Vermont Agency of Natural Resources

Watershed Management Division

Basin 17 Lake Memphremagog, Tomifobia and Coaticook

5/11/17 DRAFT TACTICAL BASIN PLAN

The Lake Memphremagog Tomifobia and Coaticook Basin (in Vermont) - Tactical Basin Plan was prepared in accordance with 10 VSA § 1253(d), the Vermont Water Quality Standards[1], the Federal Clean Water Act and 40 CFR 130.6, and the Vermont Surface Water Management Strategy.

Approved:

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Emily Boedecker, Commissioner Date

Department of Environmental Conservation

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Julie Moore, Secretary Date

Agency of Natural Resources

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Memphremagog Basin Tactical Plan Overview

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Executive Summary

The Lake Memphremagog Tomifobia and Coaticook Tactical Basin Plan (TBP) provides an assessment of the health of the basin and defines on-going and future strategies to address high-priority surface water stressors (see Surface Water Management Strategy.) The purpose of the plan is to address high priority stressors to achieve sustained ecological health and human use of surface waters by identifying actions necessary to meet or exceed state water quality standards. The plan also sets priorities for meeting phosphorus load reduction targets for the Lake Memphremagog watershed as outlined in the Lake Memphremagog Phosphorus Total Maximum Daily Load (TMDL).

Chapter 1 of the Tactical Basin Plan provides a brief description of the basin, the purpose of tactical basin planning and implementation process, and the new regulations for water quality protection. Chapter 2 provides a summary of water quality conditions in the basin based on assessment reports, inventories and monitoring data from internal and external partners, and identifies target areas for implementation, protection, monitoring, and assessment. Land erosion and nutrient loading are stressors to most of the target areas for implementation, including high phosphorus export watersheds in the lake Memphremagog watershed, the impaired tributary to Stearns Brook and Roaring Branch, Mud and Walker Ponds with elevated nutrient levels, and finally Elligo, Little and Great Averill, Holland, Long, Parker, Norton, Salem, Seymour, Shadow, Willoughby Lakes which have increasing nutrient trends. Additional focal areas for the plan include an unnamed tributary to the Black River impacted by gully erosion below the Newport City Airport, channel instability along the lower Barton River, water level fluctuations on Little and Great Averill lakes and Norton Pond, and the control of aquatic and riparian invasive species. Chapter 3 identifies implementation priorities to address these stressors and pollutants in target areas, including priorities for meeting the phosphorus reductions set by the Lake Memphremagog TMDL for each land use sector. Chapter 4 establishes management and protection goals identified in the Vermont Water Quality Standards for surface waters, including existing uses, designations and reclassifications. The heart of this plan is Chapter 5 which includes a summary implementation table and the related Watershed Projects Database, which includes geographically explicit actions to protect or restore surface waters in the basin. The following is a list of the basin-wide top objectives and strategies identified in the plan:

1. Reduce stormwater inputs into surface waters by the creation of a stormwater collaborative to implement stormwater master plans and smaller green stormwater infrastructure practices, provide technical support to partners in implementing practices and to coordinate a targeted stormwater outreach campaign.
2. Reduce shoreland erosion and stormwater runoff from developed lakeshores through Lake Wise trainings and information sharing between lake associations. Support technical and financial resources to implement priority Lake Wise practices.
3. Reduce erosion from municipal roads by completing outreach to towns on Municipal Roads General Permit, creating local capacity to assist five towns in completing road erosion

inventories each year with following up support for implementing road projects with the largest water quality benefits.

4. Reduce phosphorus loading from state transportation infrastructure by completing assessments necessary to develop phosphorus control plans, completing final designs and, if found feasible and funding is available, implementing Airport and Park and Ride stormwater retrofit projects.
5. Promote implementation of targeted agricultural water quality practices through the creation of a farmer workgroup, targeted water quality sampling and technical assistance to farmers to complete and then fully implement nutrient management plans and land treatment practices on farmsteads and fields.
6. Support farmers in installing targeted best management practices through local demonstrations and trials, increasing the availability of equipment limiting farmers ability to apply Best Management Practices (BMPs), development of a set of practical farm stormwater BMPs, and the publication of success stories where practices can be shown to have improved water quality conditions in local surface waters.
7. Protect river corridors from channel erosion and encroachment through river corridor easements, floodplain restoration, adoption of river corridor protection, and buffer planting projects.
8. Reduce permitted phosphorus loading from Waste Water Treatment Facilities by 33% by implementing the wasteload allocation as this is finalized though the wasteload allocation process.
9. Reduce chances for additional aquatic invasive species spread and minimize invasive populations currently in waterbodies in the basin by supporting Vermont Invasive Patroller program to support rapid response to new infestations, greeter programs to inform boaters and other users, tracking starry stonewort spread and evaluating spread prevention options for this new invasive species.
10. Protect very high quality surface waters through reclassification of Lake Willoughby Tributary and Shalney Branch as B(1) waters, Upper Clyde River and South Bay wetlands as Class 1 wetlands, the Black, Barton, Clyde and many tributaries as Class B(1) for fishing use, in addition to water sampling highlighted in Table 4 to identify additional reclassification opportunities.

Chapter 1 – Tactical Basin Planning Process & Watershed Description

A. Tactical Basin Planning Process

Tactical basin plans (TBPs) are developed according to the goals and objectives of the Vermont Surface Water Management Strategy to protect, maintain, enhance, and restore the biological, chemical, and physical integrity, and public use and enjoyment of Vermont's water resources, and to protect public health and safety. The tactical basin planning process allows for the completion of tactical basin plans for all of Vermont's fifteen basins every five years, as required by statute. The streamlined process for issuing tactical basin plans facilitates a review of water quality data and assessments for targeting strategies and prioritization of resources to those projects that will have the greatest impact on surface water protection or remediation. The tactical planning process is outlined in Chapter 4 of the VT Surface Water Management Strategy.

The previous Basin 17 water quality management plan was approved in 2012. Seventy-nine action items were identified in the 2012 plan and more than three quarters of these have been implemented or are in progress by VANR and its watershed partners. A report card of this progress can be viewed in Appendix A. The 2017 tactical plan builds upon those original plan recommendations by promoting specific, geographically explicit actions in areas of the basin that have been identified for intervention, using environmental modeling and on-the-ground monitoring and assessment data. This updated tactical basin plan was developed in parallel with the Lake Memphremagog Phosphorus TMDL, and it will serve as the first five year implementation plan for the TMDL to meet necessary phosphorus load reductions across land use sectors.

Action items summarized by the Implementation Table summary in Chapter 5 of this document will be addressed over the life of this and subsequent Lake Memphremagog TBPs. The total number of prospective water quality projects derived from the assessments that are integrated by this Tactical Basin Plan exceeds 400, as of this publication. Successes and challenges in implementing actions will be reviewed and addressed as part of required annual reporting pursuant to Act 64 of 2015; Vermont's new Clean Water Act. As envisioned by Act 64, the TBP will not be a static document. New projects identified by the sector-specific assessments called out in the implementation plan will be reflected by the Watershed Projects Database.

B. Vermont Water Quality Standards and Clean Water Act

The Vermont Water Quality Standards (VWQS) define biological integrity as "the ability of a body of water to support and maintain a community of organisms that has the expected species composition, diversity, and functional organization comparable to that of the water in its natural condition." The health of a biological community reflects the level of combined human-induced stresses acting upon it. Aquatic communities that are most impaired suffer from an accumulation of multiple stressors.

As a follow-up to the 1972 Federal Clean Water Act, which requires states "to restore and maintain the chemical, physical and biological integrity of the nation's waters.", the VWQS are rules **specific to Vermont** that protect the uses of surface waters of the state.

The implementation actions identified in the TBPs are meant to fulfill all the geographically-specific planning requirements in the VWQS, while the statewide planning requirements, including state-scale strategies, are addressed in the statewide Surface Water Management Strategy.

In 2015, the Vermont Legislature passed Act 64, the Vermont Clean Water Act. This Act strengthens multiple statutes related to water quality in the State. Act 64 addresses agricultural water quality on small, medium, and large farms through the Agency of Agriculture, Food and Markets. It establishes water quality requirements for stormwater discharges from new and existing development, industrial and municipal stormwater discharges, and runoff from municipal roads through the Department of Environmental Conservation (VDEC). Through the Department of Forests, Parks and Recreation and VDEC, the Act addresses water quality runoff from forest silvicultural activities and supports wetland restoration efforts within the Lake Champlain Basin. Regulations specific to these new requirements are covered in detail in the final VT Lake Champlain Phosphorus Total Maximum Daily Load (TMDL) Phase I Implementation Plan and summarized in Chapter 3 as they relate to Basin 17.

Act 64 also establishes the requirement that all water quality improvement actions undertaken by the State be integrated by means of TBPs, and establishes partnerships with regional planning commissions, conservation districts, and other organizations to support this work. Regarding work with the regional planning commissions, the Agency of Natural Resources (Agency) will work with the applicable regional planning commissions to develop an analysis and formal recommendation on conformance of this plan with the goals and objectives of applicable regional plans, see 10 V.S.A 1253(d)(2)(G). The overall role of the TBPs is not to determine where development should happen. This TBP encourages communities to take protective measures that will restore, maintain and enhance water quality in all areas, but does not preclude development that is consistent with municipal bylaws, regional and municipal plans, and with applicable state and federal regulations.

To assist Vermonters in meeting the requirements of Act 64, the Clean Water Fund has been established, and paired with other funds available for water quality improvements, allocations will be dedicated towards the highest priority water quality remediation actions.

The Tactical Basin Plans are also consistent with the U.S Environmental Protection Agency's (USEPA) framework for developing watershed-based plans. EPA's framework consists of nine key elements that ensure that the contributing causes and sources of nonpoint source pollution are identified, key stakeholders are involved in the planning process and restoration and protection strategies, addressing water quality concerns are identified. The resulting tactical basin plan uses adaptive management, has strong implementation sections, is an effective plan for restoration or protection, and identifies projects that are eligible for federal and state funding.

In order to implement the high priority actions required to protect, enhance, maintain and restore water quality, the TBP spells out clear attainable goals and targeted strategies to achieve goals laid out in the Vermont Clean Water Act, the Lake Memphremagog Phosphorus TMDL, and EPA's nine elements. The online Watershed Projects Database and Implementation Table summary are tools by which progress can be tracked with regard to measurable indicators of each major goal. In addition, the implementation of actions and implementation table summary itself will be revisited periodically, and be modified accordingly to best address newly emerging information, unanticipated events, and new requirements such as are anticipated by legislative acts such as Act 110, Act 16, and Act 64, now generally referred to as the Vermont Clean Water Act.

For more information about the Vermont Clean Water Act, readers should review the content of the Vermont Clean Water Initiative website at: http://dec.vermont.gov/watershed/cwi.

C. Lake Memphremagog, Tomifobia and Coaticook Basin

The Vermont portions of the St. Francis River Watershed encompass a total of 589 square miles including the Vermont portions of the Lake Memphremagog drainage and the Tomifobia and Coaticook river watersheds. This basin includes about 75% of Orleans County, 15% of Essex County and small portions of Lamoille and Caledonia Counties in Vermont. 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. There are 90 inventoried lakes and ponds in the watershed covering 17,660 acres or over five percent of the basin.

The Lake Memphremagog drainage basin encompasses a total of 687 square miles of which 489 square miles (71%) are in Vermont 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's area is in Canada. There are three main rivers in the U.S. portion of the Lake Memphremagog basin - the Black, Barton and Clyde Rivers, which flow northerly into the southern end of Lake Memphremagog. There are also a number of smaller streams that flow directly into Lake Memphremagog covering an area of just under 30 square miles. Most of this area is drained by the Johns River which originates in Derby west of Nelson Hill.

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. 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. 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, Moser Meadow Brook, Number 5 and Number 6 Brooks, and Averill Stream which drains Great and Little Averill ponds.

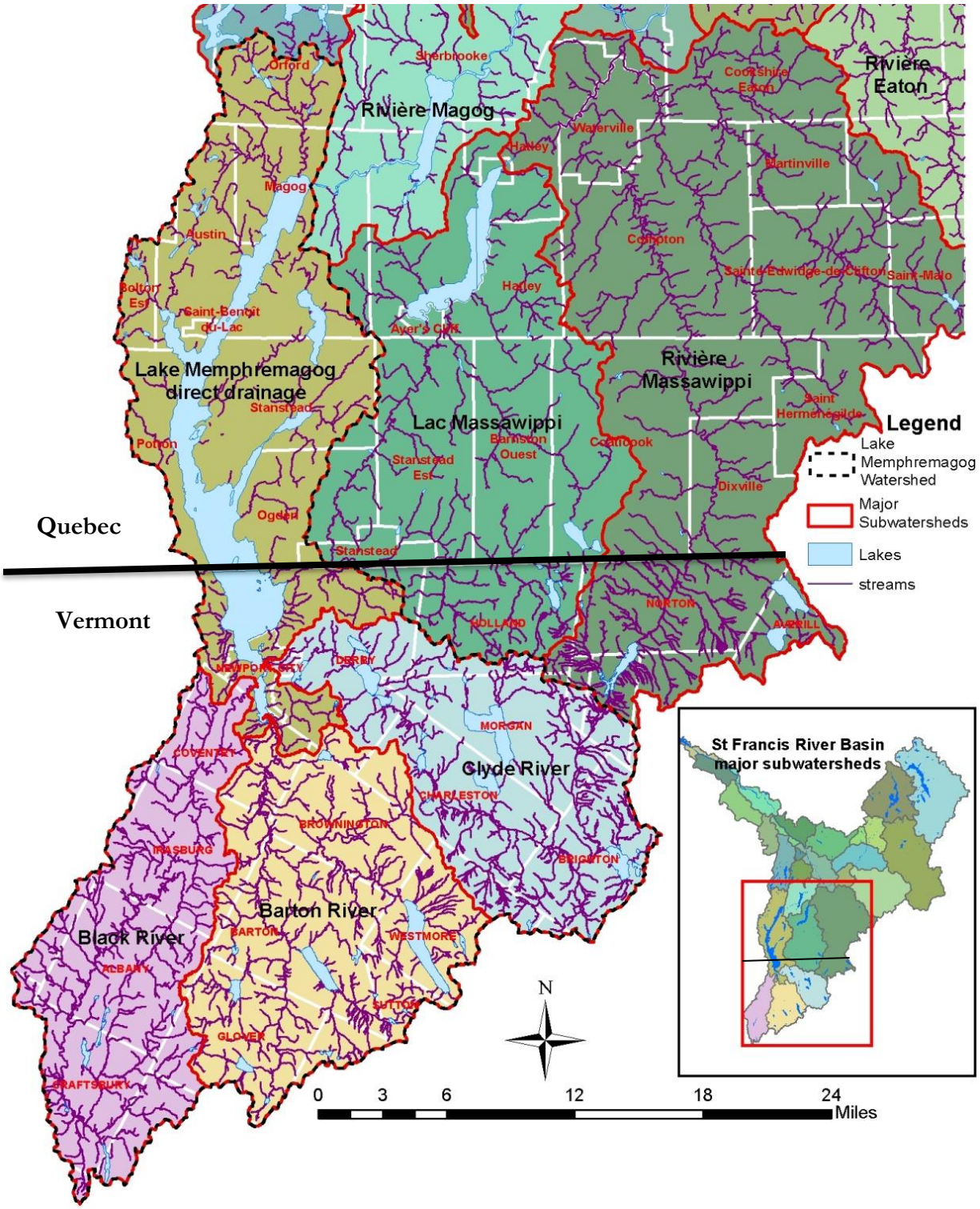


Figure 1. The St. Francis River watershed showing major subwatersheds that drain north from Vermont into Quebec.

Chapter 2 – Water Resource Assessments & Sub-basin Prioritization

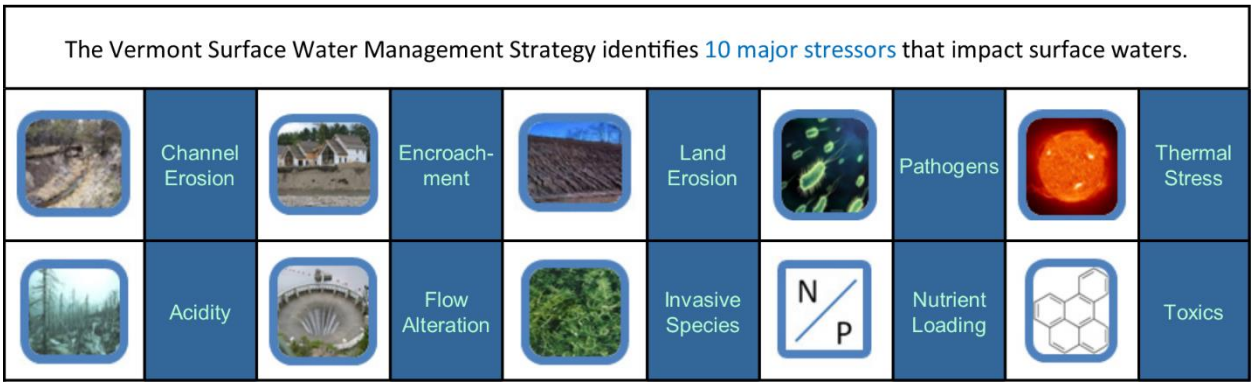
A. Assessment Methodology, Stressors and Pollutants

The Agency's Watershed Management Division (WSMD) in the Department of Environmental Conservation (VDEC) assesses the health of a waterbody using biological, chemical and physical criteria. Most of this data can be accessed through the Vermont Integrated Watershed Information System, online data portal.

The results of assessments are the basis for the biennial statewide 303(d) List of Impaired Waters and List of Priority Surface Waters Outside the Scope of 303(d) (Table 1). These priority waters lists also includes preliminary information on responsible pollutant and/or physical alterations to aquatic and riparian habitat, the stressor and if known, the source. The VDEC Basin 17 Water Quality Assessment Report provides additional information about these waters. The waterbodies included on these lists are included as a focus for remediation efforts in this plan.

The Vermont Surface Water Management Strategy (VSWMS) (VDEC 2017) lays out the goals and objectives of VDEC's Watershed Management Division for addressing pollutants and stressors that can negatively affect the designated uses of Vermont surface waters. The strategy discusses 10 major stressors, and was updated in early 2017 to reflect new provisions of Act 64 and the Lake Champlain and Lake Memphremagog TMDLs.

A stressor is defined as a phenomenon with quantifiable damaging effects on surface waters resulting from the delivery of pollutants to a waterbody, or an increased threat to public health and safety. For the most part, stressors result from human activity on the landscape; however, when landscape activities are appropriately managed, stressors are reduced or eliminated. The graphic below shows stressor chapters of the VSWMS that describe in detail the stressor, its causes and sources, and VDEC's approach to addressing the stressor through monitoring, technical assistance, regulations and funding.



In this plan, the stressors responsible for the impaired, altered and stressed waterbodies in the basin are listed next to the waterbody in Table 1. In addition to the stressor, Table 1's priority waters lists also

identify the pollutant or physical alteration responsible for degraded water quality or physical condition of each priority water.

Pollutants enter surface waters either as a point source, a discrete source from a pipe, or as non-point source, carried in precipitation that runs off the landscape (i.e., stormwater runoff). Physical alterations result from the inadvertent introduction of aquatic invasive species (AIS), or with a change in surface water levels because of dams or water withdrawal. The land use and other activities that are responsible for non-point source pollutants as well as VDEC's remediation strategies, are described in detail in the Vermont Surface Water Management Strategy (VSWMS).

Climate Change: increasing pollutant loads and impacts to waterbodies

Climate change predictions for Vermont include increased intensity of storms and resulting increases in stormwater flows leading to increased pollutant loads from the landscape as well as loss of native species. . In response, management of landscape activities will need to intensify to effectively address stressors that are intensified with additional flows. These stressors include channel and land erosion, nutrient loading and thermal stress.

Increased temperatures are also predicted, which will increase thermal stress to waterbodies. In addition, warmer temperatures will also allow invasive species to gain a competitive edge, requiring changes in management strategies to better protect native species. The Lake Memphremagog TMDL and this tactical basin plan were developed with consideration of the effects of climate change with many of the summary and targeted strategies focused on flood resiliency along with water quality improvements.

B. Overview of Water Resources

The following is an overview of water resource health in Basin 17. Information on the condition of specific water bodies is included in Table 1.

Rivers

Sediment and nutrients are the most prevalent pollutants in Basin 17[1] in streams and rivers. Prominent stressors responsible include land erosion, channel erosion, and nutrient loading. Physical alterations are also present throughout the watershed, ranging from habitat alteration, general stream channel instability and encroachment into the flood hazard zone, as well as flow alterations. Additional stressors are mercury which causes stress for all surface waters in the basin.

[1] Definition of these pollutants can be found in VSWMS Appendix B.

Lakes and ponds

The basin includes 55 lakes or ponds, 10 acres or larger. Encroachment, by way of shoreland development, is the greatest stressor to Vermont lakes, as recently reported in the National Lake Survey study (USEPA, 2012). In Basin 17, other threats to aquatic habitat and water quality in the lakes include sedimentation and increased eutrophication due to nutrient loading-related stressors. The nutrient loading has resulted in occasional algal blooms in Lake Memphremagog, though these tend to occur in late fall outside of the swimming season.

Additional stressors include flow alterations (e.g, water level fluctuations). Aquatic Invasive Species (AIS) pose a threat to the five of the lakes and acidity to several lakes (see Table 2).

All Basin 17 lakes are under a Vermont Department of Health Fish Consumption Advisory for exceeding the USEPA mercury limits in fish, although Lake Salem is considered impaired based on elevated levels of Mercury in walleye. Mercury is a chemical that becomes toxic at high concentrations. As big fish eat smaller fish, the mercury concentrations increase in the fish tissues, and through this process of bioaccumulation, mercury levels become unsafe for human consumption of the fish.

Healthy lakes with vibrant ecosystems are in-fact prevalent in the basin as well: and there are six lakes in the basin that have been identified as sentinel lakes due to their low levels of development and protected watersheds shown in Table 2 (along with Blake pond which is less than 10 acres so not included in this table.) In addition to this there are 5 lakes rated as in the top 5% of lakes statewide, two in the top 10%, three in the top 20% and 5 more in the top 20% of lakes state wide all shown in Table 2.

Wetlands

The Lake Memphremagog watershed contains a great diversity of wetlands, ranging from open water habitats to rich forested swamps, with the Upper Clyde River wetlands, South Bay Wetlands along the outlets of the Black and Barton rivers, and extensive wetlands along the upper Black River as a few examples. The wetlands in the basin are identified on the Vermont Wetlands Inventory Map (up to 39% of Vermont wetlands may not be mapped). More than 35% of the original wetlands in Vermont have been lost. In recent years, residential, commercial and industrial development have been the primary causes of wetland loss.

The USEPA's National Wetland Condition Assessment 2011 survey included Vermont wetlands with assistance from the WSMD Wetlands and Monitoring, Assessment and Planning Programs. The assessment of Eastern Mountains wetlands, including Vermont's, estimated that 52% of the estimated wetland area is in good condition; 11% is in fair condition, and 37% is in poor condition. Presently, the WSMD Wetlands Program is developing a biomonitoring program to measure wetland health to allow assessment of data specific to Vermont.

C. Condition of Specific Water Resources

Impaired Waters and Priority Surface Waters

The Department of Environmental Conservation (VDEC) uses monitoring and assessment data[2] to assess individual surface waters in relation to Vermont Water Quality Standards as outlined in the 2016 VDEC Assessment and Listing Methodology . The four categories used in Vermont's surface water assessment are **full support, stressed, altered** and **impaired**. Waters that support designated and existing uses and meet water quality standards are placed into the full support or stressed categories. Waters that do not support uses and do not meet standards are placed into the altered or impaired category.

Table 1 lists the known stressed, impaired or altered waterbodies in Basin 17. These priority waters comprise the 303(d) and the state priority surface waters lists and can be viewed on the Vermont Environmental Atlas. For a more detailed description of monitoring results use the Vermont Integrated Watershed Information System, online data portal. The goals of the Tactical Basin Plan include addressing the stressors or pollutants degrading the listed waters in Table 1 through geographically specific actions (see Chapter 5 implementation table). The types of actions prescribed are based on the stressor specific practices outlined in the Vermont Surface Water Management Strategy. Additional monitoring and assessment needs are outlined in Tables 3 and 4.

Table 1. Vermont 2016 Priority Waters and Stressed Waters List for Basin 17

IMPAIRED SURFACE WATERS IN NEED OF TMDL				
Waterbody	**Pollutant**	**Stressor**	**Problem**	**Proposed Action**
Lake Memphremagog	phosphorus	CE, LE, NL*	Algal Growth, Agricultural Runoff, Fish Kill	See Lake Memphremagog P TMDL
Stearns Brook Tributary	nutrients	CE, LE, NL	Agricultural Runoff, Nutrient Enrichment	Subwatershed-specific agricultural practices being implemented based on targeted water quality sampling.
Turtle Pond (Holland)	acid	Acid	Acidity	Acid TMDL: Support EPA's efforts to control emissions from Midwest
Duck Pond (Holland)				
Halfway Pond (Norton)				
Lake Salem (Derby)	mercury	Toxics	Elevated Levels of Hg in Walleye	Mercury TMDL: Support EPA's efforts to control emissions from Vermont and other states
Roaring Brook	nutrients	CE, LE, NL	Agricultural Runoff, Nutrient Enrichment	New impairment in 2016. See Lake Memphremagog P TMDL
STRESSED SURFACE WATERS				
Waterbody	**Pollutant**	**Stressor**	**Problem**	
Johns River 2.5 miles	nutrients	CE, LE, NL	Ag, Streambank Erosion, Loss Of Riparian	See Lake Memphremagog P TMDL

[2] (see Appendix A of the Vermont DEC Water Quality Monitoring Strategy 2011-2020

			Vegetation	
Lake Memphremagog (Newport)	mercury	CE, LE, NL, Encroachment Thermal stress	Ag, Streambank Erosion,	Mercury TMDL: Support EPA's efforts to control emissions from Vermont and other states
South Bay (Newport)	mercury, nu-trients, sedimen-tation, Eurasian watermillfoil	CE, LE, NL, AIS	Ag activity suspected	Mercury TMDL: Support EPA's efforts to control emissions from Vermont and other states. See Lake Memphremagog P TMDL
Lake Memphremagog littoral zone	new invasive species	AIS	Starry Stonewort	Implement spread prevention plan with watershed partners (See Aquatic Invasive Species section)
Stearns Brook	sediment	CE, LE	Agricultural Runoff, Gravel Road runoff, Morphological Instability	Continue implementing agricultural BMP's, complete road erosion inventory, install practices along Twin Bridges rd., monitor WQ.
Clyde Pond (Derby)	mercury	CE, LE, NL, Pathogens	Elevated Levels of Hg in Walleye	Mercury TMDL: Support EPA's efforts to control emissions from Vermont and other states
Clyde Pond (Derby	Eurasian watermilfoil	AIS		
Walker Pond (Coventry)	phosphorus	CE, LE, NL	Agricultural Runoff	See Lake Memphremagog P TMDL
Mud Pond (Craftsbury)	phosphorus	CE, LE, NL Encroachment,	Agricultural Runoff	See Lake Memphremagog P TMDL
Barton River below Ethan Allen wetlands	toxics	Toxics	Hazard waste site adjacent to wetlands	Continue VDEC biomonitoring
Black River Trib #2	nutrients	NL	Agricultural Runoff	Farm inspected with temporary practices installed in 2014 – nutrient levels lower but still elevated in 2015-2016. Biomonitoring to determine condition.
WATERS ALTERED BY EXOTIC SPECIES				
Waterbody	**Pollutant**	**Stressor**	**Problem**	
Lake Derby (Derby)	Eurasian water milfoil, Starry stonewort	AIS	Locally Abundant Eurasian Watermilfoil and Starry Stonewort Growth	Ongoing local non-chemical control program. Continue to assist landowners with management strategies (See Aquatic Invasive Species section)
Brownington Pond (Brownington)	Eurasian water milfoil	AIS	Locally Abundant Eurasian Watermilfoil Growth	(See Aquatic Invasive Species section)
Lake Elligo (Eligo Pond) (Craftsbury)	Eurasian water milfoil	AIS	Locally Abundant Eurasian Watermilfoil Growth	Ongoing local non-chemical control program. Continue to assist landowners with management strategies (See Aquatic Invasive Species section)
Great Hosmer (Craftsbury) (three segments)	Eurasian water milfoil	AIS	Locally Abundant Eurasian Watermilfoil Growth	(See Aquatic Invasive Species section)
WATERS ALTERED BY FLOW REGULATION				

Waterbody	Pollutant	Stressor	Problem	
Averill Creek, downstream from dam on Great Averill	low and fluctuating flows	Flow Alteration	Artificial Flow Regulation & Condition by downstream Hydro Station	See flow assessment section
Averill Creek, downstream from dam on Little Averill	low and fluctuating flows	Flow Alteration	Artificial Flow Regulation & Condition by downstream Hydro Station	See flow assessment section
Coaticook River below Norton Pond Dam	low and fluctuating flows	Flow Alteration	Artificial Flow Regulation & Condition by downstream Hydro Station	See flow assessment section
Little Averill Pond (Averill)	water level fluctuation	Flow Alteration	Artificial Flow Regulation & Condition by downstream Hydro Station	See flow assessment section
Great Averill Pond (Averill)	water level fluctuation	Flow Alteration	Artificial Flow Regulation & Condition by downstream Hydro Station	See flow assessment section
Norton Pond (Norton)	water level fluctuation	Flow Alteration	Artificial Flow Regulation & Condition by downstream Hydro Station	See flow assessment section
Tributaries to the Clyde River below Brighton water supply withdrawal	low & fluctuating flows	Flow Alteration	Potential water quality impacts due to water supply withdrawal	See flow assessment section
Shadow Lake (Glover)	water level fluctuation	Flow Alteration	Potential water quality impacts due to seasonal water level fluctuations	See flow assessment section
**CE: channel erosion; LE: Land Erosion; NL: Nutrient loading*			*CE: channel erosion; LE: Land Erosion; NL: Nutrient loading*	

Additional Lake and Pond Assessment Results

In addition to the 303(d) List of Impaired Waters and List of Priority Surface Waters above (Table 1), the WSMD's Lakes Program includes assessment results in the Vermont Lake Score Card to identify the overall conditions of each lake in Vermont (Table 2). The results for aquatic invasive species (AIS) and the water quality condition are also reflected in Table 2.

The score card's evaluations for the 55 lakes in Basin 17 over 10 acres (Table 2), covers five categories: Nutrient Trend and Water Quality Status, Aquatic Invasive Species, Mercury, and Shoreland and Lake Habitat. The condition for each category is described using colors: blue signifying good, yellow fair, and red reduced conditions. No color represents assessment needs. Also included are lakes that were rated in the top 25% in a best lakes rating based on a ranking system developed by the VDEC Lakes and Ponds Program. Lakes are ranked based on three categories water quality, biological diversity, and unusual or scenic natural features. In addition to this there are 7 sentinel lakes in the basin, six of which are highlighted in Table 2 and Blake Pond which is under 10 acres so not included in this table. Sentinel lakes have low levels of watershed disturbance and will be monitored each year to evaluate broad scale impacts to our lakes such as atmospheric deposition and climate change

Table 2. Lake Score Card Scores for the 55 Basin 17 lakes, ten acres or larger through 2015. Also highlighted are lakes that are rated in the top 25% of lakes through a best lakes analysis and sentinel lakes described in text above.

Lake ID	Lake acres	Town	Nutrient Trend	WQ Standards Status*	AIS	Hg	Shore	Best Lakes %	Sentinel Lakes
Back Pond	10	Brighton		pH					
Baker Pond	51	Barton		Phos, Nut, Alg**					
Bean Pond	30	Sutton		Sed**				25%	
Beaver Pond	40	Holland		pH				5%	
Beecher Pond	15	Brighton							
Brownington	139	Brownington		DO**, Sed**					
Charleston	40	Charleston							
Clyde	186	Derby							
Cobb	27	Derby		pH					
Crystal Lake	763	Barton						10%	
Daniels	66	Glover		Sed**				25%	
Daniels-W;	20	Glover							
Derby	207	Derby		Phos, Nut, Alg**					
Echo (Charleston)	550	Charleston		Sed**					
Elligo	174	Greensboro							
Graft;	12	Brighton							
Great Averill	828	Norton		Flow Alt / pH				5%	
Great Hosmer	140	Craftsbury		DO, Phos, Alg**					
Halfway	22	Norton		pH					
Hartwell	16	Albany							
Holland	325	Holland		pH				5%	Yes
Island	626	Brighton						20%	
Jobs	39	Westmore						5%	
Kidder	16	Irasburg		pH					
Little Averill	467	Averill		Flow Alt / pH				5%	
Little Hosmer	180	Craftsbury		Sed**, Alg**				20%	Yes
Long (Sheffield)	38	Sheffield						5%	Yes
Long (Westmr)	90	Westmore							
May	116	Barton		pH					
Memphremagog	5966	Newport Town		Phos / Alg**					
Moose;	10	Morgan							
Mud (Craftsbury)	35	Craftsbury		Phos, Nut, Sed**					
Mud (Holland)	14	Holland							

Lake ID	Lake acres	Town	Nutrient Trend	WQ Standards Status*	AIS	Hg	Shore	Best Lakes %	Sentinel Lakes
Mud (Morgan)-N	35	Morgan							
Mud (Morgan)-W	11	Morgan							Yes
Mud (Westmr)-W	12	Westmore							
Norton	583	Norton		Flow Alt				25%	
Page	16	Albany							
Parker	250	Glover		Phos, DO					
Pensioner	173	Charleston		Alg**, Plant**				25%	
Round (Holland)	14	Holland		pH					
Round (Sheffield)	13	Sheffield							Yes
Salem	764	Derby		Sed**					
Seymour	1769	Morgan							
Shadow (Glover)	210	Glover		Flow Alt / Alg**, Sed**					
South Bay	470	Newport City		Phos, Nut, Sed**, Alg**, Plant**					
Spectacle	103	Brighton		pH				20%	
Tildys	33	Glover		Sed**					
Toad (Charleston)	22	Charleston							
Toad (Morgan)	12	Morgan							
Turtle	27	Holland		pH				25%	
Vail	16	Sutton		Phos					Yes
Walker (Coventry)	18	Coventry		Nut, Phos					
Wheeler (Barton)	15	Barton							
Willoughby	1687	Westmore						10%	

***WQ Standards Status abbreviations Nut – Nutrients, Phos – Phosphorus, Flow Alt – Flow Alteration, DO – Dissolved Oxygen, Sed – Sedimentation, Alg – Algae, Plant – Noxious (Nuisance) Native Aquatic Plants.**
****Potential stress (not in Lake Score Card), re-assessment needed.**

Tributary Water Quality Monitoring Program

A targeted tributary monitoring program that has been supported through the LaRosa volunteer monitoring program since 2005 has included sampling at over 153 sites in the lake Memphremagog watershed with an additional 13 sites in the Stearns Brook watershed. This water sampling program has been supported through collaboration of NorthWoods Stewardship Center, the Memphremagog Watershed Association, Seymour Lake Association, and the Orleans County Natural Resources Conservation District with Fritz Gerhardt of Beck Pond LLC leading the program. This sampling program has included sampling eight times a year for nitrogen, phosphorus and turbidity with at least two dates targeting runoff events and has focused on identifying source areas through sampling small tributaries and ditches or bracketing source areas. Through these efforts, several pollution source areas

have been identified as shown in Figure 2 and many of these have been addressed in collaboration with agricultural partners and landowners while others are the focus for ongoing implementation efforts. This water quality monitoring program has demonstrated a number of cases where implementation of best management practices have resulted in reductions in phosphorous concentrations including the "Strawberry Acres" tributary where water quality sampling suggests a greater than 50% reduction in phosphorus loading after a barnyard overhaul and pasture improvement practices completed in this watershed. The Seymour Lake Association also completed sampling of six tributaries to the lake in 2008 and 2009 and will be resampling these tributaries in 2017 to see if these levels have remained consistent.

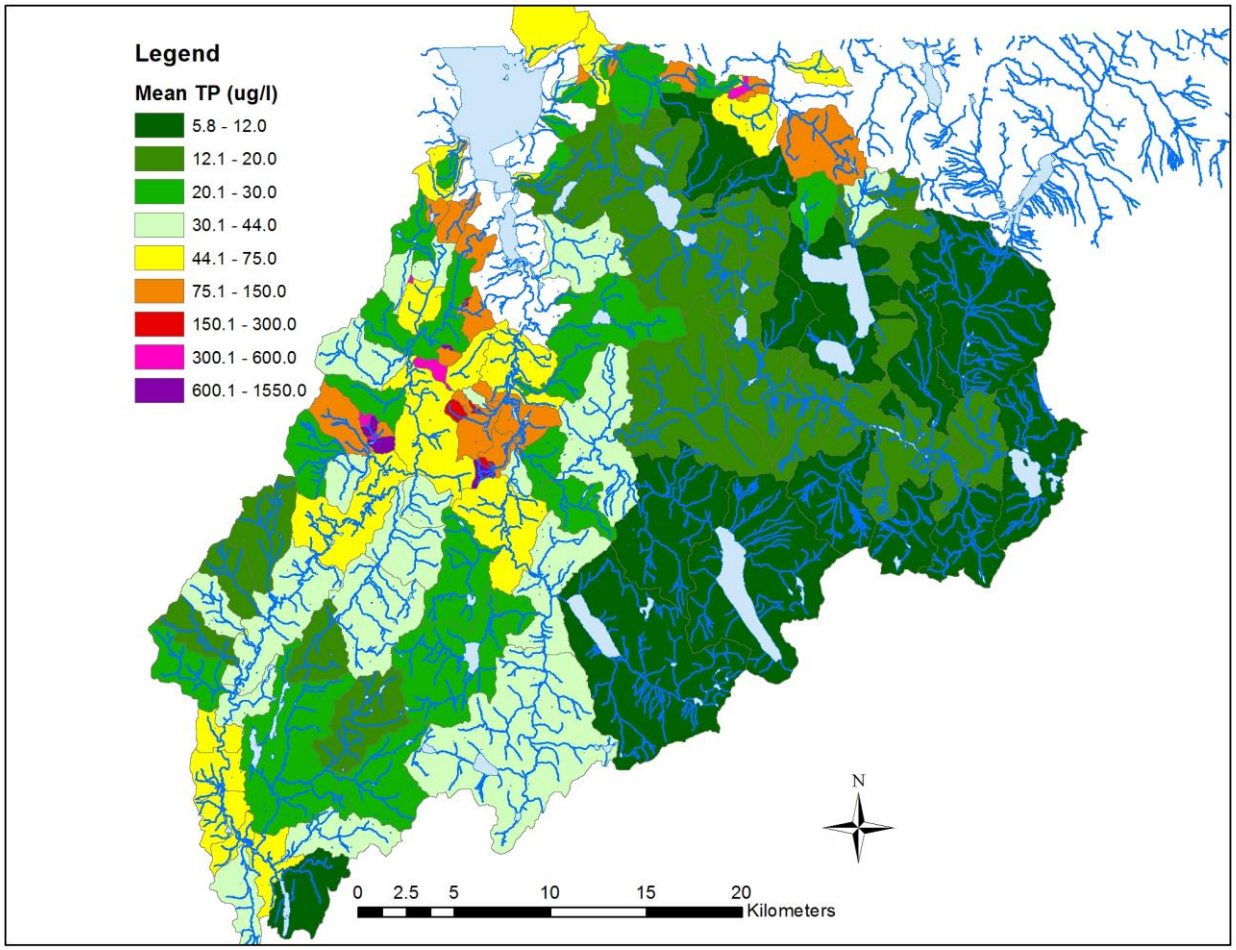


Figure 2. Mean total phosphorus concentrations measured from 146 sub-watersheds of the Lake Memphremagog Basin during 2005-2016. Watersheds with mean phosphorus concentrations of greater than 44 ug/l are targeted for phosphorus reduction efforts in the lake Memphremagog watershed.

Hazardous Waste Sites and the Coventry Landfill

There are several hazardous waste sites and Brownfields in the Basin 17 which can be viewed on the Vermont Natural Resources Atlas but no impairments to surface waters have been linked to contamination from these sites so this issue was not addressed in detail in this water quality

management plan. VDEC is continuing to monitor many of these sites thorough its biological monitoring program. There has been some migration of metals and organic contaminants into groundwater from the unlined Nadeau landfill in Coventry adjacent to the Black River but recent sampling results from two wells located in the shallow groundwater in wetlands north of the unlined Nadeau and lined New England Waste Services Vermont landfill (NEWSVT) landfills along with surface water sampling in the Black River show no indications of landfill impacts.

The Agency of Natural Resources has issued NEWSVT the following permits or certifications that address protections for water quality: a certification for Phase IV with regards to the solid waste management rules, an operational and construction stormwater, the Multi-Sector General Permit (permit #4795-9003 and a pre-treatment discharge permit (# 3-1406) which allows for treatment of 15,000 GPD of leachate at the Newport City wastewater facility. The District Environmental Commission has also issued an Act 250 land use permit covering the site which is available on the web at: https://anrweb.vt.gov/ANR/vtANR/Act250SearchResults.aspx?Num=7R0841-12. As part of the Act 250 permit, a landfill oversight committee meets twice per year to evaluate ground and surface water sampling results and as a forum for other issues that may arise with the landfill or to review landfill expansion or changes. Reports and monitoring results from the landfill including leachate, groundwater, and surface waters and biannual reports as well as waste certifications are available on the web at: https://anrweb.vt.gov/DEC/ERT/SolidWaste.aspx?SWFacID=OL510

Water Quality Monitoring and Assessment Status and Needs

Surface water assessments lead to a better understanding of the stressor or pollutants impacting surface waters as well as source areas or even specific implementation projects to address source areas. Many of these assessments target a specific land use or source category such as stream channel adjustments. During the tactical basin planning process, the results of the assessments are considered along with modeling results to prioritize geographic areas for project development and to identify priority projects for inclusion in the Tactical Basin Plan's summary implementation table (Chapter 5) and in the online implementation table database. These projects can then be used to help meet regulatory requirements or support voluntary efforts. Specific assessment needs for each subwatershed are included in Tables 3 and Table 4.

Table 3. Status of Basin 17 assessments that lead to stressor/project identification.
X= proposed in plan C= Completed PC= Partial Completion U=Underway NA=Not Applicable

	Water Quality Monitoring (volunteer)	***Geomorphic Assessment***	***Illicit Discharge Detection***	***Agricultural assessment***	***Stormwater Master planning***	***Road Assessment***
Black River	U	Need update	NA	U		X
Barton River	U	Need update	C	U	C, (Barton, Orleans)	X
Clyde River	U	Need update	C	U	C (Derby, Newport City, Brighton)	X
Direct Drainages	U		C	U	C (Derby, Newport City)	X
Tomifobia	U		NA	U	C (Derby Line)	X
Coaticook			NA	U		X

Additional monitoring and assessment priorities have been identified in Table 4 for waters that have an uncertain status based on old identification of stressed condition for lakes, where recent stream sampling has identified a stressed or impaired condition for macroinvertebrate or fish to inform remediation or protection strategies and conditions may have changed in subsequent years in some cases due to extensive BMP implementation. Additional sampling through the Lay Monitoring program, which supports volunteer sampling of lakes for Secchi transparency, total phosphorus and chlorophyll, will be targeted to lakes with increasing trends. VTDEC is also focused on completing assessments of shoreland conditions for three lakes where this information is lacking. Additional monitoring priorities are to support reclassification of streams as B(1) waters, stream geomorphic assessments, and watershed assessments for lakes which have increasing nutrient trends and local interest in supporting assessment and follow-up work.

Stream monitoring is a priority in high phosphorus export watersheds to identify source areas and evaluate reductions achieved through BMP implementation through the LaRosa volunteer monitoring program, with additional sampling of the four major tributaries by VDEC to support evaluation of changes in loading from these tributaries. Finally, the continued monitoring of Lake Memphremagog through the Lay Monitoring program is essential for understanding changes in phosphorus levels and transparency in Lake Memphremagog.

Table 4. Additional monitoring and assessment needs to inform remediation or protection strategies.

Water body	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
Baker Pond	Barton	Evaluate nutrient stressed condition	Last spring P sample was 2007	Spring P Moderate priority
Derby Pond	Derby	Evaluate nutrient stressed condition	Last spring P sample was 2007	Spring P High priority
Brownington Pond	Brownington	Evaluate nutrient stressed and DO stressed conditions	Listing is based on two Hydrolab profiles done in 1992 and 2000	Find an LMP volunteer, and summer or winter DO profile
Parker Pond	Glover	Evaluate nutrient stressed and DO stressed conditions	DO profiles anoxic 7-12m consistently in multiple 2000 visits and in 2007	High priority LMP QC with DO profile
Stearns Tributary RM .1	Holland	Evaluate WQ improvements	Reduced phosphorus at upstream sites	Macroinvertebrate, fish and Chemistry
Stearns Brook RM 2.3	Holland	Understand sediment levels		Macroinvertebrate, fish and Chemistry, Stream walk to evaluate P2 SGA need.
Roaring Brook RM 2.4	Barton	Determine status	Impaired- Fair Bugs 2009 and 2014	Macroinvertebrate, fish and Chemistry
Black River Tributary #2.	Coventry	Determine status	Poor conditions in 2015	Macroinvertebrate, fish and Chemistry
Trout Brook	Coventry	Determine status	Very good to excellent bugs in 2014-15 poor fish 2014-2016	Macroinvertebrate, fish and Chemistry. Do watershed survey

Water body	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
Lake Memphremagog Tributary #9	City of Newport	Determine status	Excellent bugs but poor fish in 2014	Macroinvertebrate, fish and Chemistry
Crystal Brook	Derby	Evaluate WQ improvements	Very good conditions in 2015	Macroinvertebrate, fish and Chemistry
Annis Brook	Barton	Evaluate potential stressed condition	Fair to very good from 2009 through 2013	Macroinvertebrate, fish and Chemistry
Upland Trout habitat	many	Explore Class B(1) or A(1) for Fishing use	Lots of existing data needs to be evaluated	
Johns River RM 3.1 and 4.8	Derby	Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data supporting higher classification than Class B2 or other: Macroinvertebrates	We need to evaluate if these sites should be listed with divergence with fish status
Hurricane Brook	Norton	Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data supporting higher classification than Class B2 or other: Macroinvertebrates	One more year of fish data
Duck Pond Brook Trib #3	Sheffield	Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data supporting higher classification than Class B	One additional year of fish data if this is a brook trout only stream
Holland Pond Tributary 3	Holland	Confirm as Class B(1) for aquatic biota and wildlife	Macroinvertebrate condition in 2009 was Ex-very good	One additional year of fish and bug data if BK trout stream only
Coaticook RM 40	Norton	Confirm as Class B(1) for aquatic biota and wildlife	2014 Very good bugs excellent fish communities	One additional year of fish and bug data
Pherrins River RM 3.1	Brighton	Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data excellent so could be B(1) or A(1) water	One additional year of Macroinvertebrates and fish
Rogers Branch RM 1	Albany	Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data supporting B(1) classification but need fish data	One additional year of fish data if this is a brook trout only stream
Phase 2 SGA priorities – see unstable stream channel section.	Multiple	Understand SGA condition and identify potential projects	Phase 1 SGA has been completed for all stream segments.	Phase 2 stream geomorphic assessment and update basin river corridor plan.
Seymour Lake Tributaries	Morgan	Identify nutrient sources	Increasing lake nutrient trends- tributary chem monitoring in 2008/9 and 2017	Chemical monitoring and watershed survey
Lake Willoughby Tributaries	Westmore	Identify nutrient sources	Increasing lake nutrient trends survey	Chemical monitoring and watershed survey
Shadow Lake Tributaries	Glover	Identify nutrient sources	Increasing lake nutrient trends	Chemical monitoring and watershed survey

Water body	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
Memphremagog high phosphorus export streams	Multiple	Identify nutrient sources, Evaluate phosphorus reductions from BMP implementation	MWA LaRosa monitoring program	Chemical monitoring with biological follow-up when necessary.
Black, Barton, Johns, Clyde	Coventry, Newport, Derby	Evaluate changes in loading related to the Memph TMDL	Ongoing sampling program managed by VDEC	
Lake Memphremagog	Newport	Evaluate changes in Lake TP concentration	LMP program monitoring program	Chemical monitoring
Rivers highlighted in Table 24.	Multiple	Identify waters for B(1) and A(1) fishing use	Widespread fisheries monitoring	More recent data and filling in data gaps

D. Basin Specific Total Maximum Daily Loads (TMDLs)

Lake Memphremagog Phosphorus Total Maximum Daily Load

Figure 3. Cyanobacteria Bloom in Lake Memphremagog

Phosphorus levels in the Vermont portion of Lake Memphremagog are over 20% higher than the water quality criterion set for the lake of 14 ug/l. Elevated levels of phosphorus contribute to occasional cyanobacteria (also called Blue Green Algae) blooms but also support excessive plant and algae growth that occasionally limits the quality of the lake for recreational use. A Total Maximum Daily Load (TMDL) is required by the Clean Water Act to set a limit of phosphorus that can enter the lake from its watershed and still meet this criterion. Lake Memphremagog is an international waterbody with over 73% of its surface area in Quebec, while 27% is in Vermont. Currently Lake Memphremagog meets its phosphorus guideline in Quebec however, through the Quebec Vermont Steering Committee on Lake Memphremagog, collaborative efforts have supported modeling and efforts to reduce loading in both Vermont and Quebec and an international agreement on the implementation of this TMDL is being considered.

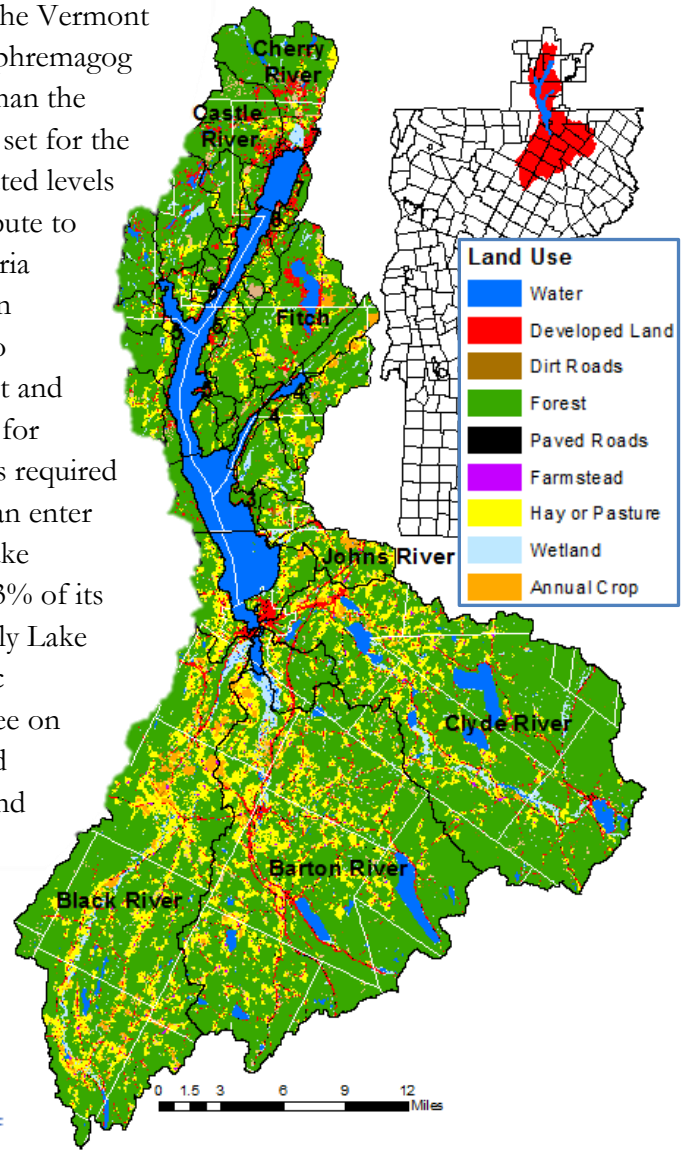


Figure 4. Land use across the Lake Memphremagog watershed.

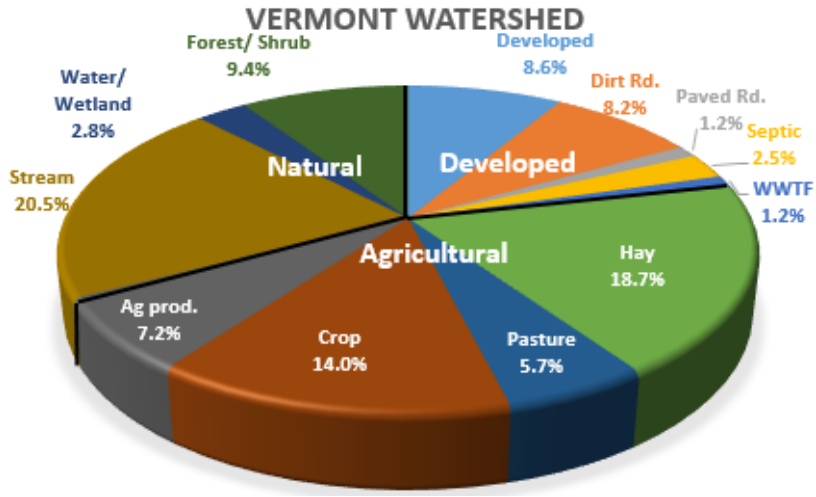


Figure 5. Estimated phosphorus loading from different land use sectors from the Vermont portion of the Lake Memphremagog watershed.

Modeling and the Draft TMDL

A land use phosphorus export model was developed for the watershed to estimate phosphorus loading from each of these land use sectors. The model estimates that much of the load is coming from agricultural lands (46%). Developed land

(including 2.5% from septic) contribute 22%, with an additional 20.5% from stream channel instability and 12% from natural sources. WWTFs contribute 1.2% of the total load. A detailed breakdown of loads from various sectors is shown in Figure 5.

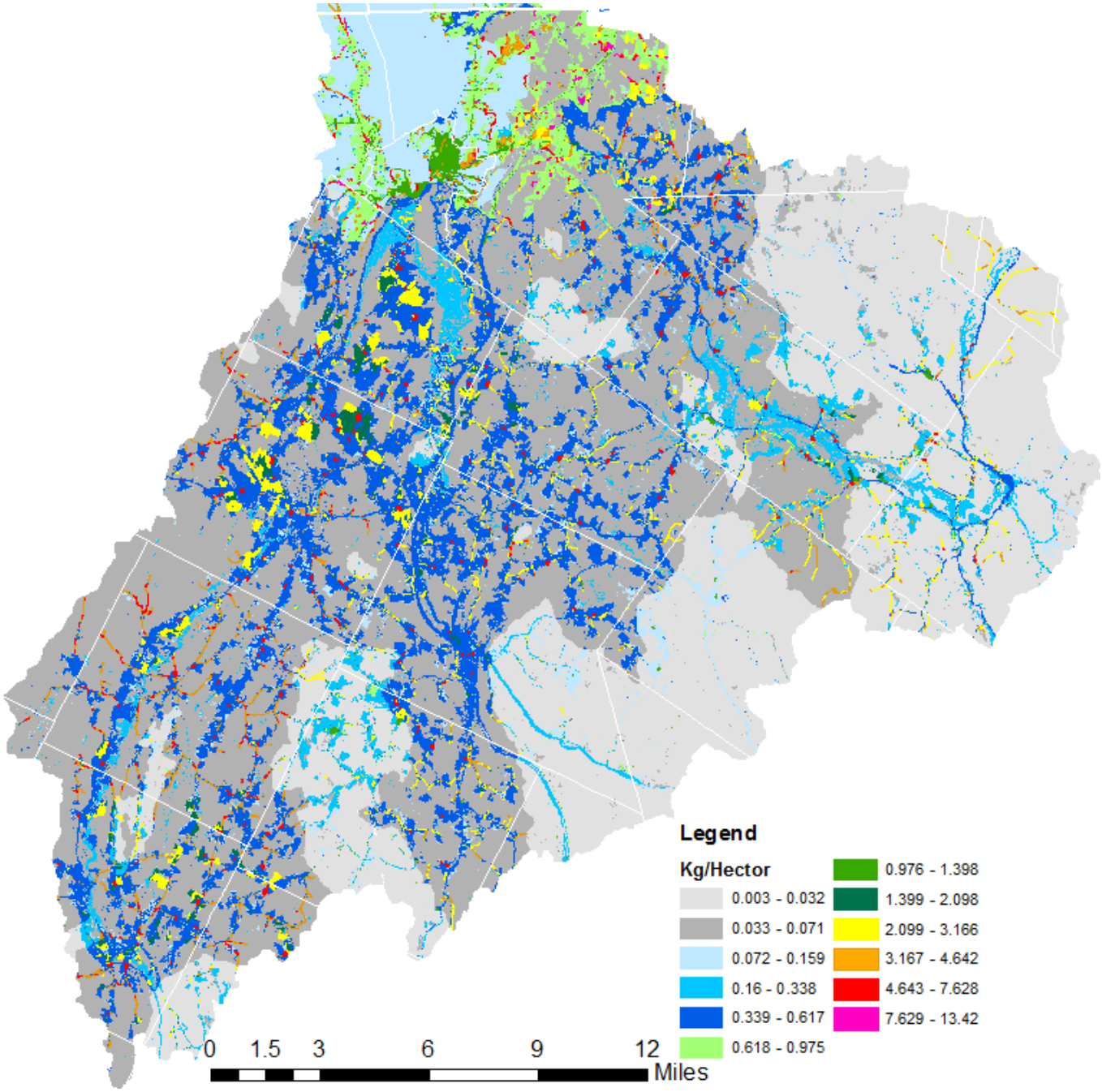


Figure 6. Estimated land use phosphorus loading rate to the main lake segment in kilograms per hector based on the calibrated land use phosphorus export model. This does not include estimated loading from septic systems, stream channel instability or WWTF loading.

This land use export model accounted for phosphorus retention in upland lakes, which for some sub-basins was estimated to be as much as 90% as water flowed through a series of large lakes in portions

of the Clyde River watershed, or as much as 80% for portions of the Upper Barton River watershed when factoring in retention in South Bay.

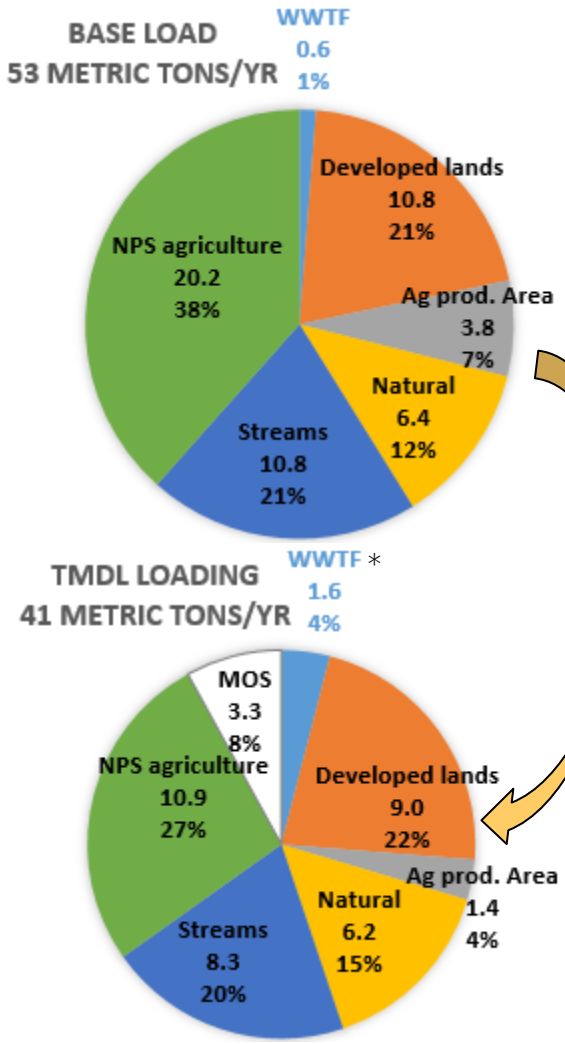


Figure 7. Proposed allocations for Lake Memphremagog

* Base load for Wastewater is shown as current actual loads (647 kg). Current permit limits are higher (2456 kg) and the final load allocation shows future permit limits (1641 kg) which is a reduction of 33%.

A lake model was developed using in-lake and tributary monitoring data to translate the watershed loading into resulting in-lake phosphorus concentrations. The lake was broken down into eight segments to describe the lake's unique characteristics of which South Bay and the Vermont Lake segments are in Vermont. Exchange between these segments, and the loss of phosphorus from each segment to lake-bottom sediments was also estimated, with a particularly large retention estimated for South Bay of 54%.

After calibration, this model suggests that a 21% phosphorus load reduction for the Vermont portions of the Lake Memphremagog watershed is necessary to bring phosphorus concentrations in Vermont waters to 14 ug/l. This percent reduction represents the overall loading reduction needed, but the TMDL allocations determine how much reduction is necessary from each sector, and also include a margin of safety of 8%, which increases the total load reduction required to 29%, to ensure attainment of the water quality standard in Lake Memphremagog.

Setting the Phosphorus Load Reduction approach

Public meetings were held over 2016 and early 2017 to discuss the most effective way that TMDL load reductions can be achieved across different land use sectors for the development of the Draft TMDL allocations. These meetings included a meeting on June 30th, a meeting on August 11th that focused on agricultural load reductions, a meeting on August 31st that was focused on upland lake watersheds and a meeting on

Table 5. Proposed allocations for Lake Memphremagog TMDL and required reductions by major land use sector.

	Waste Load Allocation (WLA) in Kg					Load Allocation (LA) in Kg					
	WWTF Permit to Lake	Average WWTF Load	Devel.	Future Growth	Ag prod. Area	Natural	Streams	Agric.	**Total**	8% MOS	**Total**
Base Load	2458	647	10791		3801	6426	10776	20233	52674		52674
Draft TMDL	1641		8823	222	1368	6198	8287	10914	37454	3257	40711
% Reduction	**33.2%**		**18.2%**		**64.0%**	**3.5%**	**23.1%**	**46.1%**	**28.9%**		**23%**

November 15th where draft allocations were discussed. Load reduction options were evaluated using the Lake Memphremagog scenario tool, which estimates the load reduction achieved by applying a combination of Best Management Practices (BMPs) across a percentage of a land use for a portion of the basin which is shown in detail in Table 7.

Through the implementation of this BMP scenario is it possible to meet the phosphorus TMDL load allocations through reductions in loading of:

- 33% of current permitted WWTF loading
- 18% for developed lands
- 64% for agricultural production areas
- 3.5% for natural lands
- 23% for stream channels
- 46% for agricultural lands

The key components of the Scenario tool are 228 BMP's where phosphorus reduction efficiencies were estimated through modeling in the Lake Champlain watershed, based on EPA's published technical analyses. Many of the practices contemplated are required through regulations passed with the Clean Water Act, Act 64 described in Table 6.

Table 6. New or updated regulations that will support BMP implementation.

Regulatory Program or Permit	Application	Issuance Date	Regulated Community
Required Agricultural Practices (RAPs)	Adopt and implement a set of minimum conservation practices to protect water quality	2016	Agricultural operations
Municipal Roads General Permit (MRGP)	Inventory and control stormwater discharges from municipal roads	2017	Municipalities
Updated Acceptable Management Practices (AMP) for forestry operations	Minimize erosion from forestry operations	2016	Forestry operations
Operational Three-Acre Permit	Inventory and control stormwater discharges on sites where impervious surfaces exceed 3 acres	2017	Municipalities and Private Land Owners
Transportation Separate Storm Sewer System (TS4) Permit	Inventory and control stormwater discharges from the transportation network and associated transportation facilities	2016	State transportation

Implementing the TMDL through Tactical Basin Planning

The Lake Memphremagog phosphorus TMDL includes one example of a BMP scenario that will achieve necessary load reductions, however the specific mix of BMPs that will be implemented over the

next 20 years will ultimately reflect the specific practices that will be required by regulations, those that have landowner support and at the local level have been identified to have the highest potential to reduce phosphorus loading. Through the five-year iterative monitoring assessment and planning cycle, new information will be learned that will help to inform which BMPs will most efficiently meet target phosphorus load reductions and will allow for adjustments if loading reductions are not being met. This tactical basin plan identifies an initial set of prioritized BMPs that will maximize phosphorus load reductions over the next five years, however further assessments will be completed which will allow the identification and prioritization of additional projects that will become a priority for the next five-year planning cycle. This adaptive management approach ensures that the practice requirements implemented by landowners, municipalities, and other entities will be as cost-effective as possible and allows for adjustments to be made to respond to changes in rainfall patterns expected with climate change along with other uncertainties. The load reductions achieved through these practices will be tracked through the BMP Accounting and Tracking Tool, a component of the Watershed Projects Database that is currently being expanded to track BMPs in the Lake Memphremagog as well.

As noted in the section on water quality conditions in the basin, 56 watersheds in the Lake Memphremagog watershed covering 13% of the basin have been identified as generating elevated nutrient levels (mean phosphorus concentrations of over 44 ug/l) and so are targets for interventions to reduce phosphorus loading. This water sampling program will be integrated into the tactical basin planning approach allowing for the targeted application of BMPs where elevated loading rates have been identified. Water sampling will be used to evaluate BMP effectiveness and opportunities for adjusting or changing BMPs if elevated levels of loading continue.

The proposed sector by sector approaches to reducing phosphorus loading to Lake Memphremagog are described in the following chapter with a summary implementation strategies listed in Chapter 5, and a detailed list of potential projects listed in the watershed projects database. Phosphorus load reductions achieved though project implementation will be tracked so progress in meeting TMDL loading reduction targets can be evaluated at the beginning of the next five-year planning cycle with a goal of meeting load reduction targets and in-lake water quality standards in 20 years.

Table 7. The current proposed set of BMPs to meet TMDL phosphorus load reduction targets across all land use sectors except WWTF

% Total load reduction	Land use	Area in acres	Load to lake (lbs)	BMP	Percentage applied	Acres treated	BMP efficiency	Load reduction (lbs)
0.7%	Developed Pervious	9,166	3,978	Ban on P Fertilizer Use on Turf	12%	1,100	50.0%	239
0.4%	Developed Pervious	9,166	3,978	Riparian buffer	5%	458	67.0%	133
0.5%	Developed Impervious	3,618	5,781	Riparian buffer	5%	181	67.0%	194
1.0%	Developed Impervious	3,618	5,781	Surface Infiltration Practices .5"	8%	289	77.0%	356
0.7%	Forest	211,240	10,021	Stream Crossing Erosion/Sedimentation Control	100%	211,240	5.0%	501
0.3%	Road Paved	1,607	1,367	Infiltration Trench.5"	10%	161	77.0%	105
9.8%	Dirt Road Combined	2,391	9,507	Roadside Erosion Control	65%	1,560	50.0%	3,574
14.7%	Farmstead	974	8,380	Barnyard Management	80%	779	80.0%	5363
12.1%	Hay	35,657	21,680	Ditch buffer or 10 ft Manure spreading setback	40%	14,263	51.0%	4423
11.9%	Hay	35,657	21,680	Riparian buffer or 25 ft Manure spreading setback	30%	10,697	67.0%	4358
1.5%	Hay	35,657	21,680	Gully stabilization and- 25 ft Riparian Buffer/setback	3%	1,070	84.0%	546
2.5%	Pasture	10,880	6,616	Fencing/livestock exclusion with out riparian buffer	25%	2,720	55.0%	910
3.3%	Pasture	10,880	6,616	Fencing/livestock exclusion with riparian buffer	25%	2,720	73.5%	1215
1.1%	Pasture	10,880	6,616	Managed Intensive Grazing	25%	2,720	24.0%	397
11.9%	Cropland Combined	6,021	16,309	Cover crop - Conservation tillage - Grassed Waterways - Ditch Buffer	31%	1,859	84.0%	4,357
2.0%	Cropland Combined	6,021	16,309	Change in Crop Rotation - Grassed Waterways - Ditch Buffer	4%	238	74.0%	727
1.5%	Cropland Combined	6,021	16,309	Cover crop	12%	735	27.3%	543
0.6%	Cropland Combined	6,021	16,309	Conservation tillage - Manure injection	6%	374	20.0%	219
3.6%	Cropland Combined	6,021	16,309	25 ft Riparian buffer	13%	805	67.0%	1,318
2.7%	Cropland Combined	6,021	16,309	10 ft Ditch buffer	13%	805	51.0%	1,004
1.4%	Cropland Combined	6,021	16,309	Grassed Waterways	10%	602	40.0%	527
15.0%	Streambank	-	23,758	Restoration of Equilibrium Condition	42%	-	55.0%	5488
100.0%	total	271,047	105,474			262,355		36496

E. Priority Sub-basins for Remediation

The assessment results described throughout this Chapter as well as the state-listed waters (Table 1), and phosphorus source areas shown in Figure 2 provide a basis for identifying priority sub-basins highlighted in Table 8 for remediation. These priority sub-basins have been identified as stressed or impaired or at risk for becoming so, or as contributing significant pollutant loading to Lake Memphremagog and so are a priority for phosphorus load reduction efforts for the Lake Memphremagog TMDL. In addition, assessments have provided information about appropriate strategies and actions to address stressors. The actions in the in the Basin 17 Implementation Table summaries and online Watershed Projects Database were informed by these priority actions.

Table 8. Priority sub-basins for remediation identifying primary stressors and priority strategies.

Priority sub-basins	Stressor	Target Sector	Priority actions
1) High phosphorus export watersheds **identified though water quality sampling where mean phosphorus values are above 44 ug/l as shown in Figure 2.**	land erosion, nutrient loading	Agricultural, Gravel roads, Developed land	Field, barnyard and road outreach and BMPs, riparian plantings
2) Roaring Branch – **does not meet biological standards and elevated nutrient levels measured through water quality sampling tied to farm runoff.**	land erosion, nutrient loading	Agricultural, Gravel roads	Field, barnyard and road BMPs, riparian plantings
3) Walker and Mud Pond watersheds. **Both ponds are listed as stressed due to elevated phosphorus levels and poor clarity.**	Land erosion, nutrient Loading,	Agricultural and for Walker Pond Developed lands	Field and barnyard BMPs, Lake Wise BMPs for Walker Pond
4) Elligo, Little and Great Averill, Holland, Long, Parker, Norton, Salem, Seymour, Shadow, Willoughby watersheds. **Lakes with increasing nutrient trends**	Land erosion, nutrient Loading, encroachment	Agricultural, Gravel roads, Developed lands	Lake Wise, shoreline planting, field, barnyard and road BMPs.
5) Airport Tributary – **Identified as having elevated turbidity and phosphorus levels through water quality sampling. Source appears to be gully erosion below Airport stormwater outfall. Retrofit designed as part of stormwater master plan.**	Land erosion, channel erosion,	Developed land	Airport Stormwater retrofit, field practices (project 2188 in WPD)
6) Barton River from Barton to Orleans. **Stream channel going through channel evolution process- focus for restoring equilibrium condition.**	channel erosion, encroachment	Unstable stream channels	Project development, riparian plantings, river corridor easements
7) Derby, Newport City, Orleans and Barton. **Areas of developed lands in the basin.**	Land erosion, channel erosion, encroachment	Developed Lands	Stormwater retrofit design and implementation, education, and outreach.

Priority sub-basins	Stressor	Target Sector	Priority actions
8) Little and Great Averill lakes and stream, Norton Pond. **Listed as Altered due to flow alteration**	Water level and flow alteration	Dam management	Support revised Public Service Board (PSB) regulations to require crest control at dams.
9) Lake Memphremagog – **Presence of nonnative invasive species Eurasian watermilfoil and Starry Stonewort along high level of boat traffic make targeted spread prevention efforts a priority for this waterbody.**	AIS	Lakes	Vermont Invasive patroller program, Greater Programs, Wash stations, targeted control efforts.

Chapter 3 – Implementation of Basin Priorities to Restore Surface Waters.

A. Stormwater Runoff from Developed Lands.

Runoff from developed lands, excluding road runoff, is estimated to comprise 11% of the total phosphorus loading to Lake Memphremagog from the Vermont portions of the basin. Stormwater runoff from developed lands is estimated to make up 8.4% of the phosphorus loading to Lake Memphremagog with an additional 2.5% from septic systems. In addition to this, some of the most heavily developed lands in the watershed are surrounding upland lakes and ponds which are particularly sensitive to increased phosphorus loading including the 13 lakes and ponds with increasing nutrient trends referenced in Chapter 2. These lakes are the focus for Lake Wise assessments and BMP implementation based on Table 4. The Lake Memphremagog TMDL allocation requires a 18.2% reduction in phosphorus loading across all developed lands including roads and reduction of 7% from stormwater runoff from non-road developed lands which is achieved in the TMDL scenario by the application of the following BMPs:

1. Ban on fertilizer use on Turf applied to 12% of developed pervious lands in the basin reducing estimated phosphorus loading by 239 lbs.
2. Riparian buffers applied to 5% of developed pervious and impervious lands in the basin reducing estimated phosphorus loading by 327 lbs.
3. Surface infiltration practices treating 0.5 inch rainfall applied to 8% impervious lands reducing estimated phosphorus loading by 356 lbs.

In the Lake Memphremagog TMDL, all regulated developed land phosphorus loads are considered part of the wasteload allocation. This section describes the so-called Operational Three-acre Impervious Surface Permit and Stormwater master planning, while the Municipal Roads General Permit and Transportation Separate Storm Sewer System Permit (TS4) are described in the transportation section.

Operational Three Acre permit – and stormwater retrofits

Stormwater runoff from existing developed land, exclusive of surfaces regulated under the state or municipal roads stormwater programs, will be addressed in a staged and prioritized manner through a system of watershed-based stormwater permitting. The first stage of implementation will require permit coverage for all stormwater discharges on sites where impervious surfaces exceed three acres. Act 64 of the 2015 Vermont State Legislature requires the Department to issue a general permit for existing impervious surfaces greater than 3 acres where the discharge did not previously obtain permit coverage, or where the discharge was permitted under standards prior to adoption of the Vermont Stormwater Management Manual. The Department must issue the final general permit on or before January 1, 2018. All affected parcels in the Lake Memphremagog basin shall obtain permit coverage by 2028. The precise level of BMPs, and associated phosphorus reduction, will be determined during development of the general permit and will be sufficient to ensure the regulated discharges are consistent with the pollutant load allocation for developed land. The reader should note that stormwater management on all VTrans-owned developed lands, including parcels of three acres or larger, will be addressed under the TS4 permit.

Mapping of parcels that will come under the three-acre permit has not been done for the Lake Memphremagog watershed and so completing this mapping is a priority for this coming planning cycle, so these parcels can be identified. Subsequently, landowners will be notified of their requirement to seek coverage under this permit and estimates of loading achieved though this regulation can be refined. Due to this 3-acre permit timeline for this basin and the relatively small number of three acre parcels in this basin, voluntary efforts to reduce phosphorus loading from non-jurisdictional properties will also be a focus of this tactical basin plan through efforts of stormwater master planning, IDDE efforts, and though implementing of storm water practices around lakes and ponds through the Lake Wise program.

Stormwater Master Planning and Outreach

The Essex County NRCD and Memphremagog Watershed Association (MWA) have recently completed stormwater master plans for the towns of Brighton, Derby, Barton, Village of Orleans and City of Newport which have identified a number of priority restoration projects. Four of the stormwater retrofit projects in the Town of Brighton have been selected for ecosystem restoration funding and installation will be finished in 2017. The MWA stormwater master planning project identified and prioritized 20 potential retrofit projects, for which four have had a 30% design created. Moving these four projects to implementation would reduce an estimated annual loading of 384 lbs per year, presenting a high priority for implementation if landowner support can be maintained and the project prove feasible upon final design and evaluation. Two of these projects, accounting for 124 lbs of phosphorus per year, are on Agency of Transportation facilities and are described in the TS4 section.

Several projects which are not yet at 30% design are a priority for further evaluation including several small Green Stormwater Infrastructure (GSI) sites in downtown Newport, at the Newport Elementary School, Glover Town Offices and one private business where infiltration may help to address a large mass failure caused by stormwater runoff. To move these projects forward, a Memphremagog stormwater collaborative has been proposed for the Lake Memphremagog watershed to support local technical expertise and local capacity, to contact landowners and obtain commitments of support, and to further evaluate potential project limitations. Once these topics are resolved, the projects should move forward for 100% design.

Several partners in the basin participated in the Leahy Center Environmental Summit on building resilience and creating a culture of clean water in March of 2017 to discuss how to best support practices that will provide flood resilience and address stormwater runoff in the Lake Memphremagog watershed. The outcome of this discussion was to form the Memphremagog Stormwater Collaborative to provide technical resources to support the implementation of specific projects identified in the stormwater master plan, but also to lead workshops and public education campaign to encourage landowners to address stormwater runoff on their own properties though workshops, demonstrations projects, and selling rain barrels. The stormwater collaborative would also work across sectors supporting the implementation of Lake Wise practices in coordination with lake associations, stormwater from farmyard areas in coordination with OCNRCD, and support to towns with road erosion inventories and capital budgets, and implementation of practices with greatest water quality benefits. There are several partners that are working on stormwater issues and so a big role for the collaborative is sharing technical expertise and identifying opportunities for coordinating funding to support projects that may be led by partners across the basin including working with the NorthWoods Conservation Crew to install practices. Click the following hyperlink to view summary strategies to address Runoff from Developed Lands.

Basin-wide Illicit Discharge Detection and Elimination (IDDE) Study

In 2015, Stone Environmental, Inc., completed a basin-wide IDDE study through an Ecosystem Restoration Grant received by MWA. The study is available on the web at: http://dec.vermont.gov/sites/dec/files/wsm/erp/docs/IDDE/erp_report_LMB.pdf with an addendum that was produced in 2016 when an additional 8 drainages were evaluated by Stone under a direct contract with VDEC which is also available at: http://dec.vermont.gov/sites/dec/files/wsm/erp/docs/IDDE/Memphremagog%20AI%20Final%20Report.pdf . Seven municipalities participated in the project: The Town of Barton, the Village of Orleans in Barton, the Town of Brighton, Newport City, and the Town of Derby and its villages of Derby Line and Derby Village. The geographic scope of the project included the entire extents of the municipal closed drainage systems. A total of 375 stormwater drainage systems were assessed with confirmation of 13 illicit discharges in 11 stormwater drainage systems. All of these identified illicit discharges have been addressed collaboratively with municipalities except for two potential failing septic systems in Derby Center where follow-up work by VDEC continues.

Lake Wise Assessments and BMP Implementation

The Shoreland Protection Act ensures that new shoreland development will have minimal impact on the lake in terms of phosphorus and sediment runoff, and degradation of aquatic habitat. In addition, areas proposed for redevelopment may not increase their impact on lake water quality. However, 39% of the lakes in the basin already have high levels of shoreland alteration based on the 2015 lake score card (Table 2) and so there is a need to restore shoreland habitat on many lakes in the basin. Phosphorus runoff from developed shoreland areas is also often a primary source of nutrients for upland lakes. Of lakes over 10 acres, over 50% in the basin have statistically significant increasing phosphorus trends or are listed as stressed due to elevated levels of phosphorus or both.

The combination of nutrient and shoreland habitat issues make restoration of lakeshore vegetation and addressing erosion and stormwater runoff from shoreland development a priority through the Lake Wise program. Lake Wise is a recent addition to VDEC's Lakes and Ponds Management and Protection Program, designed to provide outreach and technical assistance around shoreland management. Launched in the summer of 2013, the Program provides on-site review of shoreland conditions and recommendations for lessening the impact of existing shoreland development on a lake. More importantly, the program is designed to recognize and reward good shoreland management by providing landowners with an attractive sign to post on their property that indicates they are "Lake Wise." Landowners wishing to retrofit their property to meet Lake Wise standards are given a list of BMPs that can be easily implemented. Participation is tracked and a cumulative benefit of the program in terms of improved property management can be calculated. Basin 17 has been the focus of a large amount of Lake Wise assessments supported by VDEC and Lake and watershed associations. The status of Lake Wise assessments in the basin is summarized in Table 9 and can be viewed online at:

http://dec.vermont.gov/watershed/lakes-ponds/lakeshores-lake-wise/lakewisemap

Table 9. Lake Wise Awards, Certificates, completed and potential projects for lakes in Basin 17.

Lake	Lake Wise Awards	Lake Wise Certifications	Lake Wise evaluation	Completed projects	Potential projects
WILLOUGHBY	3	0	3	2	1
ECHO (CHARTN)	15	6	27	7	6
SEYMOUR	14	22	39	11	9
SHADOW (GLOVER)	0	1	2	0	1
MEMPHREMAGOG	7	0	7	0	0
ISLAND	1	0	2	1	1
Total	0	0	0	21	16

The Agency is developing a Lake Wise master planning process where coordinated Lake Wise assessments can be done around a target lake with each assessment cataloging potential BMP projects and landowner interest in implementing these. These BMPs will then be prioritized based

on their ability to reduce nutrient runoff and improve habitat conditions along lakes and landowner interest in implementing practices. The following lakes are priories for Lake Wise master planning Willoughby, Seymour, and Shadow Lakes, although if other lakes associations are supportive of such efforts the Agency will make every effort to support their efforts. The Memphremagog Stormwater Collaborative has proposed partnering with lake associations to support Lake Wise assessments and to support the mentoring by lake associations that have been successful in working with landowners with other lakes who have not been active in this program yet. The Target for Lake Wise participation on a lake is 15% and so the stormwater collaborative would like to create a map to highlight lakes which are close to meeting this target and to support the celebration when lakes meet this target.

Priority projects identified in Lake Wise Masterplans can be implemented by lake associations or watershed groups and landowners with grant support where necessary and in concert with workshops and volunteer work days to increase knowledge of these practices around each lake. The Stormwater collaborative may also work with several lake associations to provide technical assistance in implementing Lake Wise BMPs and to get funding to support BMP implementation and/or support collaboration with the Northwoods Conservation Corps.

The Agency has identified several public properties in the basin that could benefit for the instillation of Lake Wise practices which, in addition to reducing nutrient runoff and improving habitat, can serve as demonstration project to increase the understanding of such practices for private landowners. One project is being implemented on Brighton State Park in 2017, and another is being planned for Shadow Lake Beach for 2017, and additional projects are a priority on the beach at the North End of Lake Willoughby where trees could be planted, at the Coutts Moriarty Camp on Lake Salem, and finally an additional shoreline restoration on town land on Island Pond to complete a major shoreline buffer planting and stormwater treatment efforts completed by the town in recent years.

The Agency is developing an approach for developing detailed management approaches for at-risk upland lakes to be incorporated into Tactical Basin Plans through an updated lake-watershed assessment process that is being developed in 2017. Lakes with nutrient enrichment trends or stress and supportive lake or watershed associations will be a priority for this work. Click the following hyperlink to view summary strategies to address Runoff from Lakeshore Properties.

B. Stormwater Runoff and Erosion from Roads

Runoff from roads is estimated at 9.4% of the total loading to Lake Memphremagog from the Vermont portions of the basin with 1.2% from paved roads and 8.4% from gravel roads. Roads managed by the State of Vermont make up 60 percent of the paved roads in the basin with the remainder managed by municipalities. In addition to this, there are private roads and driveways that account for large areas of impervious developed lands in the basin. Gravel roads and private roads

and driveways contribute a large proportion of sediment and phosphorus to many of the 13 lakes and ponds that have been identified to have increasing nutrient trends in the basin. Erosion from roads is a contributor of sediment in headwater streams which can cause embeddedness reducing the quality of aquatic habitat and negatively impacting fisheries. Finally, many of the BMPs to reduce erosion from roads also increase flood resiliency and so should reduce the levels of damage from storm events. The Lake Memphremagog TMDL allocation requires a 32.6% reduction in phosphorus loading from paved and unpaved roads which is achieved in the TMDL scenario by the application of the following BMPs:

1. Infiltration Trench treating up to a 0.5 inch runoff event applied to 10% of paved in the basin reducing phosphorus loading by 105 lbs.
2. Roadside Erosion Control applied to 65% of gravel roads in the basin reducing phosphorus loading by 3574 lbs.

This second BMP was applied at different rates based on road erosion risk category. Most gravel roads in the Lake Memphremagog watershed are rated as no or low risk, 38% and 52% respectively, and only 9% are rated moderate risk and 1% high risk. The roadside erosion control BMP was applied to 100% of high risk roads, 95% of moderate risk roads, 89% of low risk roads and 25% of roads that were not identified to have any erosion risk factors which accounts for BMPs applied across 65% of gravel roads in the basin. In the Lake Memphremagog TMDL, all loads from roads are considered part of the wasteload allocation. This section describes the implementation of the Municipal Roads General Permit as well as the Transportation Separate Storm Sewer System Permit (TS4).

Municipal roads

Act 64, the Vermont Clean Water Act, requires VDEC to develop a new Municipal Roads General Permit (MRGP) that will require all Vermont municipalities to conduct Road Erosion Inventories for hydrologically-connected municipal road segments. An initial GIS determination of hydrologically-connected municipal road segments is available for all Vermont municipalities on the ANR Natural Resources Atlas and is shown in Figure 8 below. Towns will also be required to develop Road Stormwater Management Plans for all hydrologically-connected road segments not meeting MRGP standards. Towns would then be required to implement the Road Stormwater Management Plans over a period of time defined by the MRGP. As of the writing of this document, VDEC is preparing the MRGP and related standards and requirements. The final MRGP will be developed by December 2017.

An analysis of the length of connected roads with differing road erosion risk rankings in the Lake Memphremagog and the Tomifobia and Coaticook Watersheds has been used to prioritize towns for completing Road Erosion Inventories and Capital Budgets in this basin. With the large number of road erosion inventories and capital budgets necessary in the next few years there is a need to increase capacity for partners or private consultants to complete inventories in Orleans County.

Currently OCNRCD is working with two towns per year on road erosion inventories but this organization or other partners such as the NorthWoods Stewardship Center or the Memphremagog Watershed Association could expand capacity to do this work.

Table 10. The length of connected segments by road erosion risk category along with non-connected road length for towns in Basin 17. Priority points were awarded based on a weighted length of connected roads based on the road erosion risk class and for towns with a recent assessment the date of assessment is shown.

	Connected Roads Erosion Risk Length (Kilometers)						Length (kilometers) and priority			
Town	Basin (colored based on Lake Memphremagog, Tomifobia, out of basin)	High Risk	Mod. Risk	Low Risk	No Risk	Total	Not connect Length	Total Length Km	Priority pts	Priority Assmt/ Date
Albany	**Lake Memphremagog**	**1.7**	**19.4**	**10.5**	**4.5**	**36.1**	**65.3**	**101.4**	150	2
Averill	Tomifobia & Coat.	0.0	0.2	0.0	0.0	0.2	3.3	3.5	1	14
	Outside Basin 17	0.0	1.5	0.1	0.9	2.5	5.4	7.8	8	
	AVERILL Total	**0.0**	**1.7**	**0.1**	**0.9**	**2.7**	8.7	11.3	9	
Barton	**Lake Memphremagog**	**1.1**	**27.1**	**6.9**	**14.0**	**49.0**	**66.3**	**115.3**	181	1
Brighton	Lake Memphremagog	0.8	9.2	2.3	5.2	17.5	28.1	45.6	66	2015
	Outside Basin 17	0.0	2.2	0.2	1.6	4.0	3.4	7.4	13	
	BRIGHTON Total	**0.8**	**11.3**	**2.5**	**6.8**	**21.4**	31.6	53.0	**79**	
Brownington	**Lake Memphremagog**	**0.5**	**10.3**	**4.0**	**3.8**	**18.6**	54.4	73.0	72	7
Charleston	**Lake Memphremagog**	**0.4**	**13.6**	**6.7**	**4.6**	**25.2**	53.0	78.2	96	5
Coventry	**Lake Memphremagog**	**1.1**	**12.7**	**5.4**	**3.7**	**22.9**	45.5	68.4	94	2017
Craftsbury	Lake Memphremagog	1.3	15.1	6.0	4.1	26.5	50.3	76.8	110	4
	Outside Basin 17	0.8	5.1	2.2	1.8	9.9	17.1	27.0	42	
	CRAFTSBURY Total	**2.1**	**20.2**	**8.2**	**5.9**	**36.4**	67.5	103.8	**152**	
Derby	Tomifobia & Coat.	0.1	2.5	0.6	1.9	5.0	14.1	19.1	17	2016
	Lake Memphremagog	0.8	17.2	5.1	5.8	28.9	82.7	111.6	115	
	DERBY Total	**0.9**	**19.6**	**5.7**	**7.7**	**33.9**	**96.8**	**130.7**	**132**	
Glover	Lake Memphremagog	0.5	17.3	6.4	3.0	27.3	62.9	90.2	114	3
	Outside Basin 17	0.0	0.0	0.0	0.0	0.0	2.2	2.2	0	
	GLOVER Total	**0.5**	**17.3**	**6.4**	**3.0**	**27.3**	**65.1**	**92.3**	**114**	
Greensboro	Lake Memphremagog	0.3	5.2	2.1	0.8	8.4	21.8	30.1	36	9
	Outside Basin 17	1.2	10.4	6.5	3.3	21.3	58.5	79.8	86	
	GREENSBORO Total	**1.5**	**15.6**	**8.5**	**4.1**	**29.7**	**80.2**	**110.0**	**123**	
Holland	Tomifobia & Coat.	0.5	11.1	4.1	4.2	20.0	42.6	62.5	78	6
	Lake Memphremagog	0.0	1.9	1.0	0.6	3.5	8.8	12.4	13	
	HOLLAND Total	**0.5**	**13.0**	**5.1**	**4.8**	**23.5**	**51.4**	**74.9**	**91**	
Irasburg	Lake Memphremagog	0.7	12.5	5.3	3.3	21.8	46.1	67.9	89	2017
	Outside Basin 17	0.0	0.0	0.0	0.0	0.0	1.5	1.5	0	
	IRASBURG Total	**0.7**	**12.5**	**5.3**	**3.3**	**21.8**	**47.7**	**69.5**	**89**	
Lowell	Lake Memphremagog	0.0	1.5	0.9	0.2	2.6	3.4	6.0	10	12
	Outside Basin 17	0.7	20.2	6.5	3.0	30.4	43.7	74.1	131	

	Connected Roads Erosion Risk Length (Kilometers)						Length (kilometers) and priority			
Town	Basin (colored based on Lake Memphremagog, Tomifobia, out of basin)	High Risk	Mod. Risk	Low Risk	No Risk	Total	Not connect Length	Total Length Km	Priority pts	Priority Assmt/ Date
	LOWELL Total	**0.7**	**21.7**	**7.4**	**3.2**	**33.0**	**47.1**	**80.1**	**141**	
Morgan	Lake Memphremagog	0.6	7.9	1.9	3.1	13.5	31.9	45.3	54	2016
Newark	Lake Memphremagog	0.0	0.1	0.1	0.2	0.4	2.4	2.8	1	2015
	Outside Basin 17	0.8	9.2	4.7	2.4	17.1	46.5	63.6	71	
	NEWARK Total	**0.8**	**9.3**	**4.8**	**2.6**	**17.5**	**48.9**	**66.4**	**72**	
Newport City	Lake Memphremagog	0.2	14.4	3.2	14.3	32.1	26.5	58.6	98	2018
Newport Town	Lake Memphremagog	0.1	2.3	2.2	0.3	4.9	11.9	16.7	19	10
	Outside Basin 17	0.9	11.1	5.6	4.8	22.3	51.0	73.3	86	
	NEWPORT TOWN Total	**1.0**	**13.3**	**7.8**	**5.1**	**27.2**	**62.9**	**90.1**	**105**	
Norton	Tomifobia & Coat.	0.1	1.4	0.6	1.1	3.2	5.9	9.1	11	11
	Outside Basin 17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	
	NORTON Total	0.1	1.4	0.6	1.1	3.2	5.9	9.1	11	
Sheffield	Lake Memphremagog	0.0	1.5	0.4	0.5	2.4	6.3	8.7	9	13
	Outside Basin 17	0.7	5.5	6.5	1.1	13.8	46.2	60.0	55	
	SHEFFIELD Total	**0.7**	**7.0**	**6.9**	**1.6**	**16.2**	**52.5**	**68.7**	**64**	
Sutton	Lake Memphremagog	0.0	0.3	0.2	0.3	0.8	2.4	3.2	2	
	Outside Basin 17	1.0	11.2	5.6	2.8	20.6	60.4	81.0	85	
	SUTTON Total	**1.0**	**11.5**	**5.8**	**3.1**	**21.4**	**62.8**	**84.2**	**88**	
Westmore	Lake Memphremagog	0.6	8.5	4.0	1.5	14.6	28.4	43.0	62	8
	Outside Basin 17	0.0	0.9	0.1	0.2	1.2	3.0	4.2	5	
	WESTMORE Total	**0.6**	**9.5**	**4.1**	**1.7**	**15.8**	**31.3**	**47.2**	**67**	
Total	Total Memphremagog	10.7	197.9	74.3	74.0	356.8	698.4	1055.2		
	Total Tomifobia/Coat.	0.7	15.1	5.3	7.2	28.4	65.9	94.3		
	Total Kilometers	22.3	338.3	137	119.9	617.9		617.9		

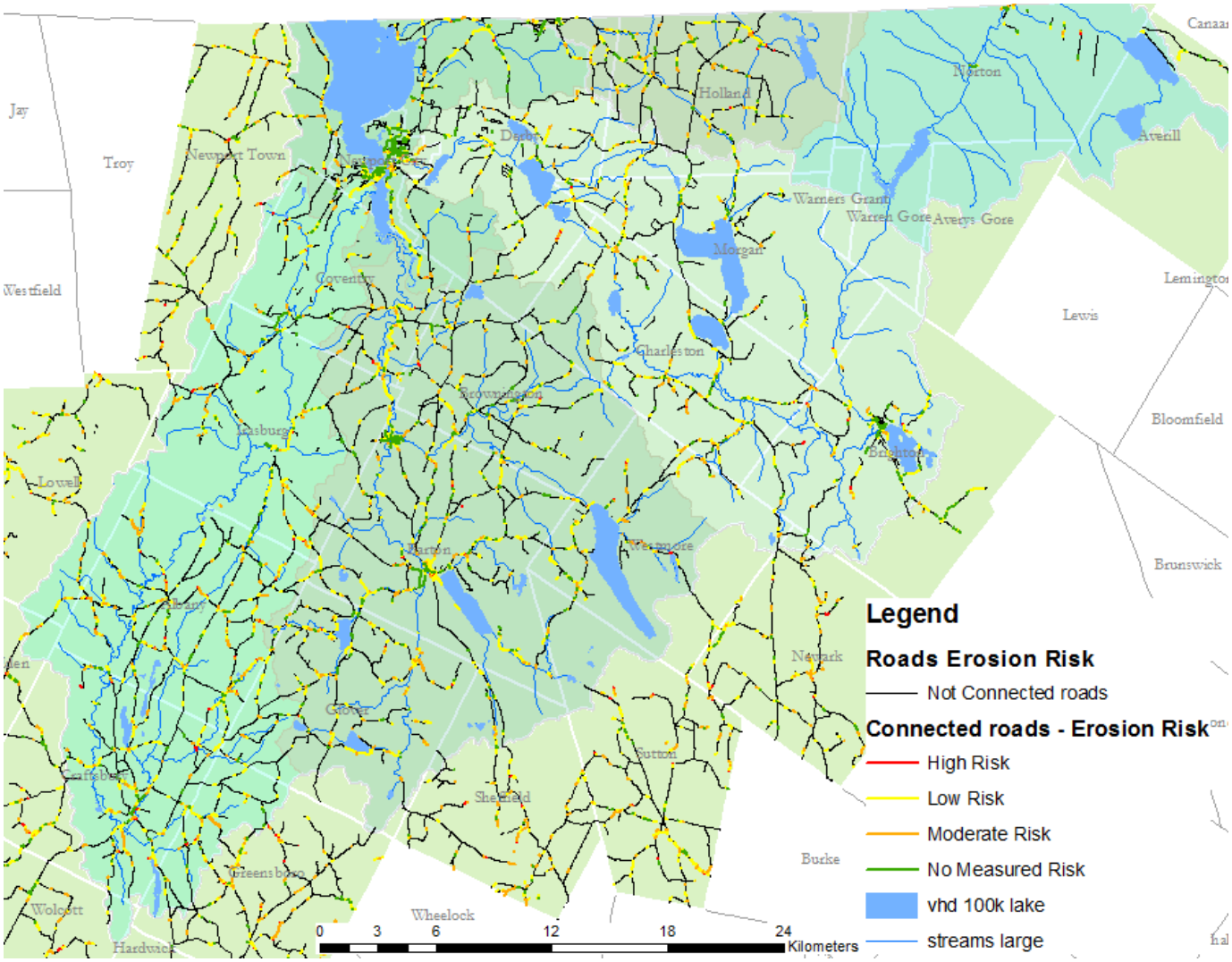


Figure 8. Road erosion risk for connected roads for towns in the Lake Memphremagog watershed.

The Northeast Kingdom Roads and Rivers workgroup (NEKRR) has been established with members from VTrans, NVDA, natural resources conservation districts, and VDEC, to provide municipalities with outreach, technical and financial assistance, and additional training to assist towns with the upcoming MRGP requirements. Many towns in this basin have limited resources and the new MRGP will require towns to complete road surveys, plan a project implementation schedule to meet permit requirements and then track these implementation efforts. The NEKRR workgroup is working to develop the technical resources needed to complete these road surveys through an app that was developed in other parts of the state. This group will coordinate all the inventories partners are involved in standardizing this data collection so this information can be compared across the region. NVDA is setting up a partnership with Lyndon State college to support the completion of these inventories necessary to meet MRGP requirements, however partners in the NEKRR workgroup will continue to work with towns on the development of more complete capital budgets to support towns in applying for better road grants. Funding through

NVDA from the CWI has supported partners in continuing to work with towns after inventories have been completed to apply for better road grants and other funding sources to implement the capital budgets.

Click the following hyperlink to view summary strategies to address Runoff from Municipal Roads.

State transportation infrastructure - Transportation Separate Storm Sewer System General Permit – TS4

The TS4 is a new stormwater permit for all VTrans owned and controlled infrastructure. State transportation infrastructure includes state roads, garages, park and rides, welcome centers, airports and sand and gravel operations. The TS4 permit includes six minimum control measures that apply state wide and several these will result in some phosphorus loading reductions in the basin. The TS4 permit can also include requirements for meeting TMDL load allocations as was done for the Lake Champlain TMDL where a phosphorus control plan is required to reduce loading from state transportation infrastructure based on the developed land load reduction set in the TMDL for each lake segment. The TS4 permit was issued in 2016 and so did not include a similar provision for the Lake Memphremagog TMDL but the next TS4 permit will include a requirement for a phosphorus control plan for the Lake Memphremagog watershed tied to the phosphorus load reduction for developed lands set at 18% in the Draft TMDL. The phosphorus control plan will require inventories of all regulated surfaces, establishment of baseline phosphorus loading, and a prioritized schedule for implementation of BMPs to achieve the lake segment percent phosphorus reductions.

Over the next 5 years VDEC will work with VTrans to complete a GIS inventory of hydrologic connectivity and areas of active erosion, establish a phosphorus baseline and coefficients for loading rates for transportation land uses in the Lake Memphremagog basin so that this information will be available to support the development of a Phosphorus Control Plan early in the life of the next TS4 permit. The phosphorus control plans will likely be required to achieve 25% of the necessary load reductions over four, four-year cycles to meet 100% of the load reductions by 2038. The plan will be similar to those for the Lake Champlain basin that include the suite of necessary stormwater BMPs that will be used to meet the required phosphorus load reduction along with a design and construction schedule and financing plan. A stormwater master plan developed for the Lake Memphremagog watershed has already identified two potential retrofit projects involving state transportation infrastructure in the towns of Coventry at the Newport State Airport as well as in Orleans at the Orleans Park and Ride. These projects would achieve an estimated annual phosphorus load reduction of 57 kg per year at an estimated cost of $60,000 and so VDEC will be working with VTrans to further evaluate these projects and move forward with them if they are feasible and funding to implement these projects can be identified.

Click the following hyperlink to view summary strategies to address Runoff from State Transportation infrastructure.

Geomorphic Compatibility and Aquatic Organism Passage (AOP)

Bridge and culvert assessments have been done on many of the stream crossings in the basin through assessments completed by NVDA for the town of Coventry and by VFW for the remaining portions of the Lake Memphremagog Basin. After data was collected, The Vermont Culvert Aquatic Organism Passage (AOP) Screening Tool was used to provide a rapid screening of structures which is available on the Vermont Atlas regarding:

1) their susceptibility to failure due to sizing or design ("geomorphic compatibility"); and
2) their ability to permit unrestricted movement for fish (The Nature Conservancy, 2012).

The AOP through stream crossings is an important issue for waters in Basin 17, in large part due to the celebrated populations of steelhead rainbow trout, brown trout and landlocked Atlantic salmon that annually travel from Lake Memphremagog into tributaries to spawn. The fish that live in Lake Memphremagog travel up the Black, Barton, Clyde and Johns rivers and smaller tributaries of the lake. In these areas of the watershed AOP is essential to providing the habitat these fish species need for natural reproduction. In addition to Lake Memphremagog, most lakes and ponds in Basin 17, especially Willoughby, Crystal, Salem, Echo, and Seymour lakes and Island, Norton and Great and Little Averill ponds support fish species that move into tributaries to spawn. AOP is critical on the minor tributaries to these waterbodies to allow for natural reproduction to sustain fish populations and the valuable fisheries they support. Other species of fish and wildlife including native brook trout also depend on stream continuity for their survival. One structure identified in the 2012 Tactical basin plan as a priority for replacement on route 58 has been replaced and now supports AOP. Table 11 identifies stream crossings in the basin known to impede or completely obstruct the passage of fish and that are targets for retrofit or replacement to restore AOP. The replacement of some of these stream crossings would also help to restore equilibrium conditions on streams, which could improve aquatic habitat in the stream and reduce streambank erosion and associated nutrient enrichment. Plans are in development for VFW to complete remaining ANR bridge and culvert assessments for structures in the Tomifobia and Coaticook Watersheds in 2017.

Table 11. Stream crossings in Basin 17 known to impede or completely obstruct the passage of fish and that are targets for retrofit or replacement to restore AOP.

Target watershed	Primary species impacted	Stream name	Road name	Structure #	Comments
Lake Willoughby	rainbow trout, rainbow smelt, white suckers	Dorin Brook	Route 5a	300287001010191	
		Myers Brook	Route 5a	300287000910191	
		Wells Brook	Route 5a	300287000810191	
		Schoolhouse Brook	Route 5a	300287000610191	
Barton River		Roaring Brook	I-91	200091103S10022 200091103N10022	retrofit

	brown trout, steelhead rainbow trout	unnamed tributary to the Barton River	I-91	300091H51S10021 300091H51N10021	
		Day Brook	Pine Hill Rd	401005000910051	
		Day Brook	I-91	300091H83S10051 300091H83N10051	
Seymour Lake Trib	Rainbow smelt	Twin Culverts at north Beach	Route 111	300316000710141	Culverts are in fair condition. Silt should be flushed out.
Crystal Lake	rainbow trout, rainbow smelt, white suckers	Sucker Brook	Pageant Park Rd	401002005210021	Local structure
Black River	brown trout, steelhead rainbow trout	Stony Brook	Route 14	300251013210051	
		Stony Brook	Route 14	# Not Available	
		Brighton Brook	Gage Brook	# Not Available	Privately maintained
		Brighton Brook	Route 58	300308000510111	
		Unnamed Tributary to Black River	Route 58	300310000710111	
		Lords Creek	Daniels Rd	401001002310011	
		Shalney Branch	Route 14	300251011510011	
		Rogers Branch	Route 14	300251011410011	
		Seaver Branch	Route 14	300251011310061	
		Cass Brook	Cemetery Rd	# Not Available	
		Cass Brook	Route 14	300251010810061	
Clyde River	brook trout	Oswegatchie Brook	VAST	VAST 2	Eastern brook trout joint venture-potential funding source
Johns River	brown trout, steelhead rainbow trout, brook trout	Crystal Brook	VAST	VAST 1	
		Crystal Brook	US Route 5	# Not Available	

C. Agricultural Runoff

Agricultural lands make up over 17% of the Lake Memphremagog watershed with nearly 2% cropland and 4% pasture, over 11% hayland and nearly a third of a percent farmstead area. Runoff from agricultural lands are identified as a primary source of pollutants to the nutrient impaired tributary to Stearns Brook and impaired Roaring Brook as well as the stressed tributary two of the Black River. Mud Pond and Walker Pond are also stressed due to elevated levels of phosphorus. Runoff from agricultural lands are also a potential factor in increasing phosphorus levels in several lakes in the basin that have increasing phosphorus trends and agricultural land use including Seymour Lake, Lake Willoughby, Lake Salem, Shadow Lake and Parker Pond although developed lands and roads are likely more significant contributors of nutrients in most of these watersheds.

Runoff from agricultural lands is estimated at 46% of phosphorus loading to Lake Memphremagog from the Vermont portion of its watershed. The phosphorus land use export model estimates that hayland from the Vermont portions of Lake Memphremagog watershed generates about 19% of the phosphorus loading while cropland accounts for 14%, pasture 6%, and farmstead areas 7%. Agricultural land use is also a contributor to streambank erosion which occurs across several different land use categories and is estimated at over 20% of phosphorus loading to the Lake. The draft Lake Memphremagog TMDL requires a load reduction of 46% from agricultural fields to meet the target load allocations and a 64% reduction from farmstead areas to meet agricultural wasteload allocation targets. Croplands are the only land use which was broken up by hydrological soil type in the phosphorus land use export model and, with the broad array of available BMPs that can be applied to this land use, this results in a complex cropland BMP scenario shown in Table 12.

The approach to setting load reductions achievable from agricultural lands was to approximate the BMPs that would be installed based on Required Agricultural Practices (RAPs) adopted in December of 2016, as well as technical and financial assistance provided through a Regional Conservation Partnership Program (RCPP) grant and other funding sources which are being targeted to maximize phosphorus reduction potential based on water quality sampling results. The proposed TMDL scenario is one way that necessary phosphorus load reductions can be achieved although this will not be the precise mix of BMPs that are implemented over the next 20 years because there are many ways that farmers can meet these regulatory requirements and uncertainty as to precise voluntary practices will be implemented. BMP's that were applied in the draft TMDL scenario are:

1. Applying barnyard management to 80% of the loading coming from farmsteads reducing loading by an estimated 5,363 lbs. per year.
2. Ditch and surface water buffers or manure spreading setbacks on 40% and 30% of hay lands respectively along with gully stabilization to address gully erosion on 3% of hay land reducing loading by an estimated 9,327 lbs. per year.
3. Applying fencing on pasture lands with and without surface water buffers (25% each) and managed intensive grazing for 25% of pasture lands reducing loading by an estimated 2,521 lbs. per year. The later BMP was based on load reduction estimates developed for the Chesapeake Bay watershed.
4. A matrix of BMPs for croplands shown in Table 12 below based on soil hydrologic group reducing loading by an estimated 8,695 lbs. per year.

Table 12. The percentage of cropland areas applied broken down by Soil Hydrologic Group for which Cropland BMPs or Suites of BMPs were applied in the TMDL scenario.

Cropland BMP	A - Excessively drained	B -Well Drained	C- Poorly drained	D-Very poorly drained
Cover crop - Conservation tillage - Grassed Waterways - Ditch Buffer	20%	30%	40%	25%
Change in Crop Rotation - Grassed Waterways - Ditch Buffer	0%	0%	0%	25%

Cover crop	15%	15%	10%	10%
Conservation tillage - Manure injection	5%	5%	10%	0%
Surface water buffer (25 ft)	20%	15%	10%	10%
Ditch buffer (10 ft)	20%	15%	10%	10%
Grassed Waterway	10%	10%	10%	10%

The Required Agricultural Practices (RAPs) and existing Medium and Large farm permit programs set baseline farm management practices to ensure environmental protection. Medium and Large farm permits have been in place for nearly 10 years, while the RAPs (formally the Accepted Agricultural Practices) have been in place as the current regulatory standard since 2006 although these were revised in 2016 to support the necessary phosphorus load reductions for the Lake Champlain and Lake Memphremagog TMDLs. This revision is expected to result in a significant increase in conservation practice implementation over the next few years. The changes to the RAPs that are expected to result in the greatest impact include:

- Nutrient Management Planning and Implementation on All Farms
- Creation of Small Farm Certification Program
- Stabilization of Ephemeral Gullies
- 10 ft. grassed filter strips on all field ditches
- Increase in grassed filter strip and manure spreading setback width from 10ft to 25ft on surface waters for small farms (already 25ft requirement for Medium and Large Farms)
- Establishment of cover crops on fields containing frequently flooded soils
- Increased manure spreading ban duration on fields containing frequently flooded soils
- Increase in grassed filter strip and manure spreading setback from 25ft to 100ft on surface waters adjacent to annual croplands with a slope greater than 10%
- Reduction in maximum soil erosion rates by ½ on small farms
- Increased setbacks for construction of waste storage facilities from surface water (50' to 200')
- Increase setbacks for unimproved stacking of ag wastes from surface water (100' to 200')
- Livestock exclusion from production areas
- Pastures need to be managed along streams to ensure the streambanks and livestock use near the stream do not impact water quality.
- Education requirements for farmers (4 hours every 5 years) and certification of custom manure applicators with continued education requirements (8 hours every 5 years).

It is impossible to estimate the exact impact that these rules will have, because doing so would require a detailed understanding of the current management on all farms. However, we are confident

that because of this rule, we will see a dramatic increase in the implementation of Nutrient Management Plans, Cover Crops, Grassed Waterways, and Grassed Filter Strips and Ditch and surface water buffers. Any of these practices that are implemented as part of the many existing financial assistance programs will be tracked and reported annually pursuant to Act 64, and summarized in the next planning cycle. Finally, through the creation of the Small Farm Certification program, inspections will be conducted on every small farm that meets the certification thresholds over the next seven years at minimum. Act 64 shortened the inspection cycle on medium farms from 5 to 3 years, and with the additional staffing the Agency received last year, this has allowed the Agency to perform more comprehensive inspections on medium and large farm facilities including a review of the NMPs for these facilities. The Agency will continue to perform annual inspections on large farm operations and the regulatory inspections on small and medium farms, all of which will result in a significant increase in compliance with the management practices set forth in the permit programs and the RAPs. AAFM staff will be a partner in the Lake Memphremagog Agricultural Workgroup to help to prioritize inspections of small farms in priority areas. In addition to this, where resource concerns have been identified on a farm efforts will be made to connect farmers to the Orleans County NRCD or other partners who could best provide technical and financial assistance.

Agricultural implementation practices from 2012 – 2016

The Orleans County Natural Resources Conservation District has compiled a list of BMPs completed by NRCS and the Agency of Agriculture over the last five years in the lake Memphremagog watershed and for Orleans County. This shows widespread implementation of practices in the Lake Memphremagog watershed to address runoff from barnyard, pasture, and cropland areas covering over 7,000 acres with a total cost over 5 years of over 1.5 million dollars.

Table 13. Practice summary in the Lake Memphremagog watershed in Orleans County 2012 – 2016

	AAFM		NRCS		Total	
	Cost	Acres	Cost	Acres	Cost	Acres
Agronomic Practices	$77,554	4342	$170,132	2996	$252,028	7338
Grazing Practices	$4,990		$259,178		$264,168	
Barnyard Improvement	$217,683		$684,022		$901,705	
Erosion Control	$8,877		$142,783		$151,660	
Total	$309,104		$1,256,115		$1,565,219	

Table 14. VAAFM practices in the Lake Memphremagog watershed in Orleans County 2012 - 2016

	Practice	Amount Implemented	Units	Number	Funding
Agronomic Practices	Conservation Tillage	2300.87	acres	15	$25,460.00
	Cover Crop	1819.66	acres	15	$49,884.00
	Cross-Slope Tillage	206	acres	3	$2,060.00
	Nurse Crop	15	acres	1	$150.00
	Fence	N/A		1	$3,018.51

Grazing Practice	Watering Facility	N/A		1	$1,971.33
Barnyard Improvement	Diversion	N/A		2	$56,767.81
	Heavy Use Area Protection	N/A		4	$87,408.02
	Roof Runoff Management	N/A		1	$16,000.00
	Waste Storage Structure	N/A		1	$31,018.00
	Waste Transfer	N/A		1	$2,126.05
	Waste Treatment (including milk house)	N/A		2	$24,363.31
Erosion Control	CREP*** Riparian Buffer Planting	17.4	acres	4	$5,399.10
	Streambank and Shoreline Protection	N/A		1	$3,478.03
	Total			**52**	**$309,104.16**

Table 15. NRCS practices in Memphremagog watershed in Orleans County 2012 - 2016

	Practice	Amount Implemented	Units	Number	Funding
Agronomic Practices	Conservation Crop Rotation	1167.8	acres	7	$19,843.26
	Conservation Tillage	1.7	acres	10	$735.05
	Cover Crop	1784.1	acres	29	$103,696.64
	Forage and Biomass Planting	41.5	acres	3	$28,017.27
	Grassed Waterway	1.1	acres	2	$17,840.00
Grazing Practices	Animal Trails and Walkways	2684	feet	10	$27,702.00
	Fence	77788	feet	56	$172,097.85
	Prescribed Grazing	222.7	acres	6	$3,322.60
	Stream Crossing	28	number	17	$52,182.40
	Watering Facility	27	number	8	$3,873.20
Barnyard Improvement	Animal Mortality Facility	1	number	1	$1,791.00
	Diversion	535	feet	2	$2,816.97
	Heavy Use Area Protection	2.3	acres	19	$194,774.72
	Roof Runoff Structure	49	number	10	$12,453.32
	Roofs and Covers	5	number	4	$78,902.75
	Waste Storage Facility	8	number	8	$290,144.40
	Waste Transfer	18	number	18	$103,138.49
Forestry and Erosion Control	Access Road	2029	feet	6	$37,645.74
	Critical Area Planting	2.8	acres	12	$2,676.22
	Forest Trails and Landings	7435	feet	22	$27,228.10
	Grade Stabilization Structure	1	number	1	$13,942.50
	Lined Waterway or Outlet	520	feet	2	$15,020.00
	Streambank and Shoreline Protection	200	feet	1	$1,540.00
	Underground Outlet	4456	feet	27	$44,730.45
	Total			**281**	**$1,256,114.93**

The OCNRCD also looked at implementation of practices that were completed each year. This analysis shows that in many cases the acreage for which these field practices were applied has increased over time. Figure 9 shows the acreage of cover cropping funded both through NRCS and VAAFM each year between 2012 and 2016 in Orleans County.

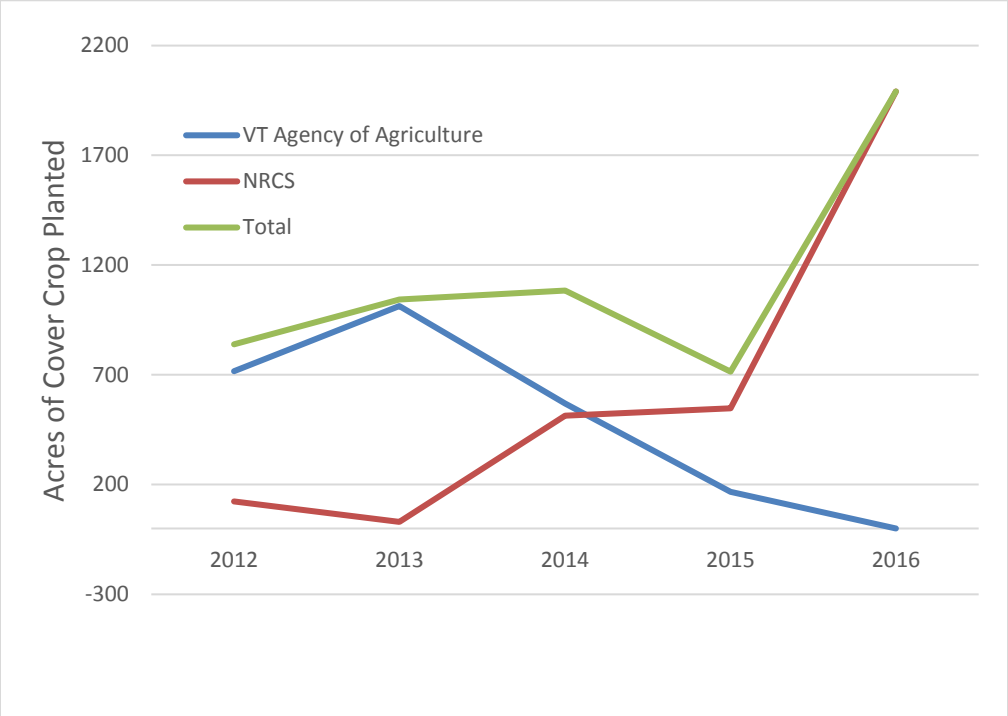


Figure 9. Acres of cover cropping in in Orleans County over the last 5 years by NRCS and VAAFM.

An analysis of BMPs applied since 2012 was completed for six subwatersheds covering 30 square kilometers which were the focus of water quality sampling efforts. In total this analysis identified over 20 acres of barnyard improvements, 60 acres of ditch buffers, 95 acres of managed intensive grazing 7 acres of fencing large areas treated by grassed waters ways, cover cropping and crop to hay conversion, which were estimated to achieve a total load reduction of over 250 kg/yr based on the scenario tool.

Tactical Basin Plan Implementation for Agriculture

The approach to meeting water quality improvement goals over the next five years is best framed through the Orleans County Natural Resources Conservation District (OCNRCD) Memphremagog Long-Term Water Quality Partnership supported through the USDA Regional Conservation Partnership Program or RCPP that is also coordinating support from 12 partners active in the basin toward meeting TMDL targets. The Memphremagog RCPP is focused on agricultural lands in the Memphremagog and Tomifobia River watersheds in Vermont, with an emphasis on targeted subwatersheds demonstrating high phosphorus loading as indicated by over a decade of water quality sampling as shown in Figure 2. The program will help small farmers develop Nutrient

Management Plans (NMPs), and provide technical and financial assistance to implement recommended nonstructural and field-based best management practices (BMPs) on all size farms in the watershed. Educational opportunities will be offered through a partnership with the University of Vermont Extension to help farmers develop and integrate their own NMPs, Sterling College to offer innovative conservation practices workshops. and the Memphremagog Watershed Association to publicize success stories. Throughout this five-year program, water quality sampling data will be used to support the development of conservation plans and to track the success of implementation efforts.

Approximately $400,000 is available in financial assistance for the development of NMPs and implementation of BMPs that will improve water quality in the Lake Memphremagog and Tomifobia River watersheds. An additional $275,000 is available for one-on-one technical assistance to farmers participating in the Memphremagog RCPP. This technical assistance will be focused on farms where NMPs and/or water quality sampling will help to define targeted BMP implementation that can maximize phosphorus load reductions from these efforts. The integration of water quality sampling with BMP implementation will support identifying and addressing source areas, optimizing BMP application, and providing farmers with data to support the needed BMPs to be implemented where they may be skeptical of the need for installing BMPs or the effectiveness of BMPs proposed. Another key element of the RCPP program is the creation and publication of success stories from farmers who have seen farm operational as well as water quality benefits from collaborative BMP implementation efforts to create a positive story of water quality improvement efforts.

Twelve partners have committed an additional $674,000 in technical and financial assistance over the five-year project to support agricultural water quality improvement efforts in the Lake Memphremagog and Tomifobia watersheds. Even with these existing financial resources additional funding is needed to support farmers in meeting required agricultural practices and phosphorus load reduction targets. Financial support is needed to continue NMP planning courses beyond 2018 when NMP support through the Magog RCPP ends. Funding is also needed to continue technical support to these farmers to maintain and implement NMPs and LTPs going forward. The most efficient way to provide this technical support would be to add an LTP position so that would free up time for LTP's to continue to work with farmers whose NMPs they have completed so that these staff could continue to build on relationships built during the development of these plans.

Funding is also needed to support trials on different cover crops, rotations and manure management scenarios such as rotation of annual Italian ryegrass, as well as to integrate a local dairy nutritionist in the Memphremagog agricultural workgroup and to support partners in make the bridge from NMP to feed & forage management. Water quality sampling in the basin has identified stormwater runoff from farmstead roads and impervious surfaces as an important source area and so the development of practical and low cost stormwater practices to address these source areas is needed to meet farmstead reduction targets. Additional financial support for farmers to implement priority BMPs will also needed, with incentives that make such projects financially viable. To support this the farm viability program will be better integrated into efforts to work with farmers in the Lake

Memphremagog watershed. Finally, it is essential that partners in the basin communicate success stories where implementing practices have improved water quality conditions and farm operations to encourage new farmers to consider such practices.

The implementation of the Memphremagog RCPP, new RAPs, as well as ongoing NRCS and AAFM funding will expand the level of BMP implementation above what was completed between 2012-2016. In addition to this, the integration of targeted water sampling to help identify priorities for implementation will allow partners to maximize potential load reduction impacts of these practices.

Click the following hyperlink to view summary strategies to address Runoff from Agricultural Lands.

D. Limiting Phosphorus and Sediment Losses from Managed Forest

Forest lands cover 67% of the Vermont portions of the Lake Memphremagog watershed with an additional 3% mapped as unmanaged shrub or herbaceous lands. The Tomifobia watershed in Vermont has just 62% forested lands while the Coaticook has 81%, with an additional 3% and 6% shrub lands in these two watersheds respectively. Forests limit erosion and the ability of water to transport sediment, nutrients and pollutants that can cause water quality problems when forest vegetation and organic debris on the forest floor slow, spread, and infiltrate surface water. Forested lands contribute the lowest amounts of nutrients, sediment and other pollutants into Vermont streams per acre compared to other land uses and are only estimated to contribute 8.6% of the phosphorus loading to Lake Memphremagog with another 0.7% from shrub or herbaceous lands.

For the Lake Memphremagog TMDL, an overall TP reduction target of 5% has been allocated to all forest lands. Documentation that the primary sources of phosphorus from forested areas are forest roads and harvest areas, and recent 2016 AMP revisions to address better management of road erosion and harvest areas to avoid water quality impacts suggests the 5% reduction called for in the TMDL scenario is easily supported.

Vermont adopted rules in 1987 for Acceptable Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont. The AMPs are intended and designed to prevent any mud, petroleum products and woody debris (logging slash) from entering the waters of the State and to otherwise minimize the risks to water quality.

The Vermont Department of Forests, Parks, and Recreation (FPR) recently updated the AMPs effective as of October 22, 2016. Key modifications include:

- Require compliance with standards set forth in the VDEC Stream Alteration General Permit for actions including the installation and sizing of permanent stream crossing structures on perennial streams.

- Strengthen standards pertaining to temporary stream crossing practices on logging operations. The proposed standards include:
    - Better management of ditch water on approaches to stream crossings. The proposal is to prohibit drainage ditches along truck roads from terminating directly into streams and to specify a minimum distance for installing turn-outs. Drainage ditches approaching stream crossings must be turned out into the buffer strip a minimum of 25 feet away from the stream channel, as measured from the top of the bank.
    - Better management of surface water runoff from skid trails, truck roads and temporary stream crossings on logging operations. The proposal is to prevent surface runoff from entering the stream at stream crossings from skid trails and truck roads and to specify a minimum distance for installing surface water diversion practices, such as drainage dips. Surface runoff is to be diverted into the buffer strip at a minimum distance of 25 feet from the stream channel, as measured from the top of the bank.
    - Better management of stream crossings after logging. The proposal is to prevent erosion and to specify a minimum distance from the stream for diverting runoff. Upon removal of the temporary stream crossing structures, the site is to contain water bars 25 feet from the stream channel on downhill approaches to the stream crossing to divert runoff into the buffer to capture sediment before entering the stream. Additionally, all exposed soil, at a minimum of 50 feet on each side of the crossing, must be stabilized with seed and mulch according to application rates specified in the AMPs.
- Include a new AMP to address the management of petroleum products and other hazardous materials on logging operations. Such materials must be stored in leak-proof containers, placed outside of buffer strips, and must be removed when logging is completed.
- Enhanced stream buffer guidance in the AMPs and established metrics for minimum residual stand density, stand structure and crown cover.
- Enhanced options and guidance with metrics provided for soil stabilization to establish temporary and permanent ground cover.
- Better clarification provided for selection and spacing of water diversions on skid trails and truck roads both during and immediately after logging.
- Increased seeding/mulching of exposed soil adjacent to streams and other bodies of water from 25 feet to 50 feet.

The focus for this tactical basin plan is to support the working forest lands across the basin to maintain forest lands for water quality as well as many other benefits. This would be done by supporting local land trusts and conservation organizations in conserving forest blocks that are important for maintaining good water quality along with wildlife and other functions. Another effort is to keep track of forest fragmentation in the basin and if so what might be driving this, to allow for the development of strategies to slow this in future years.

The other focus of the tactical basin plan is to address phosphorus sources from land management practices on forestlands. The prevalence of maple sugaring is increasing in this region and one avenue to address runoff from these operations is to encourage maple operations to be enrolled in the current use program though the forestry vs agricultural programs to provide more oversight with regards to the AMPs. Another opportunity is supporting workshops on the new AMPs, as well as resources available for addressing logging road issues which could be held at local lumberyards. Along with this, funding and technical support is needed to remediate old logging roads that might be eroding or problematic. Finally, when LIDAR becomes available for the basin, this can be used to identify areas where logging roads have become gullies or might be problem spots for remediation.

Portable skidder bridges are now widely accepted as a best management practice for controlling non-point source pollution associated with timber harvesting operations. When properly installed, used, and removed, skidder bridges minimize stream bank and stream bed disturbance as compared with alternative devices, such as culverts or poled fords. In addition, these bridges reduce the occurrence of sedimentation, channeling, and any degradation of aquatic habitat, while allowing loggers to harvest timber in compliance with the AMPs for Maintaining Water Quality on Logging Jobs in Vermont (VT Department of Forests, Parks and Recreation, 2016).

The Department of Forests, Parks and Recreation is promoting and demonstrating the use of portable bridge designs on timber harvesting operations throughout Vermont, including two bridges that are rented through the Orleans County Natural Resources Conservation District in this basin. These two bridges were rented three times in 2015. When properly installed, used, and removed, skidder bridges minimize stream bank and stream bed disturbance as compared with alternative devices, such as culverts or poled fords. In addition, these bridges reduce the occurrence of sedimentation, channeling, and any degradation of aquatic habitat, while allowing loggers to harvest timber in compliance with the AMPs for Maintaining Water Quality on Logging Jobs in Vermont (VT Department of Forests, Parks and Recreation, 2016). Continued support for this program and outreach necessary to maximize the use of the bridges will support water quality improvements in the basin and support loggers in meeting the new AMP's.

Click the following hyperlink to view summary strategies to address Runoff from Forest Lands.

E. Unstable Stream Channels and Aquatic Habitat

Unstable stream channels were estimated to contribute over 20% of the phosphorus loading to Lake Memphremagog, and also pose threats to safety, infrastructure and property in the basin. The Lake Memphremagog TMDL recognizes that we will never achieve the load reduction targets for unstable streams if we focus entirely on restoration (manipulation-type) activities. If the river corridors along our incised and straightened stream channels are not protected from encroachment, they will be developed, and the potential for restoration would be lost forever. River corridor and floodplain protection ensure that the desired channel evolution, stream equilibrium, and natural floodplain

function can take place whether it be from restoration activities or through the natural channel forming processes that occur during floods. Further, the estimation of precise subwatershed phosphorus loadings from stream channels would be a scientifically tenuous proposition at any scale smaller than that established by the TMDL. As such, this Tactical Basin Plan relies on the identification of high-priority subwatersheds where Stream Geomorphic Assessments indicate the highest likelihood for phosphorus reductions thru the pursuit of dynamic stream equilibrium.

Stream geomorphic assessments (SGA) provide the basis for stream alteration regulatory decisions, technical assistance for fluvial conflict resolution, stream corridor protection and restoration, flood hazard mitigation and water quality protection. The assessment data is critical to prioritization of riparian and fluvial process-related water quality restoration and protection projects, project design alternatives analyses, and project design criteria. SGA provides insight into the social, economic and ecological interrelationships between people and fluvial systems; as such, it is a valuable educational tool. All of the SGA datasets collected and final reports in Vermont are compiled in the Stream Geomorphic Assessment Data Management System (and can be viewed on the ANR Natural Resource Atlas).

These databases are used to ensure that projects are implemented in a manner consistent with and complementary to existing geomorphic conditions and the channel evolution process. Much of the Memphremagog watershed has been subject to SGA at the Phase I (desktop research) or Phase II (field data collection) level, and River Corridor Plans (RCP) have been established for portions of several watersheds, including the Black, Barton, Clyde and Johns Rivers, although no assessments have been completed in the Coaticook or Tomifobia watersheds (Table 16). Stream instability is estimated to contribute 20% to the total phosphorus loading to Lake Memphremagog. Most of this fluvial erosion-related loading is from the Black and Barton River watersheds, where stream instability is estimated to contribute 25 and 26% of the loading in each tributary, respectively.

Table 16. Stream Geomorphic Assessments in the Lake Memphremagog Basin.

Date Completed	River	Report	PRIORITIES IDENTIFIED	
			Projects	Bridge and Culvert[1]
12/19/2008	Barton River and Johns River	River Corridor Plan for Barton and Johns River		
3/01/2011	Black River	Black Corridor Plan FINALREPORT_March2011		
4/01/2008	Clyde River	Restoring Water Quality in the Lake Memphremagog Basin: Clyde River Phase I and II Stream Geomorphic Assessments		01/2008

The most significant finding of these stream geomorphic assessments is that significant portions of the Barton River watershed are going through a channel evolution process whereby the riverbed has cut down and lost access to floodplain and the river is now moving laterally to establish a new

floodplain at a lower elevation. This process is most evident on most of the Barton River between Barton and Coventry Station. The Black River and Lords Creek have fewer reaches identified as having lost access to floodplain, however widespread removal of riparian vegetation and channel modifications along some reaches on the main stem of the Black River along with Lords Creek appear to have increased the rates of planform or lateral adjustment, which may be slowed through the restoration of riparian vegetation or if not addressed, this could lead to more systemic channel destabilization. The Willoughby River is mapped as in stable condition however there are several large-scale mass failures which are contributing large amounts of sediment and phosphorus to the Willoughby River, however there are limited options for the stabilization of such large failures a reasonable cost. This highlights the importance of protecting downstream attenuation areas from encroachment so the Willoughby and Barton have the space to go through the necessary adjustments to balance and store these sediment inputs. By and large, assessed segments in the Clyde and Johns river were identified as being in good geomorphic condition although there could be channel instability that is not well understood/detected from the data we now have.

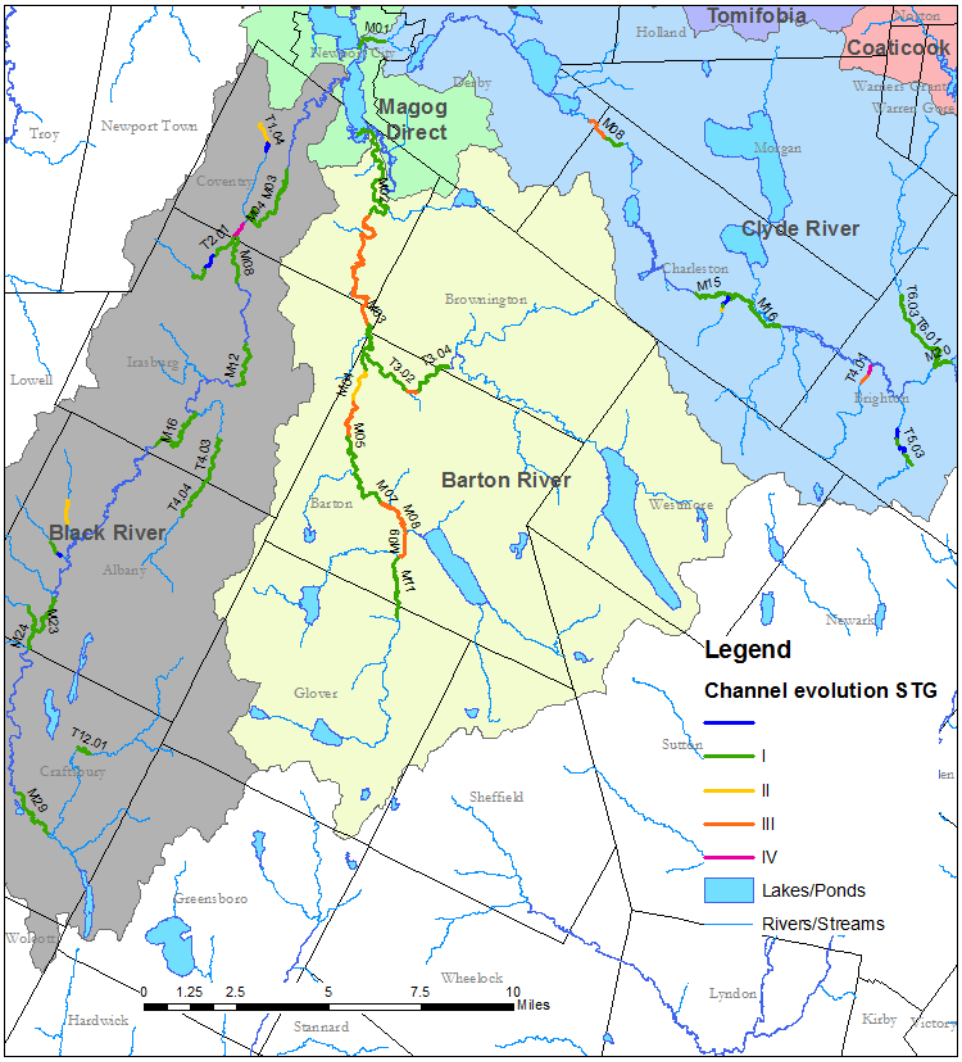


Figure 10. Channel evolution stage for streams in the basin with Phase 2 assessments (see pages 14-15 of the VSWMS Introduction for more information about channel evolution stages).

A major focus for the last 10 years has been floodplain forest restoration and buffer plantings in the watershed. There have been a number of programs that have supported this work including an effort by the Nature Conservancy to restore Elms in the watershed along the Black, Willoughby and Barton Rivers, other floodplain restoration efforts by Vermont Fish and Wildlife in the South Bay and Willoughby Falls WMA, Conservation Reserve Enhancement program buffer plantings, Northwoods Stewardship Center Buffer planting program supported by ERP grants, and finally buffer planting efforts by the Orleans County NRCD. Over the last ten years these programs have planted over 60 acres of buffers in the Basin covering a stream length of 13 miles as shown in Figure 11. The NorthWoods Stewardship Center has been evaluating survival of buffer plantings and there have been mixed results. Some of the earlier buffer planting projects had very low survival rates and a few of the sites have had to be replanted after high rates of mortality however recent plantings appear to be faring better based on lessons learned from earlier plantings including the need for larger planting stock.

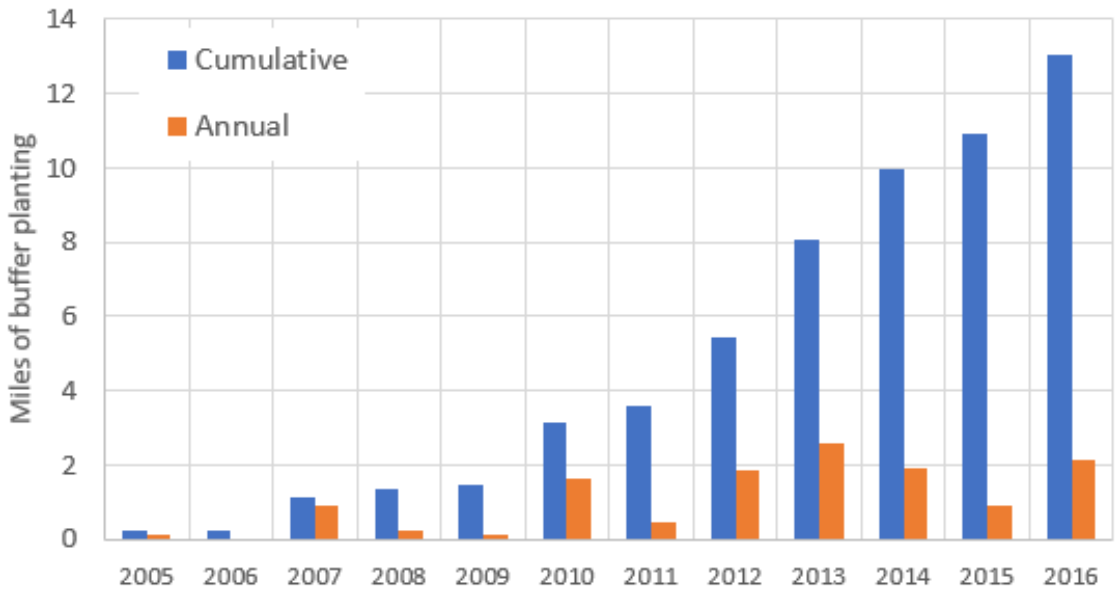


Figure 11. Annual and cumulative miles of buffer planting projects completed in the basin since 2005.

Recommendations

In the Black River watershed, additional assessments on the Seaver Branch in Craftsbury, Shalney Branch in Albany, Daniels Rd tributary to Lords Creek in East Albany, Black River main stem from reach M30 up to Whitney Branch, and of the lowest reaches of Lords Creek are recommended for Phase 2 stream geomorphic assessments. In the Barton River watershed, the additional assessments that are a priority going forward are the lowest reaches of the Brownington Branch and Willoughby

Rivers as well as the Barton River in Glover. Stearns Brook has been identified as stressed due to sedimentation which may be in part from fluvial conditions, and so a field visit to this stream and discussions with locals to see if there is support for a phase 2 assessment or consideration of river corridor zoning is recommended in which case this may be a priority for a phase 2 stream geomorphic assessment. At this time, there are no priorities for Phase 1 or 2 assessment for the Clyde and Johns, or Coaticook River watersheds.

The SGAs in this basin were completed before the river corridor planning document was produced and so potential projects were not evaluated as to their priority though this lens. A project database was created based on all three stream geomorphic assessment efforts as a shapefile with over 290 potential projects, and this has been updated over time where over 80 buffer plantings have taken place. These potential projects need to be updated to be consistent with the current river corridor planning guide and updated information on landowner interest. This project database has been useful in tracking buffer planting efforts described above, however there has been less progress in the use of river corridor easements, updating local zoning to include river corridors, or more active restoration projects identified in these reports or in the project database. To move these projects along a local partner could seek funding to hire a qualified consultant to complete recommended additional stream geomorphic assessments, evaluate feasibility, and complete preliminary design for projects identified in the existing project database as well as those identified through these additional assessments. The project database identifies 43 miles of high and moderate priority buffer or riparian zone planting projects in the basin and so it is recommended that partners continue to work on buffer planting efforts across the watershed and to evaluate ways to increase efficiency of such efforts. VFWD is evaluating the use of tillage, herbicide and a combination of these techniques to increase survival or even allow for natural recruitment of native vegetation in hayfields dominated by reed canary grass.

The Fish and Wildlife Department also has extensive one rod (16.5 ft) floating ownership along the Black, Barton, and Willoughby and Clyde Rivers in the basin as well as some larger parcels as highlighted in Figure 12. The narrow width of many of the one rod ownerships limits ability for the Fish and Wildlife Department to create fully functional buffers to provide water quality and habitat benefits. There have also been encroachments onto some of these lands by adjacent landowners. Funding is being sought to support VFWD addressing those encroachments and maximizing the functions of these lands including options to expand ownership. Through this process, the Fish and Wildlife Department will be looking for opportunities to collaborate with DEC to expand the ownership through in fee purchase or river corridor easements where river corridor protections are a priority in the basin for supporting stream channel stability as well as fish habitat and angler access.

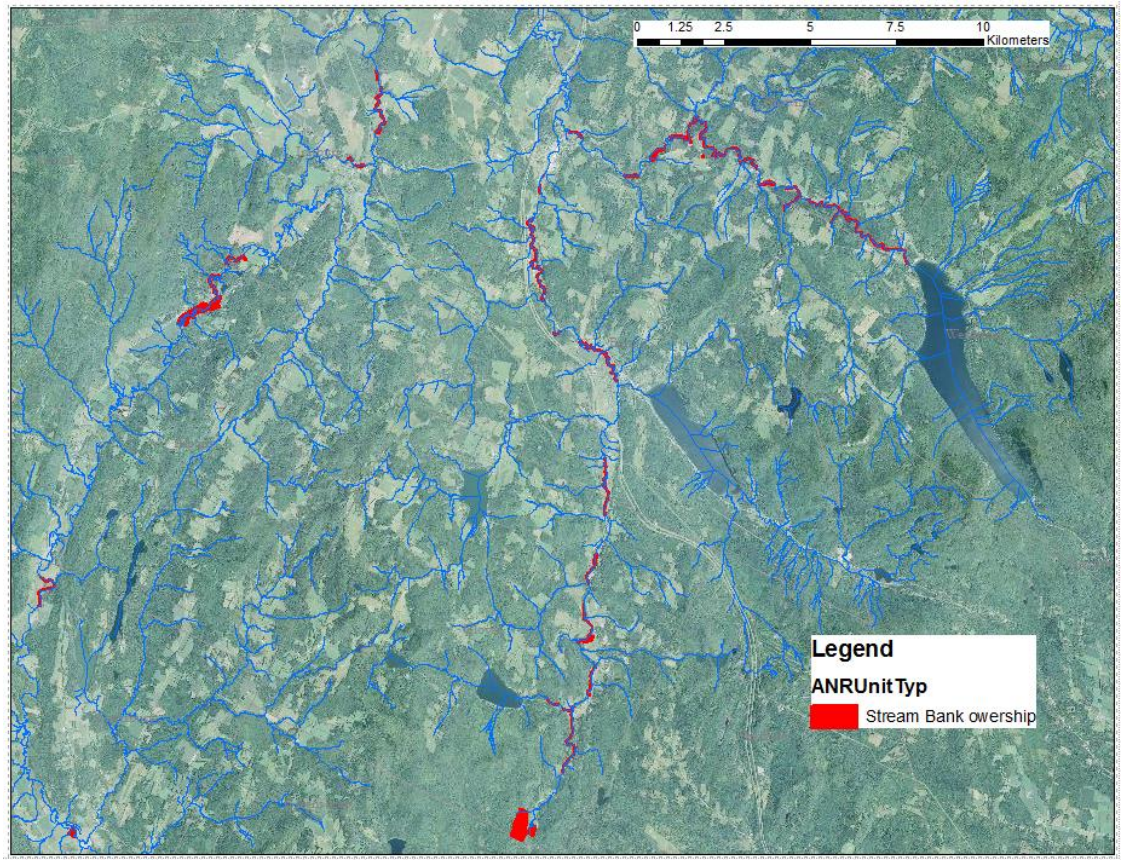


Figure 12. Locations of Vermont Fish and Wildlife streambank properties in the basin. Note that the extent of the ownership has been expanded to make parcels visible on the map.

A preliminary field visit along the Stearns Brook watershed is recommended to evaluate the status of sediment stressed condition and the contribution of stream channel erosion to this condition as well as town interest in river corridor zoning. In addition to this, NVDA, NorthWoods, Memphremagog Watershed Association and conservation districts should continue to work with towns to include a flood resiliency section of towns plans, adopt hazard mitigation plans, and adopting River Corridor Zoning or strengthening NFIP zoning regulations.

Tracking stream channels

VDEC has developed a methodology to document long-term achievement of the TMDL allocation for stream channels. This methodology serves as a surrogate for long-term physico-chemical monitoring that would be required for each restorative practice type were it possible to isolate cause and effect at this functional level of assessment—which it is not. This tracking approach follows the methodology used by Tetra-Tech (2016c) to develop the load and load-reduction calculations for unstable streams by evaluating how different practices can hasten or facilitate the evolution of Vermont's incised streams to a natural condition where stream equilibrium is achieved and the stream has access to its floodplain at the (~2-yr) channel forming flow. Under these reference

geomorphic and hydraulic conditions, we expect to see significant capture and storage of fine sediment and phosphorus.

The Stream Equilibrium (SE) Tracking Method starts by establishing a total watershed deficit where the existing condition is subtracted from the ideal condition and a total watershed sum is derived by adding the deficit that is calculated for each reach in the watershed. The deficit for each reach is comprised of two components, one to track restoration activities and another to track corridor and floodplain protection activities. This is a novel approach because most tracking tools focus entirely on activities that manipulate the environment to achieve restoration. This approach recognizes the need to allow the system to self-restore as it continues to undergo its physical processes. The total watershed deficit is envisioned to be calculated as follows:

$$\sum_{\text{All Reaches}} \frac{\text{Channel Width} \times \text{Reach Length} \times \text{Confinement Deficit (ideal – existing)} \times \text{Channel Evolution Deficit (ideal – existing)}}{\text{Reach Sensitivity Value}}$$

Plus

$$\sum_{\text{All Reaches}} \frac{\text{Channel Width} \times \text{Reach Length} \times \text{Reach Protection Deficit (ideal – existing)}}{\text{Reach Sensitivity Value}}$$

The SE tracking method includes spatial and temporal factors that recognize the value of larger floodplains along lower gradient reaches and the influence that erodibility (as a function of channel boundary and bed load characteristics) has on the time frame at which floodplain accessibility might be achieved. For deficit reduction associated with active restoration there is the opportunity to evaluate projects that remove encroachments, thereby changing the stream confinement ratio (so essential to the achievement of an equilibrium channel slope) and the evaluation of projects that directly affect channel dimensions, roughness, channel evolution stage and slope. The deficit reduction associated with reach protection projects is evaluated for the strength (standards and longevity) of the land use and channel management restrictions that are put into place.

Data to support the scoring is largely available in the Vermont Stream Geomorphic Assessment database. The land protection scoring will be developed from different existing GIS data layers, and finally, a restoration practice scoring matrix will be developed to be able to score each type of project pursued on the ground by the VANR and its partners.

Click the following hyperlink to view summary strategies to address Unstable Stream channels.

F. Wetland restoration and protection

Wetlands make up 2.5% of the Lake Memphremagog watershed and provide several important watershed services, in addition to their intrinsic values,including flood storage, important wildlife habitat and in many cases, nutrient sinks for sediment and phosphorus and nitrogen removal areas through denitrification. Because of these and many other values, wetlands are protected in Vermont though the Vermont Wetland rules, however over the history of development in the basin, many wetlands have been altered through the clearing and draining of agricultural lands and other development. Studies of wetland restoration opportunities in the Lake Memphremagog watershed have identified several possible wetland restoration sites and while there are a number of funding sources available to support the restoration of altered wetlands only one out of the many landowners contacted supported wetland conservation and restoration efforts on their properties. Landowners who are more likely to consider wetland conservation are new landowners, those conserving lands, or those whom are making major changes in land management. Outreach on wetland conservation will target these lands. Another approach to support wetland restoration is to flag wetland restoration opportunities when landowners contact wetland ecologists looking to buy or sell a property that can't be built on because of natural resource limitations. In these instances, landowners may be interested in wetland restoration opportunities through NRCS wetland restoration programs.

Click the following hyperlink to view summary strategies to support wetland restoration and protection

G. Wastewater Treatment Facility (WWTF) Loading

Measured wastewater loads are reflected in the TMDL based on annual permitted loading. Table 17 shows the current permitted daily flow, phosphorus concentration limit, and the resulting annual total permitted loading for the four facilities in the Lake Memphremagog watershed. The Brighton facility doesn't have a concentration limit, so 5 mg/l an assumed maximum concentration for this facility, is shown for illustrative purposes. This table also shows the average phosphorus load from 2009 to 2012, which indicates that all facilities are operating at less than 30% of the permitted load allowed. This is because the average concentration and flows were both substantially below the levels allowed by permit on an annual basis.

Table 17. Permitted flow, concentration, loading, and measured loading from 2009-2012 for four wastewater treatment facilities in the Lake Memphremagog watershed.

	Permit Flow (MGD)	Permit Conc. (mg/l)	Permit Load (KG)	Average Load 2009-2012
Barton	0.265	1.0	368	112
Brighton	0.150	5.0*	1040	295
Newport	1.200	0.8	1442	391
Orleans	0.190	1.0	264	38
Total	**1.905**		**3114**	**836**

The WWTF wasteload allocation was set based on an evaluation of the loading reductions possible through regulatory requirements and through the tactical basin planning process resulting in a 31% load reduction across non WWTF loading sectors. The current permitted loading from WWTF to the Main Lake is 4,663 lbs. per year and needs to be reduced to 3,110 lbs. (33%) to meet in lake phosphorus concentration targets along with the 31% reduction in non WWTF loading. Four alternatives for allocated WWTF loading between the facilities in the watershed were developed in accordance with the Agencies wasteload allocation process. All alternatives would leave current monthly concentration limits in place and would add annual loading limits for facilities with reduced phosphorus load allocations. Wasteload allocation alternatives are described in Table 18:

WLA-A Uniform effluent concentration limitations set at 0.65mg/l

WLA-B Based on existing and projected populations or populations equivalents set at 0.5 lbs per person.

WLA-C Selectively increasing the required treatment level for facilities with the greatest impact on the receiving water due to size or location which is the City of Newport facility, until water quality standards are attained.

WLA-D Reduce the loading across all facilities by 33% from the facilities current permitted annual loading.

Table 18. Alternative approaches to setting annual wastewater treatment phosphorus load limits along with current permitted loading limits.

	Current permit	**WLA-A.** Uniform effluent concentration of 0.65 mg/l*	**WLA-B.** Population (0.5 lbs per person)*	**WLA-C.** Reduction of Newport WLA to 1631 lbs *	**WLA-D.** 33% load reduction for all facilities*
BARTON (mg/l / lbs.)	1.0 / 811	0.65 / 527	0.46 / 339	1.0 / 811	0.67 / 542
BRIGHTON (mg/l / lbs.)	5.0** / 2293	0.65 / 298	0.90 / 411	5.0 / 2293	3.34 / 1532
NEWPORT (mg/l / lbs.)	0.8 / 3179	0.65 / 2584	0.65 / 2593	0.41 / 1631	0.53 / 2125
ORLEANS (mg/l / lbs.)	1.0 / 582	0.65 / 377	0.71 / 409	1.0 / 582	0.67 / 388
Total load (lbs.)	**6865**	**3786**	**3782**	**5317**	**4587**
Total loading to Main Lake (lbs.)	**4663**	**3110**	**3102**	**3115**	**3116**
Percent of TMDL load (89,993 lbs.)	6.0%	4.0%	3.9%	4.3%	4.0%
Reduction from current permit load	0%	45%	45%	23%	33%
Non WWTF load reduction required	33.9%	31.2%	31.2%	31.2%	31.2%
Potential required upgrades in first permit cycle		Brighton	Barton, Brighton	Newport	None

*Concentrations for WLA alternatives were derived by dividing the proposed annual load by the current design flow. These are provided for context, and are not necessarily reflective of final permitted monthly average concentration limits.

**Brighton does not have a permit concentration limit for phosphorus so 5 mg/l was used to calculate annual loading.

Alternative D follows the guiding principles set forward in the wasteload allocation process of protecting of water resources, providing equity, allowing for future growth, and maximizing the benefits vs the costs and so is presented in the DRAFT TMDL as the preferred alternative.

Facility-specific information

This section of the Tactical Basin Plan is intended to provide additional information to readers regarding wastewater treatment facilities in the Lake Memphremagog Basin. As of the issuance of this Plan, all facilities are presently operating under administrative continuance of existing permits, which were issued in conformance with the allocations in place at the time of their last issuance.

Table 19. Summary of current permit requirements for the wastewater treatment facilities in Basin 17.

WWTF (Permit ID)	Type of Treatment	Permitted flow-(MGD)	Phosphorus effluent Limit	Permit expiration date	Outfall location	Current Permitted Load (kg P/yr)	IWC[1] 7Q10 /LMM
Village of Barton	Aerated lagoon with filtration	0.265	1.0 mg/l	March 31, 2012	Barton River	368	0.035/0.014
Village of Orleans	Activated sludge with chemical addition and filtration	0.19	1.0 mg/l	December 31, 2012	Barton River	264	0.011/0.005
Town of Brighton	Aerated lagoon	0.15	None	June 30, 2012	Pherrins River		0.036/0.015
City of Newport	Extended aeration with chemical addition	1.3	0.8 mg/l	June 30, 2009	Clyde River	1442	0.064/0.020

* Instream Waste Concentration – or the proportion of river flow at lowest base (7Q10) and low median monthly (LMM) flow attributable to discharge, for the facility design flow. Note that the IWC is specific to the flow of receiving water.

Barton

The Barton WWTF has a permitted flow of 0.265 MGD. The facility discharges to the Barton River. The treatment system consists of two aerated lagoons in a series, a "Roberts" filter for phosphorus removal, sodium hypochlorite addition for disinfection followed by sodium bisulfite for dechlorination.

Brighton

The Brighton WWTF has a permitted flow of 0.15 MGD. Brighton is an aerated lagoon facility constructed in 1977. The facility discharges treated, chlorinated/dechlorinated wastewater to the Pherrins River. The collection system consists of approximately 0.8 miles of force mains, six pump stations and six miles of gravity sewers.

Newport City

The City of Newport WWTF has a permitted flow of 1.3 MGD and discharges to the Clyde River. The facility is a secondary treatment WWTF with conventional activated sludge treatment process and phosphorus removal. The facility chlorinates and dechlorinates the effluent before discharge. There are 6 CSO's associated with the system with a 1272 Order dated March 28, 2006 that addresses the CSO's.

Orleans

The Orleans WWTF has a permitted flow of 0.19 MGD and discharges to the Barton River. The WWTF is a tertiary facility consisting of activated sludge followed by filtration units. Phosphorus removal is achieved by biological removal, chemical precipitation and filtration. Sodium hypochlorite is used for disinfection followed by sodium bisulfite for dechlorination.

Click the following hyperlink to view summary strategies to address Loading from WWTF.

H. Restoring Flow Altered Waterbodies

Norton Lake, Great Averill Pond and Little Averill Lake and the streams below these waterbodies are listed as altered due to flow regulation. Hydro-Coaticook owns and operates the three dams to support downstream power generation in the Village of Coaticook in Quebec, Canada. The minimum and maximum water level for the three lakes is under the jurisdiction of the Vermont Public Service Board (PSB) pursuant to 30 V.S.A. Chapter 9. The 2012 Basin 17 tactical basin plan included strategies to address water level and flow issues on these waterbodies and to meet these objectives the Agency initiated a monitoring program to measure water levels on Norton, Little and Great Averill Ponds as well as the outflow streams below Little Averill Lake and Great Averill Pond for several seasons. While the Agency was completing this monitoring effort a petition was filed by lakeshore owners on December 8, 2014 to review the minimum and maximum water level of these three waterbodies and the Agency is now a party to this proceeding. Since this petition was filed there has been additional monitoring and information gathered by the Agency to inform the recommendations to the PSB.

Through the pre-hearing process the Agency of Natural Resources has recommended modifying the dams to function with a crest control to restore more natural water level fluctuations on these waterbodies and natural flows in the streams below the dams to support important ecological functions of these waterbodies. The Agency will continue to advocate for a management approach for of these dams that will restore water quality conditions and habitat in the lakes and the outlet streams.

Click the following hyperlink to view summary strategies to address Flow Altered Waterbodies.

I. Aquatic and Riparian Invasive Species

Many non-native aquatic invasive species can seriously hinder the recreational use of a waterbody, out-compete beneficial native plants and animals, and otherwise alter the natural environment. Eurasian watermilfoil (*Myriophyllum spicatum* L., or EWM) is the major invasive species that currently affects Basin 17 surface waters, and is known to occur in Lake Memphremagog, Derby Lake, Clyde Pond, Brownington Pond, Crystal Lake, Lake Willoughby, Great Hosmer Pond and Shadow Lake. Eurasian watermilfoil is known for its rapid growth and ability to spread, which can lead to significant problems within a lake. Commonly found in shallow bays and along shorelines, Eurasian milfoil forms dense beds that can impair the recreational use of a lake and negatively alter a lake's natural environment. The invasive curly-leaf pondweed is also found in Lake Memphremagog, Daniels Pond and Island Pond.

Starry stonewort is an invasive species of macroalgae that was discovered in Scotts Cove of Lake Memphremagog by a volunteer Vermont Invasive Patroller in 2015. Since this time, the presence of this invasive species has been confirmed in the Main lake and South Bay and in 2016 a major infestation was discovered in Derby Pond. A new Lake Memphremagog and South Bay greeter program with a portable decontamination unit program was initiated in late July 2016 by VDEC to spread the word about Starry stonewort (and other AIS) and encourage voluntary spread prevention. In addition to this, starry stonewort information was added to VIP and greeter training programs. This new infestation along with the widespread EWM in Lake Memphremagog have identified a need to provide education and outreach on cleaning boats as they enter and leave this waterbody to prevent further invasive species spread.

VDEC has created a new online mapping tool where the presence of AIS, as well as greeter and control programs can be viewed. This is available on the web at:
http://dec.vermont.gov/watershed/lakes-ponds/aquatic-invasives/ais-map

There are also a number of wetland and riverbank non-native invasive species in the basin including purple loosestrife (*Lythrum salicaria* L), phragmites (*Phragmites australis)*, and Japanese knotweed (*Fallopia japonica*) which can reduce the quality of riparian and aquatic habitats and spread along river corridors. The distribution of these species is not well understood, but a map of the location of some of the more common riverbank invasives has been developed where Phase 2 Stream Geomorphic Assessments have been completed, although the prevalence of these species in the watershed is much more widespread.

Click the following hyperlink to view summary strategies to address Aquatic and riparian invasive species.

J. Lake Memphremagog TMDL Implementation Summary

The information provided in the foregoing provides the best-available information regarding the implementation of the Lake Memphremagog TMDL over the next five years. This information is provided by source sector, and tied to the regulatory programs that are highlighted by Act 64 to compel phosphorus pollution reductions for each sector along with voluntary efforts supported by grant programs and technical assistance. An important consideration in the development of this modeling analysis is the pace at which the expected reductions may be achieved from any given sector. Generally, the Lake Memphremagog TMDL is envisioned to be implemented over a 20-year timeframe or 4 tactical basin planning cycles. Figure 13 provides a hypothetical representation of the pace at which nutrient reductions may be achieved, informed by the timelines during which each regulatory program is being put into place.

The capability for the State to compel reductions in the first five-year iteration of this tactical plan cycle is limited by the timelines set forth by Act 64 for the establishment and promulgation of the permit programs. and the availability of funding. In the first instance, the State cannot compel, for example, the reduction of phosphorus from specific municipal road segments, until: 1) that permit program has been established; 2) the municipality has applied for coverage under that program; and, 3) the municipality has completed their road assessment, and staged a plan for implementation based on the most effective phosphorus reduction efforts. Further, for those plans to be implemented, there needs to exist funding to support implementation of the specific projects. Figure 13 provides the timelines for permit promulgation, permit application and assessment/inspection, and implementation. However, the prior sections of this chapter focused on strategies that are aimed at accelerating the adoption of BMPs that can have the largest impact on reducing phosphorus loading to Lake Memphremagog.

In regard to funding, this current tactical basin plan cannot yet articulate a precise estimation of the total cost of implementation to achieve the full completion of TMDL activities. However, the following information provides a cost perspective based on a statewide view of clean water funding needs, and a sector-specific estimated cost per unit reduction for phosphorus.

The State of Vermont Treasurer's report describes the full costs of implementing Act 64 to achieve clean water for the entire State of Vermont. Figures available as of this writing suggest a total *statewide* cost of $2.31B, and a total gap, derived from currently available clean water funding, of $1.34B.

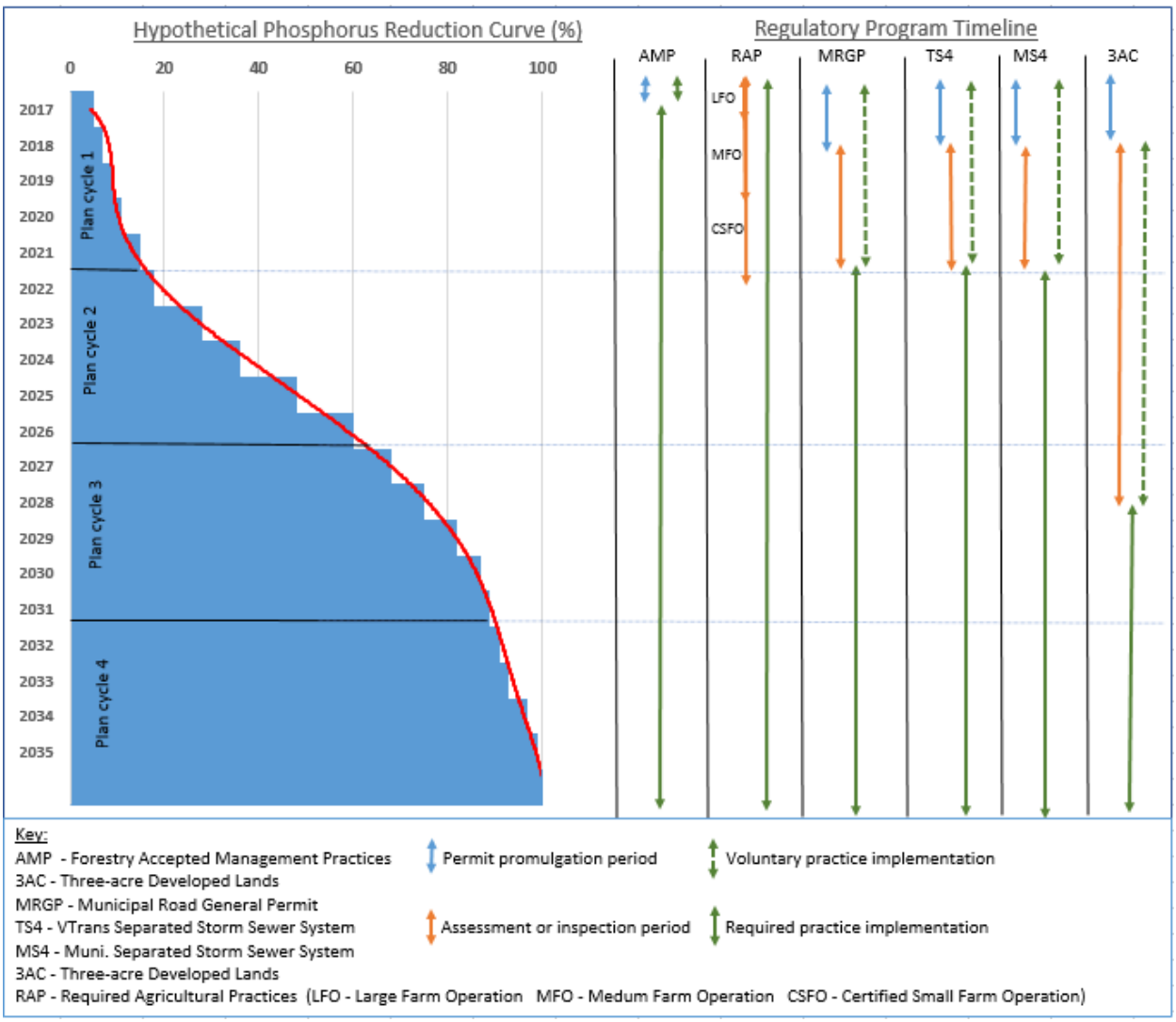


Figure 13. Theoretical phosphorus reduction, relative to the load and wasteload reductions required by the Lake Champlain TMDL. The timelines for regulatory programs are also shown.

From the perspective of sector-specific costs, Figure 14, adapted from the Lake Champlain Phase I Plan, presents useful practice-level cost estimates. These latter estimates indicate a gradient of cost efficiency, with highest efficiencies associated with agricultural field practices, followed by roads, developed lands, and wastewater infrastructure. It should be noted that in this example agricultural land practices do not include farmstead practices that would have higher costs per load reductions. Also the costs associated with the agricultural land practices presented are for one year and backroad developed land and wastewater practices generally have a longer lifespan.

Over the course of this tactical basin plan lifecycle, as projects are documented as a result of assessments, they will be entered into the implementation tracking system, and incremental, project-level costs can begin to be aggregated.

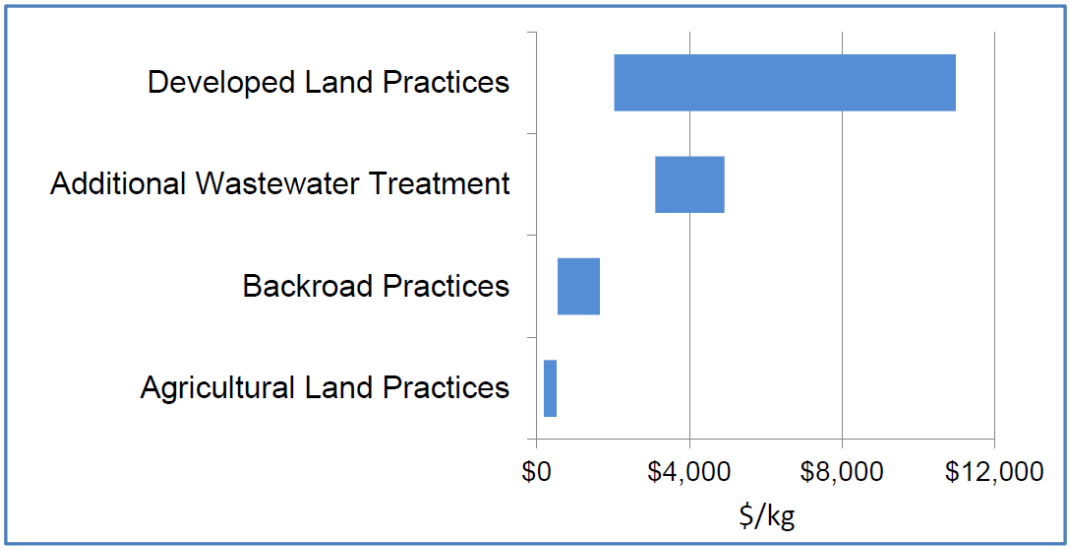


Figure 14. General costs of practices, by land use sector, expressed by kilogram of phosphorus reduced.

As has been described in this chapter, a robust phosphorus reduction tracking approach is being put into place to document implementation of on-the-ground practices and projects. It is through this system that accurate phosphorus reduction projections, and documented accomplishments will be tracked. These accomplishments will be reported publicly, as required by Act 64 on an annual basis. As of this writing, the modeling and projected phosphorus reductions shown by this Chapter are the best information available to Vermonters, but remain a starting point. Future iterations of the Basin 17 Tactical Basin Plan will provide augmented specificity in regard to phosphorus reductions achieved, reductions planned, costs, and as appropriate, success stories documenting incremental water quality improvement.

Chapter 4 - Management Objectives for Surface Waters in Basin 17

The Vermont Water Quality Standards establish water quality classes and associated management objectives. The protection or improvement of water quality and water-related uses can be promoted by establishing specific management objectives for particular bodies or stretches of water. The management objectives describe the values and uses of the surface water that are to be protected or achieved through appropriate management. In the Very High Quality Waters section of this plan, a number of waters are identified as being of notable high quality, and these, as well as other unique

areas, may be candidates for establishing alternate management objectives or augmented protections through one of the processes that are further described below.

- Opportunities for reclassification of waters
- Identification of existing uses
- Opportunities for designation of Outstanding Resource Waters
- Classification of wetlands
- Designation of waters as cold water fisheries

The Agency of Natural Resources is responsible for determining the presence of existing uses on a case-by-case basis or through basin planning, and is also responsible for classification or other designations. Once the Agency establishes a management goal, the Agency manages state lands and issues permits to achieve all management objectives established for the associated surface water. Before the Agency recommends management objectives through a classification or designation action: input from the public on any proposal is required and considered. The public may present a proposal for establishing management objectives for Agency consideration at any time, while the Agency typically relies on the publication of basin plans to promote reclassification. When the public develops proposals regarding management objectives, the increased community awareness can lead to protection of uses and values by the community and individuals.

Public involvement is an essential component to restoring and protecting river and lake ecology. The Vermont Water Quality Standards indicate that in the basin planning process, "*Public participation shall be sought to identify and inventory problems, solutions, high quality waters, existing uses and significant resources of high public interest.*" Emphasis on the identification of values and expectations for future water quality conditions can only be achieved through public contributions to the planning process.

Several rivers and streams, lakes and ponds, and wetlands in the Basin 17 watershed currently achieve a very high quality of water and aquatic habitat and may also provide exceptional opportunities for swimming, fishing, and boating. In addition to protecting and improving water resources by managing stressors, there is the opportunity to protect surface waters by identifying and documenting this high quality and preserving those excellent conditions or features through various classifications or designations. Several statewide references and reports available with descriptions of the exceptional ecological quality or recreational uses of Vermont surface waters. The Agency's Natural Resource Atlas provides a statewide application identifying surface water and riparian areas with a high contribution to biodiversity.

A. Classification and Recent Revisions to the Vermont Water Quality Standards

Since the 1960s, Vermont has had a classification system for surface waters that establishes management goals objectives and supporting criteria for each use in each class of water. Pursuant to

Act 79 of 2016, the Vermont General Assembly, recognizing the wide range of quality for Class B waters, created a new intermediary water quality class between B and A, now called Class B(1). Act 79 also sets forth the expectation that individual uses of waters (e.g., aquatic biota and wildlife, aquatic habitat, recreation, aesthetics, etc.) may be individually classified, such that a specific lake or stream may have individual uses classified at different levels. Act 79 indicates that uses may be reclassified independently to Class B(1) may be designated for individual uses if the quality of those uses are demonstrably and consistently of higher quality than Class B(2).

These waters and their elevated uses are identified through the tactical planning process or on a case by case basis. Waters where one or more designated uses demonstrably and consistently exhibit a level of quality consistent with Class B(1) criteria are considered to support the higher-level classification as an existing use. Waters whose existing uses have been identified as higher than B(2) may also be reclassified to the corresponding level of designated use. Table 20 lists the possible classes into which each use may be placed.

Table 20. A list of uses that can be placed into each water class in the Vermont Water Quality Standards.

Classification (2016)	Applicable Uses
Class A(1)	One or more of: Aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, boating, or swimming
Class A(2)	Public water source
Class B(1)	One or more of: Aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, or boating
Class B(2)	Aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, boating, swimming, public water source or irrigation

With the exception of the waters listed below, all waters in Basin 17 are Class B(2) pursuant to the proposed new Standards.

1) Waters above 2,500 feet in elevation classified A(1) by Vermont statute.
2) Surface waters classified as A(2) that are managed to be suitable for use as a public water source with disinfection, and filtration when necessary (Table 21).

Table 21. Class A(2) designated public water sources in the Lake Memphremagog Basin.

Waters	Water Source	Description
Unnamed Tributary to Island Pond	Village of Brighton	
Unnamed tributaries to unnamed tributary to Lightning Brook	Village of Brighton	

May Pond Brook watershed above water intake	Town of Barton	
Unnamed tributary to the Black River	Coventry fire district #1	
Unnamed reservoir near Derby Line	Village of Derby Line	

Tactical basin plans identify surface waters where monitoring data indicates conditions are significantly better than the water quality objectives and criteria of the VT Water Quality Standards. This high-level of quality may be protected by site-specific application of the anti-degradation policy of the Standards, or by reclassification to a higher level designated use. Data analysis of water quality and biological integrity indicates that several waters in the Basin support very high quality conditions (Table 22). Lastly, very high quality waters for supporting recreational fishing (Table 24) are included based on surveys from the VT Department of Fish and Wildlife.

Table 22. Basin streams that support exceptional ecological integrity. *

WB-ID	Name	Town	River mile (RM[1])	Score	Action
VT17-10	Shalney Branch	Albany	1.3	Excellent-very good macroinvertebrates 6 dates from 2010 – 2015 and Excellent fish 2013-2014	Reclassify as B(1) water for aquatic biota and habitat or evaluate potential Reclassification as A(1) water
VT17-06	Unnamed tributary to Lake Willoughby		0.1	Exc/VG and Very Good macroinvertebrates and Very good Fish 2014 & 2015	Reclassify as B(1) water for aquatic biota and habitat

[1] RM = river mile as measured from the mouth upstream (or from the NY state line).

*Note - Biological data indicates a consensus very good or excellent condition by both fish and macroinvertebrates.

Very High Quality Biological Integrity

There are several sub-watersheds in Basin 17 that support very high quality aquatic biota. VDEC assesses the biological health of running waters using assessments of macroinvertebrate and fish communities. Based on VDEC's long-term sampling of stream locations in Basin 17, there are two streams that exhibit ecological integrity consistent with very good or excellent conditions, based on these assessments (Table 22). Certain of these surface waters could qualify as candidates for reclassification to Class B(1) or in the case of Shalney Branch potentially A(1) with additional sampling. Streams where additional sampling is needed to support reclassification as B(1) or A(1) waters are listed in Table 4.

Table 23 lists identified surface waters that are classified as Class A(2) for public water source, and where Class B(2) management objectives are more suitable.

Table 23. Candidate surface waters for reclassification from Class A(2) to Class B.

Water	Location	Supporting Data
Unnamed reservoir near Derby Line	Village of Derby Line	No longer used.
Unnamed tributary to the Black River used by Coventry Fire District number # 1.	Coventry	No longer used.

Lakes & Ponds

The Lakes and Ponds Program of VDEC completed a process in 2013 to identify high quality lakes in the state to prioritize conservation and protection efforts. Lakes were independently ranked in three separate categories using long-term datasets for water quality, biological diversity and unusual or scenic natural features. Scores from the separate categories were combined to identify 16 lakes with exemplary qualities in all three and lakes in the top 25% categories are highlighted in Table 2.

Very High Quality Waters Supporting Recreational Fishing

VT Department of Fish and Wildlife assesses wild trout populations and important nursery areas to document very high quality recreational fisheries, which are typically found in surface waters that which support diverse and complex physical habitats and cool water temperatures. Abundant wild trout populations are defined as supporting multiple age classes of one or more species of wild trout (Brook, Brown, Rainbow Trout) at levels generally equal to or greater than 1,000 fish/mile and/or 20 pounds/acre. It should be recognized that wild trout populations vary widely from year to year and therefore an individual population may sometimes go below or greatly exceed these values in a given year. Other waters that have not been surveyed may also support similar wild trout densities and may be identified in the future.

Certain noteworthy streams are also important to support spawning and nursery habitat in Basin 17. Although, very high quality waters are being called out in this plan, it is important to note that all waterbodies that would naturally support fish populations are protected and maintained for this and future generations of people. Table 24 lists streams supporting both mixed resident trout, allopatric brook trout (populations with no other salmonids) and spawning/nursery stream populations. An updated survey of recreational fishery should be conducted regularly and this list may be adjusted based on updated surveys and as protocols are refined for identifying waters that meet the revised criteria in the water quality standards for both B(1) and A(1) fishing use.

Table 24. Basin streams supporting very high quality mixed resident trout, allopatric brook trout and spawning/nursery stream populations at a density of greater than 1000 fish per mile or 20 lbs. per acre. BKT is Brook Trout, BNT is Brown Trout and RBT is for Rainbow trout or Steelhead.

Potential B(1) waters is Basin 17			Fish/mile (>1,00) or *lbs./acre (>20)*			
Watershed	**Stream**	**species composition**	**BKT**	**BNT**	**RBT**	**Sum** fish/mile or ***#/acre***
Barton	Annis Brook	BKT & RBT	859		1105	1964
Barton	Brownington Branch	BKT, BNT & RBT	137	11	3315	3463
Barton	Country Club Brook	BNT & RBT		63	1917	1980
Barton	Day Brook	BNT & RBT		***16.4***	***7.3***	***23.7***
Barton	Dorn Brook	RBT			2815	2815
Barton	Dutton Brook	BKT & RBT	898		1108	2006
Barton	Hogtrough Brook	BKT & RBT	21		3970	3991
Barton	Mainstem elevation @ 232 meters	BNT & RBT		138	3443	3581
Barton	Mainstem elevation @ 295 meters	BKT, BNT & RBT	473	6614	139	7226
Barton	May Pond Brook	BKT & RBT	***13.5***		***6.7***	***20.2***
Barton	Roaring Brook	BKT, BNT & RBT		3404		3404
Barton	Schoolhouse Brook	BKT & RBT	90		2034	2124
Barton	Stevens Brook	BKT, BNT & RBT	713	818	633	2164
Barton	Unnamed Barton River Tributary	BKT & RBT	581		1214	1795
Barton	Unnamed Willoughby River Tributary	RBT			1583	1583
Barton	Unnamed Willoughby River Tributary	BKT	5809			5809
Barton	Wheeler Brook	BKT	2057			2057
Barton	Willoughby Brook	BKT & RBT	269		2176	2445
Barton	Willoughby River Mainstem @ 223 M	BNT & RBT		35	3907	3942
Barton	Willoughby River Mainstem @ 348 M	BKT, BNT & RBT	22	782	6663	7467
Barton	Mill Brook	BKT & RBT			1094	1094
Black	Allen Brook	BKT & RBT	1038		794	1832
Black	Beaver Brook	BKT & RBT			2162	2162
Black	Cass Brook	BKT & RBT	2482			2482
Black	Lamphean Brook	BKT & RBT	160		1866	2026
Black	Lords Creek	BKT & RBT	515		3993	4508
Black	Black River Mainstem @ 210	BNT & RBT		1613	7226	8839
Black	Seaver Brook	BKT	2798			2798
Black	Shalney Brook	BKT	1242			1242
Black	Stony Brook	BKT, BNT & RBT	1000	28	3196	4224
Black	Ware Brook	BKT, BNT & RBT	105	337	1014	1456
Black	Webber Brook	BKT	1795			1795
Black	Whetstone Brook	BKT	1715			1715

Potential B(1) waters is Basin 17			Fish/mile (>1,00) or *lbs./acre (>20)*			
Watershed	**Stream**	**species composition**	**BKT**	**BNT**	**RBT**	**Sum** fish/mile or ***#/acre***
Black	Whitney Brook	BKT	1291			1291
Clyde	Greens Brook	BKT & RBT	1126		1654	2780
Clyde	Hurricane Brook	BKT	1739			1739
Clyde	Lang Brook	BKT	1356			1356
Clyde	Mad Brook	BKT	2323			2323
Clyde	Orcutt Brook	BKT	4107			4107
Clyde	Oswegatchie Brook	BKT	4682			4682
Clyde	Pherrins River	BKT	9432			9432
Clyde	Trib to Seymour	BKT	2561			2561
Clyde	Valley Brook	BKT, BNT & RBT	194	9200		9394
Clyde	Webster Brook	BKT	3024			3024
Clyde	Clyde Mainstem	BNT & RBT		***17.5***	***2.5***	***20***
Clyde	Sucker Brook	BKT & BNT	***2.7***	***22.9***		***25.6***
Clyde	Coche Brook	BKT	1321			1321
Clyde	Pine Brook	BKT	1370			1370
Coaticook	Coaticook Brook	BKT	2535			2535
Coaticook	Trib to Little Averill	BKT	1056			1056
Johns	Crystal Brook	BKT & RBT	2442		990	3432
Johns	Johns River	BKT, BNT & RBT	633	2693	237	3563

B. Existing Uses

All surface waters in Vermont are managed to support designated uses valued by the public at a level of Class B(2) or better. These uses include swimming, boating, and fishing, aquatic biota, aquatic habitat, aesthetics, drinking water source and irrigation.

The degree of protection afforded to these uses is based on the water's class as described in Table 20. In addition, under the anti-degradation policy of the Vermont Water Quality Standards, if the Agency of Natural Resources identifies a waterbody with one or more uses that exceed the classification criteria for the designated use class, then those uses shall be protected to maintain that higher level of quality.

The Agency may identify existing conditions, known as existing uses, of particular waters during the tactical basin planning process or on a case-by-case basis during application reviews for State or federal permits. Consistent with the federal Clean Water Act, the Vermont Water Quality Standards have always stipulated that existing uses may be documented in any surface water location where that use has occurred since November 28, 1975. Pursuant to the definition of the new Class B(1) in

Act 79, the Agency may identify an existing use at Class B(1) levels when that use is demonstrably and consistently attained.

It is the Agency's long-standing stipulation that all lakes and ponds in the basin have existing uses of swimming, boating and fishing. Likewise, the Agency recognizes that fishing activities in streams and rivers are widespread throughout the state and are too numerous to thoroughly document for Basin 17. Also recognized is that streams too small to support significant angling activity provide spawning and nursery areas, which contribute to fish stocks downstream where larger streams and rivers support a higher level of fishing activity. As such, along with the larger streams and rivers that support a higher level of fishing activity these small tributaries are considered supporting the use of fishing and are protected at a level commensurate with downstream areas.

Based on the above paragraph, the existing uses identified by VDEC for Basin 17 to date should therefore be viewed as only a partial accounting of known existing uses based upon limited information. The list does not change protection under the Clean Water Act or Vermont Water Quality Standards for waters not listed. Appendix B presents the current list of Existing Uses determined for Basin 17.

C. Outstanding Resource Waters

In 1987, the Vermont Legislature passed Act 67, "An Act Relating to Establishing a Comprehensive State Rivers Policy." A part of Act 67 provides protection to rivers and streams that have "exceptional natural, cultural, recreational or scenic values" through the designation of Outstanding Resource Waters (ORW). Depending on the values for which designation is sought, ORW designation may protect exceptional waters through the permits for stream alteration, dams, wastewater discharges, aquatic nuisance controls, solid waste disposal, Act 250 projects and other activities. ORWs are waters which can be designated by the Agency of Natural Resources through a petition process. ORWs display outstanding qualities that are determined to deserve a higher level of protection.

There are currently no ORW designations in Basin 17. Although no other waters have been identified as ORW in this plan, there may be waters in the basin which merit this designation and for which ORW status should be pursued. Water quality on the Willoughby River and its exceptional recreational (primarily fishing) and scenic values make this a potential water for this designation, as was recommended by the prior basin plan (2012). Similarly, Lake Willoughby is renowned for its exceptional scenic beauty and recreational values along with water quality and so may also merit ORW designation. The Agency will support collaborative efforts to develop the materials, and to conduct outreach necessary to support rulemaking for ORW designation of these waters, should there be public interest.

D. Class 1 Wetland Designation

It is policy of the State of Vermont to identify and protect significant wetlands and the values and functions they serve in such a manner that the goal of no net loss of such wetlands and their functions is achieved. Based on an evaluation of the extent to which a wetland provides functions and values, it is classified at one of three levels:

Class I: Exceptional or irreplaceable in its contribution to Vermont's natural heritage and therefore, merits the highest level of protection

Class II: Merits protection, either taken alone or in conjunction with other wetlands

Class III: Neither a Class II or Class I wetland

Impacts to Class I wetlands may only be permitted when the activity is necessary to meet a compelling public need for health or safety. There are currently no Class I wetlands in Basin 17, however there are a handful of wetlands that warrant study for Class I potential. These wetlands are listed below.

As part of the implementation of this tactical basin plan, the Department will develop and implement procedures and documents to enable submission, evaluation, and implementation of petitions to classify wetlands as Class I. Those wetlands that satisfy criteria for designation may be proposed for such designation through Departmental rulemaking authority, and as consistent with the Vermont Wetland Rules.

The VT Wetlands Program has created a Class I website with an interactive map. This website has the determinations for the 3 existing Class I wetlands, and materials about the three newly designated Class I wetlands: Chickering Bog; Dennis Pond Wetlands; and, Sandbar Wetland Complex. Over time new materials will be added, such as, a Class I petition form and a list of other wetlands which likely qualify. The web address is: http://dec.vermont.gov/watershed/wetlands/class1wetlands.

Wetlands for Further Study for Re-Classification to Class I

- Upper Clyde River Wetlands Complex
- South Bay Wetland Complex along the Black and Barton Rivers

E. Warm and Cold Water Fish Habitat Designations

Warm Water Fish Habitat

All surface-water wetlands and the following waters are designated as warm water fish habitat for purposes of the Vermont Water Quality Standards (WQS):

- Daniels Pond, Glover
- Lake Derby, Derby
- Long Pond, Sheffield
- Little Hosmer Pond, Craftsbury
- Mud Pond, Craftsbury
- Mud Pond, (North) Morgan
- Tildys Pond (Clark Pond), Glover
- Toad Pond, Charleston
- Turtle Pond, Holland

The WQS specifies a lower minimum dissolved oxygen concentration than waters in the remainder of the basin, which are Cold-Water Habitat. There are no proposed changes to warm water fish habitat designations at this time.

Cold-Water Fish Habitat

All waters not designated as warm water fish habitat above are designated as cold-water fish habitat for Basin 17, as noted in the Vermont Water Quality Standards, 2016.

Chapter 5 – The Implementation Table: Protection and Remediation Actions

The Tactical Basin Plan addresses all impaired, stressed and altered waters (Tables 2-3) in the basin as well as protection needs for high quality waters; however, a central focus of the plan is also the identification of specific priority actions to reduce nutrient and sediment loading in priority catchments as part of the effort to meet the Lake Memphremagog TMDL goals. The list of actions cover future assessment and monitoring needs, as well as implementation projects that protect or remediate waters and related education and outreach. Table 25 is a summary of priority actions from over 400 individual project entries in the online watershed projects database. Action items in the implementation table summary are supported by the phosphorus loading reduction targets set forward in the Lake Memphremagog TMDL as well as the statewide Surface Water Management Strategy. As projects are developed, priority for funding will be given to those projects that achieve a high phosphorus removed benefit per cost ratio. Additionally, projects that provide co-benefits (i.e. flood resiliency, water quality improvement, water resource protection, aquatic organism passage) will receive additional consideration for prioritization.

A. Coordination of Watershed Partners

There are several active organizations undertaking watershed monitoring, assessment, protection, restoration, and education and outreach projects in Basin 17. These partners are non-profit, state, and federal organizations working on both private and public lands. Partnerships are crucial in carrying out non-regulatory actions to improve water quality. Partners active in working on with farms in the basin including NRCS, AAFM, OCNRCD, VDEC, UVM Extension Service, Sterling College, MWA, VLT, Beck Pond LLC. and NOFA VT (Link to list of Acronyms) are part of an agricultural workgroup that meets twice a year to coordinate efforts in the basin currently under the auspices of the Memphremagog RCPP. The Quebec Vermont Steering Committee includes partners in both Quebec and Vermont to coordinate efforts to protect and restore the lake and its watershed and similarly meets twice a year, in Vermont in the fall and Quebec in the spring. Finally, the Memphremagog Watershed Association is leading an effort to establish a Memphremagog Stormwater Collaborative to help coordinate efforts to address stormwater in the basin with many of the same partners including NorthWoods Stewardship Center, NVDA, the City of Newport and the many lake and pond associations in the basin. The large amount of work that is necessary to meet water quality targets in this basin require such tight collaborations to maximize the effectiveness of watershed partners.

B. Basin 17 Implementation Table Summary

The process for identifying priority actions is the result of a comprehensive compilation and review of both internal ANR monitoring and assessment data and reports, and those of our watershed partner organizations described in Chapters 2 and 3. The monitoring and assessment reports include, but are not

limited to, stormwater mapping reports, geomorphic assessments, river corridor plans, bridge and culvert assessments, Hazard Mitigation Plans, agricultural modeling and assessments, road erosion inventories, biological and chemical monitoring, lake assessments, fisheries assessments, and natural communities and biological diversity mapping.

A summary of priority actions to address water quality in the Basin 17, organized by basin wide actions and major sub-basin actions, are identified in Table 25. The on-going detailed list of actions can be viewed via the online Watershed Projects database. The following tables serve to identify high priority implementation actions and tasks that provide opportunities for all stakeholders in surface water management across each major river basin to pursue and secure technical and financial support for implementation. In order for these priorities to be achieved, partners and stakeholders must help to carry out the actions identified in the basin plan.

The table is organized by land use or pollutant sector and the summary strategies can be accessed directly by clicking on the bookmarks below:

A) Runoff from Developed Lands
B) Runoff from Lakeshore Properties
C) Runoff from Municipal Roads
D) Runoff from State Transportation Infrastructure
E) Runoff from Agricultural Lands
F) Runoff from Forest Lands
G) Unstable Stream Channels and Aquatic Habitat
H) Wastewater Treatment Facilities
I) Flow Altered Waterbodies
J) Aquatic and Riparian Invasive Species

Table 25. Summary implementation actions for the Basin 17 Tactical basin plan

Strategies	**Stressor Addressed**	**Partners (see Partners)**	**Funding (see** Appendix D**)**
Strategies to address runoff from Developed Lands. Priority Sub-basins include high phosphorus export watersheds in the Lake Memphremagog Basin (Figure 2) Tributary to Stearns Brook, lake watersheds with elevated nutrient levels or increasing trends.			
1. Map parcels that will come under the 3 acre stormwater permit in the basin and do outreach to landowners that will be required to seek permit coverage.	land erosion, channel erosion, encroachment	VDEC, NVDA, Towns	

Strategies	Stressor Addressed	Partners (see Partners)	Funding (see Appendix D)
2. Complete 100% design for City of Newport stormwater retrofit, and full feasibility analysis for Derby stormwater retrofit.	land erosion, channel erosion, encroachment	MWA, City of Newport, Town of Derby, OCNRCD	CWI, ERP
3. Develop 30% design for Newport elementary school stormwater retrofit and Northpoint auto dealership drainage at the head of the mass failure along the Clyde River.	land erosion, channel erosion, encroachment	MWA, Northpoint Auto	CWI, ERP
4. Create the Memphremagog Stormwater Collaborative to implement a stormwater outreach effort to make landowners aware of stormwater BMPs to support implementation of town GSI practices, and to create local expertise in implementing GSI practices in the basin that can be shared with partners. Support coordinated funding of stormwater implementation.	Nutrients, land erosion, channel erosion, encroachment	MWA, OCNRCD, VDEC, NVDA, Towns, Lake Associations	CWI, ERP
5. Complete City of Newport small GSI practices and Glover town office rain garden projects along with other small scale GSI practices. Engage volunteers in installing practices and host GSI tours to expand understanding of techniques.	Nutrients, land erosion,	MWA, City of Newport, Town of Glover, OCNRCD	CWI, ERP
6. Address two potentially failed septic systems in Derby identified by IDDE assessment.	Pathogens, nutrients	VDEC, Derby	Septic system funding..
7. Support brownfields restoration efforts that mitigate surface water pollution generated from these sites.	Toxics	NVDA, Towns, MWA,	EPA
Strategies to address runoff from Lakeshore Developed Lands. Priority sub-basins include lakes with increasing nutrients trends or elevated levels (Eligo, Little and Great Averill, Holland, Long, Parker, Norton, Salem, Seymour, Shadow, Willoughby) and lake watersheds elevated nutrient levels including Lake Memphremagog, Walker Pond and Mud Pond.			
8. Complete annual Lake Wise trainings to develop capacity for local partners to evaluate properties for Lake Wise Assessments.	Nutrients, land erosion, encroachment	VDEC, Local Lake Wise Partners	
9. Complete Lake Wise Masterplans for Willoughby, Seymour, and Shadow Lakes or as other stressed lakes	Nutrients, land erosion, encroachment	NorthWoods, OCNRCD, MWA, VDEC, FOVLAP, Lake	CWI, ERP

Strategies	Stressor Addressed	Partners (see Partners)	Funding (see Appendix D)
where there is local support to identify and implement priority projects.		and Watershed Associations.	
10. Use Memphremagog Stormwater collaborative to initiate Lake Wise Mentoring to share Lake Wise expertise between Lake Associations, and to support shared technical resources and coordinated grant funding for BMP implementation.	Nutrients, land erosion, encroachment	NorthWoods, OCNRCD, MWA, DEC, FOVLAP, Lake and Watershed Associations.	CWI, ERP
11. Implement priority projects identified in Lake Wise master plans.	Nutrients, land erosion, encroachment	NorthWoods, OCNRCD, MWA, DEC, FOVLAP, Lake and Watershed Associations.	CWI, ERP
12. Complete Lake Wise practices at Brighton State Park, Shadow Lake Beach, North End of Lake Willoughby, Coutts Moriarty Camp on Lake Salem to increase the visibility of BMP practices and Lake wise program.	Nutrients, land erosion, encroachment	NorthWoods, OCNRCD, MWA, DEC, Lake and Watershed Associations, ANR, Towns.	CWI, ERP
13. Develop and evaluate the new lake watershed assessment process to identify and address shoreland and lake sources of nutrients to upland lakes.	Nutrients, land erosion, encroachment	NorthWoods, OCNRCD, MWA, DEC, towns, Lake and Watershed Associations	CWI, Watershed grants
Strategies to address runoff from Municipal Roads. Priority areas shown in Figure 8 and Table 12.			
14. Complete outreach to towns and communities about new MRGP regulations through workshops and individual meetings with selectboards.	land erosion, channel erosion, encroachment	NVDA, VTrans, OCNRCD, MWA, DEC, FOVLAP, Vermont Local Roads	CWI, ERP
15. Develop regional collaboration for completing assessments to meet municipal Road General Permit requirements and help towns prioritize implementation of projects that address road segments with significant water quality impacts.	land erosion, channel erosion, encroachment	NVDA, VTrans, OCNRCD, MWA, DEC, FOVLAP, Vermont Local Roads	CWI, ERP
16. Update regional road erosion inventory template to incorporate MRGP requirements and to better	Nutrients, land erosion,	OCNRCD, MWA, VDEC, Lake and	CWI, ERP

Strategies	Stressor Addressed	Partners (see Partners)	Funding (see Appendix D)
highlight projects with largest water quality benefits along with town transportation needs.	channel erosion, encroachment	Watershed Associations, ANR, Towns.	
17. Develop capacity through Memphremagog Storwmater Collaborative or private consultants to support towns in completing at least 5 Road erosion inventories and capital budgets per year.	Nutrients, land erosion, channel erosion, encroachment	NorthWoods, OCNRCD MWA, VDEC, NVDA, VTrans	CWI, ERP, BBR
18. Through the Memphremagog Stormwater Collaborative and NEKRR group, provide ongoing support for towns in implementing road projects with the most significant water quality benefits through Better Roads grants and other funding sources.	Nutrients, land erosion, channel erosion, encroachment	NorthWoods, OCNRCD, MWA, VDEC, Vtrans, Lake and Watershed Associations, Towns.	CWI, ERP, BBR
19. Complete ANR Bridge and culvert surveys in the Tomifobia and Coaticook watersheds and work with towns to replace structures identified in these and earlier assessments as barriers to AOP and or that are geomorphically incompatible.	Channel erosion, encroachment	VFW, VDEC, Towns, MWA, NorthWoods	VBR, CWI, ERP, (for geomorphically incompatible structures)
Strategies to address runoff from State Transportation Infrastructure Priority Sub-basins include high phosphorus export watersheds in the Lake Memphremagog Basin in Figure 2 with a focus of the Airport Tributary.			
20. Implement six minimum control measures required in the State TS4 permit.	land erosion, channel erosion, encroachment	VTrans,	VTrans
21. Complete assessments necessary to support the development of a phosphorus control plan for the Lake Memphremagog Basin early in the next TS4 permit cycle.	land erosion, channel erosion, encroachment	VTrans	VTrans
22. Identify funding to complete final designs for Coventry Airport gully stabilization and Orleans Park and ride stormwater treatment practices.	Channel erosion, encroachment	VTrans, MWA	Vtrans, ERP
23. Scope potential treatment practices on Willoughby State Forest to treat runoff from Route 5A before this enters Lake Willoughby.	Nutrients, land erosion	VTrans, VFPR, MWA,	VTrans, ERP, Northern Borders Regional Commission

Strategies	Stressor Addressed	Partners (see Partners)	Funding (see Appendix D)
Strategies to address runoff from Agricultural lands. Priority sub-basins include high phosphorus export watersheds shown in Figure 2, Impaired Tributary to Stearns Brook, Roaring Branch, Lake watersheds with increasing nutrient trends including Willoughby, Seymour, Shadow, Parker, Salem.			
24. Create Magog farmer workgroup to support the implementation of RAPs, BMPs, and effective workshops and outreach efforts.	Nutrients, land erosion, channel erosion	OCNRCD, AAFM, NRCS, VDEC, UVM ext.	ACWIP
25. Host annual workshops on improving soil health and new RAPs.	Land erosion, nutrients, channel erosion	OCNRCD, Sterling College, AAFM, NRCS, UVM ext., NOFA	RCPP, USDA, ERP, ACWIP
26. Create tracking system for certified small farms that need NMPs, with up-to-date NMPs, schedule to keep these up-to-date.	Land erosion, nutrients, channel erosion	OCNRCD, AAFM, NRCS, UVM ext.	RCPP, ERP, ACWIP
27. Support 8 farmers per year in developing Nutrient Management Plans (NMPs) through UVM Extension's Digging In course and the development of NMPs for all certified farms through NRCS CAPS funding.	Land erosion, nutrients, channel erosion	OCNRCD, AAFM, NRCS, UVM ext.	RCPP, EQIP
28. Support the development of NMPs for certified farms that are not interested in Digging in Course through NRCS CAPS funding.	Land erosion, nutrients, channel erosion	OCNRCD, AAFM, NRCS	RCPP, EQIP, ACWIP
29. Generate funding so that VACD, OCNRCD staff, and partners can continue to work with priority farms on implementing NMPs once these have been completed to installing practices to address issues identified in NMP and LTPs.	Land erosion, nutrients, channel erosion	OCNRCD, AAFM, NRCS, VDEC, UVM ext, NOFA	RCPP, USDA, ERP, ACWIP, AAFM BMP
30. Include local dairy nutritionist in the Memphremagog agricultural workgroup and to support partners in make the bridge from NMP to feed & forage management.	nutrients,	OCNRCD, NRCS, UVM ext, NOFA	RCPP, ACWIP,
31. Evaluate additional BMPs that could be used on hay land to reduce loading from this land use. Options to evaluate include injection, timing of application, or use	Land erosion, nutrients,	OCNRCD, AAFM, NRCS, VDEC, UVM ext, NOFA	RCPP, USDA, ERP, ACWIP, AAFM BMP

Strategies	Stressor Addressed	Partners (see Partners)	Funding (see Appendix D)
of Aerway. Provide outreach to farmers to support effective BMPs that are identified.			
32. Work with farmers to do demonstrations and trials on different cover crops, rotations and manure management scenarios such as rotation of annual Italian grass.	Land erosion, nutrients,	UVM ext., OCNRCD, NRCS, VDEC, NOFA, seed companies	RCPP, USDA, ERP, ACWIP
33. Develop a practical farm stormwater BMPs for farms and provide technical and financial support for farms to implement these to address stormwater runoff from impervious surfaces in farmstead areas.	Land erosion, nutrients, channel erosion	OCNRCD, AAFM, NRCS, VDEC, UVM ext., NOFA, MWA, NorthWoods	ACWIP, EQIP, RCPP, AAFM BMP, ERP
34. Increase the availability of equipment available for rental or through custom operators to allow farmers to follow NMPs including equipment to measure crop yields, manure application rates, take soil samples, and to implement practices such as no till drills, manure injectors, tine weeder air seeders.	Land erosion, nutrients, channel erosion	OCNRCD, AAFM, NRCS, VDEC, UVM ext., NOFA	ACWIP, AAFM BMP
35. Promote existing programs (Commonwealth Grant) and develop additional programs to reduce financial match requirements for farmers to implement priority water quality improvement practices in coordination with Farm Viability Program.	Land erosion, nutrients, channel erosion	OCNRCD, AAFM, NRCS, VDEC,	ERP, ACWIP, Northern Borders Regional Commission, Commonwealth Grant
36. Develop equine specific programing including support for installing horse manure compost bins and making pasture improvements.	Land erosion, nutrients,	OCNRCD, AAFM, NRCS,	ACWIP, EQIP, RCPP, AAFM BMP
37. Complete targeted water quality sampling on 5-10 farms to help identify source areas and evaluate nutrient reductions achieved through BMP implementation.	Land erosion, nutrients, channel erosion	VDEC, OCNRCD, Beck Pond LLC, MWA	ERP, ACWIP
38. Publish success stories where farmers have installed BMP practices and seen improved farm operations and improved water quality conditions.	Land erosion, nutrients, channel erosion	VDEC, OCNRCD, NRCS, AAFM, MWA, NOFA VT	ERP
39. Increase the participation of Dairy Farms in the basin in the Caring Dairy Program, as well as new AAFM	Land erosion, nutrients,	OCNRCD, AAFM	Caring Dairy, Northern Borders

Strategies	Stressor Addressed	Partners (see Partners)	Funding (see Appendix D)
Vermont Environmental Stewardship program to highlight farms with good water quality practices.	channel erosion		Regional Commission
40. Increase the participation of Farm Viability in working with farms that are the focus of BMP implementation efforts in target watersheds to complete a cash flow analysis or develop a full business plan.	Land erosion, nutrients, channel erosion	Farm Viability, OCNRCD, AAFM, NRCS, NOFA VT	Northern Borders Regional Commission,
41. Develop Farm Conservation Corp program to support implementation of BMP practices which can be done efficiently by hand labor.	Land erosion, nutrients, channel erosion	OCNRCD, AAFM, NRCS, VDEC, UVM ext, NOFA	ERP, ACWIP
Strategies to address runoff from Forest Lands.			
42. Support local land trusts and conservation organizations in conserving forest blocks that are important for protecting water quality in headwater streams.	land erosion, channel erosion, encroachment	Lake and Watershed Associations, Northern Rivers Land Trust, ANR.	CWI, ERP, VHCB,
43. Coordinate workshops on minimizing water quality impacts of maple sugaring operations.	land erosion, channel erosion,	VT Woodlands Association, VT Coverts, VFPR	CWI
44. Host workshops on the new AMPs, as well as resources available for addressing logging road issues which could be held at local lumberyards	land erosion, channel erosion,	VT Woodlands Association, VT Coverts, VFPR	CWI
45. Use Lidar data when available to identify gullies that may have been caused by historical logging operations to evaluate restoration potential.	Land Erosion, Channel erosion	VFPR, ONCRCD, NorthWoods,	CWI, ERP
46. Continue to support local skidder bridge rental program and increase usage of bridges.	Channel erosion, land erosion	OCNRCD, NorthWoods, VFPR	CWI, ERP
Strategies to address unstable stream channels and improve aquatic habitat. Priority Sub-Basins include Middle and lower Barton River.			
47. Complete Phase 2 SGA for identified reaches in the Memphremagog watershed.	Channel erosion, encroachment	VDEC, OCNRCD, MWA, NorthWoods, Towns..	CWI, ERP

Strategies	Stressor Addressed	Partners (see Partners)	Funding (see Appendix D)
48. Complete a field visit along the Stearns Brook watershed to evaluate the status of sediment stressed condition and the contribution of stream channel erosion to this condition as well as town interest in river corridor zoning. Complete Phase 2 assessment if justified based on this evaluation.	Channel erosion, encroachment	VDEC, OCNRCD, MWA, NorthWoods, Towns..	CWI, ERP
49. Complete preliminary engineering for projects identified in existing and new SGA assessments and culvert inventories. Complete project datasheets with preliminary project descriptions and constraints for high priority projects.	Channel erosion, encroachment	VDEC, OCNRCD, MWA, NorthWoods, Towns..	CWI, ERP
50. Complete priority river corridor easement projects along the Baron River including coordination with VFW where one rod ownerships could be expanded through river corridor easements or purchase of these lands.	Channel erosion, encroachment	VDEC, VFW, OCNRCD, MWA, NorthWoods, Towns.	CWI, ERP
51. Continue buffer plantings along rivers in priority locations through CREP, Trees for Streams program, Elm restoration, and VFWD buffer planting efforts	Channel erosion, encroachment, land erosion, nutrients,	VDEC, VFW, OCNRCD, MWA, TNC, NorthWoods, Towns.	CWI, ERP, CREP
52. Continue VFWD experimentation, and if found practical, implementation of novel methods to encourage faster and more efficient means to reclaim cleared lands to floodplain forest.	Channel erosion, encroachment, land erosion, nutrients,	VFWD, OCNRCD, MWA, VDEC	ERP, State Wildlife Grants, Dingell-Johnson funds
53. Coordinate outreach to basin towns on adopting River Corridor Zoning.	Channel erosion, encroachment	NorthWoods, OCNRCD, MWA, VDEC, Lake and Watershed Associations, Towns.	CWI, MPG, HMF
Strategies to support wetland restoration and protection			
54. Continue outreach to landowners of wetlands identified as priority restoration sites – with a focus on lands with new landowners, actively being conserved	Channel erosion, encroachment	OCNRCD, NRCS, MWA, NorthWoods,	CRP

Strategies	Stressor Addressed	Partners (see Partners)	Funding (see Appendix D)
or where landowners are making changes in land management			
55. Flag wetland restoration opportunities when landowners contact wetland ecologists looking to buy or sell a property that really can't be built on to promote wetland restoration programs.	Channel erosion, encroachment	OCNRCD, NRCS, MWA, NorthWoods,	CRP
Strategies to address runoff from WWTF			
56. Finalize the wasteload allocation for facilities in the Lake Memphremagog watershed and issue permits that meet these new phosphorus limits.	Nutrients	Brighton, VDEC, NVDA	WW funding, Northern borders funding.
57. Support Barton, Orleans, Brighton and the City of Newport in optimizing WWTF facilities to minimize loading in the Lake Memphremagog watershed and to maintain WLA to allow for future growth.	Nutrients	Barton, Orleans, City of Newport, VDEC, NVDA	Town and City funds, __ funds if upgrades are required
Strategies to address flow altered waters. Norton Lake, Great Averill Pond and Little Averill Lake and the streams below these waterbodies.			
58. The Agency will advocate before the PSB the modification of these dams to function with a crest control to restore more natural water level fluctuations on these waterbodies and natural flows in the streams below the dams.	Flow Alteration	VDEC, PSB, Hydro Coaticook, Camp owners and groups	
59. Review status of other flow-altered waterbodies and, where necessary, take steps toward restoring more natural water level fluctuations and downstream flows.	Flow Alteration	VDEC, VDFW, Lake and Watershed Groups, Towns	
Strategies to address Aquatic Invasive Species			
60. Hold an annual Vermont Invasive Patrollers (VIP) training in the basin to support the establishment of VIP programs for lakes and ponds in the basin.	AIS	VDEC, Lake and Watershed Groups	
61. Support new and existing greeter programs for lakes and ponds including greeter programs on waters with invasive species to provide information to recreational	AIS	VDEC, Lake and Watershed Groups	ANC Grant-in-Aid,

Strategies	Stressor Addressed	Partners (see Partners)	Funding (see Appendix D)
users to encourage actions to prevent waterbody to waterbody transport.			
62. Support the purchase and use of decontamination equipment by greeter programs to increase the effectiveness of spread prevention programs including the use of VDEC portable decontamination unit in the basin when available to target large events and other spread prevention priorities.	AIS	VDEC, Lake and Watershed Groups	ANC Grant-in-Aid,
63. Continue to refine starry stonewort spread prevention strategy including broader Lake Memphremagog greeter program with decontamination unit, public education campaign and signage, as well as policy options to increase use of decontamination unit to prevent spread out of Lake Memphremagog.	AIS	Lake and Watershed Groups Communities, VDEC	ANC Grant-in-Aid, Watershed Grants
64. Keep abreast of Starry Stonewort research in other states and encourage research on spread prevention and control options as well as impacts of starry stonewort on the lake including fish communities through Department of Fish and Wildlife assessments.	AIS	VDEC, Lake and Watershed Groups, Communities	ANC Grant-in-Aid, Watershed Grants
65. Sample for zebra mussels, quagga mussels, and spiny waterflea in lakes in the watershed	AIS	VDEC, Lake and Watershed Groups, Communities	ANC Grant-in-Aid, Watershed Grants
66. Support active invasive species control programs with priorities going to those which have the greatest chance of keeping an invasive species population in check.	AIS	Colleges and Universities, VFWD, VDEC, watershed groups	ANC Grant-in-Aid,

List of Acronyms

319	Federal Clean Water Act, Section 319
604(b)	Federal Clean Water Act, Section 604b
AAFM	Agency of Agriculture, Food, and Markets
AAPs	Accepted Agricultural Practices
AIS	Aquatic Invasive Species

AMA	Agricultural Management Assistance Program
AMPs	Acceptable Management Practices (for logging)
ANR	Agency of Natural Resources
ANS	Aquatic Nuisance Species
AOP	Aquatic Organism Passage
BASS	VDEC Biomonitoring and Aquatic Studies Section
BBR	Better Backroads program
BMP	Best Management Practices
CREP	Conservation Reserve Enhancement Program
CWI	Clean Water Initiative Grant Funding
CWIP	Clean Water Initiative Program
CWSRF	Clean Water State Revolving Fund
DPW	Department of Public Works
DWSRF	Drinking Water State Revolving Fund
EBTJV	Eastern Brook Trout Joint Venture
EQIP	Environmental Quality Incentive Program
ERAF	Emergency Relief and Assistance Fund
ERP	Ecosystem Restoration Program
FAP	Farm Agronomic Practices
FEH	Fluvial Erosion Hazard
FERC	Federal Energy Regulatory Commission
FOVLAP	Federation of Vermont Lakes and Ponds
FSA	Farm Service Agency (USDA)
GIS	Geographic Information System
GSI	Green Stormwater Infrastructure
IDDE	Illicit Discharge Detection (and) Elimination
LFO	Large farm Operation
LID	Low Impact Development
LiDAR	Light Detection and Ranging
LIG	Local Implementation Grants (LCBP)
LIP	Landowner Incentive Program
LTP	Land Treatment Plan
LWD	Large Woody Debris
MAPP	Monitoring, Assessment and Planning Program
MFO	Medium Farm Operation
MRGP	Municipal Roads General Permit
MWA	Memphremagog Watershed Association
MWL	Morrisville Water & Light
NEKRR	Northeast Kingdom Roads and Rivers Workgroup
NEMO	Nonpoint Education for Municipal Officials
NFIP	National Flood Insurance Program

NMP	Nutrient Management Plan
NOFA	Northeast Organic Farming Association of Vermont
NPDES	National Pollution Discharge Elimination System
NPS	Non-point source pollution
NRCD	Natural Resource Conservation District
NRCS	Natural Resources Conservation Service
NVDA	Northeast Vermont Development Association
ORW	Outstanding Resource Water
PDM	Pre-Disaster Mitigation
PFW	Partners for Fish and Wildlife
PSB	Public Service Board
RAP	Required Agricultural Practices
RTE	Rare, Threatened and Endangered Species
RCP	River Corridor Plan
RCPP	Regional Conservation Partnership Program
RMP	River Management Program
RPC	Regional Planning Commission
SEP	Supplemental Environmental Program
SFO	Small Farm Operation
SGA	Stream Geomorphic Assessment
SPA	Source Protection Area
SWG	State Wildlife Grants
SWMP	Stormwater master plans
TBP	Tactical Basin Plan
TFS	Trees for Streams
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TS4	Transportation Separate Storm Sewer System General Permit
TU	Trout Unlimited
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USFS	United States Forest Service
USGS	United States Geological Survey
UVA	Use Value Appraisal program, or Current Use Program
UVM ext.	University of Vermont Extension
VACD	Vermont Association of Conservation Districts
VANR	Vermont Agency of Natural Resources
VDEC	Vermont Department of Environmental Conservation
VDFPR	Vermont Department of Forests, Parks and Recreation
VDHP	Vermont Department of Historic Preservation

VDH	Vermont Department of Health
VEM	Vermont Emergency Management
VFB	Vermont Farm Bureau
VFWD	Vermont Fish and Wildlife Department
VHCB	Vermont Housing and Conservation Board
VIP	Vermont Invasive Patrollers
VLCT	Vermont League of Cities and Towns
VLRP	Vermont Local Roads Program
VLT	Vermont Land Trust
VTrans	Vermont Agency of Transportation
VRC	Vermont River Conservancy

Glossary

10 V.S.A., Chapter 47 - Title 10 of the Vermont Statutes Annotated, Chapter 47, Water Pollution Control, which is Vermont's basic water pollution control legislation.

Accepted Agricultural Practices (AAP) - land management practices adopted by the Secretary of Agriculture, Food and Markets in accordance with applicable State law.

Acceptable Management Practices (AMP) - methods to control and disperse water collecting on logging roads, skid trails, and log landings to minimize erosion and prevent sediment and temperature changes in streams.

Aquatic biota - all organisms that, as part of their natural life cycle, live in or on waters.

Basin - one of fifteen planning units in Vermont. Some basins include only one major watershed after which it is named such as the Lamoille River Basin. Other Basins include two or major watersheds such as the Poultney/Mettawee Basin.

Best Management Practices (BMP) - a practice or combination of practices that may be necessary, in addition to any applicable Accepted Agricultural or Silvicultural Practices, to prevent or reduce pollution from nonpoint source pollution to a level consistent with State regulations and statutes. Regulatory authorities and practitioners generally establish these methods as the best manner of operation. BMPs may not be established for all industries or in agency regulations, but are often listed by professional associations and regulatory agencies as the best manner of operation for a particular industry practice.

Classification - a method of designating the waters of the State into categories with more or less stringent standards above a minimum standard as described in the Vermont Water Quality Standards.

Designated use - any value or use, whether presently occurring or not, that is specified in the management objectives for each class of water as set forth in §§ 3-02 (A), 3-03(A), and 3-04(A) of the Vermont Water Quality Standards.

Existing use - a use that has actually occurred on or after November 28, 1975, in or on waters, whether or not the use is included in the standard for classification of the waters, and whether or not the use is presently occurring

Fluvial geomorphology - a science that seeks to explain the physical interrelationships of flowing water and sediment in varying land forms

Impaired water - a water that has documentation and data to show a violation of one or more criteria in the Vermont Water Quality Standards for the water's class or management type.

Improved Barnyards - a series of practices to manage and protect the area around the barn, which is frequently and intensively used by people, animals, or vehicles, by controlling runoff to prevent erosion and maintain or improve water quality. Practices may include: heavy use area protection, access roads, animal trails and walkways, roof runoff management, and others.

Mesotrophic – An intermediate level of nutrient availability and biological productivity in an aquatic ecosystem.

Natural Community - An interacting assemblage of organisms, their physical environment, and the natural processes that affect them.

Natural condition - the condition representing chemical, physical, and biological characteristics that occur naturally with only minimal effects from human influences.

Nonpoint source pollution - waste that reaches waters in a diffuse manner from any source other than a point source including, but not limited to, overland runoff from construction sites, or as a result of agricultural or silvicultural activities.

pH - a measure of the hydrogen ion concentration in water on an inverse logarithmic scale ranging from 0 to 14. A pH under 7 indicates more hydrogen ions and therefore more acidic solutions. A pH greater than 7 indicates a more alkaline solution. A pH of 7.0 is considered neutral, neither acidic nor alkaline.

Point source - any discernible, confined and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which either a pollutant or waste is or may be discharged.

Reference condition - the range of chemical, physical, and biological characteristics of waters minimally affected by human influences. In the context of an evaluation of biological indices, or where necessary to perform other evaluations of water quality, the reference condition establishes attainable chemical, physical, and biological conditions for specific water body types against which the condition of waters of similar water body type is evaluated.

Riparian vegetation - the native or natural vegetation growing adjacent to lakes, rivers, or streams.

River Corridor - the land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel and that is necessary for the natural maintenance or natural restoration of a dynamic equilibrium condition, as that term is defined in 10 V.S.A. §1422, and for minimization of fluvial erosion hazards, as delineated by the Agency in accordance with the VANR River Corridor Protection Guide.

Sedimentation - the sinking of soil, sand, silt, algae, and other particles and their deposition frequently on the bottom of rivers, streams, lakes, ponds, or wetlands.

Thermal modification - the change in water temperature

Turbidity - the capacity of materials suspended in water to scatter light usually measured in Jackson Turbidity Units (JTU). Highly turbid waters appear dark and "muddy."

Waste Management System -a planned system in which all necessary components are installed for managing liquid and solid waste, including runoff from concentrated waste areas and silage leachate, in a manner that does not degrade air, soil, or water resources. The purpose of the system is to manage waste in rural areas in a manner that prevents or minimizes degradation of air, soil, and water resources and protects public health and safety. Such systems are planned to preclude discharge of pollutants to surface or ground water and to recycle waste through soil and plants to the fullest extent practicable.

Water Quality Standards - the minimum or maximum limits specified for certain water quality parameters at specific locations for the purpose of managing waters to support their designated uses. In Vermont, Water Quality Standards include both Water Classification Orders and the Regulations Governing Water Classification and Control of Quality.

Waters - all rivers, streams, creeks, brooks, reservoirs, ponds, lakes, springs and all bodies of surface waters, artificial or natural, which are contained within, flow through or border upon the State or any portion of it.

Watershed - all the land within which water drains to a common waterbody (river, stream, lake pond or wetland).

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Appendix A. 2012 Basin 17 Report Card

Overall, work completed in the watershed since the publication of the previous Tactical Basin Plan has allowed for the development of a TMDL for the Lake Memphremagog watershed as well as several assessments and efforts to support the implementation of specific actions. This includes mapping and assessing road and stormwater infrastructure, stream geomorphic assessments, agricultural lands and wetlands. Extensive work has been done in partnership with NRCD's, non-profits, the NRCS and other divisions of state government as well as landowners to work towards healing impaired waters and managing the watershed for healthier rivers, wetlands, and lakes. Conservation projects and especially buffer projects have increased the total land under conservation, and towns and villages throughout the watershed are working to increase flood preparedness, reduce erosion and green their infrastructure for better water quality.

Basin 17 Water Quality Management Plan Implementation Table - December 2016

Objective: Restore Crystal and Stearns Brooks to meet water quality standards.

Action	**Lead**/Key Players	Cost/ Funding	Target Date/Status (N, I C)
1. Monitor Crystal Brook to confirm that this stream has been restored and can be removed from the list of impaired waters.	**VDEC** / OCNRCD	VDEC Funds	**2011/** 2009 and 2010 results suggest this water now meets VWQS. Removed from list of impaired waters- **(completed)**
2. Complete a watershed assessment of the tributary to Stearns Brook to identify potential projects to reduce runoff to this waterbody	**OCNRCD** / VDEC, NRCS	Ag resource specialist funding	**2011- - (completed)**
3. Biologically assess the Sterns Brook tributary site to determine if recent efforts have addressed impairment and if the tributary to Sterns Brook is still impaired consider water sampling to constrain nutrient sources and work with landowners to identify and address pollution sources.	**OCNRCD** / VDEC, NRCS, VAAFM	319, EQIP, CREP, VT BMP programs	**2012 –** Biological sampling done and stream does not meet water quality standards. Nutrient sampling started in 2014 and projects implemented to address some identified sources through 2016 (more work to do) **(Initiated)**

Objective: Develop a TMDL and refine the Basin 17 Water Quality Management Plan to address the phosphorus impairment of Lake Memphremagog.

Action	**Lead**/Key Players	**Cost**/ Funding	**Target Date**/Status
4. Coordinate monitoring of phosphorus and chloride loading from major tributaries and in Lake Memphremagog to allow for the development of a Bath Tub model for Lake Memphremagog.	**VDEC** / MCI, MDDEP, MRC, MWA, COGESAF,	VDEC operational funds, Watershed grant, ERP	**2010-2012/** Joint monitoring was done 2010 through 2012. **(completed)**
5. Refine the watershed phosphorus export model for the Lake Memphremagog watershed.	**VDEC** / MDDEP, MRC	Staff time	**2010-2012/**updated with 2006 nlcd in 2011 and updates finished in 2016. **(Completed)**

6. Complete targeted tributary sampling program to identify target watersheds for phosphorus reduction.	**MWA /** VDEC, ONRDC, Beck Pond LLC	**$10,000 year**/ ERP, Watershed grant, LaRosa, 604(b)	**2011-2012/** Targeted sampling 2011 - 2016. Reports on priority phosphorus reduction projects produced using all past sampling **(Initiated)**
7. Develop a Bath Tub model for Lake Memphremagog or another method to model the necessary reductions in phosphorus load from the Vermont portions of the watershed to meet Vermont Water Quality Standards	**VDEC** / MDDEP, MRC	Staff time	**2011-2012** Bath tub modeling compleated with support from Eric Smeltzer **(Completed)**
8. Develop a TMDL to address the phosphorus impairment of Lake Memphremagog.	**VDEC** / EPA	Staff time	**2012** (revised target date winter 2016) **(Initiated)**
9. Update action plan based on the TMDL phosphorus reduction targets and watershed loading model targeting the most efficient projects and locations to reduce phosphorus loading across contributing land uses.	**VDEC** / MWA, OCNRCD, NRCS, Towns, watershed groups and partners	Staff time	**2013** (The TMDL and this Draft basin plan include an updated action plan) (Initiated)
10. /Develop a sustainable long term water sampling program to monitor changes in phosphorus load for the Vermont portions of the Lake Memphremagog Watershed and changes in in-lake phosphorus concentration to evaluate success of TMDL implementation efforts.	**VDEC** / MWA, City of Newport (LMP), Beck Pond LLC	Staff time and Department Laboratory resources	**2012-2015** Discussions on how to best support ongoing monitoring initiated with Lakes and Ponds program. **(Initiated)**

Objective: Ensure the flow altered waters in the Coaticook River watershed meet Vermont Water Quality Standards.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date/S**tatus
11. The Agency of Natural Resources will work with Hydro Coaticook, the PSB, and local residents to identify and address the water resource concerns associated with water level fluctuations at Norton and Great and Little Averill ponds so these waters will meet the Vermont Water Quality Standards.	**VDEC /** VFWD, HydroCoaticook, PSB, Averill lakes association,	Staff time	**2014/** Plan developed to monitor water levels of lakes and ponds and flows below from 2013-2014. **(Initiated)**
12. An agreement should be made to establish more formal conservation flows for each of the dams, to determine what height of gate opening would equate to these flows, and if not already existing, make modifications to the dams to ensure these minimum flows are met at all times.	**VDEC** / VFWD, Hydro Coaticook, PSB, Averill lakes association	Staff time	**2014** PSB petition has been submitted by residents and DEC is working to aid in developing conservation flows (Initiated)

Goal: Reduce phosphorus loading in the basin to allow Lake Memphremagog to meet water quality standards and reduce and/or prevent increases in phosphorus levels in other nutrient sensitive lakes in the basin.

Objective: Reduce the impacts from stormwater runoff from developed lands.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
13. Complete stormwater system mapping and illicit discharge detection for the City of Newport, Village of Derby, Village of Orleans and Village of Barton.	**VDEC** / cities and towns, ONRCD	**$40,000**/ ERP, 319, SEP	**2012-2014** mapping done in 2014 and grant to complete IDDE in 2015 **(completed)**
14. Increase awareness of stormwater runoff issues and available solutions through newspaper articles and outreach materials.	**MWA** / NVDA, Local newspapers, VDEC, OCNRCD	Watershed grant	**Ongoing - (Initiated)**

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
15. Complete demonstration projects addressing stormwater issues in the basin, such as rain barrels or rain gardens, to show how these practices can be used and increase awareness of these methods. Target priority areas identified through stormwater mapping.	**Lake and watershed organizations** / OCNRCD	Watershed grant, ERP, 319 program	**2012/** Workshop held in 2010 to discuss rain barrels and to distribute them. MWA sold barrels at famers market and installed rain garden master planning grant 2015 **(Initiated)**
16. Work with a local developer to complete a low impact development project in the basin and publicize this to increase awareness of the social, economic and environmental benefits of using low impact development techniques.	**local developer**/ Lake and watershed groups, NVDA, Towns		**2013**
17. Increase awareness of landscaping techniques to minimize nutrient, herbicide and other pollutant runoff from lawns. Techniques include: aerating, increasing organic content, maximizing natural vegetative cover, and using less and only phosphorus free fertilizers except where soil testing show low soil phosphorus levels.	**Lake and watershed organizations /** master gardener program, VDEC	Watershed grants, 319 grant program	**Ongoing** Workshops held with master gardeners in 2015, landscaper workshops planned for 2015 **(completed)**

Objective: Reduce impacts from roads and other transportation infrastructure on aquatic resources.

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
18. Organize a road review committee to identify roads, ditches and stream crossings in the basin that are having an impact on water resources, focusing initially on towns which have not yet participated in the Better Backroads Program including Irasburg, Coventry, Albany and Craftsbury.	**Road commissioners and foreman** / watershed groups, landowners, environmental consultants, conservation and planning commissions. Better Backroads tech.	Group could be ad hoc w/o funding or could apply for Better Backroads grants.	**2012/** MWA has meet with local towns and developed a Better Backroads project with Newport Town. Better backroads road assessment grant for Morgan in 2014. Possible stormwater master planning grant in 2014 could address backroads. Orleans County Roads and rivers group created in 2015 **(completed)**
19. **Work with all towns in the basin to apply for at least one Better Backroads Grant to address one of the major water quality issues identified by the road review committee.** Initially, the following towns which are in areas characterized by low watershed phosphorus retention will be targeted: Derby, Irasburg, Coventry, Albany, Craftsbury and Newport town Newport City.	**VDEC**/ road commissioners and foreman, conservation commissions, private landowners	**$5,000-10,000 per town**/ ERP, Better Back Roads	**2013/** Grants received for: Charleston, Morgan, Westmore roads. **(Initiated)**
20. Host and advertise local workshops for road crews and commissioners on the best management practices to address road/water quality issues. Include a workshop in the Roads Scholar program on minimizing impacts from roads on surface waters.	**Local Roads Program**, road commissioners and foreman, watershed associations, VANR, landowners, conservation and planning commissions.	Northern VT RC&D Council, VT Better Backroads Program	**2012-** Road resiliency workshop held in the fall of 2012 with good attendance from local road crews. **(completed)**
21. Identify and promote funding sources for towns to address road/water quality issues, and work to increase funding sources that are targeted for this purpose.	**Vtrans/** watershed groups, local, state and national elected officials	Better Backroads	**Ongoing** Better back roads program strengthened through use of ERP funds. Backroad grant amounts increased **(completed)**

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
22. Educate towns on the advantages of following locally adopted road and bridge standards in order to increase compliance with these standards in the basin. Submit articles on reducing the impact of roads on water quality in the *Vermont Local Road News* that goes to town staffs.	**Vtrans/** watershed groups, landowners, conservation commissions, road commissioners and foreman, VANR	Watershed grants, 319 grant program	**Ongoing/** 2010 Act 110 included updates to the standards effective for 2012 and required towns to annually certify compliance. Incentives for towns to adopt standards have been increased and stormwater permit for town roads being discussed. **(Initiated)**
23. Provide VANR bridge and culvert assessment results to towns in the basin so this information can be used to help towns in prioritizing stream crossing replacement.	**VANR**/ road commissioners and foreman, conservation commissions.	604(b), ERP	**Ongoing /** Coventry survey finished. **(Initiated)**
24. Encourage towns in planning for land use changes and resulting changes in hydrology on stream crossings, encouraging proper stream crossing sizing and rock aprons at outlets.	**VDEC/** NVDA, Towns	604(b)	**Ongoing (Initiated)**

Objective: Maintain the coverage of forested lands while reducing sediment and phosphorus runoff occasionally associated with forestland management.

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
25. Increase educational opportunities and outreach to the general public, landowners, and loggers on good forestry practices and the mechanics of logging.	**NorthWoods Stewardship Center**/ VDFPR, OCNRCD, VT Coverts	Watershed grant	**ongoing**
26. Work with logging equipment distributers to provide information pamphlets on logging practices and contacts when specific equipment is sold for private logging use.	**OCNRCD,** VDFPR,	Watershed grant	**2013**
27. Organize and publicize a field tour of a logging operation on state lands to demonstrate BMPs, paired with tour of a problem site if possible.	**VDFPR,** OCNRCD, ECNRCD, NorthWoods Stewardship Center		**2013-** grant proposal put in by VDFPR to complete such a project and outreach in this or nearby basin. **(Initiated)**
28. Organize a welcome kit with information for new landowners on managing forested lands as well considerations for hiring a forester and logger.	**OCNRCD,** NorthWoods Stewardship Center		**2013**
29. Maintain extensive forested lands in the basin due to the water quality and habitat benefits through the current use program, Forest Legacy Easements and the creation of new or expansion of existing town forests.	**VDFPR**/ VLT, towns, private landowners, environmental consultants	VHCB, forest legacy	**2013**
30. Initiate a portable skidder bridge project in the basin to provide bridges for lease to local loggers and outreach on their use.	**OCNRCD**/ VDFPR, loggers, LandVest,	**$4,000 - $20,000 depending on scale** / ERP, SEP, 319	**2011/** Portable skidder bridge program initiated in the basin. **(completed)**

Objective: Establish an agricultural water quality group that will represent the interest of the Memphremagog region and to leverage the positive attention of the legislature, the press, and the watershed community and to promote the best use of government cost share dollars.

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
31. Create a Steering Committee to look at the different models for such a water quality group and provide overall direction	**OCNRCD**	ERP	**2011/** Held three meetings of a steering committee in 2013/2014 **(completed)**
32. Assemble a membership from the various agricultural groups, and create an agenda for targeted funding and technical assistance based on goals below **Key players continued:** Grain and Feed Dealers, Farm Equipment Sales, Local Work Group, Watershed Association, local legislators	**OCNRCD**/ Farm Bureau, NOFA, Grange, VT Fruit and Vegetable Growers Assoc, Milk haulers, Large Animal Vets…	In-kind from members	**2011/** Decided to convene this group when TMDL development gets into high gear 2015.(OCNRCD applied for watershed grant to support in 2015**) (Initiated)**
33. Refine phosphorus reduction estimates for practices funded and prioritize those with highest potential for positive impacts	**NRCS/** VAAFM	319, ERP	**2012** Developed Basin specific BMP scenario tool to evaluate load reductions and evaluated use in two target watersheds **(Initiated)**

Objective: Minimize the acreage and number of days of fields in bare soil.

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
34. Conduct a vulnerability analysis to identify specific areas (based on soil types, land use, agronomic practices, etc) and prioritize technical assistance and funding to these	**OCNRCD**/ NRCS, Agency of Ag, UVM Coop Ext	Watershed grants, Partners	**2011/** initiated targeted assessments on ag lands in 2011 based on water sampling results. Priority Phosphorus Reduction Area study done in 2013 and being expanded upon in 2014. Erosion risk analysis done in 2015 **(Completed)**
35. Conduct extensive outreach of existing programs that provide financial incentives for cover crop, conservation cropping, no-till etc. to all farms	**NRCS**/ Agency of Ag, OCNRCD	VACD	**on-going/** RCPP grant will support technical assistance to farmers to implement practices **(Initiated)**
36. Use Local Work Group to provide priority points to NRCS projects that address bare soil.	**OCNRCD**/ NRCS	NA	**on-going (Initiated)**
37. Conduct research trials on grasses best suited for cover crops for this region and shorter season corn varieties that preserve yields.	**UVM Coop Ext**/ OCNRCD	SARE grants	**2011**

Objective: Reduce opportunities for grazing animals to be in streams and break down stream bank vegetation.

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
38. Make direct contact with producers to promote existing programs such as the Conservation Reserve Enhancement Program (CREP) that provide incentives for fencing, watering tanks, and stream crossings.	**VACD**/ OCNRCD, NRCS, VAAFM	NRCS, VAAFM	**ongoing /** 2011 ARS started targeted CREP outreach to farmers to promote this program with increased signups. BMP project funding has been secured through ERP grants and projects have been done. Expanded outreach through Magog RCPP **(completed)**

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
39. Encourage use of rotational or planned grazing plans.	**NRCS**/ VOFA, UVM, SARE, Holistic Management Practitioners	NRCS, VAAFM	**Ongoing** One grazing plan has been done in target high phosphorus watershed. Grazing plans focus of NOFA support to RCPP grant **(Initiated)**
40. Promote preservation and restoration of riparian and wetland areas for their other benefits such as thermal cooling, nutrient retention, and habitat enhancement.	**OCNRCD**/ VACD, NRCS, VAAFM, VFWD, USFWS, Beck Ponds LLC, NorthWoods Stewardship Center	USDA, VAAFM, VFWD, US Fish and Wildlife Services	**ongoing /** 2010 - 2016 grants included trees for streams project and wetland assessment and proj. development for WRP program. MWA wetlands focus for events in 2013**. (completed)**

Objective: Reduce the number of acres of agricultural land that transition to commercial and residential development which would increase nutrient loading and stormwater runoff.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
41. Continue to conserve prime agricultural lands to prevent the change in landuse to developed lands	**VLT/** VAAFM, NRCS, VACD	VHCB,	**Ongoing –** Some conservation projects done **(Initiated)**
42. Inventory idle farm land in the basin and connect farmers who are interested in CREP or other programs and have a limited land base to these landowners to increase the ability of farmers to participate in these programs.	**VAAFM /** ONRCD, Environmental Consultants	VAAFM	**2012**

Objective: Improve nutrient management and soil health on vegetable and small farms

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
43. Conduct nutrient management planning workshops for small and hobby farms	**VACD,** NERC, UVM Ext	VAAFM, UVM Ext, SARE, VACD,	**2011 on/** workshops planned for 2014. NMP courses held in 2016 RCPP grant would fund NMP for farms in the basin 2016 and 2017. **(Initiated)**
44. Provide outreach on efficient use of Nitrogen and Phosphorus fertilizers for vegetable operations	**VACD,** UVM Ext, VT Fruit &Vegetable Growers Assoc.	VACD, UVM Ext, VT Fruit & Vegetable Growers Assoc.	**2011**
45. Promote soil testing and manure analysis to determine nutrient requirements for individual fields for small farms.	**VACD,** UVM Ext	NA	**Ongoing. (Initiated)**
46. Promote workshops, programs, and materials specific to equine operations	**VACD,** VT Pasture Network, UVM Ext, Vermont Horse Association	VAAFM	**Ongoing**

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
47. Create programs to improve infiltration and water holding capacity of soils through addition of organic material, avoiding compaction	**NRCS,** VAAFM, UVM Coop Ext, Highfields Center for Composting	NRCS, VT VAAFM, UVM, VACD, SARE	**2011**

Objective: Protect and restore the equilibrium conditions of streams and rivers.

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
48. Complete Phase 1 Stream Geomorphic Assessments (SGA) of all major streams in the Lake Memphremagog Watershed where this has not been done and targeted smaller streams as identified in Figure 8.	**NorthWoods Stewardship Center**, VDEC, towns, environmental consultants	Ecosystem Restoration Grants	**2011**/ Largely finished. Barton, Black, Clyde, Johns Rivers finished. Some small tributaries have not been done. **(Initiated)**
49. Complete Phase 2 SGA for all stream reaches in the basin that were rated as in fair or poor condition in the Phase 1 assessment, stream reaches that towns would like to include in FEH zoning, or stream reaches that are of concern to local residents as shown in Figure 8.	**NorthWoods Stewardship Center**/ VDEC, towns, environmental consultants	Ecosystem Restoration Grants	**2013/** Majority of Barton, Clyde, Johns Rivers finished. Black River in progress. Some small tributaries have not been done. **(Initiated)**
50. Work with towns to include protection for floodplains, FEH zones and buffer zones in local zoning.	**NorthWoods Stewardship Center**/ VDEC, MWA, NVDA towns	Town planning grants	**2014-**increased collaboration between NVDA and VDEC to work with towns. **(Initiated)**
51. Promote BMPs for development adjacent to river corridors to protect river functions, such as maintaining setbacks and buffer strips, LID techniques.	**NorthWoods Stewardship Center**/ VDEC, OCNRCD, watershed groups	ERP	**Ongoing (Initiated)**
52. Provide education programs to increase awareness of fluvial geomorphic principles and the many benefits of managing rivers for their equilibrium condition. Examples include demonstrating the flume at Derby days, the fisherman's breakfast or other events in the basin, involving volunteers in geomorphic assessments, and holding workshops.	**NorthWoods Stewardship Center**/ VDEC, towns, OCNRCD, watershed groups	Watershed Grants	**2013 (Initiated)**
53. Protect riparian lands in Basin 17 which are identified as essential to maintaining stream equilibrium conditions (shown in Figure 10.)	**NorthWoods Stewardship Center**/ VDEC, Towns, Land Trust, OCNRCD, Environmental Consultants	ERP, VHCB,	**2014** VFW has purchased some priority lands along Lower Barton River (Initiated)

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
54. Establish a Trees for Streams Program in Basin 17 to increase natural vegetated buffers along streams.	**OCNRCD**/ VDFPR, Consulting Foresters, Lake Associations	**$10,000 per year /** 319 program, ERP	**2014 /** OCNRCD began trees for streams program in 2010 and continued through 2016 **(Completed)**
55. Increase buffers on state lands including fish and wildlife access areas, riparian land ownership and South Bay and Willoughby Falls WMAs.	**VANR**/ NorthWoods Stewardship Center,	Lands Stewardship funds	**2012 /** Buffer plantings along a 3+ miles of river 2009 -2015. Dunn property accepted by USFWD will have 100ft buffers. **(Initiated)**

Goal: prevent the spread of non-native invasive plants and animals to waterbodies and riparian lands in the basin and to control existing populations where practical to support recreation and native biological communities in the basin.

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
56. Hold an annual Vermont Invasive Patrollers (VIP) training in the basin to support the establishment of VIP programs for lakes and ponds in the basin.	**VDEC/** Lake and Watershed Groups	NA	**Yearly/** workshops held in 2008, 2009, 2012 and 2014-16. **(Initiated)**
57. Support new and existing greeter programs for lakes and ponds. Encourage greeter programs on waters with invasives (e.g. Eurasian watermilfoil) to provide information to recreational users to encourage actions to prevent waterbody to waterbody transport	**VDEC**/ Lake and Watershed Groups Communities	ANC Grant-in-Aid, Watershed Grants	**2011/** 2013-2016 Greater program trainings held in the watershed **(Initiated)**
58. Support participation in the Federation of Vermont Lakes and Ponds forum for lake and pond residents to discuss issues associated with aquatic invasive species spread prevention and control in addition to other lake and pond topics.	**Federation of Vermont Lakes and Ponds**/ Lake and Watershed Groups, VDEC	NA	**Ongoing/ (Initiated)**
59. Support active invasive species control programs with priorities going to those which have the greatest chance of keeping an invasive species population in check.	V**DEC**/ Watershed Groups, Towns	ANS grants, Town funds, Local support	**Ongoing/ (Initiated)**
60. Strengthen the enforcement of existing laws in regards to the transport of aquatic non-native invasive species.	**Enforcement programs**/ Legislature, VDEC, Watershed Groups	NA	Law passed to make transport of all aquatic plants illegal in 2010 **(Completed)**

Goal: IMPROVE aquatic habitat conditions in the basin to support fisheries, and AQUATIC, riparian and wetland communities.

Objective: Protect and restore habitat and water quality of lakes and lakeshores.

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
61. Hold a public meeting to discuss the importance of undeveloped lakeshore parcels and priorities for their protection.	**VDEC**/ UVM, Lake and Watershed Groups		**2011**

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
62. Working closely with local land trusts, lake associations, and towns, contact landowners of the highest priority undeveloped lakeshore parcels to determine interest in conservation and conserve at least one of the top priority parcels.	**VLT**/ NorthWoods Stewardship Center, VANR, Towns, Environmental Consultants	VHCB, Private funds	**2013 /** Dunn property accepted by US Fish and Wildlife with support from VANR. Bluff estates protected through VLT project in 2015. **(Completed)**.
63. Coordinate lake association comments on any lakeshore buffer legislation at the state level to increase the likelihood that any such an effort will be effective in protecting lakes in the basin.	**Federation of Vermont Lakes and Ponds**/ Lake and Watershed Groups	NA	**Ongoing –**Act 138 report included public input on options for increasing buffer protections. MWA hosted public comment section on buffer bill **(Completed)**
64. Contact all towns in the basin without existing buffer language for lakes in town zoning to offer support for the development of regulations such as those included in the VLCT *Model Lake Shoreland Protection District Bylaw*.	V**DEC**/ VLCT, NVDA, Watershed Groups, Conservation, zoning and planning commissions	Municipal planning grants, 604(b)	**Ongoing-** Increased coordination with NVDA on town buffer language has been done. NVDA has done a review of town planning and zoning with a 604(b) grant for this purpose **(Initiated)**
65. Hold annual shoreland walks or paddles in the basin to discuss good shoreland practices and advertise these to all basin lake and watershed groups.	NorthWoods Stewardship Center, VDEC, OCNRCD, MWA, Watershed Groups	Watershed Grant	**2013/** Walks have been held in Newport and Morgan. **(Initiated)**
66. Continue to develop materials on good and poor lakeshore practices for distribution to lakeshore residents. Establish a program for getting these materials to new shoreland landowners in the basin and to the press.	**MWA**/ VDEC, Watershed Groups	Watershed Grant,	**2012/** MWA developed materials for folder and has distributed around Memphremagog and to other lake associations. New Lakewise program has new materials. **(Completed)**
67. Establish lakeshore buffer planting programs that continue through the early summer when lakeshore residents are in town.	**OCNRCD**/,VDEC, Watershed/ Lake groups	**$10,000 yr**/ 319 program, ERP,Watershed grant	**2012/** Northeast Kingdom Lakeshore Buffering program established and extending season along with new Federation of lakes and ponds grant. **(Completed)**
68. Hold a training for landscapers on landscaping to protect the lakeshore environment. Contact local nurseries to encourage them to provide local native trees and shrubs for shoreland plantings at reasonable prices.	**NorthWoods Stewardship Center**/ VDEC, OCNRCD, Watershed/lake Groups, Master Gardeners	Watershed Grant	**Ongoing** Contractor training held in 2015 **(Completed)**
69. Host and do outreach to promote project WET training workshops for teachers in the Memphremagog watershed customized to address water-related topics including, wetlands, watersheds, lake ecosystems, water quality monitoring, and phosphorus.	**VDEC/** Local Schools and teachers, Watershed and lake groups		**Ongoing** MWA supported watershed focused boat rides on the lake in 2014 and 2015 targeting many of these topics. **(initiated)**

Objective: Protect the functions and values of existing wetlands and selectively restore human-altered wetlands.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
70. Increase opportunities for watershed residents to learn about the important functions and values of wetlands, and changes in the wetland rules that allow all significant wetlands, regardless of mapping, to be protected and considered class II, through events, public displays and the distribution of outreach materials.	**NorthWoods Stewardship Center**, VDEC, Lake and Watershed Groups, Beck Pond LLC	Watershed Grant	**2012** MWA organized a series of wetland events in 2013 and continuing outreach on this topic in 2014. **(completed)**
71. Complete wetlands surveys for towns in the basin to identify wetlands not included on the Vermont Significant Wetlands Inventory maps and wetlands with exceptional functions and values that may be deserving of additional protections thorough conservation efforts, town zoning, or reclassification.	**Conservation Commissions**/ NorthWoods Stewardship Center, VDEC, Towns, environmental consultants, Beck Pond LLC	**$5,000-$10,000 per town** / 604(b), Watershed grant.	**2013/** Northwoods has done a wetland survey of upper Clyde River wetlands. **(Initiated)**
72. Develop specific wetland conservation priorities for high value wetlands in the basin for both habitat and phosphorus retention and use the priorities to focus the wetland conservation and restoration work of the many different partners involved in such work in the basin.	**VDEC**/ NVDA, Watershed Groups, NRCS, OCNRCD, VLT, Northern Rivers land trust, Beck Pond LLC	604(b), Watershed Grant	**Ongoing/** Ecosystem System restoration grant received in 2011 and 2012, 2015 to identify target wetlands for restoration. **(Initiated)**
73. Work with individual landowners to conserve wetlands with exceptional functions and values in the basin.	**VANR**/ Watershed Groups, OCNRCD, NorthWoods Stewardship Center, NRCS, Landowners, VLT, NRLT, Beck Pond LLC	VHCB, Private funds and donations, Ducks unlimited	**Ongoing/** Dunn property accepted by US Fish and Wildlife with support from VANR and VLT. **(Completed)**
74. Identify and prioritize sites of prior converted agricultural wetlands and wetland buffers in the basin for wildlife and phosphorus retention potential. Contact landowners to encourage enrollment in the Wetlands Reserve Program or CREP program to restore wetland functions and values.	**OCNRCD**/ VDEC, Lake and Watershed Groups, NRCS, Private landowners, Beck Pond LLC	WRP, WHIP, CREP, ERP, Partners for Fish and Wildlife	**2012/** Ecosystem System restoration grant received in 2010, 2011, 2012, 2015 to identify lands appropriate for WRP program. One conservation project finished. VF&W completed a number of wetland restoration projects along the Barton River **(Initiated)**
75. Provide information to watershed residents about changes in the Current Use Program that allow for the enrollment of ecologically sensitive lands such as wetlands	**NorthWoods Stewardship Center**/ VANR, Consulting foresters		**2013**

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
76. Provide information to watershed residents on the benefits of beavers including their importance for creating wetland and wildlife habitat and for protecting water resources. Increase the awareness of programs available in some situations to assist landowners in dealing with human beaver conflicts while maintaining the benefits of beavers.	**VFWD**/ VDEC, Watershed groups	USFWS funding	**Ongoing-** part of 2015 MWA watershed workshop **(completed)**
77. Increase protection for the Upper Clyde River / Pherrins Wetlands Complex, including, but not limited to, having these wetlands designated a Class One Wetland under the Vermont Wetlands Rules.	**NorthWoods Stewardship Center**/ Towns, VANR, Watershed groups, private landowners	Watershed Grant	**2012/** Upper Clyde River wetlands study done by NorthWoods Stewardship Center in 2012. Identified by wetlands program as possible Class 1 wetland **(Initiated)**

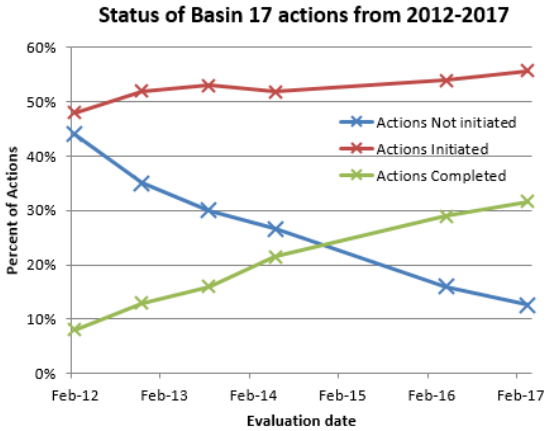
Objective: Assess barriers to aquatic species passage and replace or retrofit priority structures in the basin to increase stream continuity

Action	**Lead/**Key Players	**Cost/**Funding	**Target Date/**Status
78. Complete bridge and culvert assessments using ANR protocols on streams in the basin targeting in the following order of priority: a. Black, Barton, Johns rivers and minor tributaries to Lake Memphremagog, and the Clyde River below Charleston Dam. b. Tributaries to Willoughby, Crystal, Salem, Echo, and Seymour lakes, Norton, Island and Great and Little Averill ponds. c. The rest of the watershed used by brook trout and other native species	**VDEC**/ VDFW, OCNRCD, Vtrans	**$5,000-$10,000** / 604(b), Ecosystem Restoration	**2014/** Assessments have been done for the town of Coventry, and portions of the Black and Johns Rivers and Phase 2 assessment reaches. **(Initiated)**
79. Work with partners in the basin to replace stream crossings blocking aquatic species passage including those targeted in Table 3 as well as any identified through additional bridge and culvert assessments.	**VDEC**/ VDFW, OCNRCD, Vtrans, Towns, NRCS, VAST	WHIP, ERP, Partners for fish and wildlife, Eastern brook trout joint venture	**2014/**Culvert replaced on the unnamed tributary to the black river Structure # 300310000710111 **(Initiated)**

Acronyms

319 Federal section 319 grants for NPS pollution abatement
604(b) Federal section 604b funds for regional planning commissions
AAP Acceptable Agricultural Practices
Agency Vermont Agency of Natural Resources
AMP Acceptable Management Practices
ANS Aquatic Nuisance Species Program
AOP Aquatic Organism Passage
ARS Agricultural Rresources Specialist
BMP Best Management Practices
CREP Conservation Reserve Enhancement Program
EQIP Environmental Quality Incentives Program
ERP Ecosystem Restoration Program
FEH Fluvial Erosion Hazard
FEMA Federal Emergency Management Agency
LaRosa LaRosa Analytical Partnership Program
LEAP Logger Education to Advance Professionalism
LMP Lay Monitoring Program
MWA Memphremagog Watershed Association
NFIP National Flood Insurance Program

NMP Nutrient Management Plan
NOFA Northeast Organic Farming Association of Vermont
NPS Nonpoint Source Pollution
NRCS Natural Resource Conservation Service
NVDA Northeastern Vermont Development Association
OCNRCD - Orleans County Natural Resources Conservation District
ORW Outstanding Resource Water
PSB Public Service Board
RMP River Management Program (Agency of Natural Resources)
SARE Sustainable Agriculture Research and Education
SEP Supplemental Environmental Project
TMDL Total Maximum Daily Load
USEPA United States Environmental Protection Agency
USFWS United States Fish and Wildlife Service
UVM Ext - University of Vermont Extension
UVM WAgN - University of Vermont Women's Agricultural Network
VAAFM Vermont Agency of Agriculture, Food and Markets
VACD Vermont Association of Conservation Districts
VANR Vermont Agency of Natural Resources
VAST Vermont Association of Snow Travelers
VCGI Vermont Center for Geographic Information
VDEC Vermont Department of Environmental Conservation
VDFPR Vermont Department of Forest Parks and Recreation
VFWD Vermont Fish and Wildlife Department
VHCB Vermont Housing and Conservation Board
VIP Vermont Invasive Patrollers
VLCT Vermont League of Cities and Towns
VLT Vermont Land Trust
VSJF Vermont Sustainable Jobs Fund
VTrans Vermont Agency of Transportation
VRC Vermont River Conservancy
VWQS Vermont Water Quality Standards
VYCC Vermont Youth Conservation Corps
WHIP Wildlife Habitat Enhancement Program
WWTP Waste Water Treatment Plant



	Actions Not initiated		Actions Initiated		Actions Completed		Total
	Number	Percent	Number	Percent	Number	Percent	Number
Restore impaired waters	20	0%	7	58%	5	42%	12
Goal 1- reduce phosphorus load	8	19%	24	56%	11	26%	43
Goal 2- Aquatic invasive species	0	0%	4	80%	1	20%	5
Goal 3 – Improve aquatic habitat	2	11%	9	47%	8	42%	19
Total March 2017	**10**	**13%**	**44**	**56%**	**25**	**32%**	**79**
Total April 2016	13	16%	43	54%	23	29%	79
Total in May 2013	21	27%	41	52%	17	22%	79
Total in August 2013	24	30%	42	53%	13	16%	79
Total in November 2012	28	35%	41	52%	10	13%	79
Total in Feb 2012	35	44%	38	48%	6	8%	79

Appendix B. Existing Uses in Basin 17

Swimming

Most of the swimming in the basin takes places on the many lakes and ponds which have a presumed existing use of contact recreation. During the basin planning process, no locations of swimming use on rivers were identified that are accessed through publicly owned lands such as stream crossing right-of-ways.

Recreational Boating

A number of locations are good whitewater or flatwater boating stretches in the basin; some highly rated by the Vermont Paddlers Association, listed in the AMC or New Hampshire or Vermont paddlers Guide. The Clyde River is part of the Northern Forest Canoe Trail and includes some spectacular flat water canoeing. All sites listed on Table B1 are rated significant for recreational boating (DEC, 1989) or were otherwise brought to VDEC's attention. Many canoe access areas and dam portages have been established. Anyone boating these reaches should carefully scout routes before launching. This basin plan makes no representations as to the suitability or safety of the listed reaches with respect to the individual skills of the reader of this plan or those of prospective boaters.

Table B1. Recreational Boating as an Existing Use of Specific Waters within Basin 17.

Location	Documentation	Characteristics that support that use	Put in	Take out
Black River from Coventry to Lake Memphremagog	Appalachian Mountain Club (AMC), NH and VT paddlers guide (Fisk 2007)		Park in Coventry	South Bay VFWD Boat Launch
Barton River from Willoughby River to Lake Memphremagog	AMC		River Road Bridge	
Clyde River from Five Square Mile Road to Pensioner Pond	AMC, Northern Forest Canoe Trail, Clyde River Paddling and Fishing Guide.			South Bay VFWD Boat Launch
Clyde River from West Charleston to Salem Pond	AMC, Northern Forest Canoe Trail, Clyde River Paddling and Fishing Guide.		Five Square Mile Road	Pensioner Pond VFWD boat launch
Clyde River from Lake Salem to Clyde Pond	AMC, Northern Forest Canoe Trail, Clyde River Paddling and Fishing Guide, White water rivers of VT (rated highly		Fontain Road Bridge	Hayward Road

	important)			

Public Water Sources

Table B2. Public Water Source as an Existing Use within Basin 17.

Water Body	Town	Documentation
Unnamed tributary to Island Pond	Brighton	Town of Brighton water supply (identified in the VWQS and source protection plan)
Unnamed tributaries to unnamed tributary to Lightning Brook	Brighton	Town of Brighton water supply (identified in the VWQS and source protection plan)
Derby Lake	Derby Center	Derby Center water supply (based on source protection plan)
Holland Pond	Holland, Norton	Emergency water supply
May Pond Brook watershed above water intake	Barton, Sutton	Town of Barton water supply (identified in the VWQS and source protection plan)

Appendix C. Partners in the Lake Memphremagog, Tomifobia and Coaticook Basin

Table C1. Partners and stakeholders in the Basin 17.

Group/Program Name		Description
Natural Resource Conservation Districts (NRCD)	Caledonia County (CCNRCD); Orleans County (OCNRCD); Essex County (ECNRCD);	NRCDs play a critical role in implementing actions identified in basin plan particularly with the OCNRD's lead on the Memphremagog RCPP. They also aid Regional Planning Commissions with stormwater master planning, river corridor assessments, and road erosion assessments. NRCDs also work with the agricultural community to identify and implement farm BMPs to protect water quality.
Northeastern Vermont Development Association (NVDA);		NVDA helps towns to complete road erosion inventories and supports towns in updating their regulations to protect water quality through town plans and zoning and through the development of hazard mitigation plans. RPCs play a critical role in carrying out basin plan priorities and are contracted to help basin planners with drafting and public outreach.
Memphremagog Watershed Association		The Memphremagog Watershed Association is a 501c3 Association that was founded in 2007 as an organization dedicated to the preservation of the environment and natural beauty of the Memphremagog watershed and to ensure its protection for generations to come. The association has lead local buffer planting efforts, rain barrel sales, and hosted an annual watershed workshop and is looking to be the lead on the Memphremagog Stormwater Collaborative.
Lake and pond Associations		There are several active lake associations in the watershed including: Seymour Lake Association, Echo Lakes Proactive Association, Salem Lake Association, Shadow Lake Association, Parker Pond Association, Westmore Association, Hosmer Ponds Watershed Initiative.
Memphremagog Conservation Incorporated		Memphremagog Conservation Inc. (MCI) is a not-for-profit organization whose mission since 1967 is to protect the environmental health and preserve the natural beauty of Lake Memphremagog and its watershed. MCI has partnered on an assessment of the Lake Memphremagog shoreline in Vermont and Quebec, and has active lake patrollers on Lake Memphremagog and is working on watershed protection in the Fitch Bay watershed.
COGESAF		The Saint-François River Watershed Water Governance Council (COGESAF) implements integrated water management by watershed recognized by the Government of Quebec for the integrated management of the waters of the Saint-François River watershed. The

	government has given COGESAF mandates to plan and implement actions to improve water quality.
MDDELCC	
Beck Pond LLC	Beck Pond LLC, a limited liability company founded in 2009, partners with public and private organizations to conduct scientific research which has included leading water quality sampling efforts in the watershed, identifying priority phosphorus reduction projects and wetland restoration opportunities.
Sterling College	Sterling College is a four-year, private environmental college that is a partner on the Regional Conservation Partnership Program grant.
UVM extension	
Vermont Agency of Agriculture	The Vermont Agency of Agriculture enforces agricultural regulations including the certified small farm, medium and large farm programs, and enforces the Required Agricultural Practices or RAP's. The Agency also has a best management practice program that funds many local conservation projects and reduces the match necessary to participate in some NRCS programs.
Northern Forest Canoe Trail	
NorthWoods Stewardship Center	The NorthWoods Stewardship Center is a non-profit 501(c)3 educational, research and conservation service organization serving the communities of northern Vermont and New Hampshire since 1989. The Stewardship Center has lead a stream and lakeshore buffer planting program in the basin in addition to a watershed crew which will be working on Shadow Lake rain gardens in 2017.
Northern Rivers Land Trust	
Vermont Youth Conservation Corps (VYCC)	The VYCC works on Class IV road projects by assessing and implementing BMPs in high risk areas. The role of the VYCC in helping to implement actions in the basin plan continues to evolve as funding and needs change.
VT Agency of Transportation (VTrans)	VTrans manages and maintains miles of State highway and stream crossings within the basin and provides technical assistance in the form of hydraulic modeling for bridge and culvert replacements and transportation maintenance. VTrans also provides grant funding to basin municipalities including Structures and Transportation Enhancement grants.
Better Roads (BR) - VTrans	BR provides technical assistance, grant funding, and educational workshops related to transportation infrastructure and water quality. BR provides funding for municipalities through the Better Roads Grants. Grant funding can be used to undertake road erosion inventories and capital budgets and to implement transportation infrastructure best

		management practices (BMPs) that address road erosion and improve water quality and aquatic habitat.
USDA Natural Resources Conservation Service (NRCS)		NRCS provides cost-share, technical assistance, and targeted support of agricultural best management practices. Additionally, NRCS provides funding and technical assistance for forestry and wildlife habitat projects.
Watershed Municipalities		There are thirty-four towns wholly or partially within the Lamoille River Watershed within the six counties of Caledonia, Chittenden, Franklin, Lamoille, Orleans, and Washington. Municipalities can protect water resources through town plan language and zoning bylaws. Additionally, towns are responsible for managing large networks of roads, drainage ditches, and stream crossings.
VT Agency of Natural Resources (ANR) Internal Partners	Fish and Wildlife (VFWD); Forests, Parks and Recreation (VFPR); Environmental Conservation (VDEC)	All Departments within VANR (Fish & Wildlife Department, Forest, Parks, and Recreation, and VDEC) and Divisions within them, work collaboratively on a number of watershed assessment, restoration and protection projects. Additionally, FWD and FPR own and manage hundreds of acres of state-owned lands within the basin. Annual stewardship plans are prepared by District Stewardship Teams and includes staff from FWD, FPR, and VDEC. Long Range Management Plans of state-owned properties include restoration and protection of water resources.
The Vermont Lake Wise Program (LWP) - VDEC Lakes and Ponds Program		The Lake Wise Program is offered through the Vermont Lakes and Ponds Section to provide trainings in lake friendly shoreland management to Lake Associations and shoreland property owners. Through Lake Wise, participants receive technical assistance to evaluate specific landscaping practices for fixing erosion and polluted runoff, while improving lake quality and wildlife habitat. Vermont LakeWise Link

If you or your organization is interested in becoming an active partner or stakeholder, please contact your basin planner.

Appendix D. Municipal Protectiveness Matrix for Basin 17

Table D1. Municipal protectiveness matrix for all the towns in Basin 17 ….. need to update Flood Resiliency and Road Erosion inventory columns

	National Flood Insurance Program (NFIP)	Road and Bridge Standards	Emergency Operations Plan (LEOP)	Hazard Mitigation Plan (LHMP)	River Corridor Protection	ERAF	Flood Resiliency in Town Plan	Road Erosion Inventory		Storm-water Master Plan	IDDE		Storm-water Mapping	Municipal By-law or Zoning District for Water Resource Setback N=No, S = Some, Y= Yes		
	Enrolled?	Adopted?	Completed?	Adopted?	Adopted?	Percent	Completed?	Completed?	Year	Completed?	Completed?	Year	Completed?	Rivers and Streams	Wetlands	Lake and Ponds
Albany	No	Yes	Yes	Yes[1]	No	7.5%	No			No	N		No	N	N	N
Albany Village	No	Yes	Yes	Yes[1]	No	7.5%	No			No	N		No	N	N	N
Averill UTG	Yes	Yes	Yes	Yes	Yes	17.5%	Yes			No	N		No	Y	Y	Y
Barton	Yes	Yes	No	Yes	No	7.5%	No			No	N		No	N	N	S
Barton Village	Yes	Yes	Yes	Yes	No	12.5%	No			Yes	Y	2015	Yes	N	N	S
Brighton	Yes	Yes	Yes	Yes	No	12.5%	No			Yes	Y	2015	Yes	N	N	S
Brownington	No	Yes	Yes	Yes	No	7.5%	Yes			No	N		No	N	N	N
Charleston	No	Yes	Yes	Yes	No	7.5%	No			No	N		No	N	N	N
Coventry	Yes	Yes	Yes	No	No	7.5%	No			No	N		No	N	N	N
Craftsbury	Yes	Yes	No	No	No	7.5%	Yes			No	N		No	N	N	N
Derby	Yes	Yes	Yes	No	No	7.5%	No			Yes	Y	2015	Yes	N	N	Y
Derby Line Village	Yes	Yes	Yes	No	No	7.5%	No			Yes	Y	2015	Yes	N	N	N
Glover	Yes	No	Yes	Yes	No	12.5%	No			Yes	N	2015	Yes	N	N	N
Greensboro	Yes	Yes	Yes	Yes	No	12.5%	Yes			No	N		No	Y	N	Y
Holland	No	Yes	Yes	No	No	7.5%	Yes			Yes	N		Yes	N	N	N
Irasburg	No	Yes	Yes	No	No	7.5%	No			No	N		No	N	N	N
Lowell	Yes	Yes	Yes	Yes	No	12.5%	No			No	N		No	N	N	N
Morgan	No	Yes	Yes	No	No	7.5%	No			No	N		No	N	N	S

	National Flood Insurance Program (NFIP)	Road and Bridge Standards	Emergency Operations Plan (LEOP)	Hazard Mitigation Plan (LHMP)	River Corridor Protection	ERAF	Flood Resiliency in Town Plan	Road Erosion Inventory		Storm-water Master Plan	IDDE		Storm-water Mapping	Municipal By-law or Zoning District for Water Resource Setback N=No, S = Some, Y= Yes		
Newport City	Yes	Yes	Yes	Yes	No	12.5%	Yes			Yes	Y	2015	Yes	N	N	S
Newport Town	Yes	Yes	Yes	No	No	7.5%	Yes			No	N		No	N	N	N
Norton	Yes	Yes	Yes	No	Yes	7.5%	Yes			No	N		No	Y	N	Y
Orleans Village	Yes	Yes	Yes	Yes	No	12.5%	No			Yes	Y	2015	Yes	N	N	S
Troy	Yes	Yes	Yes	No	Yes	7.5%	No			No	N		No	N	N	N
UTG	Yes	Yes	Yes	Yes	Yes	17.5%	Yes			No	N		No	Y	Y	Y
Westmore	No	Yes	No	No	No	7.5%	No			No	N		No	Y	N	Y

[1] Work in progress

[2]Interim Bylaws adopted

Appendix E. Watershed Projects Funding Sources

Funding sources are continually changing. The table in this section represents a compilation of known funding sources as of December, 2016. Please notify the Watershed Management Division of other relevant surface water improvement funding sources.

Category (State, Fed., Foundation)	Grant Name	Funding Type	Contact
WSMD	319 Nonpoint Source Grant	Restore water quality in waters threatened by non-point sources	emily.bird@vermont.gov
WSMD	Ecosystem Restoration Program Grant	Environmental remediation, protection and runoff mitigations, P loading, Ag land enhancement, nonpoint source	emily.bird@vermont.gov
F+W	VT Watershed /License Plate	Enhance/restore water resources, restore or protect fish and wildlife habitat, education, cultural resources, reducing P loading	emily.bird@vermont.gov
WSMD	Aquatic Nuisance control	Available for municipalities; priority to new infestations, second to controlling infestations or prevention, third to ongoing maintenance.	Perry.Thomas@vermont.gov
FED	The Vermont Planning Advance Program	For planning community water resources; sewage, drinking water, feasibility studies for the aforementioned works. *Funds currently available.*	Bryan.Redmond@vermont.gov
FED	CWSRF	For WWTF construction, sewer works, stormwater mgmt. facilities. Available to municipalities Currently, funds available for planning and final design applications are accepted on a rolling basis. Funds will be available for construction projects later this year but all new projects will need to go through planning and design prior to approval. Currently there are some subsidy opportunities of up to 50% on planning and final design activities. There is also a call out for the next month for asset management grants.	terisa.thomas@vermont.gov

FED	Unsafe Dam State Revolving Fund	Available for dam removal, either 100% loan or 75% loan and 25% grant funding (if breaching or removing—maintenance or reconstruction are eligible for loan only). Generally $50,000 cap, may be expanded.	Benjamin.Green@vermont.gov
FED	DWSRF	Public and private drinking water utilities are eligible for this funding. Can be used for easements that help with drinking water quality.	Ashley.Lucht@vermont.gov
WSMD	Regional Conservation Partnership Program (NRCS)	Projects related to soil and water quality, flood prevention, water resource conservation, reducing runoff and irrigation improvement. Available to state, farmers' cooperatives, municipal water orgs, orgs with a history of working with farms, and higher education organizations. Pre-proposals already submitted for this calendar year.	RCPP@wdc.usda.gov
VFWD	Clean Vessel Act Grant	Grants for public or private marinas or a state, county/municipal org for installing or upgrading pumpout stations or dump stations, or projects related to boating septic waste. Due August 15, grant covers up to 75 percent of the project.	Mike.Wichrowski@vermont.gov
AAFM	BMP financial assistance	Financial assistance for up to 90 percent cost share on NRCS approved practices on production areas, up to 50 percent on non-production areas. Can be coupled with federal NRCS funds. Available to growers in the state of Vermont/livestock producers or private land holders	Jeff.Cook@vermont.gov
AAFM	CREP Grants	Available to landowners for land in ag use, that is adjacent to a perennial stream or waterway. Cost share may cover 90-100 percent of funding needed for swales, vegetated buffers, filter strips, livestock fencing, etc.	

AAFM	Various Farm Agronomic Practices	Funds for practices that restore soil quality and enhance water quality by reducing runoff. Includes grants for educational activities and cover cropping (paid by acre). Usually due one month prior to implementation, available to growers and livestock owners.	Jeff.Cook@vermont.gov
NRCS	EQIP	Provides assistance in the form of reimbursement up to $ 300,000 for projects that conserve agricultural or forested land, or other wildlife habitat. Project can only be started AFTER contract with NRCS signed for funding. Priority given to historically underserved customers and projects which address significant resource concerns	http://www.nrcs.usda.gov/getstarted Contact local NRCS field office
ACCD	Municipal planning grants	Municipalities eligible, priority given to those in historic settlement pattern—villages and town centers. Joint applications may be accepted. Funding provided for meetings, hearings, workshops, conservation work, legal fees, easements, administrative materials, research, inventories and mapping, and payment for support staff.	annina.seiler@vermont.gov
WSMD	Flood Mitigation Assistance Grant Program	State government applies for FEMA funding, which local governments may then access by working as "subapplicants". Project must support the flood hazard portion of State, tribal, or local mitigation plans to meet the requirements outlined in 44 CFR Part 201 Mitigation Planning. Funds are only available to support communities participating in the National Flood Insurance Program (NFIP).	ned.swanberg@vermont.gov
DEM	Hazard mitigation Grants	Provides funding for land acquisition, infrastructure projects, flood planning. State, local government and non-profits eligible. Communities must have a FEMA approved and adopted local mitigation plan to be eligible. Funds not currently available but possibly in future.	lauren.oates@vermont.gov

LCBP	Local Implementati on Grants	Grants for Lake Champlain basin bioremediation and pollution control/ environmental improvement. State, interstate, and regional water pollution control agencies, and public or nonprofit agencies, institutions, and organizations are eligible to receive grants from EPA through this program.	Jeanne Voorhees
AAFM	Water Quality Grant	For Water Quality projects initiated by VAAFM. Can be applied for through a RFP opportunity.	
Foundation	Vermont Community Foundation	"Small and Inspiring" grants: connect people to each other through volunteer work or community-building efforts connect people to the environment around them in new ways	Kim Haigis, khaigis@vermontcf.org
Foundation	Vermont Community Foundation	"Lamoille County and Beyond: Green Mountain Fund" serving children, elderly and family services, education, environment, sustainability, and the arts in Lamoille County and other parts of the Northeast Kingdom.	Kim Haigis, khaigis@vermontcf.org
Foundation	Vermont Community Foundation	"Upper CT River Mitigation and Enhancement Fund" river restoration work in the upper Connecticut River Watershed; wetland restoration, protection, and enhancement; and shoreline protection. Region: Connecticut River watershed upstream of the confluence of the White River and the Connecticut River at White River Junction, Vt. and West Lebanon, N.H.	Kim Haigis, khaigis@vermontcf.org
Foundation	Vermont Community Foundation	Lake Champlain Tributaries and Restoration Fund: protection, restoration, and enhancement of Lake Champlain's ecosystem.	Kim Haigis, khaigis@vermontcf.org
Foundation	Vermont Community Foundation	Special and Urgent Needs- helps Vermont nonprofits with unexpected expenses that impact their ability to meet their mission. A SUN grant can help an organization manage an unbudgeted, unforeseen, and time-sensitive emergency or take advantage of an unanticipated opportunity that will enhance its work.	Kim Haigis, khaigis@vermontcf.org

Foundation	Vermont Community Foundation	"Kelsey Trust" Lake Champlain and Tributaries protection. We are particularly interested in programs aimed at protecting Lake Champlain and its tributaries, the Green Mountains, and the Adirondacks. LOI needed	Kim Haigis, khaigis@vermontcf.org
VTRANS	Transportation Alternatives	F. Any environmental mitigation activity, including pollution prevention and pollution abatement activities and mitigation to-- (i) address stormwater management, control, and water pollution prevention or abatement related to highway construction or due to highway runoff, including activities described in sections 133(b)(11), 328(a), and 329; or (ii) reduce vehicle-caused wildlife mortality or to restore and maintain connectivity among terrestrial or aquatic habitats. (iii) Construction of salt sheds is eligible under the environmental mitigation category. Eligibility for salt sheds will be considered on a case by case basis based on proximity of the existing storage location to a major water body (generally within 50 ft.). We recommend reviewing eligibility with VTrans prior to application submittal.	Scott Robertson, P.E. Telephone: (802) 828-5799 Fax: (802) 828-5712 E-mail address: scott.robertson@vermont.gov
VTRANS	Better Roads	Funding to support municipal road projects that improve water quality and result in maintenance cost savings. The grant funds are provided by VTrans and the Vermont Agency of Natural Resources. The Vermont Better Roads Program's goal is to promote the use of erosion control and maintenance techniques that save money while protecting and enhancing Vermont's lakes and streams. Funds, subject to availability, will be distributed as grants to municipalities to address town erosion problems.	Alan.may@vermont.gov

VTRANS	Category (A) planning grants	Road Inventory and Capital Budget Planning (Maximum Grant Amount $8,000). Road erosion reduction requires planning and budgeting to implement road improvements that also result in cost savings. Eligible projects under this category must include: (1) Inventory of roads and/or culverts and identification of road related erosion and/or stormwater problems affecting water quality in a particular watershed or the whole town. (2) Sites identified must then be prioritized by problem area for future repair. (3) The final step is the development of a capital budget plan to correct these problems over a specific period of time.	Alan.may@vermont.gov
VTRANS	Category (D) culvert upgrade grants	Structures or culverts that carry streams or rivers must have accompanying documentation showing consultation with an ANR River Management Engineer and/or Army Corps Engineer indicating use or nonuse of river management standards prior to submittal of application.	Alan.may@vermont.gov
VTRANS	Category B – Road Erosion	Correction of a Road Related Erosion Problem and/or Stormwater Mitigation/Retrofit for both gravel and paved roads	Alan.may@vermont.gov
VTRANS	The Category (C) bank stabilization	Stream and river/road conflicts must have accompanying documentation showing consultation with an ANR River Management Engineer and/or Army Corps Engineer indicating use or non-use of river management standards prior to submittal of applicatio	Alan.may@vermont.gov
Foundation	Joe W. & Dorothy Dorsett Brown Foundation	Environmental research; housing for the homeless; support for organizations that care for the sick, hungry or helpless; religious and educational institutions; as well as organizations and groups concerned with improving our local communities. Within these areas, the focus is primarily on alleviating human suffering. Secondary consideration includes cultural, spiritual, educational, or scientific intiatives.	bethbuscher@thebrownfoundation.org 504-834-3433

Foundation	Weyerhaeuser Giving Fund	The fund helps cultivate growing minds and bodies, promote sustainable communities, and nourish the quality of life in these Weyerhaeuser communities. The Foundation's main funding areas are: affordable housing and shelter, education and youth development, environmental stewardship, human services, civic, and cultural growth.	253-924-3658 anne.leyva@weyerhaeuser.com
Foundation	The Dale & Edna Walsh Foundation	DEW contributes to medical, relief, welfare, education, community service, ministries and environmental programs, and arts organizations. All organizations must submit a letter of inquiry (LOI) to be considered for funding.	775-200-3446 info@dewfoundation.org
Foundation	Toolbox for Education Grants	Lowe's Charitable and Educational Foundation . Giving on a national basis in areas of company operations; giving on a national basis for the Outdoor Classroom Grant Program and Lowe's Toolbox for Education to support parks and playgrounds and organizations involved with K-12 education, environmental beautification, environmental education, home safety, and community development. No support for schools established less than two years ago for Lowe's Toolbox for Education. Pre-schools are not eligible.	1-800-644-3561 ext. 7 info@toolboxforeducation.com
Foundation	Captain Planet Foundation	The foundation supports projects that: 1) Promote understanding of environmental issues; 2) Focus on hands-on involvement; 3) Involve children and young adults 6-18 (elementary through high school); 4) Promote interaction and cooperation within the group; 5) Help young people develop planning and problem solving skills; 6) Include adult supervision; 7) Commit to follow-up communication with the foundation.	404-522-4270 grants@captainplanetfdn.org
Foundation	G. Unger Vetlesen Foundation	Giving on a national basis. Foundation established a biennial international science award for discoveries in the earth sciences; grants for biological, geophysical, and environmental research, including scholarships, and cultural organizations, including those emphasizing Norwegian-American relations and maritime interests. Support also for public policy research and libraries. No grants to individuals. A Letter of Inquiry must be submitted before a full proposal will be considered.	212-586-0700 contact@vetlesenfoundation.org

Foundation	Max and Victoria Dreyfus Foundation, Inc.	Giving on a national basis to support museums, cultural, and performing arts programs; schools, hospitals, educational and skills training programs, programs for youth, seniors, and the handicapped; environmental and wildlife protection activities; and other community-based organizations and their programs. Organizations seeking support from the Foundation may submit a letter of request, not exceeding three pages in length, which includes a brief description of the purpose of the organization, and a brief outline of the program or project for which funding is sought.	202-337-3300 info@mvdreyfusfoundation.org
Foundation	American Honda Foundation	The American Honda Foundation engages in grant making that reflects the basic tenets, beliefs and philosophies of Honda companies, which are characterized by the following qualities: imaginative, creative, youthful, forward-thinking, scientific, humanistic and innovative. We support youth education with a specific focus on the STEM (science, technology, engineering and mathematics) subjects in addition to the environment.	310-781-4091 ahf@ahm.honda.com
Foundation	Dr. Scholl Foundation	In general the Foundation guidelines are broad to give them flexibility in providing grants. Applications for grants are considered in the following areas: Education, Social Service, Healthcare, Civic and Cultural, and Environmental.	1033 Skokie Blvd., Suite 230, Northbrook, IL 60062 847-559-7430
Foundation	The Andrew W. Mellon Foundation	Giving nationally on a selective basis for higher education and scholarship, scholarly communications and information technology, art history, conservation, and museums, performing arts, conservation and the environment.	212-838-8400 inquiries@mellon.org
Foundation	The Xerox Foundation	The foundation supports: Education/Workforce Preparedness, Science/Technology, Employee/Community Affairs, and Environmental Affairs. Grants are made only to organizations that have been granted exemption from Federal Income Tax under Section 501 (c)(3) and ruled to be publicly supported under Section 509(a) of the Internal Revenue Code.	203-849-2453

Foundation	Lintilhac Foundation	Giving primarily in north central VT, including Chittenden, Lamoille, and Washington counties supporting medical education programs, health services, community development, civic projects, and educational institutions. Support also for local scientific, environmental, and educational issues. Grants given for building/renovation, curriculum development, equipment, general/operating support and seed money. No support for religious organizations. No grants to individuals.	886 North Gate Road, Shelburne, VT United States 05482-7211 (802) 985-4106 lint@together.net
Foundation	Perkins Charitable Foundation Educational Grants	Giving nationally, primarily in CA, CT, FL, MA, MT, OH, RI, VA, and VT for education, the arts, environmental conservation, animals, wildlife, health and medical care, and children, youth and social services. No grants to individuals.	1030 Hanna Bldg. , 1422 Euclid Ave., Cleveland, OH United States 44115-2001 (216) 621-0465
Foundation	Fields Pond Foundation, Inc.	The Fields Pond Foundation awards grants to projects and programs primarily in Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. The primary mission of Fields Pond Foundation is to provide financial assistance to nature and land conservation organizations that are community-based and that serve to increase environmental awareness by involving local residents in conservation issues.	781-899-9990 info@fieldspond.org
DOI	Rivers, Trails and Conservation Assistance Program	Applications for Rivers, Trails and Conservation Assistance program are competitively evaluated based on how well the applications meet the following criteria: 1. The project has specific goals and results for conservation and recreation expected in the near future. 2. Roles and contributions of project partners are substantive and well-defined. 3. There is evidence of broad community support for the project.	Jennifer Waite jennifer_waite@nps.gov (802) 457-3368, ext 221

Foundation	Waterwheel Foundation Grants	The WaterWheel Foundation was created by Phish in 1997 to oversee the band's various charitable activities. The primary effort then and now is our Touring Division, though in keeping with our "Local" mission we also support Vermont-based non-profits and others in need.	ww@phish.com or write to WaterWheel, PO Box 4400, Burlington VT 05406-4400.