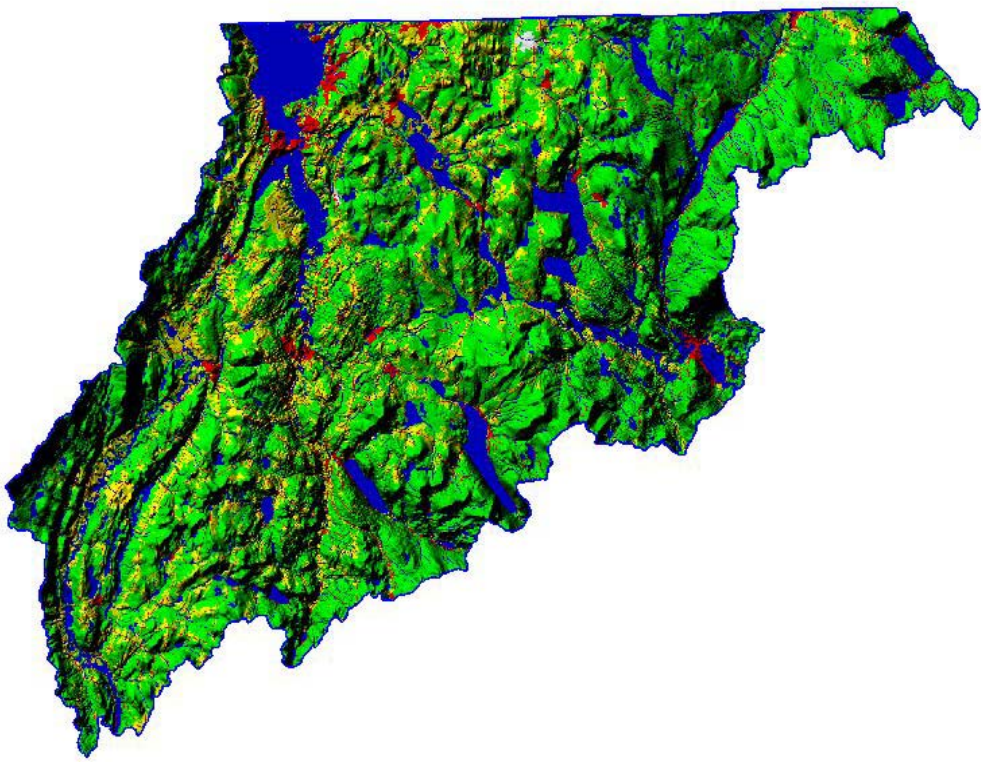
Basin 17

Lake Memphremagog Watershed Assessment Report



Agency of Natural Resources
Department of Environmental Conservation
Water Quality Division

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General Watershed Description

The Lake Memphremagog drainage basin encompasses a total of 687 square miles of which 489 square miles (71%) are in Vermont in the United States and 198 square miles (29%) are in the Province of Quebec in Canada. Although much more of the watershed is in the United States, about three-quarters of the lake water itself is in Canada. The basin, through the Magog River, is tributary to the St. Francis River, which is tributary to the St. Lawrence River. There are three main rivers in the U.S. portion of the basin - the Black, Barton and Clyde Rivers, which flow northerly into the southern end of Lake Memphremagog. A smaller river, the Johns River begins in the town of Derby, flows northwesterly into Canada and then back into the United States into Lake Memphremagog. Also in this basin are two international river watersheds: the Tomifobia River and the Coaticook River. There are 90 inventoried lakes and ponds in the watershed (17,660 acres). Sixty-four of these are actively assessed by Vermont DEC, which comprise 17,537 acres. The unassessed lakes and ponds are generally small and do not necessarily have public access.

This basin includes about 75% of Orleans County, 15% of Essex County and small portions of Lamoille and Caledonia County in Vermont. Its climate includes long, cold winters and relatively short but warm summers. Annual precipitation is about 40 inches in Newport in contrast to about 33 inches in Montpelier and Burlington. Most of the basin in Vermont is in the Northern Vermont Piedmont biophysical region, which is a hilly region with rich soils due to calcareous bedrock and dominated by northern hardwood forests.

Table 1. Land Use and Land Cover for the Lake Memphremagog watershed[1]

Land Use	Acres	% of Total
Forested	247,662.3	65.7
Agriculture	56,363,6	15.0
Surface Water	29,131.6	7.7
Wetlands	21,614.5	5.7
Transportation	15,984.0	4.2
Developed Land [2]	5,017.9	1.3
Old Field & Barren	1,231.2	0.3
Total**:**	377,005.1	99.9

1) Vermont Land Cover Classification Project, 1997 (based on satellite photographs from 1991 - 1993).

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

Black River Watershed

General Description

The Black River, 26 miles in length, originates east of Great Hosmer Pond with headwater tributaries flowing west off Ames Hill in Albany. It drains 134 square miles of land. This river has the lowest gradient of the three main rivers in the basin with an average slope of about eight feet per mile. The Black River watershed contains over 600 acres of lakes and ponds, the three largest being Elligo Pond, Little Hosmer Pond and Great Hosmer Pond.

The Black River, after beginning on the east side of Great Hosmer Pond in the southern portion of the town of Albany, It flows south-southwesterly through a relatively narrow valley. It continues in a generally southerly flow into the town of Craftsbury entering a wider valley east of Duck Pond. Whitney Brook, and then the drainage from Little Hosmer and Great Hosmer Ponds, join the river. It meanders further south then is confined briefly just north of Craftsbury village.

South of Craftsbury village, the river reverses course and flows northwesterly with Lake Elligo outlet stream joining the river from the east. The river twists and turns its way north through a broad valley, which contains many significant floodplain and wetland communities (see section below). The river flows the length of the town of Craftsbury, south to north then into the town of Albany where it continues meandering in a more northeasterly fashion on the western side of Great Hosmer Pond now. It winds through Albany and into Irasburg east of Potters Pond. It continues its tortuous route northeast and then east to the village of Irasburg.

Just upstream of Irasburg, the very sinuous Lords Creek enters the Black River. The Lords Creek is about ten miles long and drains a watershed that is 17 square miles.

Downstream of Irasburg, the Black River continues north in a narrower valley with less meandering. It flows into the town of Coventry and continues in an east-northeasterly direction until it joins the South Bay of Lake Memphremagog in Newport. For about the last 4.7 miles, the river is part of the state's South Bay Wildlife Management Area.

Special Features, Values, and Uses

Significant Wetland Natural Communites

There are many significant natural communities in the Black River watershed and these were inventoried and described by the Vermont Nongame and Natural Heritage Program in a report entitled "*An Ecological Inventory of the Wetlands of the Lake Memphremagog Watershed in Vermont*" (Wetland Community Inventory). The descriptions below are from that report.

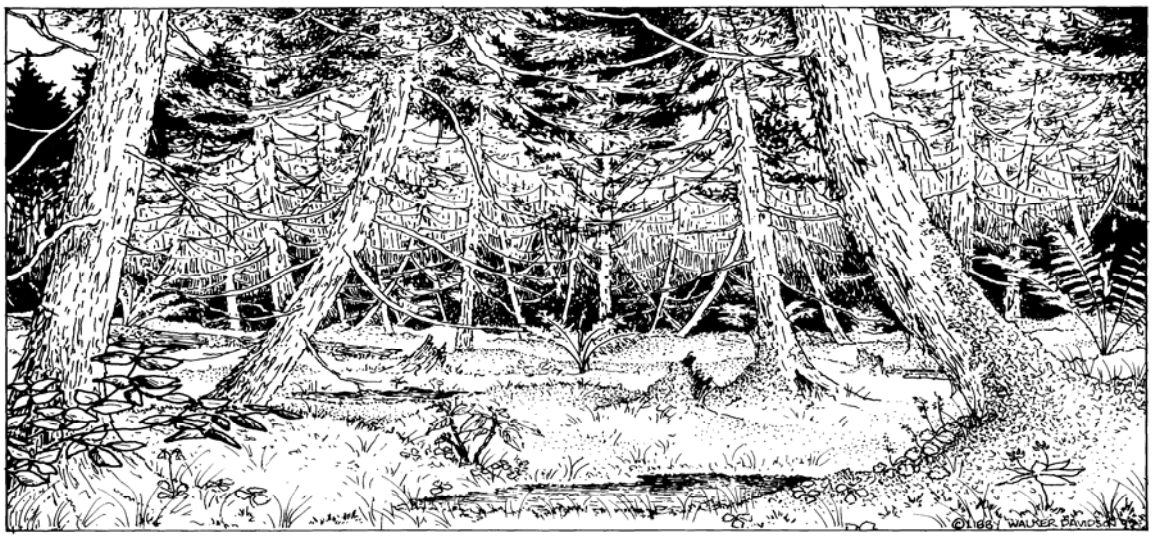
The Black River Swamp is a long, linear wetland along the Black River where it flows south from Albany into Craftsbury east of Hosmer Pond. The swamp consists of patches of "high quality" northern white cedar swamp as well as a state-threatened orchid, a rare green adder's-mouth orchid, and the uncommon yellow lady's slipper. The rare three-toed woodpecker and black-backed woodpecker nest in this swamp. The patches of northern white cedar swamp are interspersed with shrub swamp, beaver wetlands, and cut cedar forest along the almost two-mile length of this wetland.

The Lake Elligo Outlet Wetland is a 120-acre wetland complex fed by Lake Elligo, Whetstone Brook, and two distinct calcareous seeps. The site consists of cedar swamps on the upper portion of the wetland system, sweet gale shoreline shrub swamp as a band below the cedar swamp, and then large areas of sedge meadow. The most exciting part of the wetland complex is a unique cedar swamp that contains the only known population of marsh valerian in Vermont. The marsh valerian is in a cedar swamp also know as Blue Barn Swamp, which has vegetation that is somewhat different than other white cedar swamps. The tree species in the swamp are fairly typical except for some black spruce mixed in this canopy layer, but the swamp forest contains small, natural openings up to 30 or so feet across and dominated by grasses, sedges, and low shrubs. It is in the openings that the marsh valerian grows. In association with this state-endangered flower is alder-leaved buckthorn, Labrador tea, sweet gale, leatherleaf, red-osier dogwood, dwarf raspberry, small cranberry, bluejoint grass, muhlenbergia, drooping wood-reed, sedges, marsh fern, marsh cinquefoil, and bog goldenrod.

The Black River Floodplain West of Craftsbury Common site is a mile and a half length of floodplain composed of several wetland community types located between Cemetary Road and Post Road in Craftsbury. This floodplain as well as the one described below are not discrete areas, but rather part of one extensive, significant floodplain system along the upper Black River. This mile and a half stretch includes northern white cedar swamp in 10- and 55-acre patches. The 10-acre swamp is dominated by northern white cedar and larch. Black ash is also common. Between the cedar swamp at the upper portions of the floodplain and the river is shrub swamp dominated by speckled alder, meadowsweet, and shrubby willows. Large sedges are at times interspersed with the shrubs and other times dominating areas forming sedge meadows. Four ponds are also part of this floodplain mosaic: the 20-acre Mud Pond, a small (less than 1-acre) beaver pond with the very rare mare's-tail, and two small oxbow ponds that contain the uncommon to potentially rare mild water-pepper.

The Black River Floodplain West of Mill Village site is a wetland system that includes a good quality northern white cedar swamp, alluvial shrub swamp, and rivershore grassland. The site is defined as the floodplain area from the Post Road bridge north to the North Craftsbury Road bridge although this area is part of much more extensive floodplain all along the Black River (see sites described above). The white cedar swamp communities occur as large, 10 to 40-acre patches, in both the floodplain and in seeps along the upland. These swamps are old with many of the white cedars approximately 100 years old. Rivershore grasslands with reed canary grass, bluejoint grass, joe pye-weed, and tussock sedge are found close to the river at this floodplain site. Between the grasslands and the cedar swamp is an area of shrub swamp dominated by speckled alder.

Northern White Cedar Swamp



The Black River Wetlands at Shalney Brook site is located just south of Albany village between Route 14 and the Black River. It is considered a wetland complex of state significance because of the diversity of wetland community types present including a A-ranked alluvial shrub swamp and B-ranked northern white cedar swamp.

The Black River Floodplain site includes a seven-kilometer stretch of Black River floodplain from Albany village to the Route 14 bridge near Griggs Pond. Alder swamp dominates the floodplain but some of it appears successional and will likely become the silver maple floodplain that is also seen in this Black River corridor. Sedge meadows and white cedar swamps are also part of this "floodplain mosaic."

Albany Cedar Swamp is located east of the village of Albany near the Black River. It consists of two wetlands – the northern swamp is primarily white cedar swamp while the southernmost is alder swamp surrounded by a white cedar margin. Rare nodding trillium grows in both wetlands. These swamps are part of the seven kilometer Black River floodplain site described above.

Potters Pond is a seven-acre undeveloped pond, which is surrounded by poor fen. The fen is part floating mat and part deep peat.

The Lower Black River wetland site is a large, very diverse wetland complex of approximately 650 acres located along the Black River in its final 4.2 miles reach before South Bay. The wetland complex includes many, high quality natural communities including riverine floodplain forests especially silver maple-ostrich fern type, red maple-northern white cedar swamp, sweet gale shoreline shrub swamp, river mud shore, and a mosaic of sedge meadows, cattail marsh, deep broadleaf marsh, buttonbush swamp, and deep bulrush marsh. In addition to these high quality natural communities, the wetland complex provides excellent habitat for numerous wildlife species including deer, otter, great blue herons, American bittern, and many duck species.

Waterfalls, Cascades, Swimming Holes
Only one site in the *Waterfalls, Cascades and Gorges of Vermont* (1985) report was identified on the Black River. The Falls of Black River is located in Coventry off Route 14 and the site consists of five foot high falls about 60 feet across. A path to the falls indicated some use as a swimming hole and perhaps a fishing spot.

Boating
A whitewater stretch of the Black River in Irasburg was identified in *The Whitewaters Rivers of Vermont: Their Biology, Geography, and Recreational Use* report (The Whitewaters Report) (1992). North of Irasburg, below the Route 14 crossing, there is a short steep segment of whitewater with Class III waves and ledges and a Class III-IV waterfall (best left to expert boaters because it is tricky and considered dangerous). Just below this segment is 2 to 3-mile Class II section of the Black River, which flows through forest and some farmland. According to Jerry Jenkins, author of the Whitewaters Report, there is about 20 miles of flatwater paddling above this segment of whitewater and 5 to 7 miles of flatwater below.

The *Appalachian Mountain Club (AMC) River Guide* describes five boating segments on the Black River and one stretch to portage. The portage appears to be the Class III and IV waves, ledges, and waterfall described above. Four of the five segments (approximately 34 miles) are flatwater or quickwater and one four-mile segment is a Class II stretch, which again appears to be the Class II section discussed above.

Fishing and Fishery
Elligo Lake, at the drainage divide between the Black and Lamoille River basins, is the deepest (100 feet) and second largest (174 acres) lake in the Black River basin. Currently both wild (possibly native) and stocked lake trout are present. Elligo also supports populations of rainbow trout (mainly stocked), yellow perch, smallmouth bass, rockbass, pumpkinseed, chain pickerel, burbot, brown bullheads, longnose suckers, white suckers, various minnow species and possible rainbow smelt.

The Hosmer Ponds are managed as warmwater ponds, containing populations of largemouth bass, smallmouth bass, other sunfish species, chain pickerel, brown bullheads, white suckers, minnow species. Little Hosmer (180 acres) is the largest pond in the basin, but has a maximum depth of only 9 feet. Great Hosmer (140 acres) is quite long, and has three deep holes (57 feet maximum, 20 foot mean across the whole pond). This pond exhibits persistent low oxygen at depth, due to natural stratification of lake waters in the small but steep-sided deep holes of the lake.

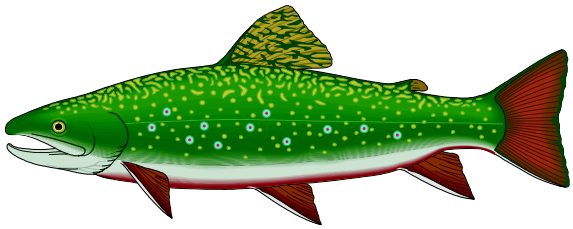
Hartwell Pond (Albany) is a very small (16 acres) and relatively deep (57 feet) headwater pond at relatively high elevation (1609 feet msl). It stratifies and maintains high dissolved oxygen levels down to about 25 feet at least in some years. It supports a coldwater fishery of brook trout (stocked). Other species believed to be present are white suckers, northern redbelly dace, brown bullheads, pumpkinseed and lake chub. There is no public ownership along Hartwell Pond, although public access occurs informally via a foot path from the town highway at the outlet end.

Sargent Pond (6 acres) is stocked with brook trout. It is situated within the vicinity of a gravel mining operation, and has relatively acidic waters.

From its origins in East Albany and West Glover down to Craftsbury, the Black River's gradient is mainly moderate and exposed bedrock is common. Wild brook trout are the principal fish of this reach, along with slimy sculpins, white suckers and fast water minnow species. This is likewise the case for the headwater streams draining west into the upper Black River.

Beginning at Craftsbury, the Black River, including Elligo Lake and its outlet stream, is a valley bottom trout stream for all its length down to Lake Memphremagog. Its gradient is very low, to the degree that the stream appears ponded in the Craftsbury area after it has turned to the north. The gradient remains low downstream to Irasburg. Wild and stocked brown trout are present in this reach and brook trout may be present seasonally and in cool water seeps. Burbot, white suckers, yellow perch and several minnow species are also known from this reach. Wild brook trout, and wild brown trout closer to the valley floor, along with slimy sculpins, white suckers, burbot and fast water minnow species are the principal fish of the feeder streams that drain the hill country to the west of Vermont Route 14.

From Irasburg village to Coventry village, the gradient is moderate and the channel is punctuated by rapids and several pronounced cascades. Lords Creek, the largest tributary in the basin, enters the Black just upstream of Irasburg village. Adult steelhead rainbow trout and brown trout migrating upstream from Lake Memphremagog have access throughout this area of the Black and into the tributaries. As at Willoughby Falls in Orleans, these fish leap the cascades at the Upper and Lower Falls in Coventry, attracting anglers and spectators from far and wide during the months of April and May, and October in the case of the brown trout. These migrating lake fish seek and use the mainstem and tributaries as critical spawning and nursery habitat.



From the Vermont Route 14 bridge below the Lower Falls in Coventry to South Bay, the Black's gradient is low and salmonid nursery habitat is less abundant. Walleyes, longnose suckers and white suckers from Lake Memphremagog ascend to the base of the Lower Falls in the spring to spawn. Yellow perch, brown bullheads and other warmwater species from the lake are present throughout this reach.

The Vermont Department of Fish & Wildlife has extensive riverbank ownership, mainly fee-owned one-rod (16½ foot) strips, in many areas along the Black River.

River Assessment

General

The macroinvertebrate community was sampled on Lords Creek at rivermile 2.4 in September 1998 and was assessed as "good". The macroinvertebrate community was sampled on the Black River at rivermile 34.8 in Craftsbury during September 1999 and was also found to be in "good" health.

The NEWS (Waste USA) Landfill in Coventry, as part of its October 5 2004 Certification, will need to hire a qualified professional to perform surface water sampling at 8 locations in May and October of each year for which the landfill is certified. In addition, the Nadeau Sites A & B (the unlined landfills) are proposed to be removed. The information below from earlier reports are on the Nadeau Landfill.

As described in the NUS Corporation Final Screening Site Inspection Letter Report on Nadeau Landfill, August, 1989, among the samples taken, two surface water samples and two Black River sediment samples were taken and analysed. "No volatile organic or extractable organic compounds or inorganic elements with concentrations greater than background were detected in the samples collected from the Black River." However, "alpha-chlordane and isophorone were identified in onsite soil and sediment samples as well as the downstream Black River sediment sample." A May 1995 water quality report also did not find organic or inorganic materials at levels of concern in surface water samples, however, "water quality standards exceedances for total mercury cannot be determined, because the laboratory's practical quantitation limit is above the water quality standard." There was no sediment sampling data in that 1995 report.

Three people provided current information on the Caulkins Gravel Pit situation all noting no known current problems at the operation. Previously complaints had been common about the settlement ponds overflowing into Stony Brook. All reports are that the operation and reclamation of the pit are proceeding without noticable impact to the brook.

As part of a hazardous release remediation at the former Irasburg General Store (91-1123), surface water samples have been taken from the Black River: "no dissolved phase petroleum-related constituents were quantified above method detection limits in the three surface water samples." These data and lack of a sheen on the river led the consultant to believe the site was not affecting the river (March 2003 report).

There are two large farm operations in this waterbody: Nelson Farm and Lawson Farm both in Irasburg.

The Lords Creek Demonstration Restoration Project (1996-1998) was a streambank stabilization and buffer re-establishment project on two farms on Lords Creek. The project's goals were to reduce erosion and phosphorus input to Lords Creek, shade a portion of the Creek, and raise the level of knowledge and awareness in the watershed about how to protect water quality and aquatic habitat. A two mile stretch of Lords Creek on the Boudreau Farm just south of Irasburg village on the Creek Road and the Robilliard Farm (on which the Vermont Land Trust has an easement including buffers) were the two sites. The buffer they created ranged from 10 feet wide to 50 to 60 feet wide on the

Boudreau Farm. Brush rolls, tree revetments, willow whips, and fascines were all used to treat the eroding banks. Cows were fenced out and trees were planted to re-establish a woody buffer on the Boudreau farm. Trees were added to the buffer of Robilliard Farm.

A windshield survey done in October 1999 by Vermont DEC Water Quality Division staff noted the abundance of pastureland with no buffers through which Lords Creek flows. The streambanks are undercut in these sections.

Specific stream segment status

Altered Miles

Seaver Branch: 0.5 miles (at least) - from mouth upstream - aquatic habitat, aesthetics, secondary contact recreation altered due to channelization, rip-rap following 1997 flood. A road was built along the lower depositional reach of stream setting up the situation for flood damage to be severe to the brook.

Stressed Miles

Lords Creek: 4.5 miles - from just upstream of the Albany-Irasburg line to the mouth - aquatic biota/habitat and secondary contact recreation due to siltation, elevated temperatures, nutrients, and physical alteration from agricultural land uses (pasture, hayland, riparian buffer loss).

Lake Assessment

There are 11 assessed lakes in the Black River watershed, comprising 622 acres. In aggregate, designated uses are supported for 587 acres, and are not supported for 15 acres (Table 2). Individual lakes and their use support status are listed in Table 3. The available assessment information indicates that conditions are good for lakes in this watershed. The small number of altered acres result from an infestation of Eurasian watermilfoil in Lake Elligo. Major stresses to lakes in the watershed include algal growth in Great Hosmer Pond and Mud Pond, a reflection of historical land use. Due to its deep and narrow nature, Great Hosmer Pond is also naturally predisposed to algal growth. The 20-acre so-called “West Daniels” pond has very limited information available, and is a priority for a field visit.

Table 2. Overall assessment of designated uses for lakes in the Black River watershed.

	Lake Area (ac)	Acres supporting uses	Acres with uses stressed	Total Supporting	Acres with uses altered	Acres with impaired uses	Total not supported
Overall Uses	370	217	587	15	0	15	20
Aesthetics	384	203	587	15	0	15	20
Aquatic Life Use Support	370	217	587	15	0	15	20
Drinking Water Supply	0	0	0	0	0	0	0
Fish Consumption	602	0	602	0	0	0	20
Secondary Contact Uses	370	217	587	15	0	15	20
Swimming	370	217	587	15	0	15	20

Table 3. Overall use assessment for individual lakes in the Black River watershed.

Lake Name	Lake Area (ac)	Acres supporting uses	Acres with uses stressed	Total Supporting	Acres with uses altered	Acres with impaired uses	Total not supported	Acres not assessed
DANIELS-W;	20	0	0	0	0	0	0	20
DUCK (CRAFBY)	9	9	0	9	0	0	0	0
ELLIGO	174	149	10	159	15	0	15	0
GREAT HOSMER	140	0	140	140	0	0	0	0
HARTWELL	16	16	0	16	0	0	0	0
KIDDER	16	16	0	16	0	0	0	0
LITTLE HOSMER	180	172	8	180	0	0	0	0
MUD (CRAFBY)	35	0	35	35	0	0	0	0
SARGENT	6	0	6	6	0	0	0	0
SMITH (COVNTY)	8	8	0	8	0	0	0	0
WALKER (COVNTY)	18	0	18	18	0	0	0	0

Barton River Watershed

General Description

The Barton River watershed, which includes the Willoughby River subwatershed, flows north into the southernmost end of Lake Memphremagog's South Bay. The Barton River is 22 miles long and its watershed drains 174 square miles. The principal tributary of the Barton River, the Willoughby River, originates at Lake Willoughby in the town of Westmore. The Barton River drops 600 feet from Runaway Pond to Orleans for an average of about 40 feet per mile. From Orleans to Lake Memphremagog, the slope of the river is less than 2 feet per mile. There are approximately 3,410 acres of lakes and ponds within the basin. The three largest are Lake Willoughby, Crystal Lake and Lake Parker.

As mentioned above, the Barton River begins in Glover at Runaway Pond, which is no longer a pond but a large wetland system, and flows downstream into Tildys Pond and then on downstream in a northerly direction. Shadow Lake outlet stream and an unnamed tributary join the Barton from the west in Glover. The river continues north into Barton and about a mile and a half downstream, Roaring Brook, the outlet stream from Lake Parker, comes into the river. The Barton River increases in size with the addition of this flow.

The river continues north flowing just west of the village of Barton where Crystal Lake's outlet stream comes in. Northwest of Barton village, the river drops rapidly, Hogtrough Brook comes in and then the Barton begins meandering through agricultural fields east of Route 5 deep within its banks in low water. The river flows through agricultural land until Orleans village where it flows adjacent to a wetland and then through the Ethan Allen furniture manufacturing complex built all around and over the river. As would be expected, the river is channelized through the village and this facility. Just north and downstream of Orleans village, the Willoughby River joins the Barton River.

The Willoughby River is the largest tributary to the Barton River beginning at Willoughby Lake in Westmore and flowing 9 miles generally in a northwestern direction throough parts of Brownington and Barton. It drains a watershed of about 62 square miles. The Willoughby River begins its journey through a nice cedar swamp (described below) at the northern end of Lake Willoughby where it has clear water and a sandy channel bottom. In about two and a half miles, Lords Brook enters the Willoughby River. The river continues northwesterly through Evansville and then south of Brownington Center, the Brownington Branch joins it. As the river flows south along Center Road, it is flanked on one shore by very high, steep, and in some stretches , bare and eroding, banks. South still of this area, the river turns west and northwest and heads towards Orleans village. At the edge of the village are the dramatic Willoughby Falls described below and then the river flows through flatter agricultural land and joins the Barton River.

The Barton River, relatively large and slow now, meanders through agricultural fields and floodplain/wetlands from Orleans Village up to Lake Memphremagog. The last several miles before the lake, the river is an integral part of a large forested wetland complex protected as South Bay Wildlife Management Area.

Special Features, Values, Uses

Natural Communities

The Lower Barton River Swamp in Coventry is an approximately 500-acre wetland complex at the mouth of the Barton River where it flows into South Bay of Lake Memphremagog. This complex is protected as the state-owned South Bay Wildlife Management Area. Extensive red maple-northern white cedar swamp dominates this wetland system, however, three other natural community types are also found here. Silver maple-ostrich fern riverine floodplain forest are on the levees that line the river along its three miles through the wetland complex. Shrub swamps are found in one area along the Barton River and another on Millers Creek deadwater. Also located on Millers Creek (an abandoned channel of the Barton River) is an intermediate fen community. The state-endangered creeping sedge, the rare slender cottongrass, and a rare bur-reed are growing in this fen.

Cobb Brook Cedar Swamp is a 60-acre northern white cedar swamp in a basin adjacent to Cobb Brook in Derby. A portion of the swamp has older trees including one that was cored and aged at 156 years old. Smaller amounts of balsam fir, yellow birch, and black ash grow with the cedars. The shrub layer is sparse but includes Canada honeysuckle, Canada yew and alder-leaved buckthorn. The herbaceous associates include several sedges, cinnamon fern, goldthread, shinleaf and naked miterwort. A number of species of moss blanket the ground.

The Willoughby River Swamp is associated with the Willoughby River from its origin at Lake Willoughby for about one and a half miles northwest. The cedar swamp is about 125 acres with typical-sized cedar trees over 100 years old. The swamp is dark with about 85 to 95 percent canopy and the ground cover is mossy and damp. There is a population of rare sheathed sedge and some scattered rare swamp fly-honeysuckle.

Stillwater Swamp is a large and diverse swamp system associated with Lord Brook, a tributary to the Willoughby River, in Westmore. It is about 150 to 200 acres in size with about 100 of the acres as high quality northern white cedar swamp. The state threatened white adder's mouth was last seen here in 1985. The site contains a population of a rare moss and a population of the uncommon yellow lady's slipper.

Waterfalls, Cascades, and Swimming Holes

The Willoughby River Falls are at the edge of the village of Orleans. The site is a 200-foot long stretch of river with cascades and a chute. People picnic, fish, and swim here, but it receives the greatest use during the spring migration of trout up the river from Lake Memphremagog. People come from all around to watch and applaud the trout as they leap up the falls.

According to the unpublished *Vermont Swimming Hole Study*, there is a swimming hole on the Willoughby River in the town of Brownington. It is a sunny site with a shallow (3 foot deep) pool and a sand and gravel beach. A well-used trail goes to the pool and a lack of many river swimming holes in this area makes it locally important. It is also used for fishing.

Mill Brook slide is another swimming hole in the Barton River watershed. Mill Brook flows down between Goodwin Mountain and Bald Mountain east of Lake Willoughby in Westmore. On this brook is a pool, a 15-foot falls, and a granite slide. People swim, slide, and fish at this site.

Boating

The AMC River Guide (2002) describes the boating on the Barton River in two segments. The first segment begins north or downstream of Glover village and goes to the confluence of the Willoughby River, which is approximately nine and a quarter miles. The majority of this river segment is Class I or quickwater but north of Barton village, there is a section of Class III-IV rapids between two railroad bridges. Below the second railroad bridge is an 8-foot high waterfall that needs to be portaged. Downstream of this stretch, between two U.S. Route 5 bridges, are several Class II to III drops. Then it is Class I down through Orleans and to the mouth of the Willoughby River.

The second segment from the confluence of the Barton and Willoughby Rivers to Lake Memphremagog is about ten miles long to South Bay or twelve and a half miles to the U.S. Route 5 bridge across the top of South Bay. There are no obstructions in this stretch, which includes a few miles through the floodplain and swamp forests of the South Bay Wildlife Management Area described briefly above.

Fishery and Fishing

The Barton River basin includes three deep, cold-water, oligotrophic lakes (Crystal, Shadow and Willoughby) and many ponds (including Baker, Bean, Bruce, Clark, Daniels, Duck-Sheffield, Duck-Sutton, Long-Sheffield, Long-Westmore, Mud, Parker, Round, Runaway, Vail, Wheeler).

Willoughby Lake is one of Vermont's largest and deepest lakes. It is known for its extraordinary clarity and chilly temperature regime owing to its disproportionately great volume and exposure to wind-driven mixing. Its waters are slightly alkaline. It is arguably Vermont's premier lake trout lake, consistently producing some of the largest lake trout caught in Vermont. In addition to lake trout, indigenous and mainly wild, Willoughby supports populations of rainbow trout (wild and stocked), landlocked Atlantic salmon (mainly stocked), rainbow smelt, burbot, yellow perch, longnose sucker, white sucker, lake chub, common shiner and round whitefish, a native species of extremely limited distribution in Vermont. Willoughby Lake does not contain some non-native species that are now common to many northeastern Vermont waters: esocids (chain pickerel, northern pike), sunfish (largemouth bass, smallmouth bass, pumpkinseed, bluegill. Willoughby, like other waters, is threatened by deliberate and unintentional additions of fish species. The presence of rockbass, a sunfish, has recently been confirmed.

Crystal Lake supports a coldwater fishery. Lake trout are native and the current population is wild. Crystal supports populations of rainbow trout (wild and stocked), yellow perch, smallmouth bass, rockbass, pumpkinseed, chain pickerel, longnose suckers, white suckers, and various minnow species.

Shadow Lake is relatively small (210 acres) but deep (139 feet). It supports a coldwater fishery. Although lake trout are indigenous, current observations suggest they may not be reproducing well or recruiting to the adult population. Shadow supports populations of rainbow trout (stocked), brook trout (stocked), yellow perch, smallmouth bass, rockbass, pumpkinseed, chain pickerel, longnose suckers, white suckers, brown bullheads, bluntnose minnow, tessellated darters and banded killifish.

Long Pond (Westmore) is smaller (90 acres) and not as deep (74 feet), but it is a remote, headwater pond at relatively high elevation (1835') predisposing the lake to an oligotrophic status. It supports a coldwater fishery, including lake trout (status as indigenous and wild not known, currently stocked), and brook trout (likely indigenous, currently stocked and possibly wild).

The other ponds of the Barton River encompass a range of conditions, from deep and cold (e.g. Duck – Sutton) to shallow and warm (e.g. Bean). Their fish communities vary accordingly, from brook trout-dominant to brown bullhead-dominant. Parker Pond is worthy of note as it contains northeastern Vermont's only occurrence of white perch. The population appears to be the result of introduction decades ago, practically vestigial today and fortunately sedentary.

The Barton River is a valley bottom trout stream for nearly all its length. From its origin downstream to the first crossing by U.S. Route 5 in Barton, its game fish population is a mix of wild brook trout, brown trout and rainbow trout. Adult steelhead rainbow trout migrating upstream from Lake Memphremagog have access to this point, and use the mainstem and tributaries as spawning and nursery habitat. From the mouth of the Willoughby River in Orleans to South Bay, the Barton's gradient is low and salmonid nursery habitat is less abundant.

The Willoughby River originates at the outlet of Willoughby Lake. Its water chemistry, thermal regime, and physical habitat were favorable for the Pacific Northwest steelhead rainbow trout that were introduced to the basin a century ago. The Willoughby is renowned for its spawning migration of steelhead from Lake Memphremagog. These fish leap a cascade in Orleans, attracting hundreds of dedicated anglers and spectators from far and wide during the months of April and May. The river for its entire length and its feeder streams are critical spawning and nursery habitat for the steelhead.

The Vermont Department of Fish and Wildlife has extensive riverbank ownership, mainly fee-owned one-rod (16 ½ foot strips), along the Barton and Willoughby Rivers.

River Assessment

General

Despite over a decade of concern and investigations, the Rock junkyard on River Road is still an eyesore and a potential problem for the Barton River. The Vermont Senate Institutions Committee held hearings in 2001 on the junkyard and heard the concerns of sportsmen, the game warden and a river guide. As of May 2005, the investigation is with the Attorney General's office. DEC Solid Waste Division has sampled soil and water

behind the junkyard and although they looked for evidence of hazardous waste spills, they didn't really find anything but the metal everywhere. Data from sampling did not turn up violations of standards from where the samples were collected.

The Barton River meanders through wetland and agricultural land that comprises the broad floodplain of the river. A number of stretches have eroding, slumping, or undercut banks.

There is a permitted large farm operation in Coventry.

The E.M. Brown & Son/Crystal Lake Outlet Stream hazardous waste site (2004-3206) was sampled in November 2004 (monitoring wells installed October 2004) for VOCs. One well had 3 compounds above standard, the other well had 2 compounds. The site and wells are quite close to the outlet stream. The site will be sampled again in Spring 2005 and the base of the retaining wall and the outlet stream will be examined for sheens or other signs of contaminants.

The Ethan Allen hazardous waste site (site #770016) is located just south of Orleans village with the Barton River along the western edge of the property and wetlands to the south. The site as of July 1998, contained 17 buildings - buildings numbers 3, 16 and 17 being used for chemical and hazardous waste storage. A former 2 ½ -acre drum disposal area in the southeastern corner of the property is just northeast of the wetlands. An intermittent stream flows northeast to southwest through the old drum disposal area into the wetland. During the September 1997 Site Inspection Prioritization (SIP) sampling, two drainage pipes with water flowing from them into the Barton River, were observed north of Building Number 3 and "bright orange colored leachate was observed along the outflow drainage route of one of the pipes." In addition, a hole about 2 feet square was seen in a concrete wall just north of Building Number 3. The pavement, and thus any stormwater, flows north through this hole into the Barton River and is considered one of two "probable points of entry" (PPE) in EPA site assessment lingo. The second PPE is the intermittent stream in the southeast corner of the property.

Sediment samples were collected during the September 1997 site inspection. Four sediment samples were taken from the Barton River and five sediment samples were taken from the wetland south of the property. Two of the river samples and two of the wetland samples were collected as background samples. In sediment sample SD-01 just downstream of the drainage pipes mentioned above, there were nine semivolatile organic compounds found anywhere from 2.6 to 17.9 times the reference level. In sediment sample SD-02, which is just downstream of the wetland discharge to the Barton River, there were seven semivolatile organic compounds found from 5.4 to 8.2 times the reference value. The PCB, Aroclor-1254, was detected in the sediment samples SD-06 and SD-07. Calcium and potassium were 4.7 to 6.1 times the reference value in both of these samples as well.

The conclusion of the contractors (Roy F. Weston, Inc. Superfund Technical Assessment and Response Team (START)) in the Final Site Inspection Prioritization Report in terms of the "Surface Water Pathway" was this: "Based on the START analytical results, a release of hazardous substances to the Barton River has been noted from on-site sources. As a result of the release, a Clean Water Act-protected water body and a fishery have been

impacted. No other sensitive environments are known or suspected to have been impacted. To date, no known actions have been taken to address the release to the Barton River."

A Vermont Agency of Natural Resources environmental enforcement officer visited the Ethan Allen site in summer 2005, however, to follow-up on the above information and did not find the 2 foot hole or see any evidence of discharges or visible problems (orange coloring or other). The officer viewed the river and buildings from several locations.

The closed Barton Landfill on West Barton Road is sampled twice a year. This site, which had approximately 500,000 gallons of waste stain, lacquer and water were disposed here over a 10 year period, is upgradient from the Barton River. In the past, low concentrations of metals were found in the stream running through landfill. From the July 15, 2004 letter from the Johnson Company (the consultant) to Vermont DEC Waste Management Division: "Three surface water samples were collected at the Barton land on May 19, 2004. The locations sampled were SS-1 (upstream) and SS-2 (downstream), both on the stream that bisects the landfill site from east to west, and SWS-1, which is southwest of the wood waste area on an intermittent stream." At both sites on the bisecting stream, sodium, chloride, and iron were above detection limits but not above water quality standards. At SS-2, the downstream site, manganese was also above detection but not above standards. In the intermittent stream, total sodium, iron and manganese were above detection limits but not standards.

The Barton Electric Department CERCLA site is located on High Street northeast of Barton village. There was illegal disposal of transformer oil contaminated with PCBs at this site and it has been investigated since 1985 with a number of rounds of soil sampling. The most recent sampling in the hazardous waste files was in August 1992 and was part of an EPA investigation of the site. Numerous contaminants were found in the soil samples at this site: 10 polycyclic aromatic hydrocarbons (PAHs) were found at concentrations exceeding reference values; 12 pesticides were found in concentrations exceeding reference values; Aroclor-1260 (a PCB) was in 4 samples exceeding reference values; and a number of inorganics were detected in all of the soil samples (from copper and iron to cyanide and arsenic). There is a small pond and unnamed stream from the pond south of the site. The stream flows to the Barton River (<1/2 mile). There has been no activity on this site since the EPA Final Report on their site inspection done in February 1993 at the time of this report.

Specific stream segment status

Stressed Miles

Barton River: 0.5 - from sample site SD-02 south of the Ethan Allen facility to just past sample site SD-01 downstream but north of the facility - aquatic habitat and fishery (secondary contact recreation) stressed at least due to a number of semi-volatile organic compounds, a PCB and 2 metals found above reference concentrations in the Barton River sediments.

Lake Assessment

There are 22 assessed lakes in the Barton River watershed comprising 3,586 acres. Willoughby Lake is a particularly important waterbody in the watershed. This spectacularly scenic glacial scour lake supports exceptional water quality and clarity, and a very high level of recreational use. In aggregate, designated uses are supported for 3,522 acres in the watershed, and are not supported for 30 acres. This is shown in Table 4 below. Individual lakes and their use support status are listed in Table 5. The available assessment information indicates that conditions are very good for lakes in this watershed, considering the development and use pressures exerted on them. The small number of altered acres result from an infestation of Eurasian watermilfoil in Brownington Pond.

Table 4. Overall assessment of designated uses for lakes in the Barton River watershed.

	Acres supporting uses	Acres with uses stressed	Total Support-ing	Acres with uses altered	Acres with impaired uses	Total not supported	Acres not assessed
Overall Uses	2721	801	3522	30	0	30	34
Aesthetics	2899	623	3522	30	0	30	34
Aquatic Life Use Support	2713	809	3522	30	0	30	34
Drinking Water Supply	116	0	116	0	0	0	0
Fish Consumption	3552	0	3552	0	0	0	34
Secondary Contact Uses	2970	552	3522	30	0	30	34
Swimming Uses	2899	623	3522	30	0	30	34

There are several significant stresses to lakes in this watershed. There is the potential for Eurasian watermilfoil infestation in most lakes simply due to the proximity of Crystal Lake and Lake Willoughby, both of which already have low-density populations of this weed. Daniels Pond shows signs of nutrient impacts, largely due to historical land use, natural sources, and potential erosion. Long Pond in Westmore has an increasing trend in measured phosphorus concentrations over time, while Shadow Lake shows evidence of minor changes in algal communities, presumably due to increased nutrient concentrations. Lake Parker has minor dissolved oxygen depletion in hypolimnetic waters. Finally, there have been beach closures in a small number of instances at the Crystal Lake State Park, owing to minor excursions from Vermont's extremely strict *E. coli* water quality criterion.

Table 5. Overall use assessment for individual lakes in the Barton River watershed.

	Lake Area (ac)	Acres supporting uses	Acres with uses stressed	Total Supporting	Acres with uses altered	Acres with impaired uses	Total not supported	Acres not assessed
BAKER (BARTON)	51	0	51	51	0	0	0	0
BEAN (SUTTON)	30	0	30	30	0	0	0	0
BLAKE (SUTTON)	8	8	0	8	0	0	0	0
BROWNINGTON	139	109	0	109	30	0	30	0
COBB	27	0	0	0	0	0	0	27
CRYSTAL (BARTON)	763	611	152	763	0	0	0	0
DANIELS	66	34	32	66	0	0	0	0
DUCK (SHEFLD)	7	0	0	0	0	0	0	7
DUCK (SUTTON)	8	0	8	8	0	0	0	0
LONG (SHEFLD)	38	38	0	38	0	0	0	0
LONG (WESTMR)	90	73	17	90	0	0	0	0
MAY	116	0	116	116	0	0	0	0
MUD (IRASBG)	5	5	0	5	0	0	0	0
MUD (SHEFLD)	5	5	0	5	0	0	0	0
PARKER	250	173	77	250	0	0	0	0
ROUND (SHEFLD)	13	13	0	13	0	0	0	0
SHADOW (GLOVER)	210	0	210	210	0	0	0	0
SWEENEY	9	9	0	9	0	0	0	0
TILDYS	33	25	8	33	0	0	0	0
VAIL	16	16	0	16	0	0	0	0
WHEELER (BARTON)	15	15	0	15	0	0	0	0
WILLOUGHBY	1687	1587	100	1687	0	0	0	0

Clyde River Watershed

General Description

The Clyde River, 30 miles long, rises in Island Pond in the town of Brighton and drains 142 square miles. The watershed is characterized by many large lakes and extensive swamps and marshes. Several dams and bypasses are along the river. The Clyde River drops 32 feet in its first 16 miles, 160 feet in the two miles below Pensioner Pond and 170 feet in less than one mile at Clyde Pond. It flows into Lake Memphremagog in Newport City.

From its source at Island Pond, the Clyde River begins a general westerly flow. Within a mile of the pond, the Pherrins River joins the Clyde from the north. The Pherrins River is ten miles long and drains a watershed of 19.1 square miles.

The Clyde River then winds southwesterly another few miles before the Oswegatchie Brook joins it from the south. Oswegatchie Brook and its steep tributaries drain a six square mile watershed. The brook itself is approximately three and a half miles long.

The Clyde River from this point meanders northwesterly for several more miles through the town of Brighton with the 4.5-mile long Cold Brook and the 6.5-mile long Webster Brook joining the Clyde from the south and the north respectively. As the Clyde flows through Brighton, it is surrounded by extensive forested, scrub-shrub, and emergent wetland communites.

The Clyde River continues its westerly/northwesterly flow into and through the town of Charleston. Here again, the river is part of an extensive forested/shrub/marsh wetland complex. In Charleston, as the river flows westerly, Mad Brook joins it and then the Seymour and Echo Lakes watersheds drain into it, and then another five to six miles downstream, the Clyde is dammed to form Pensioner Pond. Downstream of Pensioner Pond, the river is also dammed at West Charleston to form Charleston Pond.

From Charleston Pond, the river continues a northwesterly flow into Lake Salem, a very large lake. From Salem Lake, the Clyde flows generally northwest until it passes under Interstate 91 where it winds southerly into the dammed Clyde Pond. From Clyde Pond, it flows more directly west into Lake Memphremagog at Newport City.

Special Features, Values, and Uses

Natural Communities

The Clyde River macrosite is a label for an 11-mile stretch of wetland communities in the riparian corridor of the Clyde River in Brighton and Charleston. It is composed of seven separately described geographic areas in the Wetland Community Inventory. This stretch contains a diverse and special assemblage of high quality wetland natural communities and rare plants. Among the rare plants is one state endangered species and one species newly discovered in Vermont during the inventory. Each of the seven sections is briefly described below.

The Clyde River Wetlands - Five Mile Square Road to Webster Brook site is one of the sections of the Clyde River macrosite described in the Wetland Community Inventory. It includes numerous, high quality natural communities and a number of rare and uncommon plants. The natural communities in this stretch of riparian corridor include: a black ash floodplain forest, a rare type of floodplain ecosystem and one with large and old (up to 125 years old) black ash trees; northern white cedar swamp, part of which is an old growth stand and very wet; red maple-northern white cedar swamp; sweet gale shoreline shrub swamp; sedge meadow; and shallow emergent marsh. The rare plants found in one or more of these wetland communities include bog willow, shining rose, swamp fly-honeysuckle, and foliose lichen. Uncommon plants found include greenish sedge, long sedge, hooded ladies' tresses, and showy lady's slipper.

The Clyde River Wetlands at Webster Brook is the second of the seven Clyde River macrosite sections. This site is approximately 180 acres of largely black spruce swamp forest and sweet gale shoreline shrub swamp. There are also variations of northern white cedar swamp present, one of which may be unique to the Clyde River floodplain.

Five Square Mile Bog is the third of the seven sections of the Clyde River macrosite. It is a two-acre dwarf shrub bog consisting of a dense sphagnum mat and sparse herbaceous and dwarf shrub cover.

The Clyde River Wetlands at Buck Flats (Buck Flats) is the fourth section of the macrosite and is mostly intermediate fen: floating and grounded peat mats covered largely by bog sedge. Intermediate fens are rare natural communities in the state and the fen at Buck Flats occurs in expanses known nowhere else in Vermont. Common arrow-grass was found in the intermediate fen at Buck Flats during the Wetland Community Inventory. Rare plants in the Buck Flats section of the Clyde include bog willow and water bur-reed. Uncommon plants include bog-rush, greenish sedge, humped bladderwort, small bedstraw, and long sedge.

The Clyde River Wetlands - Route 105 to School Road is the fifth of the seven segments that comprise the 11-mile long Clyde River macrosite. This stretch includes extensive riverine floodplain forest that is a variant unique to the Clyde River in Vermont: the variant has dominant tree species of Fremont's maple (a hybrid between silver and red maple), black ash, northern white cedar, and yellow birch. No other river in Vermont has white cedar as a co-dominant in a riverine floodplain forest. Also included in this site are some areas of northern while cedar swamp, rare nodding trillium, uncommon yellow lady's slipper and meadow willow.

The Clyde River Wetlands - School Road to Pensioner Pond consist of high quality floodplain forest and northern white cedar swamps. The cedar swamps contain rare nodding trillium and swamp fly honeysuckle. In the river itself or in backwaters are the state-endangered mare's-tail, the rare marsh mermaid-weed and water bur-reed, and the uncommon water beggar ticks.

Clyde River East of Pensioner Pond is a small site located in a cove on the south side of the Clyde River about one-quarter mile upstream from Pensioner Pond. This location has a good-sized population of rare marsh mermaid-weed. This is the last segment of the seven segment Clyde River macrosite.

The Clyde River at Little Lake Salem site in Derby is an approximately 90-acre expanse of river and lakeside floodplain and swamp natural communities. A large population of a state-threatened orchid grows on the floodplain and two rare plants, nodding trillium and drooping bluegrass, occur at the site.

Orcutt Brook Swamp is a high quality 80-acre northern white cedar and red-maple-northern white cedar swamp complex on the east side of the Lake Salem basin in Derby. It has a small population of the rare nodding trillium.

The Pherrins River Wetlands Complex South in Morgan is a large (approximately 300 acres) and diverse wetland complex consisting of spruce-fir-tamarack swamp, northern white cedar swamp, black spruce swamp, black spruce bog, dwarf shrub bog, shrub swamps and lowland spruce-fir forest. The conifer swamps are mature, second-growth forests as are the adjacent upland conifer forests lending additional significance to this site.

The Pherrins River Wetlands Complex North is an extensive assemblage of high quality natural communities in a valley defined by eskers. The wetland communities include northern white cedar swamp, dwarf shrub bog, black spruce swamp, sweet gale shoreline shrub swamp, riverine floodplain forest. The rare black-backed woodpecker nests at this site. Rare white fringed orchis occurs in a dwarf shrub bog and the black spruce swamp, and rare shining rose grows in a shrub swamp in this complex. Three uncommon plant species also are found in the swamps.

Waterfalls, Cascades, and Swimming Holes

The Great Falls of the Clyde River is a site in a long 800-foot gorge with 40 to 60 foot walls. There are cascades, a falls, a pool then boulders and small pools below the hydroelectric dam that is at the head of the gorge. It has a high diversity of mosses. The site now has a recreation plan that includes public access.

Boating

There is an approximately 3 ½ mile stretch of the Clyde River described in The Whitewaters Report (1992) as a “highly important” stretch for whitewater boating. The run begins at Salem Lake where there is access at the town beach. Below Salem Lake, the river is Class II whitewater. The river is lined with cedar and this stretch was described as secluded and beautiful. After a mile in the cedar, the river goes under the Route 105 bridge, steepens and is possibly Class III at high water. It then goes into a ravine, crosses under Interstate 91, becomes another good Class II stretch before flattening out and flowing into Clyde Pond.

The AMC River Guide (2002) describes three “runnable sections” of the Clyde River including the Class II whitewater stretch described above. The other sections described are a 15-mile stretch of flatwater and quickwater from below Island Pond to Pensioner Pond and a three and a quarter stretch of mostly quickwater with some Class I and II rapids from West Charlestown to Little Salem Pond.

Fishing and Fishery

The Clyde River system includes two deep, cold-water, oligotrophic lakes (Echo and Seymour), a number of mainstem lakes and ponds of various sizes and depth (Island Pond, Pensioner Pond, West Charleston Pond, Little Salem Lake, Big Salem Lake and Clyde Pond), Derby Pond, Spectacle Pond and several smaller ponds (Jobs, Sukes, Underpass and two Toad ponds and at least four Mud ponds).

Seymour Lake is one of Vermont's largest and deepest lakes. It is known for its extraordinary clarity. It is one of Vermont's foremost lake trout lakes. In addition to lake trout, indigenous and mainly wild, Seymour supports populations of brown trout (wild), landlocked Atlantic salmon (mainly stocked), brook trout (stocked), smallmouth bass, rainbow smelt, burbot, yellow perch, longnose suckers, white suckers, several minnow species, brown bullheads, chain pickerel and round whitefish, an indigenous species of extremely limited distribution in Vermont.

Echo Lake, less than a mile downstream of the Seymour Lake outlet, supports a coldwater fishery. Lake trout are indigenous and the current population is wild. Echo Lake supports populations of rainbow trout (wild and stocked), brook trout (stocked), rainbow smelt, yellow perch, smallmouth bass, chain pickerel, longnose sucker, white sucker, various minnow species, and probably other species present in Seymour.

Island Pond is situated essentially on the Clyde River. The Clyde is at roughly the same elevation and Island Pond's short outlet can flow in either direction, depending on the flow of the Pherrins River. Island Pond is moderately deep (63 feet), but not a classic coldwater, oligotrophic waterbody. It has a diverse fish community, including walleye (stocked and wild), yellow perch, tessellated darters, smallmouth bass, largemouth bass, rockbass, pumpkinseed, chain pickerel, northern pike (recently observed), rainbow trout (stocked), brown trout (stocked), brook trout (wild), burbot, white suckers, brown bullheads, rainbow smelt, fallfish, golden shiners, bluntnose minnows and possibly other minnows.

Pensioner Pond, West Charleston Pond (Lubber Lake), Little and Big Salems lakes, and Clyde Pond are truly in-stream waterbodies. West Charleston and Clyde Ponds are created artificially by dams. Pensioner is natural, but raised several feet by a dam. Little and Big Salem are essentially a single waterbody at the same elevation separated by a short constriction and are natural. Big Salem is moderately deep (70 feet), but oxygen-challenged at depth. The other ponds are all shallower than 40 feet. Because of their positions in-stream and downstream of Island Pond, the fish communities of each bear some relationship to that of Island Pond and the Clyde River itself. The walleye populations of Clyde Pond and the Salems are strictly wild. The adults spawn in the Clyde in Derby Center and West Charleston, respectively. The trout that occur are the result of drift from the tributaries and stocking in the mainstem. Landlocked Atlantic salmon are stocked as fry in the river beginning at the base of West Charleston Pond's dam. They migrate as smolts (1- and 2-year old juveniles) to Lake Memphremagog through the Salems and Clyde Pond. Some remain and mature in Big Salem.

Spectacle Pond, a natural waterbody, is a short distance upstream of Island Pond. It is stocked with brown trout. Also present are yellow perch, smallmouth bass, largemouth bass, rockbass, pumpkinseed, chain pickerel, brown bullhead, white sucker, various

minnow species and possibly northern pike (based on an anecdotal report, and the recent appearance of a specimen in Island Pond).

Derby Pond is a natural waterbody with a warmwater fish community: yellow perch, largemouth bass, chain pickerel, brown bullhead, white sucker, various minnow species.

Jobs Pond and Sukes Pond are each at the head of the respective streams in the extreme southeast corner of the Clyde River basin. Jobs supports a brook trout population made up of wild and stocked fish. Sukes is also a brook trout pond that was stocked in years past, but is no longer stocked due to constraints on public access.

The Pherrins River is a moderate gradient headwater trout stream. Wild brook trout, slimy sculpin, white sucker, fallfish, creek chub and burbot are the principal fish species.

The Clyde River mainstem from Island Pond to Pensioner Pond is very low gradient. The Buck Flats reach is a large flatwater marsh area with emergent vegetation. Fish species vary by microhabitat, but include brook trout (wild and stocked), brown trout (wild and stocked), fallfish, smallmouth bass, chain pickerel, white sucker, tessellated darter, blacknose dace, creek chub, lake chub, and slimy sculpin.

The gradient of the Clyde steepens significantly at the outlet of Pensioner Pond and, with the exception of the in-stream waterbodies and a relatively flat stretch just upstream of Little Salem, the gradient is steep to moderate all the way to the Lake Memphremagog backwater at Western Avenue in Newport City. The principal species are landlocked Atlantic salmon (mainly fry-stocked from Clyde Pond to West Charleston, but wild from the Newport #1,2,3 Powerhouse to Lake Memphremagog), brown trout (wild and stocked), rainbow trout (wild), smallmouth bass, largemouth bass, rockbass, pumpkinseed, white suckers, yellow perch, tessellated darters, walleyes, longnose dace, blacknose dace, bluntnose minnows, common shiners, creek chubs, and banded killifish. Landlocked Atlantic salmon, brown trout, rainbow trout, walleyes and various other species migrate into the Clyde River in Newport to reproduce at each species' particular spawning time. The extent of upstream migration in the lower river is limited by river gradient for some species, but the presence of the Newport hydropower facility blocks the further migration of salmon and trout that enter the river. Salmon and trout upstream passage in the form of a trap&truck facility is expected to be installed in the next three years. The Clyde Pond dam likewise is scheduled for downstream passage retrofit.

Major tributaries to the Clyde include Lightening Brook (tributary to Island Pond), Oswegatchie Brook, Mad Brook, Webster Brook, Seymour/Echo Lake Outlet Brook (with Seymour Lakes main tributaries, Valley and Sucker brooks), and Salem Lakes' tributaries (Coche, Green, Orcott and others unnamed). The fish communities of these brooks typically are similar to that of the Pherrins River described above, with some exceptions. Landlocked Atlantic salmon are stocked in the lower reaches of the Salem lakes tributaries. Wild rainbow trout may be present in them, Lightening Brook and the Seymour Lake outlet as well. Valley Brook at Seymour Lake is a nursery stream for brown trout from the lake.

River Assessment

General

The Clyde River below West Charleston dam is no longer altered due to flow fluctuations from hydropower. The facility is currently not operating and so is spilling water over the dam. If it does begin operations again, it will have to meet conditions of a new license and so will presumably meet water quality standards.

The hazardous waste site on a tributary to the Clyde River in Newport was owned by Newport Plastics (site # 770059). The tributary is less than 500 feet west and downgradient of the site. At least 28,000 gallons of solvents were dumped in an evaporation pit of this site up until 1979. The pit was then filled in. In the early 1990s, GEI Consultants did borings to re-establish the location of the pit and put in four groundwater (GW) monitoring wells. In the process of doing the borings, two 55 gallon drums were uncovered. Volatile organic compounds (VOCs) were detected in three of the four groundwater samples and 2 VOCs detected exceeded primary groundwater standards. Dichloromethane was above standard in the GW sample from MW3 (745 ppb) and MW4S (5.8 ppb); tetrachloroethylene was high in the GW sample from MW4S (12.2 ppb). In 1998, a heating fuel oil tank was removed from the site and new groundwater monitoring wells established. Now in spring 2005, there is a new consultant from Virginia and a new round of monitoring is to take place. Updated information will be provided when available.

The Derby Center sewer system, which is tied into the Newport WWTF, was completed in 1981. At that time, it served the Route 5 corridor to Newport, Route 105/Main Street in Derby, and Route 111/East Street and West Street in Derby Center. Since 1998, DEC has funded a sewer extension at the northeast corner of Derby Center to serve the mobile home park just north of Lake Derby. Straight pipes on the south bank of the Clyde River opposite Derby Center and west of the intersection of Route 105 and Brownington Road may be a possibility, but there is no current information. There is no new information on West Charleston failed septics of long ago either.

Seymour Lake Outlet Stream and Echo Lake Outlet Stream below the dams on Seymour (0.5 m) and Echo (1.2m) Lakes are no longer altered due to low and fluctuating flows caused by hydroelectric storage manipulation. The dams are operating under a new FERC license and transferring them to state ownership is being considered. The dam on Seymour Lake was re-built in summer 2004. Also culverts on a tributary into Seymour Lake will be replaced or modified to allow for smelt spawning, which is currently impacted. The dam on Echo Lake operates run-of-river so Echo Lake Outlet Brook does not have the poor flow regime noted in earlier assessments.

Macroinvertebrate and fish sampling around rivermile 1.9 in 2003 found an “excellent” and a “very good” community respectively.

In summer and fall 2004, the Northwoods Stewardship Center staff sampled 18 sites for water chemistry (pH, alkalinity, DO, conductivity, nitrogen, phosphorus), flow, and physical parameters (temperature, turbidity) in the upper Clyde River watershed. Only two of the sites, however, were sampled multiple times that season: Lang Brook and the Clyde River below Echo Lake outlet were sampled once a week for 8 weeks beginning in mid-August.

Their results to date found only a few sites where concerns were raised based on somewhat high turbidity and some elevated temperatures (below the ponds as would be expected). Sampling is going to continue with a few refinements in 2005.

Several agricultural runoff problems on Mad Brook and Buck Brook in Charleston were noted during May 2000 field visits. These brooks need to be visited again.

Lake Assessment

The Clyde River watershed hosts 19 lakes and ponds comprising 4,576 acres. Seymour Lake is a particularly important waterbody in the watershed. This scenic lake supports exceptional water quality and clarity, a very high level of recreational use, and considerable development pressure. Many of the lakes and ponds are part of the Clyde River hydroelectric project, and water levels are fluctuated according to the project's Federal Energy Regulatory Commission operating license. In aggregate, designated uses are supported for 3,773 acres in the watershed, and are not supported for 774 acres (Table 6 below). Individual lakes and their use support status are listed in Table 7.

Table 6. Overall assessment of designated uses for lakes in the Clyde River watershed.

	Acres supporting uses	Acres with uses stressed	Total Supporting	Acres with uses altered	Acres with impaired uses	Total not supported	Acres not assessed
Overall Uses	3025	748	3773	10	764	774	29
Aesthetics	3652	885	4537	10	0	10	29
Aquatic Life Use Support	3586	951	4537	10	0	10	29
Drinking Water Supply	207	0	207	0	0	0	0
Fish Consumption	3783	0	3783	0	764	764	29
Secondary Contact Uses	3752	785	4537	10	0	10	29
Swimming Uses	3088	1449	4537	10	0	10	29

There are 10 acres of Derby Pond for which several uses are altered due to the presence of locally dense milfoil infestations. Clyde Pond supports a light population of this same weed. Several other lakes in the watershed are prone to Eurasian watermilfoil infestation due to proximity to existing infestations, accounting for stressed acres on Echo and Seymour Lake, and Pensioner, Toad (Charleston) and Mud (West) Pond.

Nutrient impacts stress uses on Derby Lake, and development pressure and associated potential nutrient runoff stresses uses on Island Pond. There are also localized sedimentation impacts to Echo Lake and Seymour Lake, affecting small areas of shoreline and littoral habitat. Spectacle Pond has a naturally poor acid buffering capacity, rendering it prone to cultural acidification due to acid rain. Finally, Salem Lake supports a walleye fishery, and this species is particularly prone to the bioaccumulation of atmospherically-deposited mercury. Owing to high measured mercury concentrations in walleye from Salem Lake, fish consumption use is impaired there.

Table 7. Overall use assessment for individual lakes in the Clyde River watershed.

Lake Name	Lake Area	Acres supporting uses	Acres with uses stressed	Total Supporting	Acres with uses altered	Acres with impaired uses	Total not supported	Acres not assessed
CHARLESTON	40	40	0	40	0	0	0	0
CLYDE	186	149	37	186	0	0	0	0
DERBY	207	0	197	197	10	0	10	0
DOLLIF;	5	0	0	0	0	0	0	5
ECHO (CHARTN)	550	441	109	550	0	0	0	0
HANCOCK (BRIGTN)	7	0	0	0	0	0	0	7
ISLAND	626	526	100	626	0	0	0	0
JOBS	39	39	0	39	0	0	0	0
MOOSE;	10	10	0	10	0	0	0	0
MUD (MORGAN)-N	35	0	35	35	0	0	0	0
MUD (MORGAN)-W	11	0	11	11	0	0	0	0
PENSIONER	173	139	34	173	0	0	0	0
SALEM	764	0	0	0	0	764	764	0
SEYMOUR	1769	1669	100	1769	0	0	0	0
SPECTACLE	103	0	103	103	0	0	0	0
STILLWATER	5	0	0	0	0	0	0	5
SUKES	9	0	0	0	0	0	0	9
TOAD (CHARTN)	22	0	22	22	0	0	0	0
TOAD (MORGAN)	12	12	0	12	0	0	0	0
UNDERPASS	3	0	0	0	0	0	0	3

Other Memphremagog Rivers and Streams

Johns River and tributaries

General Description

The Johns River originates in Derby west of Nelson Hill. It flows northwesterly from its headwaters to the Canadian border. Northwest of Interstate 91 and in the area where Crystal Brook joins the Johns, there is a large forested wetland and shrub swamp. The river flows through Canada for a short distance and then re-enters the United States with a southwesterly flow. From the Canadian border to Derby Bay of Lake Memphremagog, the river is part of a large forested, scrub/shrub, and emergent wetland complex.

Not a tributary to the Johns River, but a stream that flows directly to Lake Memphremagog north of the Johns, is the Ruiss Arnold or Hall's Creek (apparently one name is the Quebec name and one is the Vermont name). The stream is largely a Quebec water but it flows for almost two miles from the Quebec/Vermont border to a cove in the lake. It flows through diverse wetlands described briefly below.

Natural Communities

At the mouth of the Johns River mouth site is a forty-acre wetland complex. The complex includes deepwater marsh, shrub swamp, and red maple-northern white cedar swamp. The rare marsh mermaid-weed is scattered in the two swamp communities as is the uncommon yellow water-crowfoot.

North of the Johns River mouth are three Wetland Community Inventory sites: Halls Creek Cove, Halls Creek, and Ruisse Arnold Wetlands. As noted above, Ruisse Arnold and Halls Creek appear to be two names for the same stream. In Halls Creek Cove, there is a healthy population of the rare Vasey's pondweed and also a population of the uncommon Freis' pondweed. Upstream from the mouth of Halls Creek is an area with a widely scattered population of pygmy water lily – it is the first population ever found in the state and it may be the southernmost location for this species in North America.

The Ruiss Arnold Wetlands is a site that includes the stream described above and the large area (about 100 acres) of diverse wetlands north and south of the creek. The wetland communities present include intermediate fen, sweet gale shoreline shrub swamp, riverine floodplain forest and red maple-northern white cedar swamp. The rare mermaid-weed grows in the intermediate fen and five uncommon plants are also present in different parts of the site.

Fishery/Fishing

Much of the Johns River is a small, low gradient gravel-bottom meadow stream, punctuated by a couple cascading reaches. The Johns River, from Interstate 91 downstream to Lake Memphremagog is a critically important highly productive nursery habitat for steelhead rainbow trout and brown trout that migrate from the lake to spawn. Upstream of I-91 its branches are typical upland wild brook trout streams.

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River Assessment

Macroinvertebrate sampling on Crystal Brook in Derby found the following results: at rivermile 0.3, the community was assessed as "fair" in 1997, "poor" in 1999, and "poor" in 2004; at rm 0.4, the community was assessed as "good" in 1997; and at rm 1.4, the community was assessed as "good" in 1997 and "exc-very good" in 2004. The fish community was sampled in 1997 also and only 7 brook trout were found in an 85 meter stretch – far lower density than expected.

There was a large manure pit failure and fish kill on Crystal Brook in the late 1980s. There has not been anything since that time that ANR knows about. An April 2005 memorandum documents an agricultural investigation of a farm and manure pit adjacent to Crystal Brook. No signs of runoff from the farm were noted during the investigation but the manure pit was empty at the time and there is the possibility it could leak. Follow-up is needed.

During a field investigation in May 2005, there was a dirt road that had crossed Crystal Brook parallel to, and downstream of, Route 5. The culvert formerly underneath this "road" is now sitting in the brook and the soil around and above it has washed downstream.

The Johns River was sampled by both Vermont DEC and Department of Fish and Wildlife in 1997. The fish community assessment found a “fair” community at rm 1.4 and a “good” community at rm 3.1. Many trout were found during the Fish and Wildlife survey and so that portion of the river appears to be in healthy condition. There have been no new reports of manure pit failures or other problems having a severe impact on this water recently.

Fairmont Granite on the Canadian side of the border used to have a discharge with the Vermont ANR DEC Wastewater Management Division for their settling lagoon near the Johns River in the U.S. The permit was made "inactive" in January 1989. Granite companies with settling lagoons often try to reduce their water quantity use so they don't need to discharge and thus don't need a permit. An early May 2005 field visit saw the lagoon filled with turquoise milky liquid. The lagoon does not have an Underground Injection Control (UIC) Permit either.

A field investigation of the Johns River found a river corridor with agricultural and residential land use, stretches of intact alder wetland through which the river flows, and then many small and not-so-small intrusions on the river/wetland system including a granite waste lagoon in the former floodplain, horse and cow pasture, logging roads, fill, a road to several residences. There is one large farm operation in this waterbody.

Hazardous waste site 97-2329, Cumberland Farms in Newport, has 7 groundwater monitoring wells showing levels of one or more volatile organic compounds (including MTBE, benzene, toluene, naphthalene and others) above the Vermont Groundwater Enforcement Standard (VGES). In addition, the surface water sampling site at the head of an unnamed tributary to Lake Memphremagog has had levels of benzene above the water quality criteria for the protection of human health and aquatic biota over the last 3 years (data from 2002 and 2004). Other VOCs have been elevated in these samples too. A remediation system was put into place in late summer 2004 and got underway in fall 2004 so better results should be seen eventually.

Specific stream segment status
Impaired Miles
Crystal Brook: 0.3 - aquatic biota impaired due to organic enrichment and sedimentation from agricultural wastewater and discharges

Tomifobia River watershed

General Description
Almost all of the Tomifobia River is in Canada although two significant tributaries, Holland Brook and Stearns Brook, and their watersheds are largely in the United States. Holland Brook originates at Holland Pond and flows northwesterly about three miles to the border. Its sixteen square mile watershed in Vermont includes Holland, Turtle, Round, and Beaver Ponds. Stearns Brook originates between Mt. John and Mead Hill and flows northwesterly to Tice and then northerly to the Canadian border all in the town of Holland.

Natural Communities
The Holland Brook Wetlands site is an area of northern white cedar swamp, bog, and brook partially flooded by beaver in 1997. The site is located west of Holland Pond for about a mile downstream on Holland Brook. The beaver dam and resulting pond flooded about 30 to 40 acres of cedar swamp and also much of the bog that had been dominated by black spruce.

Fishing and Fishery
Stearns Brook and a section of the Tomifobia River support brook trout. Stearns Brook also has longnose dace, blacknose dace, creek chub, and white sucker.

General River Assessment
Stearns Brook and a tributary to Stearns Brook were sampled several times. Macroinvertebrates were sampled on Stearns Brook at rivermile 1.7 (at bridge on Twin Bridges Road north of Tice) in 1998 and 1999 and the community was assessed as "good". The macroinvertebrate community was sampled again in 2004 at rivermile 2.4 and its was "very good-good." The fish community was sampled in 1998 also at rm 1.7 and it was also assessed as "good."

The tributary to Stearns Brook (a tributary 40 meters upstream of bridge described above) was not as well off. The macroinvertebrate community was assessed as "fair" at rm 0.1 in 1998 and the fish community was assessed as "poor" at the same site also in 1998. However, the fish were sampled again at rm 0.1 in 2004 and the community was assessed as "good".

A field investigation in May 2005 found a number of conditions stressing Stearns Brook including a logging job that took large trees off the stream's bank leaving them bare and that had a muddy landing right on the stream; road ditching and grading that directly affected the stream; and slumping streambanks, and mid-channel bars. This site was visited by a forester and was to be stabilized.

Specific stream segment status

Impaired Miles

Stearns Brook tributary: 0.5 - aquatic biota/habitat and aesthetics impaired (recreation likely too) due to nutrients, organic enrichment from ag runoff, manure pit

Stressed Miles

Stearns Brook: 3.0 - from Canada border upstream to Holland Road - aquatic habitat, aesthetics, secondary contact recreation stressed due to sedimentation from poor logging practices, eroding streambanks, poor road maintenance.

Tomofobia watershed lakes

There are six ponds in the Tomofobia watershed. All of these lakes are in the vicinity of the Bill Sladyk Wildlife Management Area. The lakes have largely, or entirely forested watersheds, and are miminally impacted. These lakes are all low-nutrient, naturally low-alkalinity lakes, and they vary in their degree of sensitivity to acid rain. Acres identified as stressed or impaired in Table 8 are due to acidification. Duck, Round, and Turtle Ponds are acid-impaired while the remaining lakes are acid sensitive.

Table 8. Use support status for individual lakes in the Tomofobia watershed.

Lake Name	Lake Area	Acres supporting uses	Acres with uses stressed	Total Supporting	Acres with uses altered	Acres with impaired uses	Total not supported	Acres not assessed
BEAVER (HOLLND)	40	0	40	40	0	0	0	0
DUCK (HOLLND)	6	0	0	0	0	6	6	0
HOLLAND	325	0	325	325	0	0	0	0
LINE (HOLLND)	5	0	5	5	0	0	0	0
ROUND (HOLLND)	14	0	0	0	0	14	14	0
TURTLE	27	0	0	0	0	27	27	0

Coaticook River watershed

General Description

The Coaticook River originates at the outlet of Norton Pond and flows northeasterly for over six miles passing just west of Norton and into Canada. Tributaries in the U.S. include Station Brook, Sutton Brook, Davis Brook, Gaudette Brook, Moster Meadow Brook, Number 5 and Number 6 Brooks.

Natural Communities

The Norton Pond Northwest Arm Swamp wetland site in the town of Warrens Gore consists of a high quality 40-acre cedar swamp in a basin northwest of Norton Pond. The swamp is in the Bill Sladyk Wildlife Management Area. The cedars in the canopy of this swamp are estimated to be 140 to 180 years old, which makes this one of the most mature swamps in the state. A rare moss occurs in the swamp.

General River Assessment
Mosher Meadow Brook was sampled in 2003. The fish community sampled at rivermile 0.2 was assessed as "fair." The macroinvertebrate community was assessed as "excellent" in the same location. Further sampling and assessment are needed.

Field observations were made on Station Brook and Davis Brook in May 2000. Both are boulder-cobble-gravel streams with good buffers except for at one location on each brook. The water was clear and cool (8-10C) at the time of the field visit. The field sheet for Davis Brook had a note about a culvert 12" above the stream channel so there is a need to investigate fish passage issues.

Logging was occurring in the Mosher Meadow Brook and Coaticook River watersheds at the time of field visits in May 2000. Logging road runoff was a problem in one location but it was addressed by the county forester when contacted by DEC WQ staff.

Specific stream segment status
Altered Miles
Averill Creek: 5.4 - downstream from dam on Great Averill Lake - aquatic habitat altered due to low and fluctuating flows created by the hydro-electric facility operations
Averill Creek: 1.0 -downstream from dam on Little Averill Lake - aquatic habitat altered due to low and fluctuating flows created by the hydro-electric facility operations
Coaticook River: 3.0 - below Norton Pond dam - aquatic habitat altered low and fluctuating flows created by the hydro-electric facility operations

Coaticook lakes
There are four lakes in the Coaticook watershed (Table 9) comprising 1,900 acres. Three (Great and Little Averill, and Norton Ponds) are part of an unlicensed hydroelectric project. Accordingly, aquatic life uses in these lakes are altered due to water level manipulation. These waterbodies are also naturally acid-sensitive, and are therefore stressed for aquatic life use as well. Halfway Pond, an extremely remote waterbody deep within the Hurricane Brook Wildlife Management Area, is shallow, warm, and acid-impaired, and very likely does not support a fishery. Yet, due to its setting, Halfway Pond is worth the visit from the Hurricane Brook side, for the accomplished and stout-hearted navigator.

Table 9. Assessment of uses in Coaticook watershed lakes.

Lake Name	Lake Area	Acres supporting uses	Acres with uses stressed	Total Supporting	Acres with uses altered	Acres with impaired uses	Total not supported	Acres not assessed
GREAT AVERILL	828	0	0	0	828	0	828	0
HALFWAY	22	0	0	0	0	22	22	0
LITTLE AVERILL	467	0	0	0	467	0	467	0
NORTON	583	0	0	0	583	0	583	0

Lake Memphremagog

Lake Memphremagog and the South Bay of Memphremagog together comprise 6,436 acres within the United States. Lake Memphremagog is the ultimate receiving water for the Clyde, Barton, and Black River watersheds, and therefore is subject to the combined stresses of all land use activities throughout those three watersheds. The South Bay is 470 acres in size, while Memphremagog is 5,966 acres. The South Bay is a well-used warmwater fishing and hunting waterbody, while Lake Memphremagog is heavily used by all user groups.

Sections of both lakes totalling 521 acres are presently listed as impaired due to nutrient pollution, based on waste discharge practices that were in effect in Newport in the 1980s. Since that time, significant wastewater infrastructure has been put into place considerably reducing nutrient and pathogen discharges to the lake. The lake also supports Eurasian watermilfoil populations, which stress 306 acres (Table 10).

Table 10. Combined use support for Lake Memphremagog and the South Bay.

Use	Supporting	Stressed	Total Supported	Altered	Impaired	Total Not Supported	Not Assessed
Overall uses	5609	306	5915	0	521	521	0
Aesthetics	5609	306	5915	0	521	521	0
Aquatic Life	5609	306	5915	0	521	521	0
Drinking Water Supply	0	0	0	0	0	0	0
Fish Consumption	6436	0	0	0	0	0	0
Secondary Contact Rec	5609	306	306	0	521	521	0
Swimming	5609	306	306	0	521	521	0

Vermont DEC is presently in a two-year recharacterization of water quality conditions in both lakes, and has partnered with the Northwoods Stewardship Center in East Charleston to carry out a watershed-wide baseline chemistry monitoring project. Lake tributaries are monitored approximately bi-weekly near the lake, and monthly in upstream areas. Lake water quality is monitored at one South Bay location and two Memphremagog locations on a bi-weekly basis. Vermont DEC supports citizen lake water quality monitors for both lakes, who also measure water quality conditions on a weekly basis.

Water chemistry data results of the first year's monitoring data indicate that the existing impairment listing in these lakes may not be warranted. Vermont DEC is awaiting a second year of data collection, and a comprehensive analysis of the data, prior to proposing any de-listing of these waters. Monitoring locations for Vermont DEC and Northwoods Stewardship Center-led activities are shown by Figures 1 and 2, respectively.

During 2005, Vermont DEC partnered with Memphremagog Conservation, Inc. to carry out a complete shoreline habitat sediment and comprehensive aquatic plant survey in United States waters, to complement a similar investigation of Quebec waters from 2004.

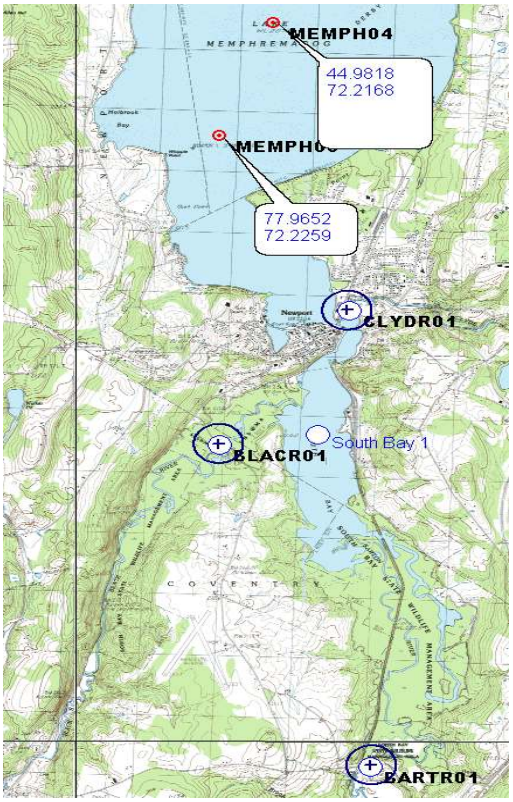

Figure 1. Memphremagog monitoring locations - VTDEC

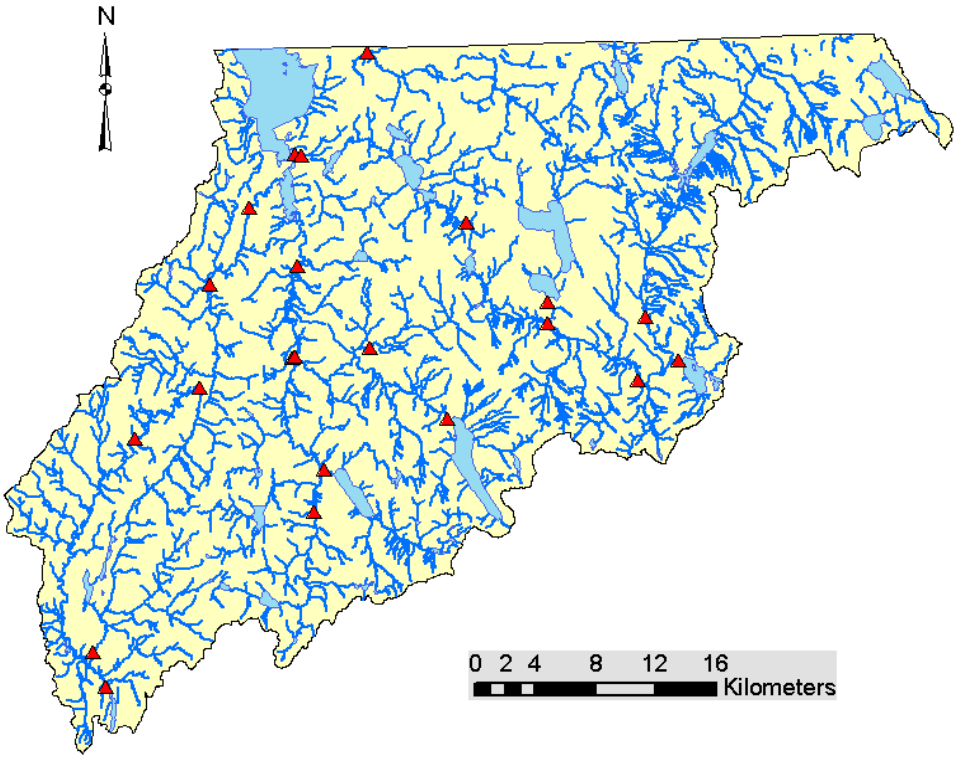

Figure 2. Memphremagog monitoring locations – Northwoods Stewardship Center

With respect to mercury contamination of fishes, no walleye tissues have been collected for mercury analysis in Lake Memphremagog by the State of Vermont. Yellow perch were last sampled in 1995. Based on these data, the concentrations of mercury in the yellow perch are median relative to other lakes and ponds in Vermont. A composite of two walleye from the Johns River was analyzed in 1998, and the level of mercury was 0.5 parts per million mercury, which is low for walleye, but still above the USEPA criterion limit of 0.3 parts-per-million. The Quebec Ministry of Environment has collected fish and analyzed mercury in several species, for central portions of Memphremagog in Quebec waters. While the concentrations in these fishes are also generally moderate or low, fish mercury levels were high in the largest fishes tested. More testing of fish mercury levels in Lake Memphremagog is warranted.

Wastewater, Stormwater, Large Farms, and Logging

Wastewater Treatment Facilities

There are six municipal wastewater treatment facilities in the Lake Memphremagog drainage basin in Vermont. The facilities and their characteristics are in the table below.

Table 11. Wastewater Treatment Facilities in Basin 17

Facility	Receiving Water	Permitted Flow (gallons per day)	Average Annual Flow (July 2003 – June 2004) (gallons per day)
Newport City	Clyde River	1,200,000	908,917
Orleans	Barton River	190,000	102,083
Barton Village	Barton River	265,000	174,917
Glover	Roaring Brook	7,000	2,524
Brighton	Pherrins River	150,000	82,667
Newport Town	Mud Creek	41,500	10,745

Permitted Stormwater Discharges

There are currently thirteen permitted stormwater discharges in the Lake Memphremagog watershed in Vermont: eight are in either Newport City or Town, four are in Derby, and one is in Barton. Details on the treatment methods used by the dischargers are in the files of the DEC Water Quality Division Stormwater Section.

Large Farm Operations

There are four permitted large farm operations in the Vermont Lake Memphremagog watershed. Two farms are in Irasburg, one in Coventry, and one in Derby Line. All are dairy operations. Details on the farm operations and permit conditions are in the files of the DEC Water Quality Division Planning Section or available from the Vermont Agency of Agriculture, Food, and Markets.

Logging Site Investigations

Over the past six years, there were seventeen logging sites investigated to insure that the operations were following the Acceptable Management Practices (AMPs) for Logging: three investigated in 1999; five in 2000; one in 2001; three in 2002; two in 2003; and three in 2004. Site investigations are generally triggered by a telephone call from the public concerned about potential or obvious impacts on surface waters from a logging job. The number of cases that are investigated are a sum of cases “with no evidence of discharges” and cases “with evidence of discharge.” These categories are broken out by forestry district but not by basin at this time.

Recent Water Resource Projects in the Basin

The Environmental Cooperation Agreement on Managing the Waters of Lake Memphremagog was signed by Vermont Governor James Douglas and Quebec Premier Jean Charest on December 4, 2003. The agreement signed on that date recognized the earlier work of the Quebec-Vermont Working Group, which had produced a final report on their efforts in 1993, and established the new Quebec-Vermont Steering Committee to further the assessment and protection work on this international lake. The steering committee itself meets twice a year and a monitoring and assessment work group established by the Steering Committee in December 2004 also meets several times a year. In addition to monitoring and assessment work, the Steering Committee has discussed solid waste issues especially the Coventry landfill expansion project in Vermont, agricultural issues, and emergency spill protocols.

The Memphremagog Monitoring and Assessment Work Group was given the task of determining ways that the two governments could cooperate on monitoring and assessment activities. In 2005, the following monitoring and assessment work was accomplished by the group: nine in-lake stations were sampled by Quebec (8 in Quebec, 1 in Vermont), a littoral zone survey in Vermont was completed (Quebec shoreline was done in 2004), tributaries were sampled in Quebec and Vermont, two in-lake stations were sampled by Vermont, an aquatic plant survey was done in the Vermont littoral zone of the lake, and Vermont began its basin assessment process for Memphremagog.

A number of river and stream, lake and pond, or wetland protection projects are often underway in a watershed at any one time. The Vermont DEC Water Quality Division administers a number of grant programs that fund some of these projects and it is this universe of activities that is described below.

Clean Water Act Section 319 nonpoint source pollution prevention funding FY 2005 has supported a Clyde River phase I geomorphic assessment done by the NorthWoods Stewardship Center. These 319 funds in FY2004 supported a Barton River phase I geomorphic assessment coordinated by the Community Planning Project of Lake Region Union High School. Eleven reaches of the Barton River were delineated and evaluated following the Vermont DEC protocols.

The State of Vermont Conservation License Plate program provides small watershed grants to local and statewide organizations. The NorthWoods Stewardship Center and Northeast Kingdom Conservation Service Corps received funding for Black River stream bank stabilization work in the summer of 2005.

The NorthWoods Stewardship Center also received a laboratory services grant for analyzing water quality samples taken throughout the watershed for the 2005 sampling season.

References

1) AMC River Guide: New Hampshire and Vermont, Third Edition, 2002. Appalachian Mountain Club, Boston, Massachusetts.

2) An Ecological Inventory of the Wetlands of the Lake Memphremagog Watershed in Vermont (and associated international drainages). June 1999. Brett Engstrom, Marc Lapin, Robert Popp, Mark Ferguson, and Eric Sorenson for the Vermont Nongame and Natural Heritage Program, Department of Fish and Wildlife, Agency of Natural Resources, Waterbury, Vermont.

3) *Draft* Quebec-Vermont Steering Committee on Lake Memphremagog 2004-2005 Report of Decisions and Actions, December 2005. Vermont Agency of Natural Resources and Quebec Ministere de L'Environnement.

3) Lake Memphremagog Basin Water Quality Management Plan, October 1974. Formerly Agency of Environmental Conservation, Department of Water Resources, Montpelier, Vermont.

4) The Vermont Management Plan for Brook, Brown, and Rainbow Trout, 1993. Vermont Department of Fish and Wildlife, Waterbury, Vermont.

5) Vermont Swimming Hole Study, 1992, Jerry Jenkins, Deborah Benjamin, and Jane Dorney for Vermont DEC, Water Quality Division.

6) Waterfalls, Cascades and Gorges of Vermont, 1985. Jerry Jenkins and Peter Zika for the Vermont Department of Environmental Conservation and Department of Forests, Parks and Recreation.

7) The Whitewater Rivers of Vermont: Their Biology, Geography, and Recreation Use, 1992. Jerry Jenkins and Peter Zika for the Vermont Agency of Natural Resources, Department of Environmental Conservation, Water Quality Division.

Appendix A

Macroinvertebrate and Fish Sampling in Basin 17

Table A.1. Macroinvertebrate Sampling in Basin 17 from 1994 to present

WBID	Stream Name	Town	Rivermile	Date	Assessment
VT17-01	Crystal Brook	Derby	0.3	09/04/1997	fair
VT17-01	Crystal Brook	Derby	0.3	09/14/1999	poor
VT17-01	Crystal Brook	Derby	0.3	09/16/2004	poor
VT17-01	Crystal Brook	Derby	0.4	09/04/1997	good
VT17-01	Crystal Brook	Derby	1.4	09/04/1997	good
VT17-01	Crystall Brook	Derby	1.4	09/16/2004	exc-vgood
VT17-02	Trib Stearns Brook	Holland	0.1	09/08/1998	fair
VT17-02	Stearns Brook	Holland	1.7	09/08/1998	good
VT17-02	Stearns Brook	Holland	1.7	09/14/1999	good
VT!7-02	Stearns Brook	Holland	2.3	09/17/2004	vgood-good
VT17-03	Mosher Meadow Brook	Norton	0.2	09/23/2003	excellent
VT17-05	Pherrins River	Brighton	1.9	09/23/2003	excellent
VT17-07	Barton River	Orleans	9.7	09/17/2004	
VT17-09	Black River	Irasburg	12.1	09/08/1999	excellent
VT17-09	Black River	Irasburg	12.1	09/21/2004	
VT17-09	Black River	Irasburg	13.5	10/13/2004	
VT17-10	Brighton Brook	Irasburg	0.9	09/21/2004	
VT17-10	Black River	Craftsbury	30.5	10/30/2004	
VT17-10	Black River	Craftsbury	34.8	09/08/1999	good
VT17-10	Lords Creek	Irasburg	2.4	09/08/1998	good
VT17-10	Lords Creek	Irasburg	2.4	09/21/2004	

Table A.2. Fish Sampling in Basin 17 from 1994 to present

WBID	Stream	Town	Rivermile	Date	Assessment
VT17-01	Johns River	Derby	1.4	09/04/1997	fair
VT17-01	Johns River	Derby	1.4	08/20/2003	poor
VT17-01	Johns River	Derby	3.1	09/04/1997	good
VT17-02	Trib Stearns Brook	Holland	0.1	09/08/1998	poor
VT17-02	Trib Stearns Brook	Holland	0.1	09/16/2004	good
VT17-02	Stearns Brook	Holland	1.7	09/09/1998	good
VT17-03	Mosher Meadow Brook	Norton	0.2	08/21/2003	fair
VT17-05	Pherrins River	Brighton	1.9	08/20/2003	very good
VT17-09	Brighton Brook	Irasburg	0.9	09/21/2004	

Appendix B

Population and Housing Growth

in the Lake Memphremagog Watershed Towns

Table B.1. Population of Lake Memphremagog Watershed Towns in Vermont

Town	Pop 1970	Pop 1980	Pop 1990	Pop 2000	% change 1970-1980	%change 1980-1990	% change 1990-2000
Albany	528	705	782	840	34	11	7
Barton	2874	2990	2967	2780	4	-1	-6
Brighton	1365	1557	1562	1260	14	0	-19
Brownington	522	708	705	885	36	0	26
Charleston	654	851	844	895	30	-1	6
Coventry	492	674	806	1014	37	20	26
Craftsbury	632	844	994	1136	34	18	14
Derby	3252	4222	4479	4604	30	6	3
Glover	649	843	820	966	30	3	18
Holland	383	473	423	588	23	-11	39
Irasburg	775	870	907	1077	12	4	19
Morgan	286	460	497	669	61	8	35
Newport City	4664	4756	4434	5005	2	-7	-13
Norton	207	184	169	214	-11	-8	27
Warners Grant	0	0	0	0	0	0	0
Warrens Gore	0	0	2	10	0	200	400
Westmore	195	257	305	306	32	19	0

Table B.2. Housing Units of Lake Memphremagog Watershed Towns in Vermont

Town	Housing Units 1980	Housing Units1990	Housing Units 2000	% change 1980 - 1990	% change 1990 - 2000
Albany	315	402	453	28	13
Barton	1291	1382	1438	7	4
Brighton	701	881	891	26	1
Brownington	285	418	450	47	8
Charleston	440	519	895	18	72
Coventry	236	283	435	20	54
Craftsbury	394	474	572	20	21
Derby	1786	2082	2258	17	8
Glover	535	607	677	13	12
Holland	223	284	354	27	25
Irasburg	291	373	493	28	32
Morgan	526	633	672	20	6
Newport City	2010	2128	2342	6	10
Norton	238	164	252	31	54
Warners Grant					
Warrens Gore					
Westmore	503	542	530	8	2

Appendix C

Dams in the Lake Memphremagog Watershed in Vermont

Table C.1. Dams in the Memphremagog Watershed

Dam Name	Stream	Town	Status	Use *	Built	Re-con+	State ID
Paine Site No. 1	Willoughby River Trib	Barton	In Service	R	1969		15.01
Paine Site No. 2	Willoughby River Trib	Barton	In Service	R	1972	1980	15.02
Evansville	Willoughby River	Brownington	Breached				34.01
Orleans Water Supply	Willoughby River Trib	Brownington					34.02
Lake Willoughby	Willoughby River	Westmore	In Service				236.01
Cyrstal Lake	Barton River Trib	Barton	In Service	R	1860	1966	15.05
May Pond	May Pond Brook	Barton	In Service	S	1900		15.04
Orleans	Barton River	Barton	Breached				15.06
Shadow Lake	Barton River Trib	Glover	In Service	R	1929		81.02
Lake Parker	Roaring Brook	Glover		R		1975	81.01
West Charleston	Clyde River	Charleston	In Service	H	1928		45.01
Pensioner Pond	Clyde River	Charleston	In Service	H	1929		45.02
East Charleston	Echo Lake Brook	Charleston	Breached				45.04
Echo Lake	Clyde River Trib	Charleston	In Service	H	1922	1984	45.03
Seymour Lake	Clyde River Trib	Charleston	In Service	H	1928	2004	45.05
Newport No. 1	Clyde River	Derby	In Service	H	1918	1936	59.01
Derby	Clyde River	Derby	Breached				59.02
Newport No. 11	Clyde River	Newport City	Breached	H	1956	1996	141.01
Prouty Mill	Clyde River	Newport City					141.02
Jobs Pond	Cold Brook	Westmore	In Service	R			
Coventry Falls	Black River	Coventry	Breached				55.02
Sargent Pond	Black River	Coventry	Breached				55.03
Great Hosmer Pond	Black River Trib	Craftsbury	In Service				56.01
Little Hosmer Pond	Black River Trib	Craftsbury	In Service	R	1969		56.02
Craftsbury-3	Black River	Craftsbury					56.03
Alexander	Black River	Irasburg	Breached				103.01
Swanson	Coaticook River	Norton	Breached	H	1920		145.02
Norton Pond	Coaticook River	Norton	In Service	HR	1893	1980	145.03
Great Averill Pond	Averill Creek	Norton	In Service	HR	1918	1983	145.01
Little Averill Pond	Averill Creek	Averill	In Service	R	1850	1989	7.01
Holland Pond	Holland Brook	Holland		S			98.01

*H = hydroelectric, R = recreation, C = flood control, S= water supply, O = other, blank = unknown

+ date re-constructed