2.4	10/06/2014	fair	----
VT07-11	Lee River	2.7	10/09/2013	----	very good

1 Waterbody VT07-04 Mainstem Lamoille is broken up between Lower and Mid Lamoille in this report

2 Blue shading are Browns River watershed sampling sites

Trib 4 to Lamoille River (Milton Landfill tributary).

Biological monitoring in 2015 shows that below and adjacent to the Milton Landfill, the macroinvertebrate community is in poor condition. The stream was determined to be impaired for Aquatic Biota use immediately adjacent to and below the Milton Landfill for a short distance above and below rivermile (rm) 0.5, based on a macroinvertebrate assessment. The stream's biological integrity recovers by rm 0.3. It is believed based on the biological fingerprint, water quality samples collected at the three sites along the stream, and ground water samples taken below the landfill that the Milton Landfill is having a toxic impact on the stream community.

DEC staff analyzing metals data collected in 2014 & 2015 noted that “[a]lthough iron was the only metal found to be above the ALS water quality criteria [by DEC], compliance monitoring by the Milton Landfill has detected several priority metals in both ground water and surface water samples.”

Surface water landfill monitoring data submitted in 2015 [from the landfill consultant] reviewed recently indicated that Pb, Zn, Cu and Fe have been observed above acute and/or chronic criteria in the last 20 years at all stations (up/mid/down). Zn has exceeded acute criteria at all sites as recently as 2012. Pb has been observed above chronic levels at the up/down sites as recently as 2012. Fe has been observed above chronic criteria at all sites, as recently as 2014 at the up site. Cu has been observed elevated at all sites exceeding chronic and acute criteria, however the detection limit for Cu changed in 2006 from 0.01 mg/L to 0.02 mg/L, which is now above applicable screening value to protect aquatic biota.

A strong hypothesis for the impaired biology would be long term exposure to elevated metals (Zn, Cu, Pb, and Fe), the source being the Milton Landfill. The 20 years of surface water monitoring data (spring/fall) would support this and the metals detected are reflective of metals commonly found in landfill leachate. Additionally groundwater monitoring results indicate significantly elevated levels for Pb, Ni, Cu, As and Fe further supporting that the landfill and contaminated groundwater is the likely source of the metals observed in these surface waters.

Streeter Brook

Streeter Brook in Milton has been sampled five times starting in 2002 at rm 0.6. The macroinvertebrate assessments resulted have been very good-good in 2002, good-fair in 2003, very good-good again in 2004 but good-fair in 2007 and then more recently in 2013, very good-good once again. It has been the EPT richness metric of the macroinvertebrate assessment that has made the difference in the final assessment call.

The stream is in a watershed that is very dominated by wetlands and the water is quite tannic. Further characterization of the stream is needed and in fall 2016, the stream will be sampled again at rm 0.6 and then at another site upstream of the Herrick Hill subdivision.

Lamoille River mainstem

Lamoille at rm 33.5 has been sampled in 2002, 2007, and 2013 and was assessed as very good to excellent on all three occasions. The last two assessments are very similar in abundance, richness, and EPT present. The Bio Index has decreased slightly indicating less organic enrichment stress but it has always been in the very good range. The dominant taxa is very water quality sensitive. Water quality samples show the stream is moderate to low in alkalinity - about 40mg/l. Chloride is low (< 10) indicating no road salt stress present and nutrients were also low with TP at 13.8 ug/l and TN 0.43 mg/l. The substrate composition was low in fines and dominated by cobbles. The embeddedness was only rated fair at 50%, but this does not seem to have had an impact on the community.

Deer Brook

Deer Brook has been sampled intermittently from 1990 to 2013 with three locations included in the sampling. Deer Brook has been on the impaired waters list since 1998. The data that originally put Deer Brook into the impaired category was a “poor” macroinvertebrate community assessment in 1990. At that time, the length of the impairment was 4.0 miles because the whey plant was suspected as part of the source of the impairment (nitrogen and “undefined” with nutrients, sediments, and pathogens as potential components of the undefined category were listed as the pollutants with agricultural and industrial discharges named as sources).

The macroinvertebrate community sample was “fair” in 1999 and the mileage on the impaired waters list was reduced from four miles to 2.5 miles in 2000 based on where the sampling was done. The whey plant was out-of-business in 1998. On the 2002 list of impaired waters, the sources of the impairment were modified after field investigations and industrial park stormwater, a sand pit, and corroding road culverts were all identified as possible sources of biological impact. The pollutants were still described as nitrogen and undefined.

Further macroinvertebrate sampling at rm 2.0 in 2002 was “fair-poor” and in 2003, “fair”. The assessment comments at rm 2.0 in 2003 note temperature as a stress (22°C in mid September, no Plecoptera present) as well as chlorides, which were high.

During the 2006 listing cycle, the pollutant was listed as sediment following further field investigations and some project work in the watershed.

Macroinvertebrate sampling also occurred at rm 2.1 and it was “fair” back in 2003. Macro algae amount was high, total phosphorus was elevated and iron and chloride were high. This station was sampled more recently in 2011 (and rm 2.0 was not) and the assessment notes moderate enrichment, temperature stress, and embeddedness at 65%.

The most recent macroinvertebrate sample was done at rm 1.4 in 2013 and it was assessed as “good” at this location.

Deer Brook watershed needs additional project implementation and ongoing monitoring to see if the stream’s biological health is improving.

Table 17. Biological sampling sites locations for the Lower Lamoille area

WBID	Stream or River	Station	Description
VT07-01	Lamoille River Trib #4	0.3	Above small trib coming in from the south below a small foot bridge.
VT07-01	Lamoille River Trib #4	0.5	Below Milton Landfill, access from end of Stacy Street
VT07-01	Lamoille River Trib #4	1.0	Upstream 100 meters from Landfill Road
VT07-01	Streeter Brook	0.6	Below Sanderson Road, below falls 75 meters
VT07-02	Lamoille River	15.7	Off Route 104A above bridge at hear of Arrowhead Mtn Lake about 0.5 miles. Near 5 chutes in river.
VT07-02	Lamoille River	19.3	Located 100 meters below Route 104 bridge in Fairfax
VT07-02	Lamoille River	20.9	Immediately below Fairfax Falls dam
VT07-04	Lamoille River	33.5	About ¼ miles below Jeffersonville WWTF. Access from dirt road and corn field on south side of the river.
VT07-03	Deer Brook	1.4	Below DEE Road down into ravine about ½ mile just below groundwater flux from Georgia Whey
VT07-03	Deer Brook	2.1	Immediately (50 meters) below I-89 and Dee Road culvert
VT07-10	Abbey Brook	0.4	Immediately above Route 128 bridge
VT07-10	Rogers Brook	0.5	Roadside site above private gate/bridge
VT07-11	The Creek	2.4	Route 15 in Underhill across from Rolling Meadows Farm
VT07-11	Lee River	2.7	Above Browns Trace Road bridge

Table 18. Biological monitoring needed in the Lower Lamoille watershed

Waterbody id	Stream or river name	Location/number of sites	Comments
VT07-01	Streeter Brook	Rm 0.6 and another site upstream of sub-division	Macroinvertebrate results have gone from “vgood-good” to “good-fair” and back several times. Needs more investigation.
VT07-03	Deer Brook	Rm 2.0 or 2.1 and rm 1.4	This brook needs to be sampled regularly until sources of impairment are addressed.
VT07-03	Stones Brook	Rm 5.2	This stream in Fletcher was sampled in 2007 and was “exc-vgood”. It should be sampled at this point again and perhaps a lower site.
VT07-05	Beaver Brook	One or two sites (no sites have been sampled)	This six mile stream needs sampling. It flows through Underhill, Westford and Fairfax into the Lamoille River.
VT07-11	Lee River	Rm 2.7	Would be good to have a macroinvertebrate sample where we have a fish community sample

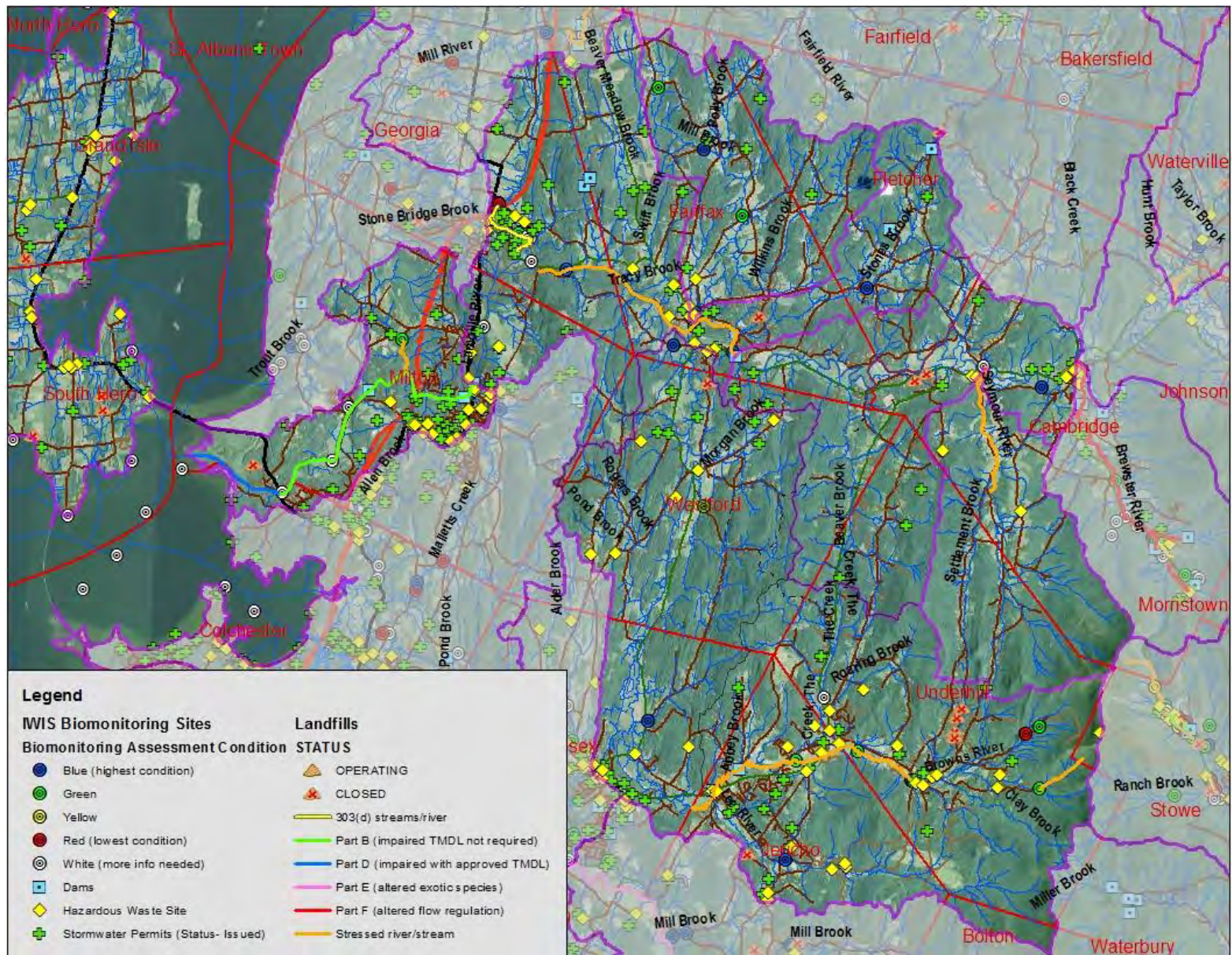


Figure 6. Lower Lamoille River and Browns River subwatershed assessment information

Landfills and Hazardous Waste Sites of the Lower Lamoille

Milton Landfill

The Milton Landfill is a closed and capped unlined landfill located off Route 7 in Milton. A tributary to the Lamoille river (Trib #4) runs along the south and east side of the landfill and this tributary has been sampled over the twenty plus years for landfill contaminants.

Some of the documentation covering certification, operation, inspection, and monitoring of this landfill includes: a 1983 Disposal Facility Certification; a 1987 Transitional Operation Authority; a 1990 Conditional Eligibility for Extension of the 1991 Landfill Line Deadline; a December 30 1992 Landfill Closure Extension Order; and a June 1993 approved Landfill Closure Plan.

When landfills were first closed, a monitoring period of 20 years was used for budgeting and planning purposes, however, was not a period of time set in stone. In September 2013, the Vermont Department of Environmental Conservation Waste Management & Prevention Division issued a letter requiring continued monitoring due to the continued presence of contaminants at levels of concern in groundwater monitoring samples. At the time of this report, there was an October 2015 ground and surface water monitoring round done at the Milton Landfill by Waite-Heindel Environmental Management.

Stormwater Discharges in the Lower Lamoille

Two areas in the Lower Lamoille watershed have high concentrations of stormwater permits. One area is that around the impaired Deer Brook (yellow stretch below) and the other is the area south of the Lamoille mainstem just downstream from Arrowhead Reservoir. (The green crosses are issued stormwater permits.)



Sources of Information for the Lamoille River watershed

Aquatic Life Use Support Attainment of Tributary 4 of the Lamoille River February, 2016. Prepared by Vermont ANR DEC Watershed Management Division, Monitoring Assessment and Planning Program, Montpelier, Vermont.

Brewster River Phase 1 & 2 Stream Geomorphic Assessment Summary, March 15, 2013. Prepared by: Fitzgerald Environmental Associates, Colchester, Vermont for the Lamoille County Planning Commission, Morrisville, Vermont.

Centerville Brook Corridor Plan Hyde Park, Vermont, February 10, 2010. Prepared by Bear Creek Environmental, Middlesex and The Lamoille County Planning Commission, Morrisville.

Data Collection and Remediation Activities at the Vermont Asbestos Group Mine, December 8, 2010. A presentation done by the Vermont DEC Waste Management Division, Montpelier, Vermont.

Detecting and Eliminating Illicit Discharges to Improve Water Quality in the Lamoille River Basin Final report, January 31, 2014, revised July 11, 2014. Prepared by Stone Environmental, Montpelier for Vermont DEC, Montpelier, Vermont.

Elmore Branch River Corridor Plan, Wolcott and Elmore, Vermont, October 30, 2009. Prepared by Bear Creek Environmental, Middlesex and The Lamoille County Planning Commission, Morrisville.

Gihon River Corridor Plan, Johnson, Hyde Park & Eden, Vermont, October 30, 2009. Prepared by Bear Creek Environmental, Middlesex and The Lamoille County Planning Commission, Morrisville.

Milton Municipal Solid Waste Landfill (closed) May 2015 Water Quality Sampling and Analysis of Trends and Standards Exceedances, September 10, 2015. Waite-Heindel Environmental Management, Burlington, Vermont.

Rodman Brook Corridor Plan: Morristown and Hyde Park, Vermont, March 22, 2011. Prepared by Bear Creek Environmental, Middlesex and Lamoille County Planning Commission, Morrisville.

Sampling and Analysis Plan for the Vermont Asbestos Group Mine Site Eden and Lowell, Vermont. Prepared by Weston Solutions, Inc. Superfund Technical Assessment and Response Team IV (START), October 2015. (Conducted under: Emergency Planning and Response Branch Generic Program Quality Assurance Project Plan August 2014)

Wild Branch Corridor Plan, Wolcott, Craftsbury and Eden, Vermont, March 18, 2010. Prepared by Bear Creek Environmental, Middlesex and The Lamoille County Planning Commission, Morrisville.