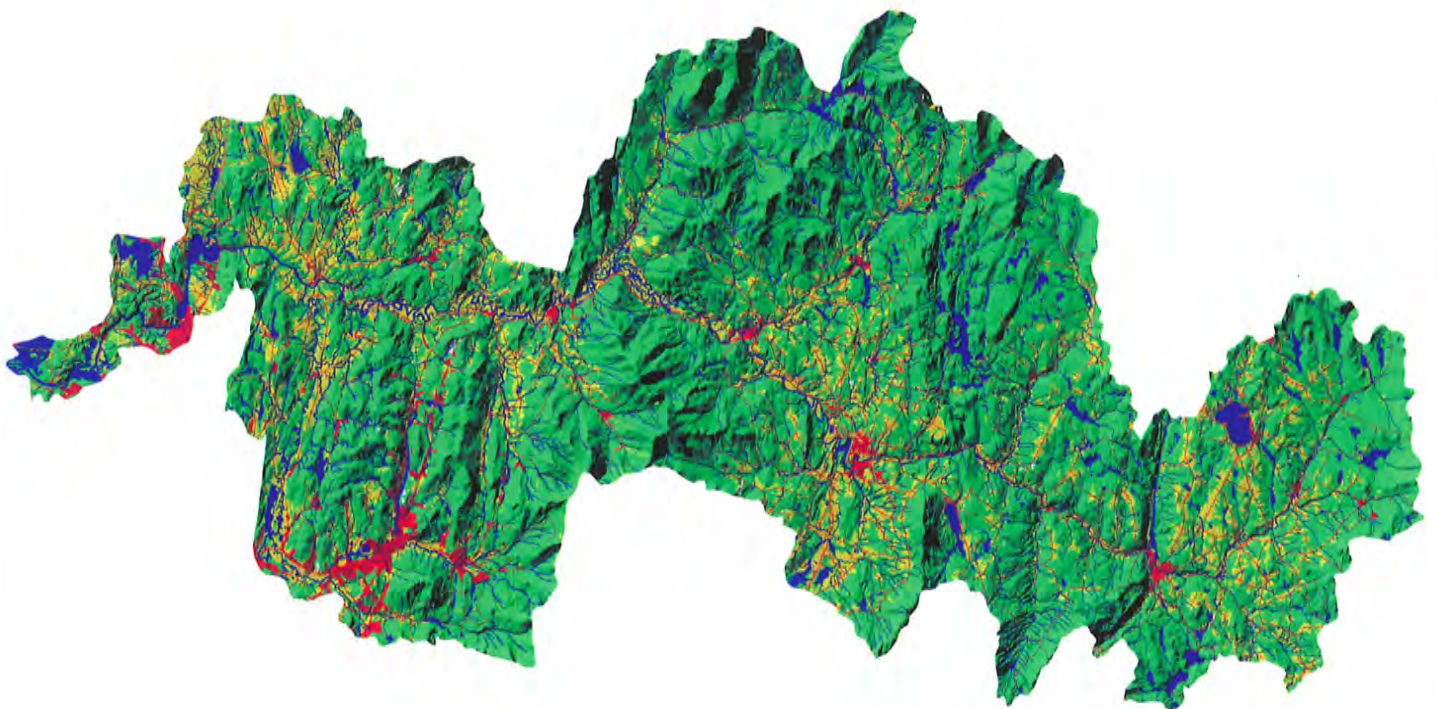


Basin 7

Lamoille River Watershed Assessment Report



Agency of Natural Resources
Department of Environmental Conservation
Water Quality Division

February 2001

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General Description of the Lamoille 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. It is a pool-riffle gravel bottom river for the majority of its length although there are smaller reaches of dune-ripple sand bottom and plane-bed cobble-boulder bottom. From its headwaters to the mouth, the river descends approximately 1,200 feet and drains a 706 square mile watershed, which is 7.5 percent of Vermont's land area. The basin occupies the major part of Lamoille and lesser parts of Franklin, Chittenden, Orleans, Washington, and Caledonia Counties.

The Lamoille River existed before the Green Mountains were upraised, and because its headwaters were far to the east of the present mountain axis, the river succeeded in cutting its valley downward in proportion as the mountains rose. It is an ancient river in the early ages of maturity and in the past, enormous amounts of sediment were deposited along its course. The ancient sediment deposits are now the stream banks, which in some areas, are high above the river. The river meanders across broad floodplains in parts of its course, and flows through narrow gorges and over rapids and falls in others. The main river valley consists of well drained to excessively drained soils on old beaches, deltas and terraces. Rock outcrops exist at many points in the river bed, along the banks and on the slopes on both sides of the valley.

There are a total of 24 lakes and ponds that are 20 acres or larger in the Lamoille River Basin. Caspian Lake, Arrowhead Mountain Lake, and Green River Reservoir are by far the largest with areas of 789, 760, and 554 acres respectively.

The dominant land cover/land use in the Lamoille River watershed is forested (71%). The second largest land use is agriculture with a relatively high percentage coverage of 13%. Surface waters cover about 7% of the watershed area and wetlands about 3%. Transportation uses cover 4% of the area and other developed land occupies 2%. (See Appendix A for a table of land cover/land use.)

Lamoille River Journey

From the Lamoille River's origin at Horse Pond to Hardwick, the river flows in a southwesterly direction with Route 16 running almost parallel to this upper section of river. A number of brooks flow from the hills, mountains, and ponds of Greensboro, Wheelock and Stannard to join this stretch of river: Morrison, Mud Pond, Paine, Sawmill, Esdon, Flagg, Stannard, and Greensboro Brooks are the main named streams (Figure 1).

East of Hardwick, the river flows in a westerly direction where Route 15 now follows the course of the river. In Hardwick Village, the river flows westerly and then northerly. The river has been armored and channelized through Hardwick Village in an effort to protect Route 15 and village properties. Just outside of the village, there is a dam near the

junction of Routes 15 and 14 that impounds the river and its tributary, Alder Brook, forming the so-called Hardwick Lake.

West of the village of Hardwick, the Lamoille River meanders westerly then northwesterly through the towns of Hardwick and Wolcott. The river once had access to a broad floodplain in this stretch but now both Route 15 and the Lamoille Valley Railroad bed are floodplain encroachments that constrain the river's movement. The floodplain through Wolcott Village has been filled and the riverbanks armored again to protect human structures. There has also been a large loss of woody riparian vegetation in this reach.

A number of significant tributaries join the Lamoille River in the town of Wolcott including Elmore Branch, Wild Branch, the Green River, Wolcott Pond Brook, and Elmore Pond Brook.

The Lamoille River flows in a westerly direction through Morristown into Morrisville. This section of the river has more riparian vegetation present and is thus relatively stable. In Morrisville and just west of the village, there are two dams that impound the river. The Cadys Falls dam has the biggest effect and results in the formation of Lake Lamoille.

West of Cadys Falls, the river flows northwesterly forming the municipal border between Hyde Park and Morristown. Kenfield Brook, Centerville Brook, and Jacob Brook flow into the Lamoille along this stretch.

The river continues a northwesterly flow through the town of Johnson and into the town of Cambridge where it changes to a more westerly course (Figure 2). This section of the Lamoille River resembles the section through Hardwick and Wolcott. Agricultural activities dominate in the river valley and hay and corn frequently come to the top of the riverbank. Gravel mining, floodplain encroachments and removal of woody riparian vegetation have promoted bank erosion, channel overwidening, aggradation, and plan-form adjustment especially below Ithiel Falls to Cambridge Village.

The most significant tributary in this stretch is the Gihon River, which enters from the north in Johnson. The Gihon is 14 miles long and drains a watershed of 66 square miles. Other important tributaries include Foot Branch, the North Branch and the Brewster River.

From Cambridge, the Lamoille River continues its meandering course westerly through Fairfax encountering Fairfax Falls dam. Route 104 parallels this stretch of the river.

Just west of the village of Fairfax, the Browns River enters from the south and increases the size of the Lamoille River substantially. The Browns River has a length of 24 miles and drains an area of 92 square miles.

From the confluence of the Browns River, the Lamoille flows westerly for almost four miles before becoming Arrowhead Mountain Lake at East Georgia. The dam that impounds the Lamoille forming this reservoir is located downstream in Milton. Below Milton village, the river flows westerly, southerly and westerly again encountering two dams and passing through a large wetland system before entering Lake Champlain.

LAMOILLE RIVER DRAINAGE BASIN

SCALE OF MILES

0 1 2 3 4 5

VERMONT STATE MAP
NATURAL RESOURCES
CHECKED BY
APPROVED
DATE

VERMONT STATE MAP
NATURAL RESOURCES
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LAMOILLE RIVER DRAINAGE BASIN

Lamoille Watershed Rivers and Streams

Over 611 miles of rivers and streams drain the land area known as the Lamoille River watershed. From the hills and forest lands of its headwaters and northern tributaries through the wide agricultural valley that is much of its length to the suburban and urban towns near the mouth, the river changes character many times. Following are some of the uses and features people have enjoyed, as well as the problems and threats that they have caused to this significant water.

Special Uses, Values, and Features of Lamoille Rivers and Streams

There are many identified special uses, features, and values of the Lamoille River and its numerous tributaries including gorges, waterfalls, cascades, whitewater boating stretches, swimming holes, and significant wetland communities. The wetland communities are described in the section on wetlands below. Some of the most well-known and significant riverine uses and features are described below.

Whitewater Boating

A number of locations are good whitewater boating stretches and are reported as such in the *Whitewater Rivers of Vermont* publication (1989). The Lamoille River from Greensboro Bend to Hardwick, a stretch of 7 to 8 miles, is a "medium-sized stream with small ledges and tight bends" and is Class II and Class III whitewater at medium water levels. There is much Class III at high water. The stretch is rated "high importance" for boating.

Another stretch of whitewater on the Lamoille River is from Pottersville to Wolcott, a reach of about 1.4 miles called the "Wolcott Ledges." It has nice Class III drops and practice rapids and is considered "highly important" in part because the Class III drops can be run in wet summers and fall.

The Lamoille River from Fairfax to Arrowhead Mountain Reservoir, a stretch of 4.6 miles, is also considered "highly important." It is Class II whitewater at medium water to Class III at high water. The rapids in this river reach are one of two remaining sets of rapids on big rivers in the state (the other being the Sheldon rapids on the Missisquoi) and thus unusual.

The North Branch of the Lamoille River is a challenging and noteworthy stretch of whitewater enjoyed by many boaters. This 9 mile or so segment of river was not described in the 1989 Whitewater report but was brought to the Vermont Department of Environmental Conservation (DEC)'s attention in 1993. Boaters put in below Long Pond in Eden at the Route 109 bridge and go through a Class III or IV gorge, travel a 6 mile stretch of Class II whitewater and then are challenged by another stretch of Class III/IV water upstream from Waterville. It is described as having "excellent to outstanding" scenery and as "pristine".

Another whitewater section in the Lamoille River watershed identified by local users is a 1.5 mile stretch on the Gihon River. This is a serious Class IV and Class V reach used by a limited number of expert paddlers.

The Wild Branch in Craftsbury and Wolcott has a fast, twisty, highly technical Class II-III whitewater run downstream of North Wolcott road for about 7 miles. It can be paddled only during snowmelt when the water is high enough. It does not have the drops or holes and waves of other whitewater streams but it does have "pushy water", many, many blind corners and obstacles. It does need serious scouting because the potential for ice, debris or fallen trees is great and the paddler can't see these coming because of the bends and turns. It is considered an important, local whitewater stretch.

Swimming

There are a number of popular swimming holes both on the Lamoille River mainstem and on its tributaries. The locations described below are also generally some of the most scenic and aesthetically pleasing spots on the river and are enjoyed by people picnicking, taking photographs, and fishing in addition to swimming.

Dog's Head Falls in Johnson consists of six-foot high twin falls, two large pools for swimming, rocks and outcrops for jumping, picnicking, and sunbathing. An impressive bedrock outcrop forms the "dog's head." Sloping Falls just downstream and also in Johnson is also a well-used recreation area. It consists of a fifty foot long cascade, sculptured rocks, undercut ledges, swift current, and several pools. The undertow in the upper area makes it too dangerous for swimming but the lower pool is enjoyed by swimmers. Picnic Ledges on the Lamoille River mainstem in Wolcott (called Wolcott Ledges in the Whitewater report) is in a wide section of river and is used for swimming, picnicking, and fishing as well as whitewater boating.

A number of swimming holes also exist on various tributaries to the Lamoille. Those identified in the *Vermont Swimming Hole Study* (1992) include an Elmore Branch swimming hole, the heavily used Terrill Gorge on Kenfield Brook, the pools and cascades of Calavale Brook, the popular Sheep's Hole and The Ledges on Foot Brook in Johnson, the Power House Covered Bridge Falls on the Gihon River, Roger's Bridge on the Seymour River, the Brewster River Gorge swimming hole, Coddington Hollow Covered Bridge on the North Branch and others.

Fishing and the Fishery

People fish throughout the Lamoille River and its tributaries. In addition, there are many sites in the watershed where more concentrated angling occurs, for example, at a number of the spots listed above as swimming holes. The Vermont Department of Fish and Wildlife owns 25 different riverbank segments totaling 62,000 linear feet (almost 12 miles), which provide riparian zone protection and direct public access for fishing. The Department's farsighted acquisition program assures that riverbank angling can continue as a use on this popular river in the face of increasing residential development and posting.

Some of the good access points for fishing include Fisher Bridge access in Wolcott, which has handicapped access for fishing and picnicking, Town Ball Field access in Wolcott, Elmore Pond Road Bridge access in Wolcott, Cady's Falls Bridge access in Hyde Park, Hogback Road access in Johnson, Cambridge Junction Covered Bridge access and Greenways Trail access in Cambridge among others.

The Lamoille River mainstem above Hardwick and its headwater tributaries are classic Vermont trout streams with regard to size, gradient, and fish community. From Glover/Sheffield to the Greensboro Brook confluence, the mainstem and its tributaries are small, moderate gradient upland streams flowing through mainly forested riparian corridors. The fish populations have been examined by electrofishing in selected stream segments over the past five decades including during the past several years. The fish community is dominated by species believed to be endemic and whose populations are supported by widespread natural reproduction: brook trout, slimy sculpins, blacknose dace, longnose dace, longnose suckers and creek chubs. The occurrence of species believed not to be native or characteristic of upland streams has also been noted: yellow perch and pumpkinseed sunfish. Downstream drift from ponds and a major lake in this segment of the drainage account for their presence.

In this uppermost reach, angling for brook trout is a common activity based on 1996 creel survey results. However, fishing effort is relatively low (55 angler-hours per mile). Resident anglers account for roughly 90% of the fishing activity. The average angler catch rate for trout is 0.65 fish per hour. Anglers kept their catch at a reported rate of roughly one for every five caught. The mix of hatchery and wild trout in the creel is unknown. Since wild trout have dominated the electrofishing samples, minimal year-to-year holdover of hatchery-origin trout is assumed in this reach.

Caspian Lake is located in the Greensboro Brook subwatershed of the upper Lamoille. Caspian is one of northeastern Vermont's major coldwater lakes with an area of 789 acres and a maximum depth of 142 feet. Its fish community includes lake trout, rainbow trout, brown trout and rainbow smelt. The fish communities of the tributaries that flow into Caspian are influenced by the lake's fish community. Smelt spawn in the downstream-most reaches of the tributaries. Porter Brook and the smaller feeder streams are nursery waters for rainbow trout, brown trout, longnose suckers and white suckers that migrate into them seasonally to spawn. The brook trout/slimy sculpin/blacknose dace assemblage is assumed to be in these headwaters above the influence of migration from the lake.

Downstream of its confluence with Greensboro Brook to Hardwick Lake dam, the Lamoille's fish community expands to include wild and hatchery-origin rainbow trout. However, hatchery-origin trout make up only a small portion of the late summer electrofishing samples. Wild young-of-year and older brook trout and rainbow trout dominate in both the mainstem and the tributaries (e.g., Hainesville Brook). In addition to species named above for the upper river, white suckers and brown bullheads also appear in the fish community.

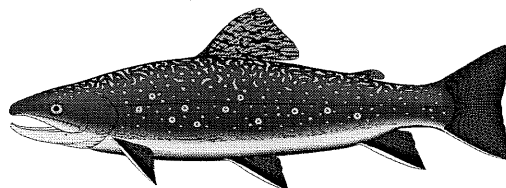
The river's drainage area (222 square miles at Morrisville Dam) expands in relatively small increments. The largest tributary in the upper Lamoille watershed is the Wild Branch (31 square miles) followed by the Green River (22 square miles). As its drainage area increases and it flows westward to Morrisville, the Lamoille becomes more characteristic of a valley-bottom trout river.

The river gradient between Hardwick Lake and the Pottersville dam in Wolcott is relatively low and shows signs of observable riverine degradation, especially sediment accumulation from repeated Hardwick Lake desilting. The Vermont Fish & Wildlife Department has no systematic fish population sampling information from this reach. In 1996, fishing effort (288 angler hours per mile) was five times greater here than in the upper river. The trout catch rate was 0.37 fish/hour, and is made up mainly of hatchery-origin rainbow trout.

The mainstem from the Pottersville Dam, just upstream of Wolcott village, to Morrisville is a valley-bottom river punctuated by stretches of moderate gradient with ledge drops, rapids, riffles and coarse substrate. Brown trout and various minnows (common shiners, fallfish) become part of the fish community. Again, hatchery-origin trout make up only a small portion of the late summer electrofishing samples. Wild young-of-year and older brown trout and rainbow trout dominate in both the mainstem and the tributaries. Wild brook trout continue to occur but in reduced numbers. The lower reaches of the tributaries (Elmore Branch, Green River) appear to play some role as spawning and nursery areas for mainstem rainbow trout and brown trout.

This river reach is a popular trout fishing area. It received angler effort of 664 hours per mile in 1996. The trout catch rate for the three species combined was 0.59 fish per hour. The vast majority of the catch was rainbow trout. One of every two rainbows reported caught was creeled. Most creeled rainbow trout appear to be of hatchery origin from the current year's stocking. Based on angler estimates of the size of released fish, we suspect that many of these are wild. All brown trout and brook trout caught and harvested are the product of natural reproduction. Brown trout up to 17 inches were documented during the creel survey.

The composition of the fish population of the Wild Branch resembles the middle Lamoille mainstem more than that of the upper Lamoille mainstem. Wild brown trout and rainbow trout are more dominant than brook trout, and minnows of the middle river are present. Major floods in 1995 and 1997 have affected the stability of the streambed and banks in several areas. Private and municipal activities to restore property and infrastructure may have aggravated the flood impacts on fish populations and habitat. Their current status is unknown.



River Water Quality and Aquatic Habitat Impacts and Threats

Designated Use Support Status for Rivers

For each river use or value that is assessed, the miles of river or stream fully supported, threatened, partially supported or not supported are determined. For example, river miles that are fully supported for aquatic biota have macroinvertebrate and fish communities in good to excellent health. River miles that are fully supported for swimming have no known high levels of *E. coli*, a bacteria that is used as an indicator for pathogens. Table 1 below gives the miles in each support category for seven uses or values: aquatic biota and/or habitat, contact recreation (swimming, tubing), secondary contact recreation (boating, fishing), aesthetics, fish consumption, drinking water supply and agricultural water supply. The use called "overall" reflects the miles for which one or more of the uses are not supported, partially supported, threatened or fully supported. The fish consumption use is not factored into the "overall" category because all miles of river and stream are at least threatened for fish consumption due to a statewide fish consumption advisory. If taken into account in "overall", this status would mask the extent of other threats.

Table 1. Use Support Status of Basin 7 Rivers and Streams.

Use	Miles of full support	Miles threatened	Miles of partial support	Miles of non-support	Miles not assessed
Overall	215.7	27.2	155.5	16.3	196.8
Aquatic biota/habitat	215.7	27.2	155.5	16.3	196.8
Contact recreation	198.8	74.3	39.3	0.9	297.8
Secondary contact recreation	210.7	65.9	78.9	13.5	242.1
Aesthetics	230.2	35.9	133.2	7.3	204.5
Drinking water supply	62.1	1.8	0	0.9	546.3
Agriculture water supply	0	0	0	0	611.1
Fish consumption	0	602.6	8.5	0	0

Of the 611.1 miles identified to date in the Lamoille River watershed, 35% of the miles (216) fully support aquatic biota and habitat with no threats identified, 4% (27 miles) fully support this use but threats are known, 32% of the miles (197) have not been assessed, and 28% (172 miles) do not fully support aquatic biota/habitat. As discussed below, sediment and habitat alterations are the major causes of the habitat problems. Loss of riparian vegetation, streambank erosion, and channel instability result in the sediment and physical alterations that affect aquatic habitat through much of the Lamoille watershed.

E. coli or other bacteria data needed to determine if swimming is supported is limited, and, therefore, 49% of the miles (298) are not assessed for "contact recreation". Thirty-two percent (199) of the miles fully support swimming with no identified threats, 12% (74 miles) fully support swimming with threats identified, and about 7% (40 miles) do not fully support swimming. Failing septic systems, manure runoff, high turbidity, severe siltation, and lack of flow are the reasons that the swimming use is partially to non-supported.

Secondary contact reaction, primarily fishing, is fully supported with no known threats for 34% (211) of the river miles. This use is fully supported but threatened on 11% (66) of the miles. Fishing is partially or not supported on 15% (92) of the miles. Forty percent of the miles were not assessed for this use. Fishing was not fully supported where there were habitat alterations, sedimentation, flow alterations, and temperature modification.

Fish consumption is considered threatened statewide because there is a "health alert" that recommends that people limit consumption of fish caught in Vermont waters. Where there is waterbody-specific fish tissue data showing high levels of mercury or PCBs then the miles of river or stream containing the contaminated fish are listed as partial or non-support. In the Lamoille River watershed, 99% (603) of the miles are considered threatened for fish consumption and 1% (8.5 miles) are partially supported because of mercury in walleye that were sampled at the mouth of the Lamoille.

Thirty-eight percent (230) of the river miles are fully supported and 6% (36 miles) are fully supported but threatened for aesthetics. Twenty-three percent of the river miles do not fully support aesthetics and 33% of the miles were not assessed for this use. Physical alterations to the stream channel, streambank erosion, low flow, turbidity, and excessive algae all affect the support status of aesthetics.

Causes and Sources of River Impacts and Threats

The major causes of impacts to the Lamoille River and its tributaries are sediment and habitat alteration/channel instability, which are integrally connected. Nutrients and thermal modifications affect the third and fourth greatest number of miles. See Table 2 below for the cause (a pollutant or condition) and the number of miles affected by each cause.

Riparian vegetation removal, streambank erosion, floodplain encroachments, floods, and agricultural land uses are the five top sources that affect the water quality and aquatic habitat of the Lamoille River (Table 3). Again these sources are integrally related. Agricultural land use in the productive floodplain of the Lamoille resulted in some riparian vegetation removal. The lack of vegetation along, and back from, the riverbank is often a major contributing factor to streambank erosion and channel instability. The habitat alteration and flood damage was greatly exacerbated by the unstable condition of the river and the lack of riparian vegetation along the Lamoille and some of its tributaries such as the Wild Branch. The dams and impoundments for hydro-electric production on the Lamoille also alter the river's condition by degrading water quality, substrate composition and thermal regime from flow fluctuations, drawdowns, and desilting.

Table 2. Causes of River Impacts and Threats in the Lamoille Watershed.

Cause or Pollutant	Miles of high impact	Miles with moderate impact	Total miles of impact	Miles threatened
Sediment	64.9	91.1	156.0	25.0
Habitat alteration	77.7	69.7	147.4	17.9
Nutrients	2.5	83.3	85.8	9.5
Thermal modifications	0	82.2	82.2	5.0
Flow alterations	20.5	17.9	38.4	5.0
Turbidity	0	33.8	33.8	0
Pathogens	0	31.8	31.8	48.0
Low dissolved oxygen	0	8.5	8.5	0

Table 3. Sources of River Impacts and Threats in the Lamoille Watershed.

Source	Miles of high impact	Miles with moderate impact	Total miles of impact	Miles threatened
Riparian vegetation removal	15.0	111.5	126.5	6.5
Streambank erosion	61.3	48.8	110.1	11.2
Floods	26.8	80.2	107.0	0.4
Habitat modification*	58.9	46.5	105.4	11.9
Agriculture	8.5	92.3	100.8	26.0
Flow modification - hydro	9.7	21.0	30.7	5.0
Road/bridge runoff	0	30.2	30.2	8.2
Land development	0	26.9	26.9	7.0
Upstream impoundment	0.9	24.2	25.1	5.0
Urban runoff	0	15.7	15.7	0
Road/bridge construction	15.5	0	15.5	1.5

*Habitat modification - sum of channel instability, floodplain encroachments, and past instream work that has led to current channel adjustment.

Lamoille Watershed Lakes and Ponds

Special Uses and Values of Lamoille Watershed Lakes and Ponds

Vermont DEC's Lake Protection Classification System is one framework within which lakes can be evaluated for their special significance when compared to other lakes statewide. The Lake Protection Classification System identifies unique lakes based on: wilderness status; occurrence of scenic and natural features; existence of very high water quality; and/or, the presence of very rare, threatened, and/or endangered species. The following Lamoille River Basin lakes are significant in these respects:

Caspian Lake, Greensboro: Caspian Lake exhibits ultra-oligotrophic water quality, meaning that the long-term nutrient concentrations in the lake are remarkably low (less than 6 parts-per-billion of total phosphorus, measured after ice-out in the spring). Accordingly, water clarity remains quite high throughout the summertime recreation season. Caspian Lake also is characterized by a very scenic bouldered shoreline.

East Long Pond, Woodbury: This pond has vast stretches of undisturbed shoreline, and also has a particularly scenic bouldered shoreline section. East Long Pond also supports a breeding pair of the threatened common loon (*Gavia immer*).

Lake Eden, Eden: Lake Eden supports two noteworthy plant species. These are the threatened waterweed *Elodea nutallii*, and the rare aquatic buttercup *Ranunculus longirostris*.

Lake Elmore, Elmore: This lake supports four noteworthy plant species. These are the threatened burreed *Sparganium fluctuans*, and three rare species: the burreed *S. natans*, and the pondweeds *Potamogeton Vaseyi*, and *P. obtusifolius*.

Flagg Pond, Wheelock: This small pond supports an unusual and particularly scenic shoreland and wetland plant community.

Green River Reservoir, Hyde Park: During the summer, water levels are stabilized, and this reservoir is managed for flatwater, non-motorized boating (e.g. canoeing and kayaking). The use of any craft powered by an internal combustion engine is prohibited on this reservoir during the openwater season. The reservoir provides a wilderness-like setting with a unique assemblage of islands, and supports threatened common loons.

Horse Pond, Greensboro: This small lake supports two noteworthy aquatic plants. These are the threatened burreed *S. fluctuans*, and rare burreed *S. natans*.

Little Elmore Lake, Elmore: This 20-acre lake can only be accessed by foot from a small, wooded track, approximately 3/4 mile from the nearest road. It is a wilderness-like lake,

which also supports the threatened burreed *S. fluctuans*, and the rare watermilfoil *Myriophyllum farwellii*.

Long Pond, Eden: This pond supports the rare naiad *Najas gracillima*.

Long Pond, Greensboro: This is a wilderness-like lake, accessible only by foot or four-wheel drive, with most of the shoreline in The Nature Conservancy ownership. Better than 95% of the shoreline is undisturbed forestland. The pond provides habitat for the rare aquatic buttercup *R. longirostris*.

Milton Pond, Milton: This small pond, located quite near to downtown Milton, was once Milton's principal water supply. Despite its proximity to large developed areas, this wilderness-like pond is completely undisturbed, accessible at best by four-wheel drive. A network of interpretive nature paths is being established within the pond's watershed by the local conservation commission.

Nichols Pond, Hardwick: Nichols Pond has vast stretches of undisturbed, very scenic shoreline, including islands and steep wooded shores. It is overlooked by the 200-foot tall Nichols Ledge, providing one of only a handful of lake-cliff views available statewide. It also provides habitat for nesting common loons.

Schofield Pond, Hyde Park: This is a small, wilderness-like acidic lake located at the center of a vast and spectacular wetland system, which drains into Green River Reservoir. It is accessible only by foot via a private footpath, or more directly by canoe, departing from a network of logging roads and navigating the upper wetland complex. The scenic juxtaposition of the hillsides and wetlands which surround the pond and the water itself provides an unusual viewscape in Vermont. One small inconspicuous camp is present near the shoreline.

Stannard Pond, Stannard: This is one of only 10 true wilderness lakes in Vermont. It is accessible only by foot up a one-mile trail.

Tuttle Pond, Hardwick: This is a small, wilderness-like lake which is accessible only by foot, and which is surrounded by a scenic wetland complex.

Wolcott Pond, Wolcott: This wilderness-like lake supports a perennially breeding common loon pair, and three noteworthy aquatic plants. These are the threatened waterweed *E. nutallii* and *Littorella americana*, and the rare coontail *Ceratophyllum echinatum*.

Zack Woods Pond, Hyde Park: This is a small, wilderness-like lake, accessible only by car-top boat, which has a completely undisturbed shoreline.

Lake Water Quality and Aquatic Habitat Impacts and Threats

The Lamoille River watershed is characterized by having numerous lakes. There are 79 lakes and ponds in the basin, comprising 4,268 acres. Forty-eight of these lakes (4,144 acres) are tracked in Vermont DEC's Lake Assessment Database. Of these 4,144 acres, 3,739 are monitored (24 lakes), while 405 are evaluated (24 lakes).

Designated Use Support Status for Lakes

Overall, there are 1,493 lake acres in Basin 7 that only partially support one or more uses, and 115 acres where one or more uses are not supported. All designated uses are fully supported on 2,507 assessed lake and pond acres in Basin 7. Table 4 provides an accounting of lake acres where designated uses are supported, threatened, or not fully supported.

Table 4. Designated use support for lakes in the Lamoille River Watershed.

Use	Acres Fully Supporting Uses	Supporting Acres with Uses Threatened	Acres Partially Supporting Uses	Acres Not Supporting Uses	Acres Not Assessed
Overall Uses	459	2048	1493	115	29
Aesthetics	3195	805	0	114	30
Aquatic Life Use Support	459	2048	1493	115	29
Agricultural Water Supply	0	0	0	0	4144
Drinking Water Supply	27	0	0	0	24
Fish Consumption	3344	0	760	0	40
Filtered Water Supply	27	0	0	0	4117
Industrial Water Supply	0	0	0	0	4144
Secondary Contact Uses	3012	695	293	114	30
Swimming Uses	3153	847	0	114	30

The designated use that is most affected by activities or conditions resulting in less than full support (partial or non-support) is aquatic life use. Fish consumption is the use with the second largest number of acres not fully supported. Secondary contact use (boating or fishing) is the use with the third largest number of acres with less than full support. Swimming, secondary contact recreation, aquatic life use, and aesthetics are threatened on a relatively large number of acres but those lake acres still currently support those uses. Industrial water supply and agricultural water supply uses were not assessed.

Causes and Sources of Lake Impacts and Threats

The principal cause of impairment to lakes in the Lamoille River watershed is flow alteration (drawdown of water levels), which affects aquatic life use on several lakes as discussed below, for a total of 1,607 acres. Mercury contamination in fish tissue impairs 760 acres. Critically low pH in a tiny pond impairs aquatic life use on one lake acre, but an additional 899 acres are threatened by low buffering capacity, which could lead to episodic low pH events. Siltation impairs aquatic life use in the 194 acre Hardwick Lake, and is noted as a threat to uses on 295 additional acres, though some reassessment of this threat is warranted. The consequences associated with existing or potential infestations of exotic species impair 114 acres, and threaten an additional 434 lake acres. Table 5 provides an accounting of the causes of impacts to lakes in this basin.

Table 5. Causes of impacts to lakes in the Lamoille River Basin.

Cause of Impact	Acreage by Magnitude of Impact			Total Acres Not Fully Supporting	Total Acres Threatened
	High	Moderate	Minor		
0500 Metals	0	760	0	760	0
0560 Mercury	0	760	0	760	0
0900 Nutrients	0	0	0	0	421
1000 pH	1	0	0	1	899
1100 Siltation	0	145	0	145	295
1200 Organic enrichment - DO	0	0	0	0	100
1500 Flow alteration	1607	0	0	1607	1470
2200 Noxious aquatic plants - Native	0	0	0	0	25
2210 Noxious aquatic plants - Algae	0	0	0	0	163
2600 Exotic Species	114	0	0	114	434

Table 6 provides an accounting of the sources of impairment and threats to lakes in the Lamoille River Basin. The most important source of impairment to Lamoille River watershed lakes is flow regulation which impairs 1,607 lake acres due to habitat modification and partial loss of aquatic life use. Atmospheric deposition is largely the source of mercury found in fish tissue, and this impairs fish consumption use on 760 acres. Atmospheric deposition is also responsible for the critical acidification of one lake acre, and threatens an additional 899 acres. Some of these waterbodies may also exhibit natural sensitivity to acidification, which explains some of the 861 threatened acres attributable to natural sources. Boating traffic ('in-water releases') between waterbodies is assumed to be the primary vector for Eurasian watermilfoil (*Myriophyllum spicatum*) introduction to lakes. This impairs 114 lake acres and threatens an additional 395 acres. Boating traffic also threatens an additional 194 acres due to shoreline erosion. Finally, general land development and construction threatens 364 lake acres with sedimentation and/or organic enrichment.

Table 6. Sources of impacts to lakes in the Lamoille River watershed.

Source of Impact	Acreage by Magnitude of Impact			Total Acres Not Fully Supporting	Total Acres Threatened
	High	Moderate	Minor		
1000 AGRICULTURE	0	0	0	0	64
1100 Nonirrigated Crop Production	0	0	0	0	21
1800 VT-Animal holding/management area	0	0	0	0	42
2000 SILVICULTURE	0	0	0	0	35
2100 Harvesting, Restoration, Residue Management	0	0	0	0	35
3000 CONSTRUCTION	0	0	0	0	364
3200 Land Development	0	0	0	0	364
4000 URBAN RUNOFF/STORM SEWERS	0	0	0	0	153
4300 Other Urban Runoff	0	0	0	0	148
4500 Highway/Road Bridge Runoff	0	0	0	0	5
5000 RESOURCE EXTRACTION	0	0	0	0	15
5100 Surface Mining	0	0	0	0	15
7000 HYDROMODIFICATION	1607	0	0	1607	515
7400 Flow Regulation/Modification	1607	0	0	1607	436
7900 MARINAS AND RECREATIONAL BOATING	114	0	0	114	589
7910 In-Water releases	114	0	0	114	395
8100 ATMOSPHERIC DEPOSITION	1	760	0	761	899
8300 HIGHWAY MAINTENANCE AND RUNOFF	0	0	0	0	211
8600 NATURAL SOURCES	0	1	0	1	861

To provide background information on individual lakes in this basin, a summary of overall use support by individual lake is provided in Table 7. The paragraphs following Table 7 describe threats or impacts to selected Lamoille River watershed lakes.

Table 7. Threats and impairments to individual Lamoille River watershed lakes.

Lake Name	Lake Area (ac)	Last Assessed (YYYYMM)	Assessment Type	Acres Fully Supporting	Threatened Acres	Acres Partially Supporting	Acres Not Supporting
ARROWHEAD MOUNTAIN	760	200009	Monitored	0	0	646	114
BEAR	1	199903	Evaluated	1	1	0	0
BEAVER (HYDEPK);	16	200009	Evaluated	16	16	0	0
BELDING	4	199903	Evaluated	4	4	0	0
BELVIDERE-NE;	9	199903	Evaluated	9	0	0	0
BIG MUDDY	17	199903	Evaluated	17	17	0	0
CAP HILL;	9	199903	Evaluated	0	0	0	0
CASPIAN	789	200012	Monitored	789	789	0	0

Lake Name	Lake Area (ac)	Last Assessed (YYYYMM)	Assessment Type	Acres Fully Supporting	Threatened Acres	Acres Partially Supporting	Acres Not Supporting
CLEAR	8	199903	Evaluated	8	0	0	0
COLLINS	16	200009	Monitored	16	0	0	0
EAST LONG	188	200009	Monitored	188	188	0	0
EDEN	194	200009	Monitored	194	194	0	0
ELMORE	219	200009	Monitored	219	219	0	0
FLAGG	111	200009	Monitored	111	0	0	0
GREEN RIVER	554	200009	Monitored	0	0	554	0
GUT	13	200012	Evaluated	13	0	0	0
HALFMOON	21	200009	Monitored	21	21	0	0
HARDWICK	145	200009	Monitored	0	0	145	0
HORSE	32	200009	Monitored	32	0	0	0
KEELER	5	200009	Evaluated	5	5	0	0
LAKE-OF-THE-CLOUDS	1	200009	Monitored	0	0	0	1
LAMOILLE	148	200009	Evaluated	0	0	148	0
LANDFILL;	7	199903	Evaluated	7	0	0	0
LITTLE ELIGO	15	199903	Evaluated	15	15	0	0
LITTLE ELMORE	24	199903	Monitored	24	24	0	0
LONG (EDEN)	97	200009	Monitored	97	97	0	0
LONG (GRNSBO)	100	200009	Monitored	100	0	0	0
LOST (BELVDR)	3	199903	Evaluated	3	0	0	0
MACKVILLE	11	200009	Evaluated	11	0	0	0
MILTON	24	200009	Monitored	24	0	0	0
MORRISVILLE;	8	199903	Evaluated	0	0	0	0
MUD (HYDEPK)	14	200009	Evaluated	14	0	0	0
NICHOLS	171	200012	Monitored	171	171	0	0
NORTH UNDERHILL;	12	199903	Evaluated	0	0	0	0
PERCH (WOLCTT)	7	199903	Evaluated	7	1	0	0
RITTERBUSH	14	199903	Evaluated	14	0	0	0
RITTERBUSH MEADOW;	10	199903	Evaluated	10	10	0	0
ROUND (MILTON)	22	199903	Monitored	22	22	0	0
RUSH	14	199903	Evaluated	14	0	0	0
SCHOFIELD	29	200012	Monitored	29	0	0	0
SILVER (GEORGA)	27	200009	Evaluated	27	27	0	0
SLAYTON (WOODB)	8	200012	Evaluated	8	8	0	0
SOUTH (EDEN)	103	200009	Monitored	103	103	0	0
STANNARD	25	200009	Evaluated	25	0	0	0
TUTTLE (HARDWK)	21	199903	Monitored	21	21	0	0
WAPANACKI	21	200009	Monitored	21	21	0	0
WOLCOTT	74	200009	Monitored	74	74	0	0
ZACK WOODS	23	200009	Monitored	23	0	0	0

Condition of Selected Individual Lakes

Arrowhead Mountain Lake, Milton: This 760-acre reservoir is impaired by artificially fluctuating water levels leading to the aquatic life use being partially supported. This reservoir provides a valuable walleye fishery. Since this species is singled out by the Vermont Department of Health as creating an enhanced risk of mercury contamination to anglers who consume the fish, all 760 acres are considered to only partially support fish consumption use. In addition, 114 acres do not support uses due to Eurasian watermilfoil infestation.

Caspian Lake, Greensboro: A small portion of this 789-acre lake's nearshore waters is threatened by sedimentation. Significant recent growth of sediment deltas was noted by Vermont DEC staff at a few localized areas, which in aggregate may encompass up to 5 acres. To remediate this threat, the town of Greensboro is presently improving nearby dirt roads that were determined to be one source of the sediments. Aquatic life use for the entire lake is also threatened by water level fluctuations.

East Long Pond, Woodbury: Presently, the water level on East Long Pond is not manipulated. However, the pond is connected to the Hardwick Electric power generating network. As such, aquatic life use is considered threatened on this 171-acre lake due to the potential for water level fluctuations to occur.

Lake Eden, Eden: This 194-acre lake is characterized by a highly developed shoreline. Indeed, by 1991, 127 camps or homes had been built along the lake's shores, many since the 1970's. Many of these properties are characterized by little or no shoreline buffer vegetation, and many shoreline areas are routinely mowed. In addition, the lake is heavily used for recreational purposes. The generalized, fairly recent heavy development pressure around this waterbody, in concert with frequent boating use, appears to have produced a situation where the lake's shoreline quality is degrading significantly. This in turn threatens the quality of the lake's waters, to the extent that aquatic life, aesthetic, swimming, and boating uses are considered threatened. A 1998 assessment of the lake's phytoplankton (algae) community indicates that the community is not outside the range of expected characteristics. There exists, however, concern that wakes caused by boating may be undercutting areas of the shoreline, contributing to erosion and shoreline habitat degradation.

Lake Elmore, Elmore: Aquatic life use is threatened on this 219-acre lake due to water level fluctuations.

Green River Reservoir, Hyde Park: Aquatic life use on this 554-acre reservoir is considered threatened by acidification due to the water's low buffering capacity. In addition, aquatic life use is not fully supported due to extreme (~15 to 20 feet) winter drawdowns.

Hardwick Lake, Hardwick: Aquatic life use is not fully supported on this 145-acre reservoir due to extreme water level fluctuations. The lake is de-watered each winter.

Lake Lamoille, Morrisville: This is a 148-acre impoundment on the Lamoille River mainstem. Aquatic life and secondary contact uses are not fully supported due to water level fluctuations. Several uses (aesthetics, aquatic life, swimming, and secondary contact) are also threatened due to runoff from urbanized areas in adjacent Morrisville, and from sediment and nutrient import from agricultural portions of the upstream watershed. The resultant algal growth is noted as another cause of threats to designated uses on Lake Lamoille.

Long Pond, Eden: Aquatic life use is threatened for the entire 97 acres of this lake due to the low acid buffering capacity of the lake waters. The lake is also imminently threatened by the presence of Eurasian watermilfoil, which was first discovered in the lake in 1998, and which has been actively handpulled each year since. As this is a shallow lake, if Eurasian milfoil becomes well established in the lake, it would easily outcompete native plants and dominate the plant community, resulting in cascading effects to other biological communities.

Nichols Pond, Hardwick: Presently, the water level on Nichols Pond is not manipulated. However, the pond is connected to the Hardwick Electric power generating network. As such aquatic life use is considered threatened on this 171-acre lake due to the potential for water level fluctuations to occur. In addition, 33 acres of the lake's littoral zone are considered threatened by Eurasian watermilfoil infestation due to the proximity of Nichols Pond to milfoil-infested lakes.

South Pond, Eden: The water level of this pond was raised significantly by the construction of a hydropower-related dam. The level remains stable through the summer, and is dropped by one to two feet during the fall (and spring, if necessary) to avoid potential flooding damage to nearby properties. While the pond is no longer fluctuated for the purpose of power generation (ownership of the dam transferred from Central Vermont Public Service to the South Pond Landowners Association in 1990), fall and spring fluctuations occur and the potential for manipulation remains, and thus Vermont DEC considers aquatic life use threatened on this pond. In addition, the pond is considered threatened by acidification due to its low alkalinity (acid buffering capacity).

Wolcott Pond: Aquatic life use on this 74-acre lake is considered threatened by acidification due to the water's low buffering capacity.

Lakes Targeted for Further Information Gathering

There are ten lakes and ponds in the Lamoille River watershed at least 10 acres in size where additional information is needed to assist in use attainment decisions. These are mostly small ponds, for which Vermont DEC has limited or no information. Some of these waterbodies would be good candidates for monitoring or evaluation by a volunteer watershed association using standard procedures available from Vermont DEC. Table 8 lists these ponds. Below Table 8 is a summary of information from the Lake Assessment Database that identifies what is presently known about these ponds and the reasons for which an assessment should be performed. There are also numerous very small ponds (less than 10 acres) in the basin for which Vermont DEC has little or no information.

Table 8. Lakes and ponds in the Lamoille River watershed in need of further assessment.

LakeID	Lake Area (acres)	Town
BIG MUDDY	17	Eden
COLLINS	16	Hyde Park
EDEN	194	Eden
GUT	13	Eden
LITTLE ELIGO	15	Hardwick
MUD (HYDEPK)	14	Hyde Park
RITTERBUSH MEADOW;	10	Eden
RUSH	14	Eden
SILVER (GEORGA)	27	Georgia
TUTTLE (HARDWK)	21	Hardwick

Big Muddy Pond: Old information suggests that sedimentation and low alkalinity threaten uses in this lake. This information should be verified.

Collins Pond: Nutrient concentrations in this pond appear to be increasing, but insufficient data exist to make a definitive determination in this regard. Additional monitoring of this pond through Vermont DEC's spring phosphorus program is warranted.

Lake Eden: For the reasons described above, water quality trends in Lake Eden should be followed closely. In addition, a re-survey of in-lake and shoreline conditions is warranted during the next Lamoille River Basin assessment cycle.

Gut Pond: Very old data indicate that this pond may be threatened by acidification. The acid buffering capacity of this pond should be measured.

Little Eligo Pond: Old information suggests that gravel extraction near the pond has released sediments and nutrients to the pond resulting in algal and plant growth. This should be verified during the next Lamoille River watershed assessment cycle.

Mud Pond in Hyde Park: Old information suggests that sedimentation from gravel road erosion may be affecting this otherwise fine trout fishing pond. This concern should be investigated during the next Lamoille River watershed assessment cycle.

Ritterbush Meadow Pond: Old information suggests that logging activity near the pond released sediments and nutrients to the pond, resulting in algal and plant growth. This should be verified during the next Lamoille River watershed assessment cycle.

Rush Pond: Very little information is available on this purportedly excellent fishing pond. An in-lake and shoreline survey is warranted during the next Lamoille River watershed assessment cycle.

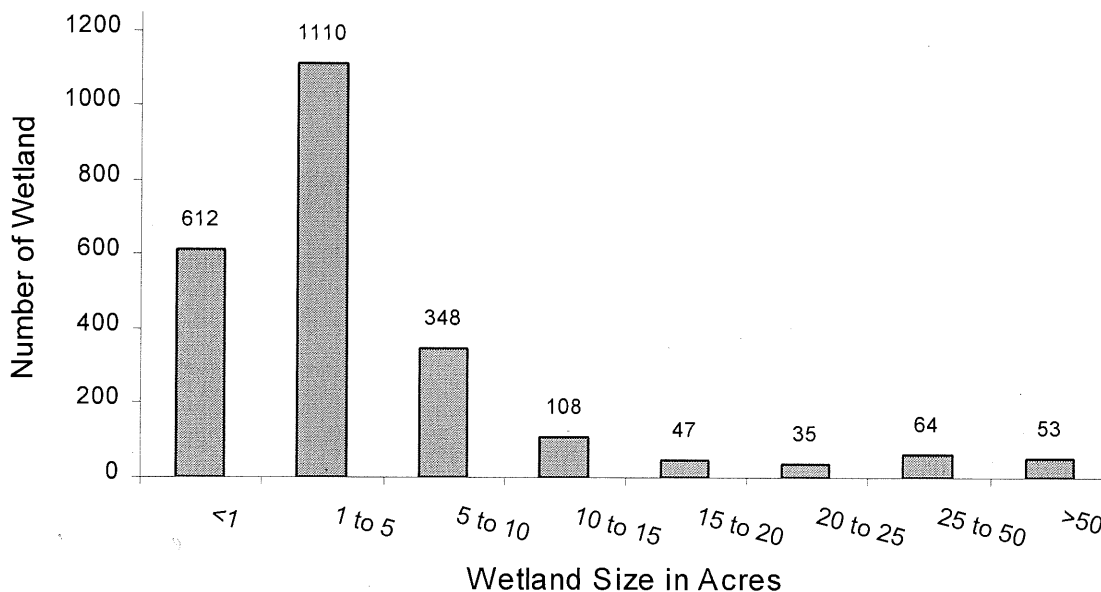
Silver Lake in Georgia: This is a small water supply lake for the town of St. Albans. Little is known by Vermont DEC about this lake. An in-lake and shoreline survey is warranted during the next Lamoille River watershed assessment cycle.

Tuttle Pond in Hardwick: This is a small, secluded pond with a rich biological community. There are indications that the pond may be impacted by nearby pasturelands. The inlet stream runs unbuffered through the pasture. The extent to which the inlet stream may be carrying nutrients to the pond should be evaluated.

Lamoille Watershed Wetland Communities

The Lamoille River watershed contains 2,377 wetlands mapped on the Vermont Significant Wetland Inventory (VSWI) maps, totaling over 18,454 acres. Mapped wetlands constitute more than 4% of the watershed area. Of these mapped wetlands, most are between 1-5 acres, although there are 53 wetlands over 50 acres (Figure 3). There are 32,329 acres of hydric soil in this watershed (excluding Caledonia and Orleans Counties), indicating there may be 43% more acres of wetland than the VSWI maps indicate. Hydric soils make up 7% of the watershed.

Figure 3. Number of wetlands in different size categories in the Lamoille River watershed.



The east to west orientation of the Lamoille River watershed incorporates a number of biophysical regions in Vermont. These include the Northern Vermont Piedmont region to the east, the Northern Green Mountain region in the center of the watershed, and the Champlain Valley region at the western end of the watershed. Each biophysical region contains wetland natural community types characteristic of that area (Thompson and Sorenson, 2000).

The headwaters of the Lamoille River start in the Northern Vermont Piedmont region. This area is underlain by calcium-rich bedrock, producing poor, intermediate and rich fens. There are many acres of wetlands associated with lakes and ponds in the region such as Tuttle Pond, Flagg Pond and Hardwick Lake. The region is also characterized by northern white cedar swamps, alluvial shrub swamps, and sweet gale shoreline swamps.

The central portion of the Lamoille River watershed lies within the Northern Green Mountain region. The flat floodplains of the Lamoille River and associated tributaries are vastly different from the surrounding mountainous terrain. Many of the wetlands are directly adjacent to the Lamoille and its tributaries. Wetland types characteristic of this region include seeps, bogs and wetlands associated with Lake Elmore, Lake Lamoille, Green River Reservoir, and Lake Eden (Thompson and Sorenson, 2000). This region also contains Belvidere Bog, one of the larger, more diverse wetland complexes of the watershed.

The Champlain Valley region is a transitional environment between the Green Mountains and Lake Champlain. The warmer temperature and rich soils of the region make it more comparable to the Great Lake and St. Lawrence Valley lowlands than to other regions in Vermont. This region contains a rich diversity of wetland community types, some of which are not found anywhere else in the state. Wetland types characteristic of this region include red maple-black ash swamps, red maple-white cedar swamps, cattail marshes, wild rice marshes, deep bulrush marshes, lakeshore grasslands and buttonbush swamps. Many of these wetland types can be seen at the Sandbar State Park and Wildlife Refuge, at the mouth of the Lamoille River (Thompson and Sorenson, 2000).

Significant Wetlands in the Lamoille River Watershed

Northern Vermont Piedmont Region

There are a number of wetlands in the Lamoille River watershed that are highly significant because of their size, diversity, and/or unique characteristics. In the Northern Vermont Piedmont region, many of these wetlands are nested in basins between large topographic features. Good examples of this are long linear wetlands associated with the inlets of Hardwick Lake and Long Pond in Eden, and Greensboro and Page Brooks.

The Northern Vermont Piedmont region at the headwaters of the watershed contains a number of northern white cedar swamps that were surveyed by the Vermont Nongame and Natural Heritage Program in 1996. One of the largest of these areas is at the southern end of Long Pond in Greensboro. This wetland is about 115 acres. The vegetation is second-growth dominated by white cedar and interspersed with emergent white spruce. This site supports a population of the fairy slipper (*Calypso bulbosa*), a state-threatened orchid; a rare moss in Vermont (*Calliergon richardsonii*); and an adult black-backed woodpecker (*Picoides articus*) was observed in the swamp in 1996. This is a more typical northern white cedar swamp with a mossy groundcover growing on over a meter of woody muck. A portion of this wetland is owned and managed by The Nature Conservancy.

Page Brook Swamp, located in Wheelock and Sheffield, is a more diverse wetland complex than Long Pond. The wetland complex is approximately 100 acres, 45 acres of which is northern white cedar swamp. This complex also includes spruce-fir-tamarack swamp, beaver meadows, ponds, and a fen-like area at the eastern side of the swamp. This wetland complex is relatively isolated, with forested buffers and only scattered residences. The wetlands contain diverse vegetation including a rare state endangered sheathed sedge (*Carex vaginata*); the rare swamp fly-honeysuckle (*Lonicera oblongifolia*); a rare moss (*Calliergon richardsonii*) currently known in only eight sites in the state; and a population of uncommon swamp thistle (*Cirsium muticum*).

Other significant northern white cedar swamps in the headwaters of the Lamoille River watershed include Flagg Pond in Wheelock (70 acres), Bear Mountain Pond Swamp in Walden (50 acres), Mount Sarah Southeast Swamp in Greensboro (20 acres), and Hardbury Swamp in Hardwick (22 acres). The 1996 *Significant Northern White Cedar and Red Maple-Cedar Swamps of Vermont Report* by the Vermont Nongame and Natural Heritage Program contains more information on these and other wetlands.

Northern Green Mountain Region

Many of the important wetlands in the Northern Green Mountain Region lie along tributaries of the Lamoille River such as the Lawrence Brook, North Branch, Gihon River, and Black Creek. The Molly Bog wetland complex in Morristown lies along the Lawrence Brook and is more than 300 acres. The complex is on the west side of Route 100, extends south into Stowe, north along the Lawrence Brook, and contains forested, scrub-shrub and emergent wetlands. The wetland complex also contains a peatland complex consisting of four bogs: Molly Bog, Beugrand's Bog, Percy's Bog and Andromeda Bog. Molly Bog is an example of a northeastern kettlehole bog, and is owned by the University of Vermont, along with 35 acres of spruce-fir swamp and upland hardwood forest. This area is designated a State Fragile Area and is registered as a National Natural Landmark by the National Park Service. The wetland complex provides habitat for uncommon species such as endangered Southern Twayblade orchid (*Listera australis*), rare white-fringed orchid (*Platanthera blephariglottis*), uncommon tuberous grass-pink (*Calopogon tuberosus*), and rose pogonia (*Pogonia ophioglossoides*). The peatland complex also contains one of the greatest diversities of mosses in the state. The peat layers in the bogs provide evidence of past glacial activities, making this a natural area of considerable scientific and educational interest.

The Belvidere Bog wetland complex is located at the headwaters of the Lamoille River North Branch, and is approximately 375 acres. A number of wetland types are present in this complex including shrub swamp, cedar swamp, shallow marsh, mixed shrub swamps, deep marsh, a rare dwarf-shrub bog community, and numerous beaver ponds. The wetland complex is highly significant for its size, diversity and function in the watershed. The Belvidere Bog wetland complex has been rated highly significant for coldwater fishery habitat, water quality protection, erosion control, education, recreation, and wildlife habitat. The wetland complex is considered habitat for the state's endangered common loon (*Gavia immer*), the endangered Southern Twayblade orchid (*Listera australis*), and also was rated as a high quality northern level bog. The size of the wetland complex and the undisturbed area surrounding the complex makes this area suitable for wildlife species that need large ranges such as black bear, bobcat and moose.

Other important wetlands in this region of the Lamoille River watershed include the scrub-shrub wetlands along the White Branch in Eden (±217 acres), Black Creek in Cambridge (±125 acres), and Gihon River in Eden (±151 acres). There are also large wetlands associated with Bear Swamp in Wolcott (246 acres), Green River Reservoir in Hyde Park (209 acres), Lake Elmore in Elmore (144 acres), Beaver Meadow in North Hyde Park (171 acres), and various oxbows in the Lamoille River in Cambridge and Fletcher.

Champlain Valley Region

The Champlain Valley region contains a rich diversity and abundance of wetlands. The warmer climate of the Champlain Valley and the rich delta soil make this region distinct from other areas in Vermont. One important wetland is the Sandbar State Park and Wildlife Refuge wetland at the mouth of the Lamoille River. This extensive wetland complex is over 1,600 acres, and much of which is owned and managed by the Vermont Fish and Wildlife Department. In addition to containing 20 acres of one of the best examples of floodplain forest in Vermont, the wetland complex also contains extensive shallow water and deepwater marshes; shrub swamps dominated by buttonbush (*Cephalanthus occidentalis*); and large stands of the uncommon wild rice, *Zizania aquatica*. This wetland complex provides nesting habitat for rare and uncommon waterfowl and wading bird species including: pied-billed grebe (*Podilymbus podiceps*), American bittern (*Botaurus lentiginosus*), least bittern (*Ixobrychus exilis*), great blue heron (*Ardea herodias*), blue-winged teal (*Anas discors*), common goldeneye (*Bucephala clangula*), hooded merganser (*Lophodytes cucullatus*), sora (*Porzana carolina*) and common moorhen (*Gallinula chloropus*). The wetland complex is also the only known nesting site in Vermont for the cerulean warbler (*Dendroica cerulea*). A large population of the uncommon meadow horsetail (*Equisetum pratense*) is also present in this wetland complex. The size, location, functions, and diversity of this wetland complex make it one of the most important wetlands in the Lamoille River watershed.

Milton Towne Swamp in Milton is privately owned and is the only red maple-northern white cedar swamp located in a deltaic sandplain landscape. This community type comprises only the eastern half of the 600-acre wetland, and contains balsam fir, red maple, black ash and white cedar. The western half of the wetland contains largely undisturbed red maple-black ash swamp with green ash, hemlock and poison sumac. These two halves are divided by a powerline corridor, which is considerably less diverse than the eastern and western sections of the wetland. The wetland complex contains the state-threatened white adder's-mouth orchid (*Malaxis brachypoda*); the rare false hop sedge (*Carex lupuliformis*); and the uncommon Tuckerman's sedge (*Carex tuckermanni*). The wetland complex is located within the sands of the historic, periglacial delta of the Lamoille, which in addition to its largely undisturbed nature makes it an important wetland.

There are a number of other large, diverse wetlands in the Champlain Valley region of the Lamoille River watershed including: Mill Brook Black Spruce Bog in Fairfax (300 acres); Lower Lamoille Oxbow Swamp just upstream from Sandbar in Milton (275 acres); Essex Center Swamp in Essex (100 acres); Browns River Swamp in Essex (500 acres); Browns River Wetland in Jericho (120 acres) and many others. These wetlands provide water quality protection and wildlife habitat in an environment that is becoming increasingly urbanized. Review of these wetlands and others can be found in the 1992 *Wetlands of Outstanding Ecological Significance In Chittenden County, Vermont*; the 1996 *Significant Northern White Cedar and Red Maple-Cedar Swamps of Vermont Report*; and the 1997 *Vermont Advanced Wetlands Planning and Protection Project Report: Lake Champlain Basin*.

Impacts and Threats to Wetlands in the Lamoille River Watershed

The Vermont DEC Wetlands Section examines more than 500 new projects a year that could potentially have an impact on Vermont's wetlands. More than 546 wetland projects have been reviewed in the Lamoille River watershed since the implementation of the Vermont Wetland Rules in 1990. The Wetland Rules give the state jurisdiction over Class One and Class Two wetlands, which are mapped in VSWI maps. These wetlands are deemed significant by the Water Resources Board unless field investigations prove otherwise. Class Three wetlands are those that are not mapped. They may or may not be significant wetlands.

Projects are examined to determine if the following functions and values of the wetlands will be lost as a result of the proposed use: surface and ground water protection; water storage for flood water and storm runoff; fisheries habitat; wildlife and migratory bird habitat; hydrophytic vegetation habitat; threatened and endangered species habitat; education and research in natural sciences; recreational value and economic benefits; open space and aesthetics; and erosion control through binding and stabilizing soil. Physical impacts to wetlands are recorded as loss (when the wetland is permanently destroyed from filling or draining) or impairment (when the wetland is not permanently destroyed but is not functioning at its original level due to ditching, dredging and partial filling and draining).

In the Lamoille River watershed approximately 4.3 acres (187,308 square feet) of Class Two wetlands have been lost, and 4.87 acres (222,137 square feet) of Class Two wetland have been impaired between 1990 and 1999. Approximately 7.52 acres (327,571 square feet) of Class Three wetlands have been lost, and 3.34 acres (145,490 square feet) of Class Three wetland have been impaired between 1990 and 1999.

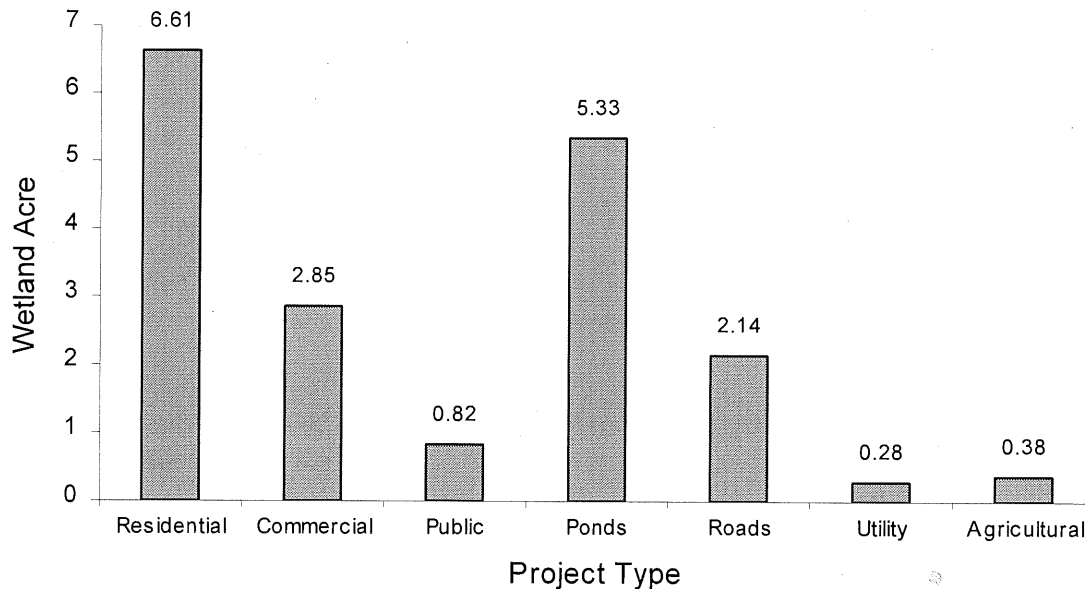
Road projects constitute the greatest loss to Class Two wetlands, followed by residential development (Figure 4). The expansion of old roads built along river corridors and wetlands, and the construction of new roads over the past ten years has resulted in almost 2 acres of loss to Class Two wetlands in the watershed.

Residential development has resulted in 1.2 acres of wetland loss, and 2.2 acres of wetland impairment in Class Two wetlands. Residential development also constitutes the greatest loss of Class Three wetlands in the watershed, almost 3 acres. More than 180 recorded projects have been residential in nature over the past 10 years, totaling more than 6.6 acres of wetland impacts. Most residential development is at the western end of the watershed in Chittenden and Franklin Counties.

At least 72 commercial projects have been examined in the watershed. These projects have resulted in almost 3 acres of wetland impacts, most of which are the loss of Class Three wetlands.

Pond construction projects represent the second highest acreage of wetland impacts in the watershed, over 5.3 acres. At least three acres of impairment to Class Three wetlands are pond projects. The total amount of impacts to Class Two and Class Three wetlands from all projects (including projects not listed in the figures) is over 20 acres.

Figure 4. Overall wetland loss and impairment by project type 1990 - 1999.

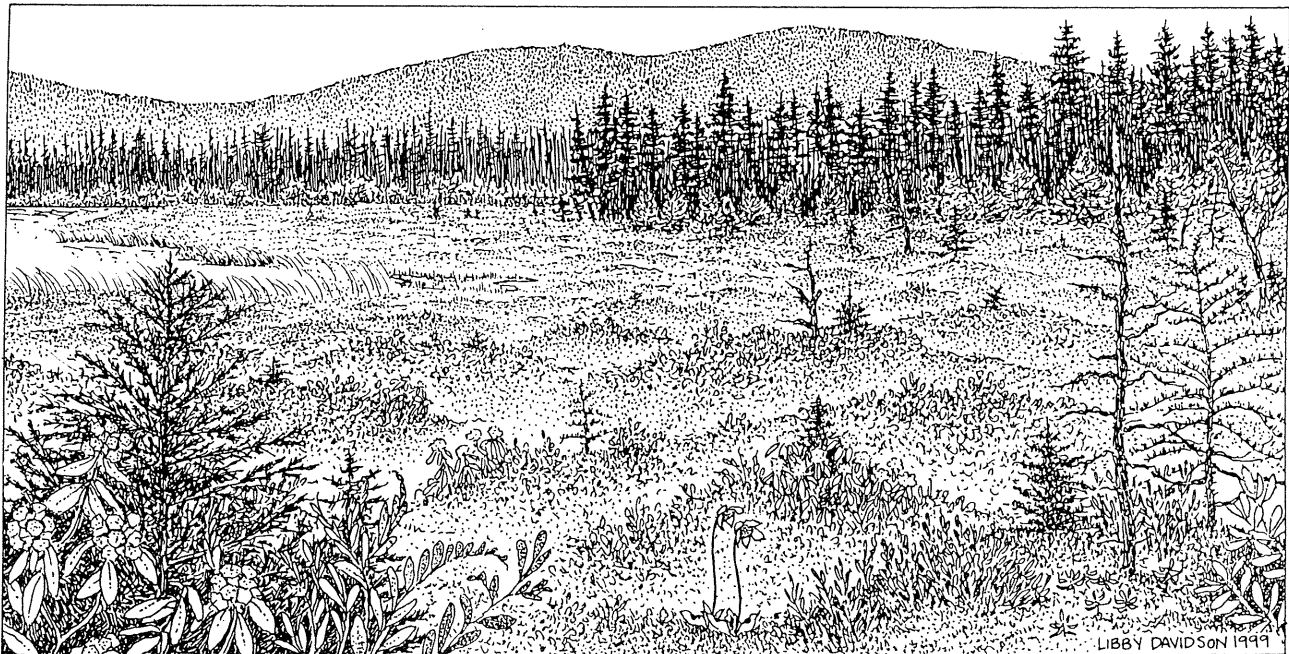


The above number indicates that the total acreage of wetlands lost or impaired is approximately 0.1% of the VSWI mapped wetlands in the Lamoille River watershed. However, this number reflects only wetland loss or impairment that has been recorded by the Vermont DEC Wetlands Section. Some projects in Class Two wetlands are performed illegally and at least 48 violations in the watershed have been detected since 1990. There are also a number of projects in Class Three wetlands that are not reported or detected because these wetlands are unregulated by the Vermont Wetland Rules.

Most of the wetlands impacted in the Lamoille River watershed are deciduous scrub-shrub wetlands. These types of wetlands are usually dominated by speckled alder or buttonbush. Almost 5 acres of impacts to scrub-shrub wetlands have been recorded since 1990. Approximately 2.3 acres of impact to emergent wetlands have been recorded in the watershed. These types of wetland can range from wet meadow wetland to emergent marshes depending on the hydrology. Many of the emergent wetlands are prior converted agricultural fields. These often go from pastures straight to residential developments. Over 2 acres of broad leaved, deciduous forested wetland has been impacted by various projects. These include red maple swamps and black ash swamps.

The Future of Wetlands in the Lamoille River Watershed

The wetlands in the Lamoille River watershed are essential to the health and quality of the watershed. Protecting wetlands will ensure that there are fish, wildlife, recreation opportunities, and biological diversity in the Lamoille River and its tributaries. Threats to many of the important wetlands described above include logging, agricultural conversion, runoff, and residential development associated with an expanding population. In the eastern section of the watershed, the significant northern white cedar swamps are most at risk from logging. The bogs in the Northern Green Mountain region are more vulnerable to small changes in hydrology and nutrient loads. Runoff from agriculture, silviculture, and residential development threaten both Molly Bog and Belvidere Bog. The Champlain Valley region contains the most diverse and abundant wetlands, but also the most threats to these wetlands. The rapid urbanization of the landscape pushes the boundaries of natural areas to smaller dimensions, and creates more opportunities for pollution and stormwater runoff. Wetlands that were converted to agriculture years ago, go straight from wet meadow to residential development because they don't contain as many protected functions and values as they did in their original state.



Dwarf Shrub Bog

Libby Davidson from Wetland, Woodland, Wildland

Other Lamoille Watershed Issues and Information

Population and Housing Growth in Basin Towns

The rate of growth, and especially housing growth, has been very high in the towns of the Lamoille River watershed. The population growth rate for the watershed from 1970 to 1980 was 32% and from 1980 to 1990 was 20%. The housing unit growth rate from 1980 to 1990 was 28%. The towns with the highest population and housing unit increases were primarily in the lower part of the watershed although several upper Lamoille towns also had very high rates. The towns of Georgia, Fairfax and Fletcher saw the fastest rate of growth from 1980 to 1990 both in terms of population and housing units. All three towns have become bedroom communities for people travelling originally just to St. Albans and Burlington for work, but now also to Milton. Although almost all of the towns in the watershed have experienced high rates of growth from 1970 to 1990, other towns in the lower Lamoille watershed that have seen especially high growth include Cambridge, Essex, Jericho, Milton, and Underhill. Population and housing data are in Appendix C.

Permitted Discharges to Basin Waters

In the Lamoille River watershed, there are six municipal wastewater treatment facilities that discharge either to the river (Milton Fairfax, Jeffersonville, Morrisville, Hardwick) or to a tributary (Johnson) (see table below). As of February 2000, there were 62 permitted stormwater discharges to the river or a tributary and 22 permitted stormwater discharges to Arrowhead Mountain Reservoir.

Table 9. Municipal Wastewater Treatment Facilities in the Lamoille Watershed

WWTF	WBID	Permitted flow (gallons/day)	Annual Average Flow (gallons/day)
Milton	VT07-01	275,000	134,900
Fairfax	VT07-02	78,000	40,700
Jeffersonville	VT07-04	77,000	38,800
Johnson	VT07-15	270,000	186,700
Morrisville	VT07-07	425,000	292,300
Hardwick	VT07-07	371,000	183,700

Dams of the Lamoille River Watershed

There are 58 dams on rivers and streams of the Lamoille River watershed as documented in the state's dam database. Twenty-eight of these dams are in service, 10 are breached, and the status is unknown for 20 of the dams. The list of all fifty-eight dams and the river or stream on which they are located is in Appendix D.

303(d) Listed Waters in the Lamoille River Watershed

There are six river or stream segments and two lakes on Vermont's Year 2000 List of Impaired Surface Waters (the 303(d) list) (see Table 10 below for the waterbodies and the list itself from Vermont DEC for additional information). These are waters of the basin where Vermont DEC has sound monitoring data to identify the impairment and its cause(s). There are a number of other river and stream stretches in the basin that do not fully support one or more "uses" of the waters (aquatic habitat, fishing, swimming, boating, aesthetics), but the protocol to document the impairments is not yet developed (channel instability/physical habitat impairments); the impact is known from modelling (flow); or the information is based on observations of problem conditions but there is no instream monitoring (extensive algae, turbidity from observed runoff), as examples.

Table 10. 303(d) Listed Waters in the Lamoille River Watershed

Waterbody id	Segment	Pollutant	Problem
VT07-01	Lamoille River - mouth to Clarks Falls dam	Mercury	Elevated levels of mercury in walleye
	Lamoille River - Clarks Falls dam to Route 2 Bridge	Low D.O.	Three dams create D.O. problems downstream
VT07-03	Deer Brook	Nitrogen, Ag runoff components	Wyeth Plant discharges (plant now closed), agricultural land runoff
VT07-03L04	Arrowhead Mountain Lake	Mercury	Elevated levels of mercury in walleye
VT07-09	Mill Brook in Fairfax	Sediment, nutrients	Fair biological conditions, excessive algae growth
VT07-10	Lower Mid-Browns River	Sediment	Severe streambank erosion and poor biological condition
VT07-13	Trib to Brewster River	Iron	Inactive leachfield leachate and poor biological condition
VT07-13L02	Lake of the Clouds	pH	Critically acidified (chronic)

Specific Projects or Water Quality Protection Work in the Basin

Project Impact Stream Stability Assessment in Lamoille County

In 1998, the Lamoille County Regional Planning Commission (RPC) received a grant for \$500,000 from the federal Emergency Management Agency as part of its "Project Impact" initiative, the goal of which is to "build disaster resistant communities." Major floods and the resulting ecological and human infrastructure losses in 1995, 1997, and 1998 were the impetus for this grant award. As part of Project Impact, funds were awarded to a contractor to conduct a river and stream stability assessment for the county. The study evaluated 50 reaches on 21 different river or stream systems doing a Rosgen Level II geomorphic assessment at each reach. Nine sites were then studied in further detail using the Rosgen Level III protocol. The assessment data were used to identify the river or stream reaches that are unstable and to prioritize these reaches based on their degree of instability and the possible threats to infrastructure. Several restoration projects were identified from the assessment. There is a report distributed by the Lamoille County RPC summarizing this assessment, which provides background, methods, reach by reach results, and recommendations. Following is a small portion of the Executive Summary of the report.

The study results indicate that the majority of the unstable stream reaches in the county are located in the transfer zone within the watershed. This transfer zone is located inbetween the higher gradient erosional headwaters area and the lower gradient depositional areas, which are generally located in the lower portions of the watershed. ... This area of instability within the watershed also coincides with the areas of greatest anthropogenic disturbances. ... Negative human impacts to the river systems were aggravated by severe flood events in 1995, 1997, and 1998. ...Although localized stream reach instability was noted in the upper portions of watersheds, generally 1st and 2nd order streams, system-wide instability was not as widescale in these areas. ... Local stream instability in the upper watershed locations was generally the result of poor highway management practices that resulted in a sediment and water imbalance. ...These practices were often responsible for infrastructure failures that contributed enormous amounts of sediment and large woody debris to the adjacent stream systems.

Trees for Streams Program

The Lamoille County Natural Resources Conservation District has a program to promote tree re-establishment along rivers and streams in Lamoille County. The Trees for Streams program will provide river or streamside landowners with trees, stakes, brush blankets and consultation for just \$1.00 per tree. The landowners agree to leave the area with the newly planted trees as a woody buffer for the river or stream. In May and June 2000, 5,100 trees were planted along 3.25 miles of river and stream for 37 landowners. The program has funding to offer trees again in the 2001 growing season.

Vermont Department of Fish and Wildlife Lamoille River Streambank Land Inventory

The Vermont Department of Fish and Wildlife acquired extensive river and stream frontage around the state from the 1950's into the 1970's in order to ensure public access for fishing. In the Lamoille River watershed, riparian land from Greensboro to Johnson was acquired. In the mid-1980's, the Department began to discuss how to systematically approach the management of its river and streamside lands. The Department's Fisheries Division formalized the idea and discussion into a project entitled "Restoration and management of Department riparian lands." In 1998, the Department conducted an inventory of the streamside land it owned along the Lamoille River. This inventory and assessment of the riverside land was a pilot of what the Department intends to be a series of inventories and evaluations of its riparian land holdings. Following these evaluations, management decisions and strategies can be made. In the summer of 2000, trees and shrubs were planted on the Lamoille Fish and Wildlife Land to re-establish buffers.

Browns River Watershed Council

There is a newly formed Browns River Watershed Council beginning to bring people in the watershed together and to develop a mission, goals, and plans to protect the health of the Browns River and its watershed. Their efforts will be followed and supported.

Hydro-electric Facility Re-licensing

The Lamoille River has eight hydroelectric dams on the mainstem. They include, from the mouth upstream: Peterson Dam, Milton Dam, Clarks Falls Dam, Fairfax Falls Dam, Cadys Falls Dam, Morrisville Dam, Wolcott Dam, and Hardwick Lake Dam. These facilities have affected the stretches of river downstream of them as well as the impoundments above them with low and fluctuating flows and water level fluctuations respectively.

The lowest three hydroelectric facilities, which are under a single federal license, were denied 401 certification by the Water Resource Board. A new application is pending before the Vermont DEC following the completion of additional environmental studies. Operation of these facilities under the 401 conditions should result in much improved conditions above and below the dams. The Fairfax Falls dam project is being operated voluntarily as a run-of-river project while CVPS and the Vermont Agency of Natural Resources negotiate about minimum flow below the tailrace. There is no spillage over the falls or in the bypass at the current time. The upper Lamoille River is a highly regulated reach with four hydroelectric dams on it: Cadys Falls Dam and Morrisville Dam owned by Morrisville Water and Light Department and Wolcott Dam and Hardwick Lake Dam owned by Hardwick Electric Department. Morrisville's facilities are licensed by the Federal Energy Regulatory Commission and operate under a 401 water quality certification issued in 1981. Hardwick's facilities are unlicensed and do not comply with water quality standards. There are discussions underway about the possibility of removing the Hardwick Dam, which would greatly benefit the Lamoille River.

Summary

The Lamoille River watershed is a large and diverse watershed with numerous and significant tributaries and important lakes, ponds, and reservoirs. The river flows through three different biophysical regions in its journey from the Northeast Kingdom to Lake Champlain. Thus, the watershed encompasses a variety of aquatic, wetland and upland natural community types representing great biological diversity. Swimming, fishing, whitewater and other boating are just some of the recreational activities enjoyed on the waters of the basin. The floodplains of the Lamoille are important agricultural lands and a number of villages cluster on the banks of the river.

The Lamoille River watershed has been hard hit by a number of severe flood events in the last decade. The impacts from the floods themselves as well as from the infrastructure failures during the floods (road washouts, culvert and bridge failure) are still very evident in many of the tributaries to the Lamoille. Channel instability, which has been caused by excessive gravel mining, loss of riparian vegetation, inadequately designed culverts, poorly located roads, and floodplain encroachments, and which has been aggravated by the series of severe floods, is the most serious problem for aquatic biota and habitat, aesthetics and recreational uses of watershed rivers and streams. There is a lot of focus on this issue in Lamoille County, which covers a large portion of the watershed. It is important that the Agency of Natural Resources assist with ongoing assessment, protection, and restoration work in addition to conducting its own assessment, planning, and protection work in the watershed.

Hydroelectric power generation and the dams in place for this activity has a large effect on the Lamoille River. Much Agency time and effort has been invested in discussions, negotiations, and review with the owners of these facilities. There has already been some improvement in water quality and aquatic habitat as a result and more improvements can be expected.

Lakes are affected largely by drawdowns and mercury deposition in the Lamoille watershed - two problems that will not be addressed easily or quickly. Most lake acres in Basin 7 are in the threatened status, however, and so there is the opportunity to prevent a further decline in water quality and aquatic habitat.

There is a large diversity of wetland types in the Lamoille River watershed with a variety of threats to their integrity and functions. There are, however, as many means of protecting these special communities as there are threats and the basin planning process is one good opportunity to raise awareness of the importance of wetlands in a watershed.

Just as there is a diversity of water and wetland types in the Lamoille River watershed so too is there a diversity of people and organizations who care about the resource. The cumulative effect of their growing efforts is a watershed change worth watching.

References and Resources

- 1) Inventory of Riverbank Lands Owned along the Lamoille River by the Vermont Agency of Natural Resources, December 1998. Vermont Department of Fish and Wildlife, Waterbury, Vermont.
- 2) Lamoille River Basin Water Quality Management Plan, May 1976. Vermont Department of Water Resources and Environmental Engineering, Montpelier, Vermont (now the Department of Environmental Conservation, Water Quality Division).
- 3) Lower Lamoille River History, February 2000. Jeff Fellingner for the Vermont Natural Resources Council.
- 4) Options for State Flood Control Policies and a Flood Control Program, February 1999. Vermont Department of Environmental Conservation, Water Quality Division.
- 5) Significant Northern White Cedar and Red Maple-Cedar Swamps of Vermont, 1996. Vermont Department of Fish and Wildlife, Nongame and Natural Heritage Program.
- 6) Stream Stability Assessment for Lamoille County, Vermont, 2000. Jim Ryan for Federal Emergency Management Agency (FEMA) Project Impact, Lamoille County, Vermont.
- 7) Use Attainment for Streams affected by Snowmaking Water Withdrawals in Vermont, May 1996. David Bottamini for the Vermont Department of Environmental Conservation, Water Quality Division.
- 8) Vermont Advanced Wetlands Planning and Protection Project Report: Lake Champlain basin, 1997. Vermont Department of Environmental Conservation, Water Quality Division.
- 9) Vermont Swimming Hole Study, 1992, Jerry Jenkins, Deborah Benjamin, and Jane Dorney for Vermont Department of Environmental Conservation, Water Quality Division.
- 10) Waterfalls, Cascades and Gorges of Vermont, 1985. Jerry Jenkins & Peter Zika for the Vermont Department of Environmental Conservation and Department of Forests, Parks and Recreation.
- 11) Watershed Plan - Lower Lamoille Watershed, Vermont, June 1992. U.S.D.A. Soil Conservation Service.
- 12) Whitewater Rivers of Vermont, 1989. Jerry Jenkins for Vermont Department of Environmental Conservation.

Appendix A

Land Use and Land Cover of Basin 7

Table A.1. Land Use and Land Cover in the Lamoille River Watershed¹

Land Use ²	Acres	% of Total
Forested	326,552	71
Agriculture	58,492	13
Surface Water	30,592	7
Transportation	17,396	4
Wetlands	15,500	3
Developed Land ³	9,883	2
Total ⁴ :	459,514	100

1 Vermont Land Cover Classification Project, 1997 (based on satellite photographs from 1992 - 1993).

2 Does not include "brush or transitional land" or "barren land"

3 Developed land = residential, commercial, industrial but not transportation, which is listed separately

4 Does include all land use categories

Appendix B

River or Stream Macroinvertebrate Sampling Sites

1992 - 1999

Table B.1. Basin 7 River or Stream Macroinvertebrate Sampling Sites 1992-1999

WBID	River or Stream	Town	Mile-point	Date	Assessment
VT07-02	Lamoille River	Georgia	15.7	9/29/92	Excellent
VT07-02	Lamoille River	Georgia	15.7	10/19/93	Excellent
VT07-03	Deer Brook	Georgia	2.0	10/19/99	Fair
VT07-09	Mill Brook	Fairfax	0.1	10/8/97	Fair
VT07-10	Browns River	Fairfax	0.4	10/14/92	Good
VT07-11	Browns River	Underhill	17.7	9/24/93	Good
VT07-11	Browns River	Underhill	20.8	10/19/92	Fair
VT07-11	Browns River	Underhill	20.8	9/24/93	Good
VT07-11	Browns River	Underhill	20.8	10/12/94	Excellent
VT07-11	Browns River	Underhill	20.8	9/29/95	Good
VT07-11	Browns River	Underhill	20.8	9/23/96	Fair
VT07-11	Browns River	Underhill	20.8	9/24/97	Excellent
VT07-11	Browns River	Underhill	20.8	9/24/98	Fair
VT07-11	Stevensville Brook	Underhill	2.1	10/19/92	Excellent
VT07-11	Stevensville Brook	Underhill	2.1	9/24/93	Excellent
VT07-11	Stevensville Brook	Underhill	2.1	10/12/94	Excellent
VT07-11	Stevensville Brook	Underhill	2.1	9/29/95	Fair
VT07-11	Stevensville Brook	Underhill	2.1	9/23/96	Good
VT07-11	Stevensville Brook	Underhill	2.1	9/24/97	Good
VT07-11	Stevensville Brook	Underhill	2.1	9/24/98	Fair
VT07-11	Stevensville Brook	Underhill	2.1	9/20/99	Fair
VT07-13	No Name Brook	Cambridge	0.4	9/11/97	Poor
VT07-14	North Branch Lamoille River	Belvidere	12.3	9/2/92	Excellent
VT07-19	Wild Branch	Wolcott	1.2	9/5/97	Poor

Appendix C

Population and Housing Data

Lamoille River Watershed Towns

Table C.1. Population for Lamoille River Watershed Towns*

Town	1970 Population	1980 Population	Change 1970 - 1980	1990 Population	Change 1980 - 1990
Belvidere	189	218	15%	228	5%
Cambridge	1528	2019	32%	2667	32%
Craftsbury	632	844	34%	994	18%
Eden	513	612	19%	840	37%
Elmore	292	421	44%	573	36%
Essex	10951	14392	31%	16498	15%
Fairfax	1366	1805	32%	2486	38%
Fletcher	456	626	37%	941	50%
Georgia	1711	2818	65%	3753	33%
Greensboro	593	677	14%	717	6%
Hardwick	3466	2613	-25%	2964	13%
Hyde Park	1347	2021	50%	2344	16%
Jericho	2343	3575	53%	4302	20%
Johnson	1927	2581	34%	3156	22%
Milton	4495	6829	52%	8404	23%
Morristown	4052	4448	10%	4733	6%
Stannard	88	142	61%	148	4%
Underhill	1198	2172	81%	2799	29%
Walden	442	575	30%	703	22%
Waterville	397	470	18%	532	13%
Westford	991	1413	43%	1740	23%
Wheelock	238	444	87%	481	8%
Woodbury	399	573	44%	766	34%
Wolcott	676	986	46%	1229	25%
Watershed	40,290	53,274	32%	63,998	20%

* Towns completely or largely within the watershed.

Table C.2. Housing Units for Watershed Towns*

Town	1980 Housing Units	1990 Housing Units	Change 1980 - 1990
Belvidere	140	156	11%
Cambridge	845	1104	31%
Craftsbury	394	474	20%
Eden	350	466	33%
Elmore	303	398	31%
Essex	4826	6310	31%
Fairfax	576	906	57%
Fletcher	288	407	41%
Georgia	1053	1397	33%
Greensboro	588	654	11%
Hardwick	1155	1275	10%
Hyde Park	773	967	25%
Jericho	1079	1489	38%
Johnson	896	1097	22%
Milton	2321	3009	30%
Morristown	1787	2080	16%
Stannard	76	90	18%
Underhill	751	1013	35%
Walden	323	433	34%
Waterville	196	222	13%
Westford	468	635	36%
Wheelock	175	253	45%
Woodbury	523	564	8%
Wolcott	424	552	30%
Watershed	20,310	25,951	28%

* Towns completely or largely within the watershed.

Appendix D

Dams of the Lamoille River Watershed

Table D.1. Dams of the Lamoille River Watershed

Dam Name	Stream	Town	Status	Use	Built	Recon	State ID
Winter	Alder Brook	Hardwick	Breached	R	1969		93.03
Green River Reservoir Dike	Baldin Brook	Hyde Park	In Service	H	1947		101.06
Silver Lake North Dike	Beaver Meadow Br	Fairfax	In Service	S	1912		70.04
Silver Lake South Dike	Beaver Meadow Br	Fairfax	In Service	S	1912		70.05
Silver Lake	Beaver Meadow Br	Georgia	In Service	S	1912		79.02
Grist Mill Hill	Brewster River	Cambridge	Unknown				41.03
Bingham Falls	Brewster River	Cambridge	Unknown				41.04
Bryan	Brewster River	Cambridge	Unknown				41.06
Rood	Brewster River - TR	Cambridge	Unknown		1971		41.01
Smugglers Notch Village	Brewster River - TR	Cambridge	In Service	S	1966	1979	41.02
Smugglers Notch Snow	Brewster River - TR	Cambridge	In Service		1992		41.07
Westford	Browns River	Wolcott	Breached				233.01
Jericho - 1	Browns River	Jericho	Unknown				107.01
Essex-2	Browns River - TR	Essex	Unknown				69.02
Greensboro - 2	Caspian Lake - OS	Greensboro	Unknown				87.02
Shadow Pond	Cooper Brook	Woodbury	Unknown				252.03
Lake Elmore	Elmore Brook	Elmore	In Service	HR	1943		67.01
Lake Eden	Gihon River	Eden	In Service	R	1900	1958	66.01
Hyde Park	Gihon River	Hyde Park	In Service	H	1911		101.04
North Hyde Park	Gihon River	Hyde Park	Breached				101.03
Johnson Village	Gihon River	Johnson	Unknown				108.01
Johnson Woolen Mill	Gihon River	Johnson	Unknown				108.02
East Johnson	Gihon River	Johnson	Unknown				108.04
South Pond	Gihon River - TR	Eden	In Service	R	1922		66.02

Dam Name	Stream	Town	Status	Use *	Built	Recon	State ID
Green River Reservoir	Green River	Hyde Park	In Service	HR	1947		101.01
Garfield	Green River	Hyde Park	Breached				101.07
Beaver Lake	Green River - TR	Hyde Park	In Service	R	1967		101.02
Hill	Green River - TR	Hyde Park	Unknown	R	1971		101.05
Caspian Lake	Greensboro Brook	Greensboro	In Service	HR	1929		87.01
Fairfax Falls	Lamoille River	Fairfax	In Service	H	1919		70.03
Hardwick Lake	Lamoille River	Hardwick	In Service	H	1920	1952	93.01
Hardwick	Lamoille River	Hardwick	Breached				93.06
Johnson State Upper Dam	Lamoille River	Johnson	In Service	R	1960		108.05
Johnson State Lower Dam	Lamoille River	Johnson	In Service	R	1960		108.06
Clark Falls	Lamoille River	Milton	In Service	HR	1937		128.01
Peterson	Lamoille River	Milton	Unknown	H	1949		128.02
Milton	Lamoille River	Milton	Unknown	H	1929		128.03
Cadys Falls	Lamoille River	Morristown	In Service	H	1894		134.01
Morrisville	Lamoille River	Morristown	In Service	H	1924		134.02
Wolcott	Lamoille River	Wolcott	In Service	H	1920		251.04
Wards Pond	Lamoille River - TR	Morristown	Breached				134.03
Georgia - 3	Lamoille River - TR	Georgia	Unknown				79.03
Simonds	Lamoille River - TR	Morristown	Unknown		1982		134.06
Boardman Mill	Lamoille River - TR	Morristown	Breached				134.07
Ransom	Mud Brook	Morristown	In Service				134.09
Bryan	Mud Brook - TR	Morristown	In Service	R	1964		134.04
Mackville Pond	Nichols Brook	Hardwick	In Service	R	1900		93.02
Hardwick - 4	Nichols Brook	Hardwick	Breached				93.04
Jordan Pond		Hardwick	Breached				93.05
Nichols Pond	Nichols Brook	Woodbury	In Service	RO	1900		252.01
East Long Pond	Nichols Brook	Woodbury	In Service	RO	1930		252.02

Dam Name	Stream	Town	Status	Use *	Built	Recon	State ID
Laraway	North Branch Lam	Waterville	Breached				228.01
Anderson	Stannard Brook	Stannard	Unknown				196.01
Ferguson	Stones Brook - OS	Fletcher	Unknown		1969		77.01
Coles Pond	Stream Mill Brook - TR	Walden	In Service	R	1900	1962	218.01
Wapanacki Lake	Tucker Brook	Wolcott	Unknown		1790	1945	251.03
Wolcott - 1	Wolcott Pond Brook	Wolcott	Unknown				251.01
Wolcott Pond	Wolcott Pond Brook	Wolcott	In Service	R	1968		251.02

Appendix E

Individual River Waterbody Reports

Lower Lamoille Assessment Report

Waterbody No: VT07-01

Assessment Year: 2000

River Length (mi.): 8.5

Date Last Updated: 9/11/2000

Description: Main Stem- Mouth to Clark's Falls & tributaries

Location Identifiers

ANR Enforcement District: 4

NRCS District: 5

Fish and Wildlife District: 4

Regional Planning Commission: CHI

Assessment Information

Monitored (mi.): 0.0

Assessment Types

Evaluated (mi.): 8.5

Surveys of fish and game biologists or other professionals

Occurrence of conditions judged to cause impairment

Water Quality Limited? Y

Fish tissue analysis

On 303(d) List? Y

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

Restricted consumption for general population

Metals in fish tissue

No consumption for subpopulation (e.g. children...)

Waste Management Zone - Miles: 1.00 **Description:** below Milton WWTF outfall

Assessment Comments

PARTIAL SUPPORT MILES

Lamoille River: 8.5 - from Clarks Falls dam to mouth - partial support of fish consumption due to mercury contamination from atmospheric deposition and partial support of aquatic biota/habitat, aesthetics, non-contact recreation and contact recreation due to low and fluctuating flows, sedimentation and turbidity, oxygen depletion, pathogens, increased temperatures, and oil, grease, metals from three hydro dams, failing septic systems, urban runoff and eroding riverbanks. c(500,1100,1200,1400,1500,1900)
s(4000,6500,7410,7700,8100)

THREATENED MILES

Lamoille River: 8.5 - same stretch as above - threats to aquatic biota/habitat due to toxics from a hazardous waste site. c(2400)
s(6600)

COMMENTS

The 401 for the three hydro facilities (Clarks, Milton, Peterson), which are under a single federal license, was recently denied by the Water Resources Board and a new application is pending before the Department after recent completion of additional environmental studies. (Sept 2000)

Lower Lamoille**VT07-01**

The Vermont Dept. of Health has issued a health advisory warning for walleye consumption that recommends no consumption for pregnant women and children age 6 or under and no more than one meal per month for all others. There is a fish tissue collection point at the mouth of the Lamoille River. (2000)

Failing septic systems are a problem at the Birchwood Manor Trailer Park that is located west of the interstate. The other two trailer parks in town have also been mentioned as places with potentially failed systems. (2000)

The Milton WWTF occasionally violated permit limits for BOD (11/97,2/96,1/96), E. coli (11/97) and TRC (11/97,12/97) in 1996 and 1997 (based on a file review in summer 1998). The plant is a 225,000 gallon per day facility although Milton proposes to enlarge the plant's capacity to first 275,000 gallons per day and then 1 million gallons per day. The town also proposes to run sewer lines four miles south of Route 7 as part of the plant upgrade. An Act 250 permit for the project has been denied at the time of this writing. The denial has been appealed to the Environmental Board. The town recently hit phosphorus and BOD triggers in their permit and as a result put in aerators and phosphorus removal. All is operational now.

Monitoring results from the Arrowhead Body Shop hazardous waste site show that several compounds are well exceeding the groundwater enforcement standard at several monitoring well locations. The following results are from a round of sampling in December 1999. Benzene exceeded the Vermont Groundwater Enforcement Standard (VGES) of 5.0 ppb at 2 monitoring wells (510 ppb, 59 ppb), MTBE exceeded the VGES of 40 ppb at 1 well (59 ppb), 1,3,5-trimethylbenzene exceeded the VGES of 4.0 ppb at 3 wells (36 ppb, 18 ppb, 120 ppb), 1,2,4-trimethylbenzene exceeded the VGES of 5.0 ppb at 3 wells (460 ppb, 210 ppb, 400 ppb), and naphthalene exceeded the VGES of 20 ppb at 3 wells (120 ppb, 75 ppb, 42 ppb). The seep or outfall on the Lamoille River that is sampled showed no exceedances during this round. Sampling in spring 2000, however, found benzene at 10 ppb.

There has been no new sampling around the Milton landfill since 1994 although wells are being replaced now and sampling will resume October 2000. Past sampling showed the landfill leachate responsible for elevated iron, pH, COD, chlorides and manganese. Results of new monitoring should be reviewed.

The phosphorus load to the Malletts Bay segment of Lake Champlain from the mouth of the Lamoille river is calculated to be 29.6 metric tons/year (1991) based on data collected from sampling. Flood events in 1995, 1997, and 1998 brought large loads of sediment and attached phosphorus downstream likely exceeding this loading number in those years.

Zebra mussels are considered a threat to the lower Lamoille although no veligers were found in samples taken from this area in 1999.

INFORMATION SOURCES

Brian Chipman, Vermont Dept of Fish & Wildlife Fisheries Division - information on lower Lamoille conditions in earlier assessment (1990)

Jeff Cueto, Vermont DEC Water Quality Division - noted the status of the 401 for the hydroelectric facilities. (2000)

Vermont Department of Health, June 2000 Health Alert

Vermont DEC Wastewater Management Division files (summer 1998) and David DiDimenico, Wastewater Management Division (2000) - information on Milton landfill.

Lake Champlain 1999 Zebra Mussel Monitoring Program Final Report, June 2000.

Vermont DEC Waste Management Division files and Linda Elliott, Waste Management Division - information on sampling results at Arrowhead Body Shop (2000)

Point Source Description	NPDES No.
Milton WWTF 0.225mgd	VT0100684
Haydenberry Park Subdivision-UT Lamoille	1-0565 SW
Overlake Subdivision - UT Lamoille	1-0679 SW
Pine Harbor Marina - Lamoille River	1-0769 SW
GBIC Subdivision - UT Malletts Creek	1-1179
Ridge Field Subdivision - Lamoille River	1-1190 SW
Milton School Expansion - UT Lamoille R	1-1266 SW
Goodwin Subdivision - Streeter Brook	1-0885 SW

**Lower Mid-Lamoille
Assessment Report****Waterbody No:** VT07-02**Assessment Year:** 2000**River Length (mi.):** 5**Date Last Updated:** 2/17/2000**Description:** Lower Mid-Lamoille River from Arrowhead Mountain Lake upstream to Fairfax Dam

Location Identifiers**ANR Enforcement District:** 6**NRCS District:** 6**Fish and Wildlife District:** 4**Regional Planning Commission:** NW

Assessment Information**Monitored (mi.):** 0.0**Assessment Types****Evaluated (mi.):** 5.0

Land use information and location of sources

Modeling

Water Quality Limited?**On 303(d) List?** N**Monitored for Toxics?** N**Aquatic Contamination****Toxics Testing**

None detected

Waste Management Zone - Miles: 1.00 **Description:** 1 miles below Fairfax WWTF outfall**Assessment Comments****THREATENED MILES**

Lamoille River: 5.0 - below Fairfax Falls hydro dam to beginning of Arrowhead Mountain Lake - threats to contact recreation (swimming), secondary contact recreation, aesthetics, and aquatic biota/habitat due to potentially low and fluctuating flows, nutrient enrichment, turbidity, siltation, pathogens from agricultural land runoff and activities, eroding streambanks, some leachfields very close to river and on shallow soils. c(900,1100,1400,1500) s(1000,6500,7410)

COMMENTS

Earlier assessments identified impairment in the stretch below the Fairfax Falls dam due to low and fluctuating flows. However, CVPS is voluntarily operating the project as a run-of-river facility pending relicensing. No spillage is yet provided over the falls and in the bypass (about 400 feet). Below Fairfax Falls dam, former problems included reduction of fish and macroinvertebrate habitat, temperature problems and flows too low for all uses. Fairfax Falls considered unusual and scenic resource when water flows over natural falls below dam but this only occurs after a rainfall. CVPS has FERC license that expired in December 1987 - currently renegotiating with Vermont ANR for minimum flow below tailrace (ANR recommends 296cfs) and maximum drawdown (ANR recommends 2'). A minimum flow below the dam and above the falls would improve scenic and recreational values of the falls.

Lower Mid-Lamoille**VT07-02**

Serious violations of the Fairfax WWTF's BOD limits occurred in 1997 with the discharge of over two times the quantity of BOD allowed by the permit. BOD violations also occurred in 1996 and 1998. TSS and TRC violations also occurred in 1997.

The Wyeth Nutritionals Inc. wastewater facility has consistently met its permit limits during the period for which the files were reviewed (up through summer 1998). The facility has a 200 foot mixing zone in Arrowhead Mountain and has water quality-based BOD and UOD limits. A whole effluent toxicity (WET) limit is included in the permit and has been consistently met.

INFORMATION SOURCES

Brian Chipman, Vermont Dept of Fish & Wildlife - noted improved condition below Fairfax Falls facility (1998)
Vt.DEC Hydro Power Report 1987

The Waterfalls, Cascades, and Gorges of Vermont, Vermont DEC 1987

Vermont DEC Wastewater Division permit files, June 1998.

Jeff Cueto, Vermont DEC Water Quality Division - update on the hydro situation at Fairfax Falls (2000)

Point Source Description**NPDES No.**

Fairfax WWTF

VT0101087

**Minor Tribs - Lower Mid-Lamoille
Assessment Report**

Waterbody No: VT07-03**Assessment Year:** 2000**River Length (mi.):** 26**Date Last Updated:** 11/1/2000**Description:** Minor tributaries draining into the Lower Mid-Lamoille including Deer Brook, Silver Lake outlet stream, Beaver Meadow Brook, Stones Brook, Swift Brook, Tracy Brook

Location Identifiers

ANR Enforcement District: 6**NRCS District:** 6**Fish and Wildlife District:** 4**Regional Planning Commission:** NW

Assessment Information

Monitored (mi.): 2.5**Assessment Types****Evaluated (mi.):** 0.0

RBP III or equivalent benthos surveys

Water Quality Limited?**On 303(d) List?** Y**Monitored for Toxics?** N**Aquatic Contamination****Toxics Testing****Waste Management Zone - Miles:** 0.00 **Description:****Assessment Comments****PARTIAL SUPPORT MILES**

Deer Brook: 2.5 - from 1/2 miles above sample site to mouth - partial support of aquatic biota/habitat likely due to nutrient enrichment but sources unclear at this time. c(900) s(9000)

COMMENTS

Macroinvertebrate sampling at milepoint 2.0 on Deer Brook done in 1990 found the community integrity and health to be poor (i.e. severe impacts to the aquatic biota). Sampling at this same point in 1999 resulted in a macroinvertebrate community assessment of fair+. The EPT metric is low, richness is low, the BI value is moderate. There was a lot of blue-green algae present - 70% cover indicating an enriched condition there.

Nutrient samples were taken from Deer Brook also in the summer of 1999. The results were as follows: on 6/24/99, TP = 0.071 mg/l and TN = 0.77 mg/l; on 7/7/99, TP = 0.082 mg/l and TN = .021 mg/l; on 8/4/99, TP = .021 mg/l and TN = 0.59 mg/l; on 9/9/99, TP = 0.058 mg/l and TN = 1.02 mg/l.

Information is needed on Beaver Meadow Brook, Stones Brook, Silver Lake Outlet Brook, Swift Brook, and Tracy Brook.

INFORMATION SOURCES

Minor Tribs - Lower Mid-Lamoille

VT07-03

Steve Fiske, Vermont DEC Water Quality Division - data and interpretation of macroinvertebrate sampling results (1999)

DEC Lab results from water samples taken and analyzed for total phosphorus (TP) and total nitrogen (TN)

Point Source Description	NPDES No.
Residential Subdivision - UT Lamoille R	1-1032 SW
Arrowhead Industrial Park - Deer Brook	1-1173 SW

Upper Mid-Lamoille Assessment Report

Waterbody No: VT07-04

Assessment Year: 2000

River Length (mi.): 48

Date Last Updated: 11/2/2000

Description: Main Stem - Fairfax Dam to Cady's Falls Dam

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 4

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 0.0

Assessment Types

Evaluated (mi.): 48.0

Surveys of fish and game biologists or other professionals

Land use information and location of sources

Water Quality Limited?

Occurrence of conditions judged to cause impairment

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

None detected

Waste Management Zone - Miles: 2.00 **Description:** below Jeffersonville WWTF outfall, Johnson TF

Assessment Comments**PARTIAL SUPPORT MILES**

Lamoille River: 48 - whole waterbody length - partial support of aquatic habitat, and aesthetics, and threats to contact and secondary contact recreation due to sedimentation, turbidity, habitat alteration, nutrient enrichment, and pathogens from agricultural activities including pastures, corn, hay right up to the river and in the floodplain, loss of riparian vegetation, streambank erosion, morphological instability and flood damage. c(900,1100,1400,1600,1700) s(1000,7550,7600,7700)

Lamoille River: 0.3 - below Cadys Falls dam (subset of miles above) - non-support of aesthetics due to 0.3 miles of falls de-watered. c(1500) s(7410)

COMMENTS

A 12 mile subsection of this 48 mile stretch has been called out as especially unstable. A summary of the Lamoille River's condition in Johnson and Cambridge from the "Stream Stability Assessment" report (see info sources) states that "agricultural practices dominate this reach where corn and hay crops frequently come to the top of the streambank. Significant plan-form adjustment has taken place below Ithiel Falls to Cambridge Village. Gravel mining, floodplain encroachments and removal of woody riparian vegetation have contributed to bank erosion, channel overwidening, aggradation, and plan-form adjustment throughout this section."

Upper Mid-Lamoille**VT07-04**

Field observations on the reach from Fairfax Falls to Johnson in November 1998 noted a lot of silt and sediment on the channel bottom. There were narrow vegetated buffers, 10 to 40 feet, at the locations from which observations were made.

Several thousand feet of bank stabilization projects, minor amounts of riparian plantings and over 500 acres of cropland enrolled in integrated crop management (ICM) have happened over the last 6 or 7 years. (2000)

Jeffersonville WWTF went into operation on 6/15/90 and so should have eliminated direct discharge problem mentioned in 8801 assessment. This facility exceeded BOD limits on a number of occasions during 1996 - 1998.

Leaking gas tanks were removed at Bradley's General Store in June 1996. Semi-annual groundwater monitoring began at four wells in October 1996. BTEX, MTBE, benzene, and toluene levels have been high in one or two of the monitoring wells over the years. The general store, however, is located on Route 15 fairly far from the Lamoille River.

INFORMATION SOURCES

Stream Stability Assessment for Lamoille County, Vermont, November 2000. Jim Ryan for FEMA Project Impact - Lamoille County, Vermont. (2000)

Jerry McArdle, Vermont DEC Water Quality Division - field observations on the river in November 1999. (2000)

Tim Beaman, SCS - noted bank stabilization projects and resulting improvements to the river (1992)

Richard Stiles, DEC Water Quality Investigator - noted operation of Jeffersonville WWTF (1992)

John St. Onge, USDA - noted bank stabilization and ICM work (2000)

Vermont DEC Wastewater Management Division files, June 1998 - information on Jeffersonville WWTF permit violations

Vermont DEC Waste Management Division, Hazardous Waste Section - information and data on Bradley's General Store from their files (2000)

Point Source Description	NPDES No.
Jeffersonville WWTF	VT0101150
Jeffersonville Village - Lamoille River	1-0785 SW
AOT Route 15 project - Lamoille River	1-0836 SW

Minor Tribs - Upper Mid-Lamoille (A) Assessment Report

Waterbody No: VT07-05

Assessment Year: 2000

River Length (mi.): 20.5

Date Last Updated: 11/6/2000

Description: Tributaries to the Lamoille River mainstem between Fairfax Dam and the confluence of the Brewster River including Beaver Brook

Location Identifiers

ANR Enforcement District: 4

NRCS District: 5

Fish and Wildlife District: 4

Regional Planning Commission: CHI

Assessment Information

Monitored (mi.): 0.0

Assessment Types

Evaluated (mi.): 5.5

Occurrence of conditions judged to cause impairment

Water Quality Limited? N

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination**Toxics Testing**

None detected

Waste Management Zone - Miles: 0.00 Description:**Assessment Comments****THREATENED MILES**

Beaver Brook and an unnamed tributary: 0.5 - threats to aquatic biota/habitat and aesthetics due to sedimentation from eroding banks and road runoff respectively. c(1100) s(4500,7700)

COMMENTS

The lowest part of Beaver Brook (from just above Route 104 down to the Lamoille River) appeared to be in poor shape physically - slumping banks, silt and sediment deposits mid-channel as seen in April 1999. This same condition was also noted in November 1998.

A small brook seen along Allen Irish Road at the same time appears to receive road runoff and road bank slumping and erosion are threats to the brook.

The Cambridge landfill is also located in this waterbody. Data from an intermittent tributary that flows along the base of the landfill's slopes shows elevated levels of iron, manganese, chromium, lead and nickel from sampling done in May 1999. October 1999 sampling was not done. May 1999 sampling found iron and manganese above the maximum contaminant levels (MCL) for those elements in the tributary. There were also three violations of the pH standard - one in 1996, one in 1997 and one in 1998. It was not clear from the plans if the tributary is a natural tributary or the result of seepage from the landfill.

Minor Tribs - Upper Mid-Lamoille (A)

VT07-05

INFORMATION SOURCES

Cathy Kashanski & Jerry McArdle, Vermont DEC Water Quality Division - field observations in April 1999 and November 1998 respectively.

Vermont DEC Waste Management Division files with assistance from Jim Surwilo of the Solid Waste Section - data and information on the Cambridge landfill

Point Source Description

NPDES No.

Plains Road Subdivision - UT Lamoille R

1-0889 SW

Minor Tribs - Upper Mid-Lamoille (B)

Assessment Report

Waterbody No: VT07-06

Assessment Year: 2000

River Length (mi.): 30.5

Date Last Updated: 11/6/2000

Description: Minor tributaries to the Lamoille River from the confluence of the Brewster River to Cady's Falls dam including Centerville, Foot, Hunt, Judevine, Smith, Waterman and Jacob Brooks

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 4

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 7.0

Assessment Types

Evaluated (mi.): 9.0

Fish surveys

Habitat assessment

Water Quality Limited? N

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

None detected

Waste Management Zone - Miles: **Description:**

Assessment Comments

PARTIAL SUPPORT MILES

Foot Brook: 0.5 - partial support of aquatic habitat and secondary contact recreation (fishing) due to physical alteration from channelization and inadequately-sized transportation infrastructure. c(1600) s(7100,7550)

THREATENED MILES

Centerville Brook: 6.5 - whole length - threats to aquatic biota/habitat, secondary contact recreation and aesthetics due to sedimentation, habitat alteration (channel instability) due to loss of riparian vegetation, undersized road culverts, channelization and some bank erosion where the woody vegetation was removed. c(1100,1600) s(1000,7100,7550,7600,7700)

COMMENTS

Foot Brook and Waterman Brook in Johnson are high quality brooks with significant natural reproduction of rainbow, brown and brook trout.

Foot Brook flows through a largely forested watershed and for much of its length is a step-pool and plane-bed type (Rosgen type A and B) stream system. In the vicinity of Route 15, which crosses the brook, the stream channel is unstable. Upstream of Route 15, the channel bed is actively degrading and entrenched

Minor Tribs - Upper Mid-Lamoille (B)**VT07-06**

and the streambanks are oversteepened. The Route 15 bridge is undersized and partially responsible for the channel instability. Downstream of Route 15 to the Lamoille river confluence, prior channelization has caused the flood prone width to be reduced (a result of moderate entrenchment as the channel lost access to its prior floodplain). This reach is re-establishing a new floodplain at a lower bed elevation. Foot Brook is scheduled for restoration in spring 2001.

Centerville Brook is a small agricultural subwatershed to the Lamoille river. Alterations of woody riparian vegetation, channelization, and undersized road culverts have created sections of instability throughout its length.

French Brook is listed on the "F list" because there is a water supply withdrawal point located on it. The use of the brook for a supply and possible impacts from that use are not known. (WSID #5156).

Smith Brook from its confluence with the Lamoille to Route 15 was subject to earlier instream work and there is still livestock access. The banks are unvegetated and eroding in spots in this short stretch (~0.2 miles). Just upstream of Route 15 the stream had been previously channelized and the adjacent land is hayfield. There are some buffers but they are minimal. Upstream of the rail crossing, the river turns into a fairly stable higher gradient brook in a forested area.

There was only information or data on Centerville, Foot, Smith and Waterman Brooks for this assessment. Information or data are needed on Hunt, Judevine, Jacob and unnamed brooks.

INFORMATION SOURCES

Brian Chipman, Vermont Dept of Fish & Wildlife - high quality of Foot and Waterman Brooks as trout fisheries. (1998)

Stream stability assessment for Lamoille County, Vermont, 2000. Jim Ryan for FEMA Project Impact. (2000)

Point Source Description**NPDES No.**

Sterling View Senior M.H.P.- UT Lamoille

1-0693 SW

Maurice Harris Subdivision-UT Centervill

1-0912 SW

Upper Lamoille River Assessment Report

Waterbody No: VT07-07

Assessment Year: 2000

River Length (mi.): 15.7

Date Last Updated: 12/18/2000

Description: Main Stem - Cady's Falls Dam to Hardwick Dam

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 5

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 0.0

Assessment Types

Evaluated (mi.): 15.7

Surveys of fish and game biologists or other professionals

Occurrence of conditions judged to cause impairment

Water Quality Limited?

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination**Toxics Testing****Waste Management Zone - Miles:** 1.70 **Description:** below Morrisville and Hardwick WWTF outfalls**Assessment Comments****PARTIAL SUPPORT MILES**

Lamoille River: 15.7 (entire length of waterbody) - partial support of aquatic biota/habitat, secondary contact recreation (fishing), aesthetics, and contact recreation - from heavy siltation of river bottom, frequent high turbidity, nutrient enrichment, thermal problems, habitat alterations, low and fluctuating flows and pathogens due to 3 hydro dams impounding water, major floods, morphological instability, cropland and manure pits along river, loss of riparian vegetation, land development, urban runoff, and streambank erosion. c(900,1100,1400,1500,1600,1700) s(1000,3200,4000,4500,7410,7550,8600)

COMMENTS

The entire reach is highly regulated by four mainstem hydroelectric dams: Hardwick Lake Dam and Wolcott Dam owned by Hardwick Electric Department and Morrisville Dam and Cadys Falls Dam (Lake Lamoille) owned by Morrisville Water and Light Department. Morrisville's facilities are licensed by FERC and operate under a 401 water quality certification issued in 1981. Hardwick's facilities are unlicensed and do not comply with water quality standards. The Department is currently in an enforcement proceeding related to Hardwick Lake Dam where a significant silt release and fish kill occurred in November 1999. Hardwick Lake is drained in the fall to prevent ice jams, but this action degrades water quality including wetlands associated with the lake. There are no current constraints in place at either of Hardwick's dams to

Upper Lamoille River**VT07-07**

protect stream flow.

The Lamoille River watershed has been hard hit by major flooding in the last ten years. Serious river and stream damage resulted from the flooding, flood repair work, and human infrastructure failures in August 1990, August 1995, January 1996, July 1997, June and August 1998.

In 1998, there were about 200 acres enrolled in Integrated Crop Management programs along this stretch of river.

The Green Mountain Sanitation site (known earlier as Hardwick Recycling & Salvage Center) was found to have volatile organic compounds, semi-volatile organic compounds and metals in some soils and in the water of some of the former chicken coop foundations. Some of the metals and semi-volatile organic compounds were above State of Vermont regulatory limits. These compounds "do not appear to have impacted the groundwater downgradient of the source area." The files on this site are at the Attorney General's office as there is an investigation because of "allegedly illegally disposed waste" so any more recent data or information are not readily available. (November 2000)

Through this reach of the Lamoille River, especially from Hardwick Village to the Wolcott-Morristown town line, human activities have altered or removed much of the woody riparian vegetation and there is extensive streambank erosion. Channel widening and aggradation of sediment were also noted along this reach. Mid-channel bars indicate insufficient sediment conveyance. In addition, both Route 15 and the Lamoille Valley Railroad bed are floodplain encroachments through this reach - further cause for channel instability. In Wolcott Village, landowners have placed fill on the floodplain to increase their property elevation and so the floodprone width has been narrowed here. The banks have been extensively armored in the village. There are short stretches of this waterbody length where the channel is stable due to bedrock control.

INFORMATION SOURCES

Options for State Flood Control Policies and a Flood Control Program, Vermont ANR DEC Water Quality Division, February 1999 - info on the floods of the last several decades (2000)

Barry Cahoon, Vermont DEC River Management Program - information on impacts from the major flood events and identification of unstable stretches of river (2000)

Stream Stability Assessment for Lamoille County, Vermont, 2000. Jim Ryan for FEMA Project Impact. (2000)

Jeff Cueto, Vermont DEC Water Quality Division - information on the hydroelectric dams and their impacts (2000)

Gary Kessler, Vermont ANR Enforcement Division - status of Green Mountain Sanitation case (2000)

Report on the Hardwick Recycling and Salvage Center by Environmental Products & Services Inc for the Hazardous Materials Management Division (now Waste Management Division, Hazardous Materials Section), 1995 (2000)

John St. Onge, USDA - noted ICM acres (1998).

Steve Wright, Vt.F&W Commissioner - noted decline of fishery, macroinvertebrates changing to silt tolerant species; desiltation of hydro dams is a great problem (1988)

Len Gerardi, Vt.F&W Fisheries Biologist - notes thermal problems due to low and fluctuating flows (1988)

Tim McKay, SCS - farm problems and natural erosion (1988)

Ron Regan, Vt.F&W Wildlife Biologist - noted meandering river course, siltation, turbidity, and thermal problems (1988)

Arlo Sterner, Lamoille Co. Forester - fish kill, natural meanders, over 30 manure containment systems installed over last 10 years (1988)

Point Source Description	NPDES No.
Morrisville WWTF 0.425mgd	VT0100480
Hardwick WWTF 0.371 mgd	VT0100137
Morrisville 2 Permits SW/SA	VT0100480
AOT Relocation of Rte 100 in Morristown	1-0860 SW

Minor Tribs - Upper Lamoille Assessment Report

Waterbody No: VT07-08

Assessment Year: 2000

River Length (mi.): 55.5

Date Last Updated: 11/8/2000

Description: Minor Tribs draining into the Upper Lamoille including Rodman Brook, Elmore Pond Brook, Jones Brook, Wolcott Pond Brook

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 5

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 0.0

Assessment Types

Evaluated (mi.): 18.1

Surveys of fish and game biologists or other professionals

Occurrence of conditions judged to cause impairment

Water Quality Limited?

Visual observation, may quantify some parameters, single season,

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

Waste Management Zone - Miles: 0.00 **Description:**

Assessment Comments**PARTIAL SUPPORT MILES**

Elmore Pond Brook: 2.2 - below Lake Elmore and lake dam operated by a utility - partial support of aquatic biota/habitat and aesthetics due to siltation, turbidity, and physical alteration of stream bed, channel, and banks from erosion, loss of streambank vegetation, and debris jams as a result of the August 1995 flood. The aquatic biota has also been partially supported due to extreme low flows below the dam (before the flood). c(1100,1500,1600,2500) s(7410,7600,7700,8600)

Wolcott Pond Brook: 2.5 - from Wolcott Pond to mouth - partial support of aquatic biota/habitat and aesthetics due to siltation, turbidity, thermal modifications, and physical alteration of the stream bed, channel, and banks from road and bridge failures, streambank vegetation removal, bank erosion and the failure of an upstream impoundment failure all a result of the August 1995 flood. c(1100,1400,1600,2500) s(7600,7700,8600,8950)

Kate Brook: 2.0 - headwaters to mouth - partial support of aquatic biota/habitat and aesthetics due to siltation, turbidity, and physical alteration of stream bed, channel, and banks from road and bridge failures, streambank vegetation loss, and bank erosion as a result of the August 1995 flood and again in 1997 flood. c(1100,1600,2500) s(7600,7700,8600,8950)

Bunker Brook: 1.5 - headwaters to mouth - partial support of aquatic biota/habitat and aesthetics due to siltation, turbidity, and physical alteration of stream bed, channel, and banks due to streambank vegetation

Minor Tribs - Upper Lamoille**VT07-08**

loss, streambank erosion and road erosion as a result of the August 1995 flood. c(1100,1600,2500)
s(7600,7700,8600,8950)

THREATENED MILES

Small tribs west of Lake Elmore: 2.0 - threats to aquatic biota and aesthetics due to erosion and sedimentation from development. c(1100), s(3200)

Rodman Brook: 0.5 - from Lamoille Landfill and Salvage Depot to mouth - threats to aquatic biota/habitat, contact recreation, drinking water supply and aesthetics due to metals (iron & manganese) and organic compounds from the landfill. c(500) s(6300)

COMMENTS

The August 1995 flood was a MAJOR flood reaching elevations in the Lamoille River basin above the 1927 flood in some locations. Source code 8950 "other" was used above where road, bridge, culvert failures led to additional impact on the stream. Another flood event in 1997 affected Kate Brook again. The brooks have still not recovered from the alterations. (2000)

Morrisville Power & Light owns the dam on Lake Elmore.

The Lamoille Landfill and Salvage Center is located north of Route 15 and east of Garfield Road and Rodman Brook in Morristown. The landfill was closed in 1992. Groundwater and surface water monitoring has been ongoing since 1992 and will continue until 2010. Monitoring for both organics and inorganics occurs in May and October each year. In the last round of sampling, May 2000, manganese exceeded enforcement standards in 6 monitoring wells; iron exceeded enforcement standards in 5 monitoring wells; nickel exceeded the enforcement standard in one well; and arsenic exceeded the "Preventive Action Level" (PAL) in the same well. One or more organic compounds exceeded the enforcement standards, the PAL, or both in four wells. There were no exceedances of surface water standards.

A bridge and culvert blew out on the lower section of Rodman Brook during a flood. Large amounts of sediment moved downstream. The replacement bridge and culvert were larger and the brook is expected to heal with time.

INFORMATION SOURCES

Len Gerardi, Phil Wightman, Will Staats - Vt. F&W District Fisheries biologists (1990)

Vt. DEC Hydro Assessment 1987

Barry Cahoon, Vermont DEC Water Quality Division - provided information on the flood impacts (1996 and 2000)

Jim Surwilo, Vermont DEC Waste Management Division - provided monitoring results and other information from the Solid Waste files on monitoring data at the Lamoille Landfill (1996,2000)

Jim Ryan, Vermont DEC Water Quality Division - noted impacts and fixes on Rodman Brook (2000)

Point Source Description**NPDES No.**

none

Lamoille Landfill & Salvage Depot

Mill Brook Assessment Report

Waterbody No: VT07-09

Assessment Year: 2000

River Length (mi.): 14.5

Date Last Updated: 9/20/2000

Description: Mouth to headwaters and tributaries including Polly Brook

Location Identifiers

ANR Enforcement District: 6

NRCS District: 6

Fish and Wildlife District: 4

Regional Planning Commission: NW

Assessment Information

Monitored (mi.): 0.2

Assessment Types

Evaluated (mi.): 0.0

Surveys of fish and game biologists or other professionals
RBP III or equivalent benthos surveys

Water Quality Limited?

On 303(d) List? Y

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

Waste Management Zone - Miles: **Description:**

Assessment Comments

PARTIAL SUPPORT MILES

Mill Brook: 0.2 - partial support of aquatic biota/habitat due to nutrients and sediments from currently unknown sources but upstream gravel operations are suspected. c(900,1100) s(5000)

COMMENTS

Mill Brook was sampled at milepoint 0.1 in October 1997. The macroinvertebrate community was assessed as "fair", which indicates a substantial alteration to the community integrity. The site was embedded (category 50-75%) and there was a lot of algae present.

In previous assessment, 14.5 miles were listed as threatened due to gravel operations. This is likely true given that large gravel operations are shown on the USGS map on the Mill River and its tributaries and this issue was cited in the past. No ANR professional had been up into the Mill River watershed recently so for now the miles in this waterbody are not assessed except for 0.2 miles given partial support due to macroinvertebrate sampling. Upstream threats or impacts need assessing!

INFORMATION SOURCES

Jon Anderson, Vermont Dept of Fish & Wildlife - first noted threats from gravel operations (1990) but has not been up the brook in awhile (2000)

Mill Brook

VT07-09

Brian Chipman, Vermont Dept of Fish & Wildlife - hasn't been in this watershed recently and doesn't know situation (2000)

Steve Fiske, Vermont DEC Water Quality Division Biomonitoring Section - data and information on Mill Brook site near mouth. (2000)

Point Source Description

NPDES No.

none

Lower Browns River Assessment Report

Waterbody No: VT07-10

Assessment Year: 2000

River Length (mi.): 25

Date Last Updated: 11/9/2000

Description: Mouth to confluence of Lords Brook and tributaries including Rogers Brook and Abbey Brook

Location Identifiers

ANR Enforcement District:	4	NRCS District:	6
Fish and Wildlife District:	4	Regional Planning Commission:	CHI

Assessment Information

Monitored (mi.): 11.0

Assessment Types

Evaluated (mi.): 0.0

RBP III or equivalent benthos surveys

RBP V or equivalent fish surveys

Water Quality Limited?

On 303(d) List? Y

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

Waste Management Zone - Miles: Description:

Assessment Comments

NON-SUPPORT MILES

Browns River: 7.5 - from milepoint 3.5 upstream to milepoint 11 - non-support of aquatic biota/habitat (fish) and partial support of secondary contact recreation and aesthetics due to sedimentation from unstable banks, loss of riparian vegetation, past intensive gravel removal, adjacent agricultural land uses and flood events exacerbating already unstable conditions. c(1100,1600) s(1000,5000,7600,7700,8650)

COMMENTS

A comment from the 9001 assessment described extensive gravel mining that had altered the watercourse in some areas and destabilized riverbanks that led to heavy siltation. The channel had become wider and shallower leading to increased temperatures. The sedimentation was noted when sampling was done in 1997 and the fish community impairment is in part a result of these past instream disturbances and the river's attempt to re-adjust.

Fish sampling for the last five years have produced the following results: at milepoint 0.4, the fish community assessment was excellent in 1994, 1995, 1996 and very good in 1998, 1999. At milepoint 5.9, the fish community assessment was poor in 1996, 1997, 1998, 1999 and fair in 2000. At milepoint 10.4, the community assessment was poor in 1996, fair in 1997, poor in 1998 and 1999, fair in 2000.

Lower Browns River**VT07-10****INFORMATION SOURCES**

Brian Chipman, Vt Dept of Fish & Wildlife Fisheries Biologist - noted impacts from earlier gravel mining. Had no new information in 9807 but referred to sampling by Rich Langdon and Doug Facey (St. Michaels College).

Rich Langdon, Vt DEC Water Quality - fish sampling data and interpretation from three sites on the lower Browns River (2000).

ASSESSMENT STATUS

There was only the data and information on the lower Browns River for this assessment cycle. Information is needed on Rogers Brook, Abbey Brook and any other tributaries to this reach.

Point Source Description**NPDES No.**

Jericho East

1-0767 SW

Upper Browns River Assessment Report

Waterbody No: VT07-11

Assessment Year: 2000

River Length (mi.): 41.2

Date Last Updated: 11/14/2000

Description: Confluence of Lords Brook to headwaters and tributaries including the Lee River, The Creek, Roaring Brook, Stevensville Brook, Clay Brook, Crane Brook

Location Identifiers

ANR Enforcement District: 4

NRCS District: 5

Fish and Wildlife District: 4

Regional Planning Commission: CHI

Assessment Information

Monitored (mi.): 0.0

Assessment Types

Evaluated (mi.): 26.0

Surveys of fish and game biologists or other professionals

RBP V or equivalent fish surveys

Water Quality Limited?

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination**Toxics Testing****Waste Management Zone - Miles:****Description:****Assessment Comments****PARTIAL SUPPORT MILES**

Browns River: 7.5 - from just west of Jericho-Essex town line to 7.5 miles upstream in Underhill - partial support of aesthetics and aquatic habitat due to sediments, temperature increases, and physical alteration of the riverbed due to former gravel mining on an excessive scale, bank destabilization, stream channel instability and major flood events. c(1100,1400,1600) s(5000,7550,7700)

THREATENED MILES

Stevensville Brook & tributaries: 5.0 - whole length - threats to aquatic biota/habitat due to low pH from acid deposition c(1000) s(8100)

COMMENTS

Macroinvertebrate sampling on the upper Browns River took place at milepoint 20.8 in 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998 and the resulting community assessments varied: good, fair, good, excellent, good, fair, excellent, fair respectively. The fair assessments were due to flood effects (scouring) on top of low alkalinity. The condition of the macroinvertebrate community in this upper reach of the river is considered good overall. (2000)

Fish sampling on the upper Browns River took place in 1996, 1997, 1998, 1999, 2000 at milepoint 17.2 and each year the fish community assessment was excellent. (2000)

Upper Browns River**VT07-11**

Macroinvertebrate sampling has occurred on Stevensville Brook in Underhill from 1992 to 1999. The community was rated excellent based on the metrics in 1992, 1993, and 1994. It was rated fair in 1995, good in 1996 and 1997 then fair again in 1998 and 1999. The fair rating was due primarily to low densities as a result of scouring from flood events in those years. Stevensville Brook is a flashy, high elevation stream and so the severe rain events in the last five years in the Lamoille watershed have affected this brook. Low alkalinity and low pH values have been found when sampling there and so the brook is considered threatened due to acidity, but at this time it has a good macroinvertebrate community and good water quality overall.

On the Lee River, fish sample data from 1992 and 1993 at milepoint 2.7 and 2.8 showed the fish community to be good to excellent. In addition, reports are that some riparian restoration activities have occurred on the lowest mile of the Lee River and there has been better streambank management at the Ethan Allen Firing Range (and over half the length of the Lee River flows through the Range). The impacts and threats to the Lee River listed in past assessments have been removed as a result. (9807)

The Wells Corner Market is located in Underhill Center about 150 feet south of the Browns River. Two underground gasoline storage tanks were removed from the market site in 1995. Both tanks were old and showed signs of leakage. Since then new tanks have been installed, there has been regular monitoring at groundwater monitoring wells and 2 surface water sites, and installation and operation of a soil-vapor extraction and air-sparging system. Some of the monitoring wells have had high levels of BTEX and MTBE but those concentrations have declined substantially since the remediation system was installed in all but one well. The last 4 rounds of surface water sampling (all in 1998) have had no BTEX or MTBE detected. In September 1997, 4.7 ppb and 4.5 ppb MTBE were found in the two Browns River samples taken.

Surface water sampling from two sites on Crane Brook upstream and downstream of the Underhill landfill in July 1999 and July 2000 found none of the parameters violating the Vermont Water Quality Standards. Temperature, conductivity, volatile organic compounds, chloride, sodium, COD, and a number of dissolved metals were measured.

The impacts due to the high fecal coliform numbers from sampling done in 1988 have been removed for now as there has been no other information and data or correspondence on this issue. (The sources of the high numbers were given as direct and indirect discharges of animal waste and allegedly failed septic systems.) There should be some follow-up on the issue of failing septic systems at least as this issue gets raised periodically still. (2000)

INFORMATION SOURCES

Brian Chipman, Vt Dept of Fish & Wildlife fisheries biologist - noted the riparian restoration and streambank management improvements on the Lee River. (9807)

Rich Langdon, Vt DEC Water Quality Division - fish sample data and interpretation for the upper Browns River and Lee River sites. (2000)

Bob Haslam, Vermont DEC Waste Management Division - results from monitoring associated with the Wells Corner Market hazardous waste site (2000)

Vt. DEC Solid Waste Files - report dated August 2000 from Kent Koptluch, Geo-Environmental Services about Underhill Landfill sampling results (2000)

Vt. DEC Permits, Compliance and Protection Division letter to Town of Jericho Zoning Administrator. High fecal coliform and fecal streptococcus counts (20,000-24,000) in trib found in 6 samples taken from July 14 to September 1, 1988.

Jon Anderson - Vt. F&W District Fisheries Manager - noted that three fourths of the "The Creek" is impounded by beaver. Stocked with large-mouth bass and the fishery ok.

Ray Bouchard, Vt. National Guard

Point Source Description**NPDES No.**

Laisdell Pond Subdivision - UT Lee River
Jericho East Com Sub - Browns R & UT
St Thomas Church parking lot - UT Browns
White Farm Meadows Sub - UT Lee R
Mt Mansfield Union H.S. - UT Lee River

1-0642 SW
1-0767 SW
1-0817 SW
1-0923 SW
1-1261

Seymour River Assessment Report

Waterbody No: VT07-12

Assessment Year: 2000

River Length (mi.): 11.5

Date Last Updated: 2/6/2001

Description: Mouth to headwaters and tributaries including Settlement Brook

Location Identifiers

ANR Enforcement District: 4

NRCS District: 5

Fish and Wildlife District: 4

Regional Planning Commission: CHI

Assessment Information

Monitored (mi.): 0.0

Assessment Types

Evaluated (mi.): 11.5

Occurrence of conditions judged to cause impairment

Water Quality Limited? N

On 303(d) List? N

Monitored for Toxics? Y

Aquatic Contamination

Toxics Testing

None detected

Waste Management Zone - Miles: **Description:**

Assessment Comments

PARTIAL SUPPORT MILES

Seymour River: 3.5 - mouth upstream 3.5 miles - partial support of aquatic biota/habitat, contact recreation, and secondary contact recreation due to sedimentation, physical habitat alterations, channel instability due to road runoff and road embankment erosion, loss of riparian vegetation, de-stabilized streambanks, agricultural land uses.. c(1100,1600) s(3200,4500,7600,7700)

THREATENED MILES

Settlement Brook: 1.5 - threats to aquatic biota/habitat, aesthetics, and secondary contact recreation due to sedimentation due to de-stabilized banks, bridge and road repair work. c(1100) s(3100,7700)

COMMENTS

On Settlement Brook, bridge repair work on the lower portion of the brook left a lot of exposed soil on the banks of the brook and in the vicinity. There were also big piles of exposed soil near the brook - a rainstorm would have easily sent soil into the stream. Further upstream there was severe sedimentation in the stream - it looked like a culvert had blown out. (2000)

The stream stability assessment report done for Lamoille County noted that a home on Settlement Brook located about a mile upstream from the brook's mouth was the site of a FEMA property buyout after the

Seymour River**VT07-12**

house was damaged by the 1995 and 1997 floods. It also noted that "extensive road ditching, culvert replacement, and a bridge replacement resulted from flood damage." This would corroborate the interpretation of the field observations described above. The house removal and bridge and culvert replacement should hopefully accommodate future high water.(2000)

The lower three and a half miles of the Seymour river in Cambridge are unstable due to loss of riparian vegetation and agricultural land use. Two of the sites measured had high width-depth ratios. One site had widening and aggradation. The other site was entrenched.

INFORMATION SOURCES

Tim Beaman, SCS in Morrisville - noted that 250 feet of a 6 foot high eroding bank protected with rock riprap near the Cambridge/Underhill town line (9201).

Cathy Kashanski, Vermont DEC Water Quality Division - field observations of Seymour River, Settlement Brook in April 1999.

Stream Stability Assessment for Lamoille County, Vermont, draft copy May 31, 2000. Prepared for FEMA Project Impact - Lamoille County, Vermont by Jim Ryan.

Point Source Description**NPDES No.**

McGrath Subdivision - Fords Creek

1-0590

Brewster River Assessment Report

Waterbody No: VT07-13

Assessment Year: 2000

River Length (mi.): 20.1

Date Last Updated: 2/7/2001

Description: Mouth to headwaters and tributaries including No Name Brook, Sterling Brook, Gallup Branch

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 4

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 6.0

Assessment Types

Evaluated (mi.): 14.1

Land use information and location of sources

Occurrence of conditions judged to cause impairment

Water Quality Limited?

RBP III or equivalent benthos surveys

On 303(d) List? Y

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

Waste Management Zone - Miles:**Description:****Assessment Comments****NON-SUPPORT MILES**

Sterling Brook: 0.8 - from confluence with the Brewster River up 0.8 miles to the withdrawal point - non-support of aquatic biota/habitat due to water withdrawal for snowmaking. c(1500) s(7420)

No Name Brook: 1.0 - from the confluence with the Brewster River up 1 miles to withdrawal point - non-support of aquatic biota/habitat due to flow impacts from snowmaking and water supply withdrawals. c(1500) s(7420)

Trib to Brewster River: 1.0 - below old failed Smugglers Notch leachfield - severe impacts to aquatic biota/habitat and aesthetics due to iron bacteria which coats the bottom. Source is a pipe from the old leachfield. c(500), s(6500)

Brewster River: 0.4 (subset of the 5.9 miles below) - from the school downstream to the mouth - non-support of aquatic biota/habitat, secondary contact recreation and aesthetics due to a huge bank slump into the river blocking the channel and sending sediment downstream. c(1100) s(7700)

PARTIAL SUPPORT MILES

Brewster River: 5.9 - from the Lamoille River upstream to the confluence of Sterling Brook - partial support of aquatic biota/habitat due to flow alteration from snowmaking withdrawals. c(1500) s(7420)

Brewster River**VT07-13****THREATENED MILES**

Brewster River: 5.0 - from the ski area to the mouth (subset of 5.9 miles in partial support above and includes the 0.4 miles in non-support above) - threats to aquatic biota/habitat and aesthetics due to sedimentation, habitat alteration and sections of channel instability from watershed development, increased peak stormwater discharge, and road and parking lot runoff. c(1100,1600) s(3200,4500,7000, 7550)

COMMENTS

A site at milepoint 0.4 on the unnamed tributary below the old Smugglers Notch leachfield was last sampled in 1997 and the community assessment was poor.

Two sites were sampled on the Brewster River in 1996 at milepoints 4.9 and 5.0. Three sites were sampled in 1998 at milepoints 4.9, 5.0 and 5.3. Milepoint 4.9 is a regular ABN site. Milepoint 5.0 is a site below route 108 at Smugglers Notch and is a compliance monitoring site for an indirect discharge. The data at milepoint 4.9 in 1996 found the macroinvertebrate community to be in good to excellent condition, however, the stream channel had a relatively high percentage of sand.

The Brewster river has a primarily high elevation, forested mountain watershed. The steep valleys with step-pool morphologies transition to plane-bed morphologies for the majority of the river's length. Some bedrock cascades, which act as grade controls are interspersed as well. Several localized sections of channel instability are present throughout the watershed. The most unstable section of the Brewster River is the lower portion in Jeffersonville Village. A very high bank has been undermined - exact causes of the slide are not known. Earlier channelization, gravel extraction, and floodplain encroachment are suspected contributors at least. More specific morphological information of the Brewster River is available from the Vermont DEC Water Quality Division.

INFORMATION SOURCES

Steve Fiske, Vermont DEC Aquatic Biologist - data and information on macroinvertebrate sampling (2000)

Chris Thompson, Vt. DEC Wastewater Treatment Engineer - noted that the Jeffersonville STP is now on line so the straight pipe and failed leachfields from residences on the Brewster should not cause impairment as they are now tied into the new system. (9001)

Cathy Jamieson, Vt DEC Environmental Protection Hydrogeologist - noted that the new Smugglers Notch spray system is being studied by Middlebury College. It is in compliance and has causes no impact on the Brewster R. (9001)

Vt. DEC Solid Waste files

Kathy Fallon, Vt. DEC hydrologist & Water Supply Division information - location of stream water supply withdrawal

Use Attainment for Streams Affected by Snowmaking Water Withdrawals in Vermont, David Bottamini, 1996, Vt Agency of Natural Resources Water Quality Division.

Stream Stability Assessment of Lamoille County, Vermont, 2000. Jim Ryan for FEMA Project Impact, Lamoille County, Vermont.

Point Source Description**NPDES No.**

Bell-Gates Lumber - log pile drainage

3-1269

Smugglers Notch condominiums-No Name Brk

1-0900 SW

Smugglers Notch lagoon underdrain - UT

1-0903 SW

Smugglers Notch executive duplexes - UT

1-1149 SW

Smugglers Notch parking lot upgrade - UT

1-1236

Water withdrawal - Smugglers Notch water

North Branch - Lamoille River Assessment Report

Waterbody No: VT07-14

Assessment Year: 2000

River Length (mi.): 36.5

Date Last Updated: 2/7/2001

Description: Mouth to headwaters and tributaries including Hunt, Taylor, Coddington and Basin Brooks

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 4

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 1.0

Assessment Types

Evaluated (mi.): 13.0

Occurrence of conditions judged to cause impairment

Fish surveys

Water Quality Limited?

Visual observation, may quantify some parameters, single season,

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

Waste Management Zone - Miles: Description:

Assessment Comments**PARTIAL SUPPORT MILES**

North Branch Lamoille River: 1.0 - lower mile - partial support of aquatic biota/habitat and aesthetics due to loss of riparian vegetation from grazing. c(1100, 1400), s(1400,7600)

THREATENED MILES

North Branch Lamoille River: 0.5 - from the seep below Waterville Garage downstream - threats to aquatic bio/habitat, contact recreation, drinking water supply due groundwater contaminated with MTBE xylenes and TMBs. C(300) s(6600)

COMMENTS

Assessment done during the Lamoille County stream stability assessment project found the following results: the North Branch is in excellent condition from its headwaters to Belvidere; it is in good condition from Belvidere to the Cambridge town line with the exception of a stretch behind the Waterville Elementary School where the channel has widened, incised and lost sinuosity and bed form features; and it is in poor condition upstream and downstream of the Route 109 bridge where the channel has widened and incised and there is mid-channel bar development. Channel instability from loss of riparian vegetation and other sources was greatly aggravated by the July 1997 flood. The stretch especially altered from the flood was

North Branch - Lamoille River**VT07-14**

the stretch from Route 109 to its confluence with the Lamoille River mainstem.

As of spring 1998, there were close to 100 acres of cropland enrolled in the USDA Integrated Crop Management (ICM) program.

Underground petroleum storage tanks were removed from the Waterville Garage site (92-1315) in 1992. However, petroleum odors have been noticed along the North Branch downgradient of the garage on several occasions. Seep samples collected in August 1998 showed methyl-t-butylether (MTBE), total xylenes, 1,2,4-trimethylbenzene (TMB), and total volatile hydrocarbons well above the Vermont Groundwater Enforcement Standards. The seep occurs at the base of a waterfall and the bank where the seep emanates is very steep and is boulder and bedrock. It is not clear how to address the seep.

There was an effort to classify the North Branch of the Lamoille River as a Class A water in the early to mid 90's. Despite a number of letters from professionals supporting the re-classification with their information and knowledge of the resource, the process was never completed and the petition never filed with the Board.

Fish and macroinvertebrate sampling was done on the North Branch in September 1992. A memo on the fish sample results stated: "the water appeared to be a tannic color with low to moderate alkalinity. The physical habitat of the section was characterized by minimal sedimentation and a boulder-cobble-coarse gravel substrate. The population integrity was rated excellent due to the dominance of benthic insectivores combined with a strong presence of all three trout species. Four of the seven species collected were considered intolerant to general pollution effects... The Vermont Index of biological Integrity rated excellent (43 out of a possible 45)." The macroinvertebrate community also was found to be in excellent condition.

A letter from Brian Chipman, Vermont Department of Fish & Wildlife, written in support of the proposed North Branch Lamoille River reclassification stated "the headwaters of the North Branch lie in a largely undeveloped forest and wetland complex. Self-sustaining native brook trout populations thrive throughout this area, which are indicative of high quality coldwater habitat."

Information is needed on the tributaries to the North Branch - Hunt, Taylor, Coddington and Basin Brooks

INFORMATION SOURCES

Jon Anderson, Vermont Dept of Fish & Wildlife - noted grazing threats.

John St. Onge, USDA Farm Service Agency - noted flood damage to the North Branch as well as ICM acres. (1998)

Rich Langdon, Vermont DEC Water Quality Division BASS - noted "excellent" fish community of North Branch in 1992 memorandum. (2000)

Brian Chipman, Vermont Department of Fish & Wildlife - noted excellent fishery in North Branch in 1994 letter. (2000)

Mike Kline, Vermont DEC Water Quality Division - file and information on the potential North Branch reclassification (2000)

Bob Haslam, Vermont DEC Waste Management Division - information and data from files on Waterville Garage site (2000)

Stream Stability Assessment of Lamoille County, Vermont, 2000. Jim Ryan for FEMA Project Impact, Lamoille County, Vermont

Point Source Description**NPDES No.**

none

Gihon River Assessment Report

Waterbody No: VT07-15

Assessment Year: 2000

River Length (mi.): 40.8

Date Last Updated: 2/7/2001

Description: Mouth to headwaters and tributaries including Bell, Wild, Beaver Meadow and Stony Brooks, White and Dark Branches

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 4

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 13.0

Assessment Types

Evaluated (mi.): 7.0

Occurrence of conditions judged to cause impairment

Chemical/physical monitoring

Water Quality Limited?

Quantitative measurements of instream parameters, channel morph

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

None detected

Waste Management Zone - Miles: **Description:**

Assessment Comments**NON-SUPPORTED MILES**

South Pond Brook: 0.9 - in Eden to first trib below outfall on South Pond - impaired for all uses due to dewatering and low flows creating lack of habitat and water to support uses. c(1500) s(7410,8800)

PARTIAL SUPPORT MILES

Gihon River; 0.2 - from mouth upstream to Pearl Street bridge - partial support of aquatic biota/habitat due to sediment, habitat alteration, channel instability from floodplain encroachments, streambank erosion. C(1100,1600) s(7550)

Gihon River: 2.0 - from North Hyde Park downstream to Dump Road (includes the stretch along the landfill) - partial support of aquatic biota/habitat due to sediment, channel widening, channeling bifurcating. Sources not clear. C(1100,1600)

Gihon River: 0.5 - below the double culvert bridge on Deuso road - partial support of aquatic biota/habitat from sediment, habitat alteration due to culvert obstructing flow and failing. c(1100,1600) s(4500,7550)

THREATENED MILES

Gihon River: 0.4 - 0.2 miles below Clutes Market and 0.2 miles below Village Citgo - threats to aquatic biota, contact recreation and drinking water supply from organic compounds due to hazardous waste sites

Gihon River**VT07-15**

(0.2 is an arbitrary number until more is understood about these situations). c(300) s(6600)

COMMENTS

Earlier assessment (1988) had problems listed from cows being pastured right down to the river, row crops being cultivated perpendicular to the river, and streambanks being unvegetated and eroded. John St. Onge of the USDA notes that there has been a significant improvement since that assessment: there are no row crops being grown near the river and there are fewer animal units in the watershed.

Clutes (Franks) Market in Eden (880224) had leaking oil tanks not far from the Gihon River, which were removed in 1988. Groundwater at the site flows from the site of the leaking tanks past a monitoring well that is 20 feet from the river then into the river. Samples taken from this well (MW-NW) since 1989 have had very high levels (well above VGES sometimes by orders of magnitude) of benzene, ethylbenzene, 1,3,5 trimethylbenzene, 1,2,4 trimethylbenzene and naphthalene. In June 1989, benzene concentrations in MW-NW (MW2) were 14,400 ppb and in 1999, were 847 ppb (VGES = 5.0 ppb). In 1989, ethylbenzene concentrations in MW-NW (MW2) were 800 ppb and in 1999, were 1520 ppb (VGES = 700 ppb). There was no surface water sampling done and so any possible instream concentrations are not known.

Village Citgo in Johnson (880226) oil spills resulted in subsurface contamination of the site and petroleum sheens and staining along the base of the bank of the Gihon river. Results of sampling at monitoring well G1-2 for the last three years were: benzene - 142 ppb in 1997, 108 ppb in 1998, and 157 ppb in 1999 (the VGES is 5 ppb); MTBE - 339 ppb in 1997, ND>100 in 1998 and 223 ppb in 1999 (the VGES is 40 ppb); 1,3,5 -trimethylbenzene - 41.5 ppb in 1999 (VGES 4 ppb); 1,2,4 - trimethylbenzene - 807 ppb in 1999 (VGES 5 ppb); and naphthalene - 80 ppb in 1999 (VGES 20 ppb). Again no surface water sampling was done although the "Seep Area" is inspected at the time the groundwater is sampled and in 1999 "no sheens or petroleum seepage were observed."

The Johnson landfill was closed and capped in 1994. Five groundwater monitoring wells are sampled twice a year. In the past (1993-1998), several of the wells have had high levels of iron and manganese. One well (JO-2) has had high levels of arsenic. Several organic compounds have also been found in samples from well JO2 above Preventative Action levels or above Enforcement Standards. Well JO2 is over 100 feet from the Gihon River.

Stability of the Gihon River was investigated as part of the Lamoille County Stability Assessment project. The lowermost section of the river from its mouth at the Lamoille River to the Pearl Street bridge is "evolving from a pool-riffle C-type stream to an unstable F-type stream." The major cause of the instability is floodplain encroachments especially upstream and downstream of Route 15, which is all part of Johnson village. "The flood prone width has been substantially reduced in this section causing accelerated bank erosion and channel incision."

Another site on the Gihon River that was classified as a medium priority site by the Lamoille County Stability Assessment project was just off Blakesville Road on Deuso Road across from the Cooper Hill Road intersection. "An old fuel tank double culvert obstructs flow transport and threatens all three roads. As of the writing of this report (spring 2000), one of the two culverts is blocked with woody debris." This same site was seen in October 2000 and the field notes read "the Gihon flows under a double culvert bridge that looks like it was relatively recently repaired after a washout - looks like an accident waiting to happen again - culverts could easily get jammed with debris, plug, and sand/gravel road would be gone.. Two sand/gravel bars on channel edge below culverts, 1 cobble/gravel bar in middle .." It seems like a proper bridge in this location should be a high priority!

A windshield survey of the Gihon River in October 2000 found no substantial impacts or serious threats in addition to the situations described above. There were just the ubiquitous and common nonpoint source threats from road maintenance (tree removal on banks or sand and gravel migration from pull-offs or roads themselves), road crossings (culverts and bridges), and some agriculture (riparian vegetation loss). It is a very pretty river with a number of nice cascades.

Aerial photo review indicates that Bell Brook has been previously relocated and channelized where the watercourse runs parallel to Route 100C. Woody buffers are sparse in this reach. Livestock have been recently excluded and a riparian buffer is being re-established on a farm upstream of town road 32.

Information on the tributaries to the Gihon River is needed: Bell Brook, Wild Brook, Beaver Meadow Brook, Stony Brook, White Branch, Dark Branch.

Gihon River**VT07-15****INFORMATION SOURCES**

John St. Onge, USDA Farm Service Agency - noted agricultural changes from 1988 to 1998.

Vermont DEC Hydro Study 1987

Vermont DEC Waste Management Division hazardous waste site files - information and data on the Clutes Market and Village Citgo sites (2000)

Stream Stability Assessment for Lamoille County, Vermont, November 2000. Prepared for FEMA Project Impact - Lamoille County, VT by Jim Ryan.

Cathy Kashanski, Vermont DEC Water Quality Division - windshield survey of Gihon River in fall 2000

Point Source Description	NPDES No.
Johnson WWTF 0.2mgd - Gihon R	VT0100901
Johnson Bypass - Gihon R	VT0100901
Apt Building in Johnson - UT Gihon R.	1-1008SW
Residential Subdivision Eden-UT Gihon R	1-1026SW

Kenfield Brook Assessment Report

Waterbody No: VT07-16

Assessment Year: 2000

River Length (mi.): 12.5

Date Last Updated: 12/4/2000

Description: Mouth to headwaters and tributaries including Beaver Meadow and Mud Brooks

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 4

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 0.4

Assessment Types

Evaluated (mi.): 12.1

Surveys of fish and game biologists or other professionals

Fish surveys

Water Quality Limited?

Quantitative measurements of instream parameters, channel morph

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

None detected

Waste Management Zone - Miles: **Description:**

Assessment Comments**THREATENED MILES**

Kenfield Brook: 0.4 - from mouth upstream to bottom of Terrill Gorge - threats to aquatic biota/habitat due to physical alterations from 1984 flood, instream and floodplain work following flood, undersized bridge that is now replaced. c(1600) s(7100,7550,8650)

COMMENTS

There was a major flood on Kenfield Brook in 1984. Following that flood, there was instream and floodplain work done that resulted in habitat alterations and a berm in the floodplain of the brook above the Terrill Road bridge near Cady's Falls nursery. Fish and other habitat was impaired. The 1996 assessment update noted that the fish habitat status was much improved and that a healthy wild trout population was documented in 1995. A new bridge with associated habitat features had been put in over Kenfield Brook on Terrill Road. In 1994 and 1995, NRCS did some bioengineering and other work downstream of the bridge to stabilize the riparian area. The floods in 1995 and 1997 on the Lamoille River did not result in the Kenfield Brook drainage receiving high velocity, erosive flood waters coming downstream but rather the lower stretch of the river was inundated from Lamoille River backwater. Stream stability assessment work in 1999 found a high width-depth ratio and large point bar development despite some good riparian vegetation.

Fish surveys were done several times on lower Kenfield Brook in the 1990's, the last time in 1999, and

Kenfield Brook**VT07-16**

there was quite a bit of variation in abundance of young of year rainbow trout (from Lamoille River spawners). Brian Chipman thinks that flood events likely play a major role in this variation. Anglers have reported that the upper part of the drainage have a very productive wild brook trout fishery. Brian considers Kenfield Brook to be one of the highest quality small streams from a fishery perspective in the district.

INFORMATION SOURCES

Brian Chipman, Vt. Dept. of Fish and Wildlife - noted that fishery condition especially in the lower section below Terrill Gorge. Also noted the re-construction of the Terrill Road bridge and associated habitat improvement as well as streambank stabilization and riparian planting work that has happened in the lower stretch. (1996 & 2000)

Chuck Mitchell, USDA NRCS - information on the timing and type of bioengineering and other work on lower Kenfield Brook. (2000)

Jim Ryan, Vermont DEC Water Quality Division - additional information on status of lower Kenfield Brook based on his stability assessment work for Lamoille County (2000)

John St. Onge, USDA Farm Service Agency - also noted the streambank stabilization work and riparian plantings near the mouth (1998)

Point Source Description**NPDES No.**

none

Ryder Brook Assessment Report

Waterbody No: VT07-17

Assessment Year: 2000

River Length (mi.): 29.5

Date Last Updated: 12/14/2000

Description: Mouth to headwaters and tributaries including Lawrence Brook and Bedell Brook

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 4

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 9.0

Assessment Types

Evaluated (mi.): 20.5

Surveys of fish and game biologists or other professionals

Occurrence of conditions judged to cause impairment

Water Quality Limited?

Visual observation, may quantify some parameters, single season,

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

Waste Management Zone - Miles: Description:

Assessment Comments**PARTIAL SUPPORT MILES**

Ryder Brook: 3.5 - partial support of aquatic biota/habitat, aesthetics, and non-contact recreation due to physical habitat alterations, sediments, nutrients, and turbidity from morphological instability, flood impacts (erosion, debris jams, loss of streambank vegetation) as well as secondary development, agricultural activities (corn, pasture to top of banks). c(900,1100,1600,2500) s(1000,3200,7550,7600,7700,8650)

Bedell Brook: 5.5 - confluence with Ryder Brook upstream - partial support of aquatic biota/habitat and aesthetics due to sediments, physical habitat alterations and turbidity from morphological instability, erosion, loss of streambank vegetation, and debris jams caused by the August 1995 flood. c(1100,1600,2500) s(7550,7600,7700,8650)

COMMENTS

Information from the stream stability assessment project and report includes the following:

Ryder Brook is located along the broad valley floor (Rosgen type VIII) between Stowe and Morristown. The broad flood plain is conducive to agricultural practices throughout the watershed. Unexcluded livestock, and grass and row crops planted to the top of bank are responsible for channel instability related to overwidening. A major channel relocation and channelization project occurred from Goeltz Road downstream to Route 100 to accommodate the Morristown Airport. Channel sinuosity has been greatly reduced and

Ryder Brook**VT07-17**

channel incision has been observed upstream to the Goeltz Road culvert...Undersized and improperly installed road culverts are responsible for local channel instability at the Goeltz Road and Meade Road. Bridges should be considered in these locations. So Ryder Brook, except for about a half mile stretch downstream from where Route 100 crosses it (woody vegetation, some gradient, some bedrock), is unstable. Some agricultural land where there is no woody riparian vegetation has been abandoned, some has been fenced, some has been stabilized and planted with willows and other woody plants so some stretches are being restored. There are areas, however, where there is still pasture and corn to the top of the banks and no riparian vegetation.

The headwaters of Bedell Brook are the forested slopes of the Worcester Mountains. As Bedell Brook enters its unconfined valley floor, one of the few stable pool-riffle gravel bottom reaches is located. This reach has been identified by the author and the Vermont Agency of Natural Resources as a reference reach for a Rosgen C4 stream with a corresponding type VIII valley with a mature hardwood forest buffer. The stream transitions to a slower gradient E-type stream before transitioning to a C-type stream in a lower broad flood plain. The reach surveyed is in this lower stretch. Bank erosion, aggradation and widening were indicated from the reach assessment. Bedell Brook is still listed as partial support of all of its length due to the flood impacts - the brook is still recovering from that event in 1995. The River Management Section staff believe that the relatively undisturbed upper part of the watershed and the riparian vegetation that exists along much of the brook prevented damage that would have been worse in a more disturbed watershed. The channel is recovering but more time needs to pass before the aquatic habitat is restored to good condition.

An unnamed tributary to Bedell Brook is "a dune-ripple E-type stream reach that has been altered through channelization, livestock grazing, and is immediately downstream of an undersized road culvert. Sinuosity has been greatly reduced and channel incision has begun."

There has been a fair amount of livestock exclusion work in this watershed with some riparian planting. Close to 200 acres of cropland are enrolled in integrated crop management. (1998)

INFORMATION SOURCES

Barry Cahoon, Vt. DEC Water Quality Division - provided information on flood damage (1996)

Len Gerardi, Vt. F&W Fisheries Biologist - provided info. on impacts other than flood during 1994 assessment

John St. Onge, USDA Farm Service Agency - noted the improvements with respect to agricultural land use impacts (1998)

Stream Stability Assessment for Lamoille County, Vermont, November 2000. Prepared for Project Impact - Lamoille County by Jim Ryan - source of information on stream channel types and stability quoted and cited above. (2000)

Jim Ryan, Vermont DEC Water Quality Division - more detail on the land uses and situations on Ryder Brook and Bedell Brook (2000)

Mike Kline, Vermont DEC Water Quality Division - additional information on Bedell Brook (2000)

Point Source Description	NPDES No.
Elmore Mtn Road subdivision-UT Ryder Brk	1-1021 SW
Strawberry Fields subdivision-Lawrence	1-1146 SW

Green River Assessment Report

Waterbody No: VT07-18**Assessment Year:** 2000**River Length (mi.):** 25.6**Date Last Updated:** 12/27/2000**Description:** Mouth to headwaters and tributaries including Boomhour Branch and Wiley Brook

Location Identifiers

ANR Enforcement District: 5**NRCS District:** 7**Fish and Wildlife District:** 5**Regional Planning Commission:** LAM

Assessment Information

Monitored (mi.): 0.0**Assessment Types****Evaluated (mi.):** 9.0

Land use information and location of sources

Water Quality Limited?**On 303(d) List?** N**Monitored for Toxics?** N**Aquatic Contamination****Toxics Testing**

None detected

Waste Management Zone - Miles: **Description:****Assessment Comments****COMMENTS**

More information needs to be gathered on the Green River and its tributaries. It has been noted that there is the Green River Reservoir on the river and it has peaking hydro power which causes big streamflow fluctuations. There is a minimum flow requirement but it is not optimal. However, the watershed and riparian corridor are mostly forested and there are few road crossings. Fish sampling done in the 1980's found that the brook supports wild brook trout and the lower end is a spawning and nursery stream for brown trout and rainbow trout from the Lamoille River.

INFORMATION SOURCES

Len Gerardi, Vermont Dept of Fish & Wildlife - noted the above about the Green River (2000)

Point Source Description**NPDES No.**

none

Wild Branch Assessment Report

Waterbody No: VT07-19

Assessment Year: 2000

River Length (mi.): 43.9

Date Last Updated: 2/7/2001

Description: Mouth to headwaters and tributaries including Tamarack, Clark, Bruce, Baldin Brooks and unnamed tributaries in Craftsbury and Eden

Location Identifiers

ANR Enforcement District: 5

NRCS District: 7

Fish and Wildlife District: 5

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 15.0

Assessment Types

Evaluated (mi.): 28.9

Surveys of fish and game biologists or other professionals

Land use information and location of sources

Water Quality Limited?

RBP III or equivalent benthos surveys

On 303(d) List? N

Quantitative measurements of instream parameters, channel morph

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

None detected

Waste Management Zone - Miles: Description:

Assessment Comments

NON-SUPPORT MILES

Wild Branch: 7.2 - from mouth to Denton's Garage in Craftsbury - non-support of secondary contact recreation (fishing), aquatic biota/habitat, and aesthetics due to sedimentation, turbidity, and habitat alterations due to morphological instability as a result in part of road relocation and construction, destabilized clay banks, severe flooding, and cows with access to the river. c(1100,1600,2500) s(1000,3100,7550,7600,7700,8650)

PARTIAL SUPPORT MILES

Wild Branch: 7.8 - from Denton's Garage in Craftsbury upstream to headwaters - partial support of secondary contact recreation (fishing), aquatic biota/habitat, and aesthetics due to sedimentation, turbidity, and habitat alterations due to morphological instability as a result in part of road relocation and construction, destabilized clay banks, severe flooding, and cows with access to the river. c(1100,1600,2500) s(1000,3100,7550,7600,7700,8650)

THREATENED MILES

Tributaries: 4.5 - threats to aquatic biota/habitat due to nutrients and sediments from streambank erosion due to morphological stability, ag related activity, and road runoff. c(900,1100) s(1000,4500)

Wild Branch**VT07-19****COMMENTS**

"The Wild Branch is an unstable stream system." The Lamoille County stream stability assessment work done under Project Impact resulted in nine sites on the Wild Branch being measured and analyzed in terms of stream channel stability and stream dimensions. A brief history of the river and the reasons for its condition are given in the Stream Stability Assessment Report listed below. The Wild Branch was re-located in 1927 after the flood and then there was a major road relocation and construction project on the North Wolcott Road in the 1960's and 1970's. When they relocated the road, the river's belt width was reduced and the active floodplain was halved in some sections. As a result of the road project, the river degraded, aggraded, widened and cut off meanders leading to the system instability. Bank stabilization work, mainly rip-rap, but some riparian planting, was done in the early 1990's. Then the 1995 and 1997 floods came along and caused more erosion and damage taking out or undermining rip-rap, bridges, streambanks. Most of the length of the branch remains in an unstable, impaired condition.

Since the last assessment in 1992, "aggressive bank stabilization and riparian planting projects have been underway." Much of the work, however, was damaged by the 1997 flood, which caused extreme impairment. (1998)

Logging as a threat and source of impairment was removed in 1997 because there was no recent information on logging problems on the Wild Branch. (Brad Greenough checked with Len Gerardi and Len has heard of no problems. The assumption is that Brad also knows of no current problems.)

The Wolcott and Eden landfills are located in the watershed of the Wild Branch, however, neither site is considered a threat to surface waters. Some staining was noted on an unnamed tributary near the Wolcott landfill back in 1993 but there were no violations of standards instream in sampling from 1995, no sampling instream since, and no groundwater standards violations in the monitoring wells sampled. It is not a site of concern. At the Eden landfill, there has been groundwater monitoring but no groundwater standards violations recently. No organics have shown up in the groundwater since 1994. It is also not a site of concern.

INFORMATION SOURCES

Stream Stability Assessment Report of Lamoille County, Vermont, November 2000. Done for Project Impact by Jim Ryan.

Jim Surwilo and Vermont DEC Waste Management Division files - information on the Eden and Wolcott landfills (2000)

John St. Onge, USDA Farm Service Agency - noted flood impacts, bank and riparian planting work (1998)

Brad Greenough, Vermont Dept of Forests, Parks and Recreation - no recent logging problems reported or identified (1997)

Tim Beaman, NRCS in Morrisville - noted some bank stabilization work on the Wild Branch (rip-rap) (1992)

Dave Brown, Sterling College professor & angler - note sedimentation, decline in fishing (1988)

Arlo Sterner, Lamoille County Forester - noted poor logging practices (1988)

Point Source Description**NPDES No.**

none

Elmore Branch Assessment Report

Waterbody No: VT07-20

Assessment Year: 2000

River Length (mi.): 25.2

Date Last Updated: 12/14/2000

Description: Mouth to headwaters and tributaries

Location Identifiers

ANR Enforcement District: 7

NRCS District: 7

Fish and Wildlife District: 5

Regional Planning Commission: LAM

Assessment Information

Monitored (mi.): 8.0

Assessment Types

Evaluated (mi.): 17.2

Surveys of fish and game biologists or other professionals

Quantitative measurements of instream parameters, channel morph

Water Quality Limited? N

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

None detected

Waste Management Zone - Miles: 0.00 **Description:**

Assessment Comments

PARTIAL SUPPORT MILES

Elmore Branch: 4.0 - partial support of aquatic biota/habitat, aesthetics, and non-contact recreation due to habitat alterations, sedimentation, and turbidity from morphological instability as a result of channel relocation, channelization, road encroachment on the floodplain, poor road maintenance practices and then bank and other erosion, loss of streambank vegetation, road and bridge failures, and debris jams as a result of flooding. c(1100,1600,2500) s(7550,7600,7700,8650)

COMMENTS

The August 1995 caused severe damage to the Elmore Branch. Road and bridge failures and debris jams in addition to the volume and force of the floodwaters themselves caused the damage. This brook was hit again in 1997. The flood damage resulted in "repair" work that led to morphological instability. However, earlier infrastructure work also caused some instability and resulted in the brook being more susceptible to the floods' effects.

The Stream Stability Assessment Report (see below) has the following about the Elmore Branch:

The Elmore Branch is a Rosgen E4 and C4 type stream. It was relocated and channelized immediately downstream of the "Lydenmeyer site" (mile 3.6). "The channel relocation has contributed to some channel

Elmore Branch**VT07-20**

incision but it still has access to its active floodplain. Agricultural fields have recently become idle and riparian vegetation is becoming reestablished in many sections. Streambank erosion is evident where herbaceous vegetation dominates. The East Elmore Road is responsible for much of the Elmore Branch's instability. The road acts as a major flood plain encroachment reducing the river's flood prone width.. Also blamed for the instability are undersized and/or poorly installed culverts and high sediment loads from tributaries.

INFORMATION SOURCES

Barry Cahoon, Vt. DEC Water Quality Division - reported the flood damage (1996) and confirmed current condition (2000).

John St. Onge, USDA - agrees with the assessment of physical damage to Elmore Branch (1998)

Stream Stability Assessment for Lamoille County, Vermont, 2000. Jim Ryan for FEMA Project Impact.

Point Source Description**NPDES No.**

none

Lower Headwaters Lamoille River Assessment Report

Waterbody No: VT07-21

Assessment Year: 2000

River Length (mi.): 33.3

Date Last Updated: 12/19/2000

Description: Lamoille River from Hardwick Dam upstream to confluence of Greensboro Brook and tributaries including Alder, Cooper, Porter, and Haynesville Brooks.

Location Identifiers

ANR Enforcement District:	7	NRCS District:	11
Fish and Wildlife District:	5	Regional Planning Commission:	NE

Assessment Information

Monitored (mi.): 0.0

Assessment Types

Evaluated (mi.): 33.3

Surveys of fish and game biologists or other professionals

Visual observation, may quantify some parameters, single season,

Water Quality Limited?

On 303(d) List? N

Monitored for Toxics? N

Aquatic Contamination

Toxics Testing

Waste Management Zone - Miles: Description:

Assessment Comments

PARTIAL SUPPORT MILES

Lamoille River: 7.6 - Hardwick dam to Greensboro Brook confluence - partial support of aesthetics, aquatic biota/habitat, contact recreation, and secondary contact recreation due to severe siltation, high turbidity, nutrient enrichment, severe channelization, erosion due to cows along the river, manure storage problem in 1 location, ice scouring, ice jam removal from Hardwick Dam up to Hardwick Lumber and August 1995 major flood event. c(900,1100,1600,1700,2500) s(1000,7600,7700,8650)

Tucker Brook: 1.5 - mouth to headwaters - partial support of aquatic biota/habitat, aesthetics, and non-contact recreation due to siltation, thermal alterations, physical alteration, turbidity due to erosion, debris jams, scouring, and loss of streambank vegetation as a result of the August 1995 floods. c(1100,1400,1600,2500) s(7600,7700,8650)

Haynesville Brook: 3.5 - mouth to headwaters - partial support of aquatic biota/habitat, aesthetics, and non-contact recreation due to siltation, physical alteration, turbidity due to erosion, debris jams, scouring, and loss of streambank vegetation as a result of the August 1995 floods. c(1100,1600,2500) s(7600,7700,8650)

Nichols Brook: 3.1 - partial support of biota and non-contact recreation due to two hydro dams creating low and fluctuating flows during critical spring and fall spawning periods leading to habitat loss and thermal alterations. c(1400,1500,1600) s(7410)

Lower Headwaters Lamoille River**VT07-21****THREATENED MILES**

Unnamed trib. to Nichols Brook: 0.2 - threats to aquatic biota/habitat, contact recreation and drinking water supplies by leachate, which has been observed entering a wetland drained by this trib. from inactive Hardwick Landfill. (0.2 is an arbitrary number until more is known about the situation. c(100) s(6300)

Buck Lake Brook: 0.2 - downstream of Woodbury Country Store - threats to aquatic biota/habitat, contact recreation and drinking water due to toxics from underground storage tank leaks at the store. c(300) s(6600)

COMMENTS

An update on the agricultural issues in 1998 included: one dairy farm still needs manure storage and other management practices (a farm at the confluence of Greensboro Brook). One other farm has a manure management problem (poorly timed spreading close to the brook). Two farms built manure storage in 1996 and 1997.

A fair amount of bank stabilization work was done on this stretch of the Lamoille after the 95 flood. Several other major floods have occurred since with the river cutting off a 500 foot +/- oxbow in January 1998.

Removed the reference to slaughterhouse waste because we don't know the source of the comment and neither Len Gerardi or Herb Conly knew of a slaughterhouse problem in Hardwick. There was a slaughterhouse in Hyde Park but that is now out of business. There was also a chicken farm that may have been responsible for some fish kills many years ago but that site is now the Hardwick Recycling facility. (1998)

Summary of hazardous waste site information for this waterbody:

The Lamoille River's bank was stained along a 15-20 foot are by the petroleum contaminated groundwater from Mike's Gulf in 1988. At that time, benzene concentrations instream were measured at 170 ppb while nearby groundwater samples were at 8,600 ppb. The groundwater sample levels climbed as high as 13,200 ppb in 1990 before dropping to 228 ppb in 1993. No sampling was done again until May 2000. In May 2000, the sampling results "show that 1,3,5-trimethylbenzene and 1,2,4-trimethylbenzene were the only gasoline related constituents quantified above VGES at the site." The Lamoille River behind the Gulf Station was inspected at this time at an active seep area. There was no petroleum sheen or odor and no photoionization detector readings above background levels.

Hayes Texaco (88-229) had underground tank leaks from 197-1982. These problems were followed by a fuel spill in 1995. In July 1996, instream concentrations of BTEX were 71.2 ppb and concentrations of MTBE were 290 ppb. In January 1998, instream BTEX levels were <6 ppb and MTBE levels were 5.3 ppb. From April 1998 through April 2000, BTEX levels were < 6 ppb and MTBE levels were < 5 ppb in the Lamoille River.

Measurements in Cooper Brook in 1991 of 4.48 ppb and 2.29 ppb farther downstream were attributed to releases from Ed's Deli in Hardwick. Groundwater measurements at the same time were 111 ppb near the stream and 3,090 ppb closer to the spill site. In 1996, the owner removed tanks and some soil. There was no monitoring data in the file since 1996.

Leaks at Woodbury Country Store resulted in low levels of MTBE and xylene measured in Buck Lake Brook from 1994 to 1996. In the sediments during this same time period, benzene was measured at 328 ppb and 82 ppb; BTEX, 159 ppb and 746 ppb; and total volatile hydrocarbons at 2,630 ppb and 2,530 ppb.

At Shatney's Garage, recent (1998) groundwater monitoring in 2 wells showed petroleum compounds (toluene, ethylbenzene, others) below the VGES in one well and no petroleum compounds detected in the other. The monitoring well which is closest to the brook and in the direction of GW flows was not sampled. Nothing since 1998 is in the file although further soil pile sampling and a wetland assessment should be done.

INFORMATION SOURCES

Vermont DEC Waste Management Division hazardous waste site files (2000)

Len Gerardi, Vt Dept of Fish & Wildlife - didn't know of the slaughterhouse problem. Noted annual drawdown of Hardwick Lake that leads to silt being discharged downstream. (1998)

Vt. DEC Hydro Assessment 1987

Tim McKay, NRCS - noted flood impacts, a few agriculturally related problems along river but improving

Lower Headwaters Lamoille River**VT07-21**

situations as well (1998 as well as earlier assessments)

Barry Cahoon, Vt. DEC Water Quality Division - noted flood damage (1996)

David Didomenico, Vt. DEC Waste Management Division - noted that there is no new information on the Hardwick Landfill (2000)

Herb Conly, ANR Enforcement Division - noted that the slaughterhouse that was in Hyde Park (now out of business) had a failed system at one time and the reference might have been to that. They know of no slaughterhouse in Hardwick. (1998)

Point Source Description**NPDES No.**

Bessette Rental Storage Facility-Cooper

1-0720 SW

Upper Headwaters - Lamoille River Assessment Report

Waterbody No: VT07-22**Assessment Year:** 2000**River Length (mi.):** 41.8**Date Last Updated:** 12/20/2000**Description:** Lamoille River from confluence of Greensboro Brook to headwaters and tribs including Greensboro, Stevens, Stannard, Flagg, and Edson Brooks.

Location Identifiers

ANR Enforcement District: 7**NRCS District:** 12**Fish and Wildlife District:** 5**Regional Planning Commission:** NE

Assessment Information

Monitored (mi.): 0.0**Assessment Types****Evaluated (mi.):** 41.8

Surveys of fish and game biologists or other professionals

Visual observation, may quantify some parameters, single season,

Water Quality Limited?**On 303(d) List?** N**Monitored for Toxics?** N**Aquatic Contamination****Toxics Testing****Waste Management Zone - Miles:** **Description:****Assessment Comments****NON-SUPPORT MILES**

Stannard Brook: 5.0 - whole length - non-support of aquatic biota/habitat, aesthetics, and non-contact recreation due to siltation, thermal modification, physical alterations, and turbidity from land development, removal of riparian vegetation, streambank erosion, road erosion, and failure of an upstream impoundment as a result of the August 1995 flood. c(1100,1600) s(7200,7600,7700,8650)

PARTIAL SUPPORT MILES

Lamoille River: 7.7 - from confluence with Greensboro Brook to headwaters - partial support of aquatic biota/habitat, aesthetics, and non-contact recreation due to siltation, and physical alterations from streambank erosion, road erosion, and failure of upstream impoundment as a result of the August 1995 flood as well as from land development and removal of riparian vegetation. c(1100,1600) s(3200,7600,7700,8650)

COMMENTS

Field investigations in July 2000 found Paine Brook and Edson Brook in good condition. Paine Brook flows through a beaver meadow/alder swamp near Taylor Road. Edson Brook flows through a cedar and shrub swamp complex at its headwaters. Greensboro Brook, except for the stretch through Greensboro and

Upper Headwaters - Lamoille River**VT07-22**

at its mouth at the Lamoille, flows through a relatively narrow but distinct and relatively undisturbed valley where cedar swamp and shrub swamp dominate.

Stannard Brook was also seen in July 2000 at a number of locations and was in really bad physical condition. There were gravel, cobble, boulder piles in the middle of the stream channel or along the sides. Banks were severely undercut and trees or groups of trees were toppling into the channel. This was the case up to the point where Lazy Mill Road joins Stannard Mountain Road. In this area, bedrock outcrops line the stream channel and above this the stream flows through a fairly larger alder swamp. Above the swamp, impacts become obvious again in the form of a lot of sand in the brook from road repair and/or maintenance work. It turns out that NRCS dredged Stannard Brook deeply after the 1973 flood and it is likely that began the instability in this stream, which exacerbated the flood damage.

INFORMATION SOURCES

Barry Cahoon, Vt. DEC Water Quality Division - reported flood damage from 1995 and updated information in 2000 (1996,2000)

Cathy Kashanski, Vermont DEC Water Quality Division - field visits in July 2000

Point Source Description**NPDES No.**

none