Missisquoi Bay Basin

Water Quality Management Plan

THE WATER QUALITY PLAN FOR THE MISSISQUOI BAY BASIN WAS PREPARED IN ACCORDANCE WITH 10 V.S.A. § 1253(d), THE VERMONT WATER QUALITY STANDARDS, THE FEDERAL CLEAN WATER ACT AND 40 CFR 130.6.[1]

Approved:

David Mears, Commissioner
Department of Environmental Conservation

3/27/13
Date

Deb Markowitz, Secretary
Agency of Natural Resources

3/28/13
Date

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[1] The revised Water Quality Standards require that all basin plans place Class B waters into one of the three water management types. However, considerable challenges over the past decade have limited ANR's ability to identify proposed management types, and the Panel's ability to promulgate these designations. These challenges are listed in detail in VDEC's 2010 Report to the Vermont General Assembly on Basin Planning. As such, recommendations for water management types are not presented in this basin plan.

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Acronyms

2CR – Secondary Contact Recreation
319 – Federal Clean Water Act, Section 319
AAP – Accepted Agricultural Practices
AES – Aesthetics
ALS – Aquatic Life Support
AMA – Agricultural Management Assistance Program
AMP – Acceptable Management Practices
ARS – Agricultural Resource Specialist
BBR – Better Back Roads Program
BMPs – Best Management Practices
CAFO – Concentrated Animal Feeding Operation
CCC – Vermont Center for Clean & Clear
CNMP – Comprehensive Nutrient Management Plans
CR – Contact Recreation
CREP – Conservation Reserve Enhancement Program
CTA – Conservation Technical Assistance
CWA – Clean Water Act
EPA – US Environmental Protection Agency
EQIP – Environmental Quality Incentives Program
ERP – Ecosystem Restoration Program
FC – Fish Consumption
FNLC – Friends of Northern Lake Champlain
FNRCD- Franklin Natural Resources Conservation District
FPP – Farmland Protection Program
FSA – Farm Services Agency (USDA)
FWA – Franklin-Grand Isle Farmers Watershed Alliance
GIS – Geographic Information System
LCBP – Lake Champlain Basin Program
LFO – Large Farm Operation, subject to LFO rules
LID – Low-Impact Development
LPP – Land Protection Plan
MFO – Medium Farm Operation, subject to MFO rules
MRBA – Missisquoi River Basin Association
NMP – Nutrient Management Plan
NOFA – Northeast Organic Farming Association
NPS – Nonpoint source pollution
NRCD – Natural Resources Conservation District
NRCS – Natural Resources Conservation Service
NRPC – Northwest Regional Planning Commission
NWR – National Wildlife Refuge
ONRCD – Orleans Natural Resource Conservation District
ORW – Outstanding Resource Waters
PPP – Preliminary Project Proposal
RC&D – Resource Conservation & Development Council
SFO – Small Farm Operations
SGA – Stream Geomorphic Assessment
TMDL – Total Maximum Daily Load
TNC – The Nature Conservancy
TSP – Technical Service Providers
USDA – United States Department of Agriculture
USFWS – US Fish and Wildlife Service
UVM – University of Vermont
VAAFM – VT Agency of Agriculture, Food, and Markets
VACD – VT Association of Conservation Districts
VANR– VT Agency of Natural Resources
VDEC – VT Department of Environmental Conservation
VDFW – VT Department of Fish and Wildlife
VFPR – VT Dept. of Forests, Parks, and Recreation
VFB – Vermont Farm Bureau
VLCT – VT League of Cities and Towns
VSWMS – Vermont Surface Water Management Strategy
VTrans – Vermont Agency of Transportation
WRP – Wetland Reserve Program
WWTF – Wastewater Treatment Facility
WSMD – VT DEC Watershed Management Division

Executive Summary

The Vermont Agency of Natural Resources' Missisquoi Bay Basin Plan (Plan) focuses on the Vermont portions of the Missisquoi, Rock and Pike River watersheds. The Plan's goal for the Missisquoi Bay and all of the waters in its drainage basin is the sustained ecological health and human use by meeting or exceeding state water quality standards, including targets for phosphorus loading and in-lake phosphorus concentrations.

The watershed begins with the mountain streams and gorges along the flanks of the Green Mountains and includes the pastoral meanderings of the Missisquoi River along the Canadian border. The lowest section includes the Missisquoi River delta: a complex of marshes, floodplain and wetland forests covering thousands of acres. Rivers, lakes, including Lake Carmi, and numerous wetlands also comprise the network of waterbodies in the Basin.

The waterbodies in the Missisquoi Bay Basin supports swimming, boating and fishing. In addition, the Basin's waters provide drinking water and are appreciated for the wildlife habitat and plant communities that they support. For a majority of the waterbodies, water quality is sufficient to protect the uses. For the remainder, impairments to or stressors on the uses include: sedimentation, turbidity, habitat alterations, nutrients, thermal modifications, flow alterations, metals from the Eden Mine, as well as physical instability and river corridor encroachment. Many of these stressors collectively result in the nutrient-driven algae blooms observed in Missisquoi Bay, which impairs many uses of the Bay itself.

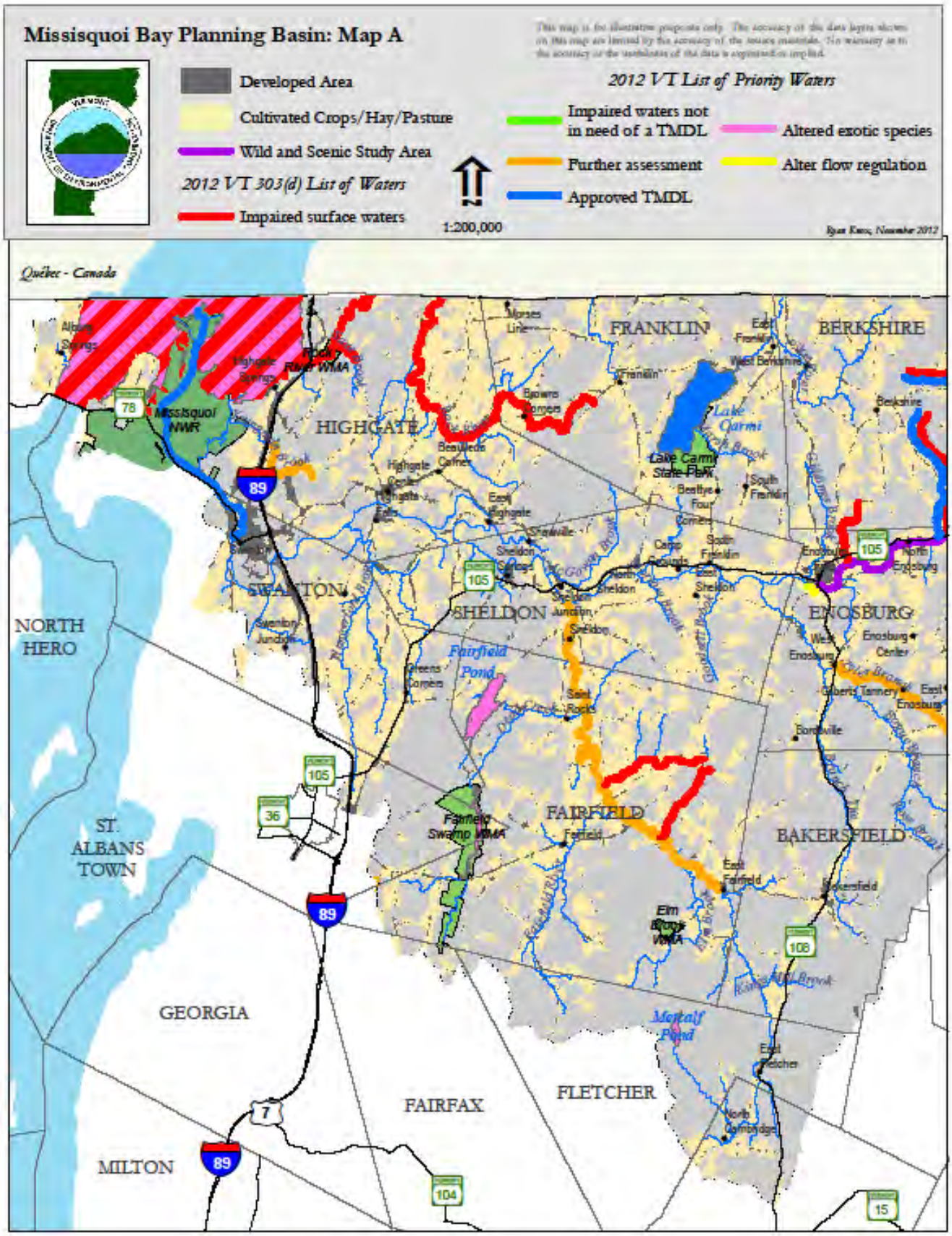
This water quality management plan provides an overview of the basin's surface waters and a description of ongoing and future steps to restore and protect those waters. The Plan integrates the results of numerous planning processes concurrently operating in the watershed. With the purpose of improving both water quality and aquatic habitat, this plan presents the recommendations of a cross section of partner stakeholders, including residents of the basin, the Agency of Natural Resources (VANR) and professionals from other State and federal agencies to guide efforts in the basin over the next five years.

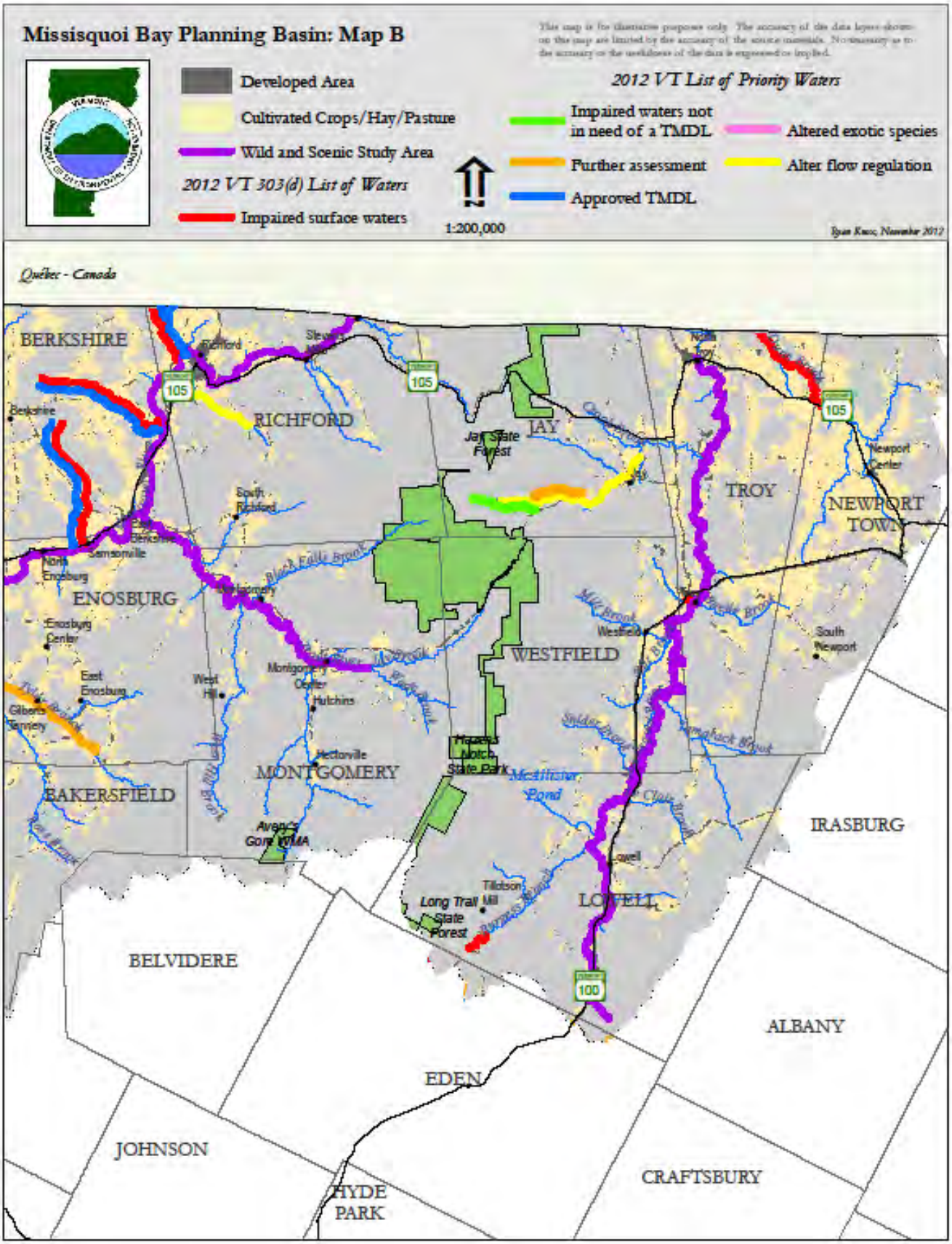
The strategies discussed and supported by the plan's partners are summarized in Chapter 3 and are the basis for the specific actions outlined in the Chapter 6 implementation table. The actions reflect the need to control pollution from all land use activities, including developed land and agricultural land.

The tables' strategies are expected to be revised over the life of the plan as new information is obtained. The high priority strategies (unranked) in this management plan follow:

- Implement projects to meet the phosphorus reduction targets for Lake Champlain and Lake Carmi, and to meet the bacteria reduction targets for Berry, Godin and Samsonvillle Brooks.
- Evaluate the feasibility of removing the Swanton Dam.
- Augment stormwater system mapping and address 13 suspected illicit discharges identified in the towns of Enosburg Falls, North Troy, Richford, and Swanton.
- Support stormwater master planning and plan implementation in Swanton, Highgate, Enosburg Village and Falls, and Richford.

- Assist road town foremen with the identification and remediation of erosion from town roads by promoting Better Backroads inventories and projects in Lowell, Albany, Troy, Jay, Westfield, Berkshire, and Highgate.
- Work with towns, VTrans and private landowners to use the existing culvert assessments to identify appropriate replacement size and placement to improve fish passage and the geomorphic stability of the stream.
- Use the Critical Source Area study (Stone Environmental, Inc., 2011) to direct technical and financial agricultural resources to identified critical sources.
- Work with towns to protect river corridors and promote flood resiliency by establishing Fluvial Erosion Hazard zones and buffer zones in local zoning.
- Identify wetlands on agricultural lands for phosphorus retention, and in the river corridor for sediment attenuation, and then prioritize and conserve and/or restore.
- Encourage use of the basin's rivers and lakes to increase people's appreciation of the water resources.
- Assist the towns to address specific wastewater treatment infrastructure upgrade needs identified in the Clean Water Fund's forthcoming Needs Survey.


Missisquoi Bay Planning Basin: Map A
Developed Area
Cultivated Crops/Hay/Pasture
Wild and Scenic Study Area
2012 VT 303(d) List of Waters
Impaired surface waters
1:200,000
2012 VT List of Priority Waters
Impaired waters not in need of a TMDL
Further assessment
Approved TMDL
Altered exotic species
Alter flow regulation
Quebec - Canada
FRANKLIN
BERKSHIRE
HIGHGATE
SWANTON
SHELDON
ENOSBURG
FAIRFIELD
BAKERSFIELD
FLETCHER
FAIRFAX
GEORGIA
NORTH HERO
ST. ALBANS TOWN
MILTON
Missisquoi NWR
Lake Carmi
Lake Carmi State Park
Fairfield Pond
Fairfield Swamp WMA
Elm Brook WMA
Metcalf Pond
Rock River WMA


Missisquoi Bay Planning Basin: Map B
This map is for illustrative purposes only. The accuracy of the data layers shown on this map are limited by the accuracy of the source materials. No warranty as to the accuracy or the usefulness of the data is expressed or implied.
Developed Area
Cultivated Crops/Hay/Pasture
Wild and Scenic Study Area
2012 VT 303(d) List of Waters
Impaired surface waters
1:200,000
2012 VT List of Priority Waters
Impaired waters not in need of a TMDL
Further assessment
Approved TMDL
Altered exotic species
Alter flow regulation
Ryan Kunz, November 2012
Québec - Canada
BERKSHIRE
RICHFORD
JAY
TROY
NEWPORT TOWN
ENOSBURG
WESTFIELD
MONTGOMERY
BAKERSFIELD
IRASBURG
LOWELL
BELVIDERE
EDEN
ALBANY
JOHNSON
HYDE PARK
CRAFTSBURY
Jay State Forest
Hazens Notch State Park
Long Trail State Forest
Avery's Gore WMA
McAllister Pond
Black Falls Brook
Mill Brook
Missisquoi River
Trout River
Clark Brook
Snider Brook
Tamarack Brook
Berkshire
Richford
Sheldon Junction
Samsonville
North Enosburg
Enosburg Center
East Enosburg
Gilbert's Corners
Montgomery
Montgomery Center
West Hill
Hutchins
Hectorville
Westfield
Lowell
Tillotson
Newport Center
South Newport
105
100

Chapter 1 – Introduction

Vermont's surface waters, including lakes, ponds, rivers and streams, are an invaluable asset offering environmental, economic, recreational and cultural benefits to those who live, work, and visit the state. Proper protection and management of these resources is critical to ensure their health for current and future generations.

The Missisquoi Bay Basin Water Quality Management Plan is intended to be a comprehensive planning document that details the current and future threats to water quality and identifies the strategies necessary to protect and restore the surface waters of the Basin found in Vermont. The completion of this Basin Plan represents many years of effort and contributions from a wide variety of local, regional, state and federal partners.

1.1 The Purpose of the Basin Plan and the Basin Planning Process

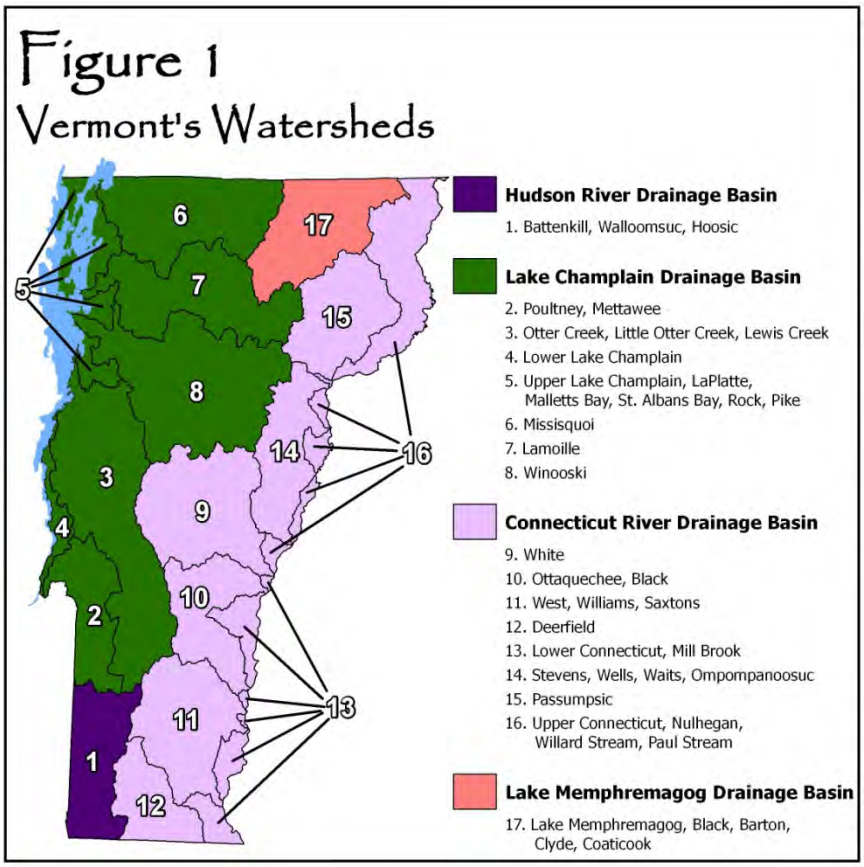
The planning process used to develop a water quality management plan for the Missisquoi Bay watershed is described in the *Vermont Watershed Initiative Guidelines for Watershed Planning (2007)* prepared through a collaboration of a public Statewide Watershed Framework Committee and the Vermont Department of Environmental Conservation (VDEC). Basin planning is an on-going process designed to be compatible with the Vermont Water Quality Standards and other applicable State and federal laws. In general, the planning process serves to integrate topics of special local concern with topics of special state importance, and make management recommendations on these topics.

In 2010, the Vermont Agency of Natural Resources (VANR) developed the Vermont Surface Water Management Strategy,[2] (VSWMS) and will be using the process laid out therein to streamline forthcoming basin plans into tactical basin plans. The VANR initiated the Missisquoi Bay Basin planning process prior to completing the VSWMS. The revision of the plan in five years will use the new approach, tactical planning, to focus efforts on remediating specific water bodies identified as stressed, altered or impaired, while promoting protection activities for specific waters that either promote stream equilibrium or maintain certain high quality characteristics.

The VANR prepares 5-year plans for 17 basins, each including one or more major river watersheds (Figure 1). The Missisquoi Bay Basin includes three major watersheds: the Missisquoi River (Basin 6), and the Rock and Pike Rivers (parts of Basin 5) (see Maps A and B). Nonpoint sources are by far the largest contributors of pollutants to surface waters in Vermont. Because reducing the load of pollutants from lawn care, farming, construction, and myriad other activities on the land requires the participation of many watershed stakeholders, basin planning employs a collaborative process between individual citizens, businesses, private organizations, and local, state, and federal government programs.

[2] http://www.anr.state.vt.us/dec/waterq/wqdhome.htm

1.2 Partners in the River Basin Planning Process



The water quality protection and improvement strategies presented in this plan are the result of an inclusive, multi-year planning process. The Vermont Agency of Natural Resources worked with members of the watershed community to identify concerns and build upon existing water quality improvement activities, including those of volunteer-based groups. It is important to note that many individuals, groups, and agencies had been implementing water quality projects before the planning process began and they have already begun to implement many of the strategies presented here.

The collaborative planning process for the Missisquoi Bay watershed formally began in the winter of 2005 with a series of public meetings designed to hear water quality concerns and begin discussing possible solutions. A diverse mix of interested stakeholders then began to meet as a watershed council. They included farmers, foresters, business owners, municipal officials, anglers, local watershed and lake organizations, environmental advocates, teachers, and regional planners. Supported by a VANR watershed coordinator, the watershed council and several issue-specific sub-groups further investigated the identified water quality concerns and potential strategies to address them.

In 2006, membership in the watershed council was made more formal. Although meetings remained open to the public, key members committed themselves to completing the strategies. Presentations from agency technical staff provided the council with information about current programs and approaches. The watershed coordinator and staff from the Vermont Agency of Agriculture, Food, and Markets (AAFM) developed draft water quality improvement strategies. With facilitation assistance from the Northwest Regional Planning Commission (NRPC) staff, the council discussed the draft strategies and commented on their relative priority for implementation.

In 2010, the NRPC received a grant from Vermont Department of Fish and Wildlife to make updates and revisions to the draft plan. VANR was responsible for final revisions and overseeing the public comment period as required before presenting the interim plan to the VANR Secretary for approval.

1.3 Coordination with the Province of Quebec

Given that a significant portion (42%) of the Missisquoi Bay watershed is located in the province of Quebec, an international coordinated effort is critical to successfully addressing the water quality concerns. In addition to sharing ideas and approaches, Vermont and Quebec have adopted an agreement that divides the needed phosphorus load reductions between the two jurisdictions: 60% for Vermont and 40% for Quebec (Vt. and Quebec, 2002). Vermont and Quebec have also developed a combined water quality monitoring network in the Missisquoi Bay watershed (Vt. and Quebec, 2005) designed to help determine which sub-watersheds are contributing the highest nutrient and sediment loads and to compare cross-border results. In addition, in August 2008, the Governments of Canada and the United States asked the International Joint Commission (IJC) to help implement a transboundary initiative to reduce phosphorus loading in Lake Champlain's Missisquoi Bay. See Missisquoi Bay Critical Source Area Project under section 1.4.

1.4 Other Concurrent Planning Processes

The following water quality related planning processes were underway during the development of this plan. The findings and recommendations of the studies were considered during the development of the implementation table. These studies are briefly summarized below.

Wild and Scenic Designation Study

In 2009, the Missisquoi River Basin Association (MRBA) gathered support to request Congressional authorization to initiate a Wild and Scenic designation eligibility study for the upper Missisquoi and Trout Rivers. The National Wild and Scenic Rivers System was created by Congress in 1968 (Public Law 90-542; 16 U.S.C. 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. In March 2009, President Barack Obama signed a bill into law authorizing funding this study in Vermont. The study is supported by the ten towns through which these rivers flow (Berkshire, Town of Enosburgh, Village of Enosburg Falls, Jay, Lowell, Montgomery, Town of Troy and Village of North Troy, Richford, and Westfield).

The focus area of the study comprises:

- 25 miles of the upper Missisquoi from Enosburg Falls/Enosburgh, through Berkshire to Richford/Canadian border
- 25 miles of the upper Missisquoi from the Canadian border/North Troy/Troy, through Westfield, Jay, to Lowell
- 20 miles of the Trout River through Montgomery and Berkshire

The Upper Missisquoi and Trout Rivers Wild and Scenic Study Committee, consisting of local appointees from each of the ten towns and villages in the study area, along with regional and state partners, including VANR, was created to oversee the study and identify the Outstandingly Remarkable Values of the rivers to be highlighted in their voluntary management plan. Over the course of three years, the Study Committee explored whether designation is desirable and whether the rivers meet the criteria for designation.

At the writing of this plan, the Study Committee has determined that the rivers meet the criteria for designation and voted to move forward with designation of the mainstem of the upper Missisquoi and Trout Rivers. Based on voter support in eight of the nine municipalities voting in their March 2013 Town Meetings (Berkshire, Enosburgh/Enosburg Falls, Montgomery, Richford, Troy/North Troy, and Westfield) it is anticipated that the Upper Missisquoi and Trout Rivers Wild and Scenic Study will agree to petition our U.S. Senate and House Representatives to introduce bills to Congress that request an amendment to the National Wild and Scenic Rivers Act to include the Missisquoi (from Westfield to Enosburg Falls) and the

Trout Rivers as Wild and Scenic rivers. Should this pass through Congress, such a bill would need to be signed into law by the U.S. President as was legislation authorizing the Study.

If designated, Congress would appropriate funds for projects to preserve the recreational, scenic, historic, cultural, natural, and geologic resources in the designated sections of the upper Missisquoi and Trout Rivers. The prestige of being designated could help attract tourists, or promote marketing for local businesses if there was interest to do so. Additionally, designation could make projects/organizations in the area more competitive in grant applications, and a post-designation Advisory Committee, similar to the Study Committee, would work in conjunction with local organizations, land owners, local and state government to encourage good stewardship of the waterways through the voluntary recommendations described in their management plan which will be available for public comment in the fall of 2012.

Lake Champlain Phosphorus TMDL Revision

In response to a federal lawsuit filed by the Conservation Law Foundation, the U.S. Environmental Protection Agency (EPA) reconsidered its previous approval of the 2002 Lake Champlain Phosphorus Total Maximum Daily Load (TMDL) or phosphorus reduction target, (see below) and disapproved the Vermont portion of the TMDL in January 2011. Under federal law, upon such disapproval, the EPA is responsible for establishing a new TMDL to implement the water quality standards. The EPA initiated the process of developing a new TMDL for Lake Champlain in 2011 in cooperation with the State of Vermont.
Several key steps involved in this process include:

- Review and revision of the in-lake water quality model to update the lake segment loading capacities
- Complete the study of effects that climate change may play on lake loading capacities
- Estimate phosphorus loads from subwatershed areas within tributary watersheds and estimate potentially achievable phosphorus reductions
- Identify programs and requirements to provide sufficient reasonable assurance that nonpoint phosphorus controls are achievable

Completion of the TMDL revision is tentatively expected in the summer of 2013.

Lake Champlain Phosphorus TMDL Implementation Plan

Section 303(d) of the Clean Water Act requires waters that do not meet state water quality standards to have a Total Maximum Daily Load (TMDL) analysis prepared. A phosphorus TMDL, identifies a daily amount of phosphorus that can enter the lake without causing water quality problems. Lake Champlain exceeds such a daily load currently and the TMDL will provide guidelines as to how much the load needs to be reduced to correct water quality problems.

In 2010, VDEC produced a Phosphorus TMDL Implementation Plan for Lake Champlain. This plan describes the program, policies and actions that were needed to achieve the phosphorus reductions established by TMDL. Although the TMDL was revoked by EPA in 2011 (see above), the plan has and will guide the State of Vermont's remediation work in the lake until a new TMDL and subsequent implementation plan is adopted. The plan identifies ten specific next steps that should be taken by the State of Vermont and provided a recommended annual budget:

1) Increase the number of extension personnel (agronomists and nutritionists) available for on-farm technical assistance, education and support. $500,000 annually
2) Require additional post-construction stormwater management for impervious surfaces using existing stormwater management authorities, such as state operational stormwater permits, MS4 permits, and residual designation authority. $375,000 annually

3) Develop and implement a set of water quality-based design standards and best management practices for road maintenance and drainage and link state transportation funding for municipalities to adherence to the standards. $225,000 annually
4) Provide technical assistance and financial incentives to encourage municipalities to adopt stream corridor protection that prevents conflicts between streams and infrastructure and provides for stream equilibrium, floodplain function, and vegetated buffers on tributaries and lakeshores. $150,000 annually
5) Expand the Farm Agronomic Practices and Nutrient Management Programs to support increased use of soil erosion reduction practices and alternative manure application techniques, such as soil aeration. $300,000 annually
6) Increase capacity to provide landowners and municipalities with engineering assistance in the siting and design of infrastructure near or in stream and eliminate the 10 mi^2 drainage area threshold for issuing stream alteration permits. $300,000 annually
7) Provide financial incentives to achieve a minimum width (10 feet) of buffer zone along intermittent streams and ditches that pass through annual cropland. $500,000 annually
8) Provide incentives for the use of low-impact development (LID) practices in new and existing development. $400,000 annually
9) Provide financial and regulatory incentives to install fencing (temporary and permanent), watering systems, and stream crossings in order to improve management of animals in and around streams and rivers. $200,000 annually
10) Broaden the conservation purposes of and annually expend all funds made available through the Wetland Reserve Program (WRP) and Farmland Protection Program (FPP) to permanently protect and restore wetlands and stream corridors. $200,000 annually

Clean and Clear Action Plan

The VDEC Ecosystem Restoration Program's (Program) work is guided by the 2003 Vermont Clean and Clear Action Plan as well as the 2010 Revised Implementation Plan for the Lake Champlain Phosphorus Total Maximum Daily Load (TMDL) described above. The goals of the plans are to accelerate phosphorus pollution reduction in Lake Champlain and reduce pollutants in waters statewide. The Program provides leadership, financial resources, technical and educational assistance to Vermont's Agency of Natural Resources (VANR) and Agency of Agriculture, Food and Markets (VAAFM), and federal, municipal and non-governmental partners to facilitate remediation efforts. State and federal agencies have invested more than $140 million since 2004 and expanded programs to reduce phosphorus and sediment pollution in Lake Champlain and other waters statewide. The plan and annual reports from VANR and VAAFM as well as other information are available on the state's Ecosystem Restoration Program webpage at http://www.vtwaterquality.org/erp.htm.

Lake Carmi Phosphorus TMDL and Action Plan

The Lake Carmi Phosphorus Total Maximum Daily Load (TMDL) or phosphorus load reduction target was approved by EPA on April 8, 2009. Section 303(d) of the Clean Water Act requires waters that do not meet state water quality standards to have a phosphorus load reduction target prepared. A phosphorus load reduction target identifies a daily amount of phosphorus that can enter the lake without causing water quality problems. Lake Carmi exceeds such a daily load currently and the phosphorus load reduction target will provide guidelines as to how much the load needs to be reduced to correct water quality. The report articulates the phosphorus concentration goal in terms of maximum allocation of the annual loading of phosphorus to the lake from the watershed that will permit the lake to attain the target concentration of 22 ppb phosphorus.

Once the target phosphorus concentration and needed loading reduction are identified, nonpoint source control (land-use based) projects need to be identified that will accomplish these goals. The watershed of Lake Carmi contains a wide variety of land uses, including residential development (year-round and seasonal), agriculture, roads, and forestry. The VDEC Lake Carmi Phosphorus Reduction Action plan, dated August 2008, includes actions to address sources of phosphorus loading from landuses to meet the phosphorus reduction target. This Action Plan is written to encompass improvements needed in all land use types since all are sources of phosphorus. Some of the following 19 action items are ones that can be undertaken by the Franklin Watershed Committee with its existing annual budget, while others will necessitate significant additional funds. The action plan also recommended additional study of the rivers and in 2009, the Franklin Watershed Committee contracted to develop the Lake Carmi stream assessment, which includes recommendations for improvements to stream corridor and culverts to reduce erosion and increase stability of the corridor.

Vermont Statewide TMDL for Bacteria Impaired Waters

A 2.6 mile reach of Berry Brook, a 4.4 mile reach of Godin Brook and a 4.5 mile reach of Samsonville Brook are listed as "impaired" primarily due to bacteria. These waters fail to meet the Vermont Water Quality Standards based primarily on water quality monitoring for *E. coli* that was last conducted in 2000. The streams are included in the "Vermont statewide TMDL for Bacteria-impaired Waters" completed by FB Environmental Association for VDEC in September 2011 where bacterial load targets were established.

Agriculture land represents a significant portion of the watershed area of these three streams with dairy as the predominant agricultural activity. The completion of actions in the Chapter 6. Implementation Table would help the streams meet their targeted bacterial loads. The actions include assessing the extent of agricultural waste application and potentially reducing applications through improved nutrient management planning and other land treatments that reduce runoff of animal waste into streams. In addition, working with farmers to convert grazing land in the riparian area into permanent livestock exclusion areas is recommended. Finally, the bacterial concentrations of each stream will need monitoring to show improvements.

Opportunities for Action

In 2010, the Lake Champlain Basin Program (LCBP) released a revised "Opportunities for Action" Report. This report is intended to be a comprehensive management plan, addressing all of the various issues facing Lake Champlain, including Phosphorus Pollution, Fish and Wildlife, Aquatic Invasive Species, Toxic Substances and Pathogens, Climate Change and the Economy. The 2010 plan identifies specific action steps that will be taken by LCBP, the State of Vermont, the State of New York, and the Province of Quebec and other state and federal partner organizations. The actions that have or will be taken in United States portion of the Missisquoi Watershed are listed below. Action numbers 1, 3, 5 have been completed through the Missisquoi Bay Critical Source Area Project and action number 6 has been completed through the USDA Agricultural Research Service (ARS) Bank Stability & Toe Erosion Model. Both projects are described further on in this section.

1. Continue to work with partners to identify flow accumulation or critical source areas in agricultural fields within the Missisquoi Basin and educate farmers on the potential impacts and conservation practices that can be employed. (Vermont)
2. Work with other federal partners to perform a riparian regulatory gap analysis in the Missisquoi Basin in FFY2012 and establish a timetable to analyze riparian regulatory gaps in other subbasins in subsequent years. (USEPA)
3. Continue the IJC project, *Identification of Critical Source Areas of Phosphorus Pollution in the Missisquoi Bay Watershed*, through December 2011. (LCBP)

4. Continue to research internal nutrient dynamics in Missisquoi Bay to inform and develop a eutrophication model for the Bay. (LCBP)
5. Update the Missisquoi Area-Wide Plan in Vermont by 2011 and continue to implement recommendations from the plan. (USDA-NRCS)
6. Actively participate in the ongoing IJC project, Identification of Critical Source Areas of Phosphorus Pollution, in the Missisquoi Bay watershed. (Quebec and Vermont)
7. Implement a procedure for estimating contributions of stream banks to the total sediment load being delivered by Vermont tributaries to Missisquoi Bay by 2011. Extend the results of this project to tributaries throughout the Basin by 2014 in partnership with New York, Québec, LCBP, and USDA-NRCS-VT. (Vermont)
8. Staff at the Missisquoi National Wildlife Refuge (NWR) will work with partners, the public, and landowners to develop a Preliminary Project Proposal (PPP), to identify high priority habitats, especially those along the Missisquoi River corridor, the lakeshore of Lake Champlain, and other important habitats in the Missisquoi River watershed by 2010. (USFWS)
9. Staff at the Missisquoi National Wildlife Refuge will work with partners, the public, and landowners to develop a Land Protection Plan (LPP) by 2011. The LPP will identify in detail those lands that are seeking protection as part of the NWR system or through one of our land protection partners. (USFWS)
10. Monitor fish communities. Vermont and USFWS will conduct annual forage fish abundance surveys, primarily through annual sampling of rainbow smelt and alewife by trawl and hydroacoustics, allowing managers to respond to fluctuations in the prey base by manipulating predator numbers through harvest control and stocking. Québec will conduct a fish survey of Missisquoi Bay by 2015. LCBP will communicate the results of this work to the public through regular web updates. (LCBP, USFW, Vermont, Quebec)
11. Annually survey, remove, and quantify water chestnut in the Missisquoi National Wildlife Refuge. Provide financial support for control activities on 20 acres of wetland habitat in the Basin each year. (USFWS)

Missisquoi Area Wide Plan

In 2008, the USDA Natural Resource Conservation Service (NRCS) released the Missisquoi Area Wide Plan, "An NRCS-Led Partnership Project to Develop Strategies for Reducing Agriculturally-Related Phosphorus Pollution in Missisquoi Bay." The plan acknowledges that NRCS, the Farm Service Agency (FSA) and the Vermont Agency of Agriculture, Food and Markets (VAAFM) have targeted the Missisquoi for conservation work since the early 1980s, but that those efforts had largely been on a first-come-first serve basis. The plan anticipates that to meet the conservation needs of all the farms in watershed would require more than 200 waste storage facilities, 185 barnyard runoff control systems, conservation crop rotation on 2,550 acres, 180 comprehensive nutrient management plans, 800 acres of filter strips, and over 300 acres of forested riparian buffer for a total cost of $30,804,500.

Based on the recognition of these extensive conservation needs, an interagency partnership, along with non-profit organizations and many citizens, has since that publication entered into an adaptive management strategy for northern Lake Champlain. This strategy steers our workload based upon measured results of prior actions to reduce phosphorus pollution from concentrated sources near streams. The partners have coordinated efforts to focus funds, scientific watershed modeling, and conservation work in the Missisquoi Bay basin. NRCS has garnered national initiatives that also focus funding to implement beneficial practices more commonly throughout the region. The primary difference is that funds are now being targeted to the most critical source areas for sediment and phosphorus, to address those problems first.

Missisquoi Bay Critical Source Area Project

The project and final report "Identification of Critical Source Areas of Phosphorus within the Vermont Sector of the Missisquoi Bay Basin" (Stone Environmental, 2011) was prepared under contract for the Lake Champlain Basin Program (LCBP). The International Joint Commission provided funding to the LCBP for the preparation of this report and related work, which was budgeted through the efforts of Senator Patrick Leahy. The overall purpose of this project was to identify critical source areas (CSA) in order to improve the cost-effectiveness and efficiency of land treatment efforts to reduce phosphorus loads. The final report presents the results of intensive watershed modeling of the Missisquoi Bay Basin to identify critical source areas of phosphorus pollution at both a strategic and a tactical scale.

The strategic level assessment of critical source areas employed a Soil and Water Assessment Tool (SWAT) model that was capable of assessing broad watershed-scale trends, while also able to evaluate land use categories, sub-watershed characteristics, and field-level assessments of phosphorus source areas. In all cases, the SWAT model was applied over the entire watershed. The tactical level work combined data generated through the strategic assessment with other high-resolution datasets to define CSAs at a scale practical for specifying Best Management Practices (BMPs) at the farm and field scale. The principal goal of this project was to identify, locate, and rank the most important critical source areas of phosphorus loads in the Vermont sector of the Missisquoi Bay Basin.

The Missisquoi Bay Basin SWAT model was able to evaluate the phosphorus load associated with specific landscape units, from major sub-watersheds, through smaller subbasins, down to the highest resolution landscape representation—the unique combinations of land use, soils, and topographic characteristics that form a SWAT hydrologic response units. These areas have been mapped and described quantitatively. Identifying CSAs at multiple scales allows future management activities to be focused on major sub-watershed, subbasin, and field scale goals. The model also clearly demonstrated the value of targeting BMPs to the areas of highest risk. For each BMP tested, significant benefit was realized by implementing the BMP on areas representing the most important CSAs. For the three BMP scenarios tested, targeted BMPs gave two to three times the phosphorus load reduction that resulted from traditional, more random, implementation. Key findings of the study are that 74% of the upland sources of phosphorus is generated from only 20% of the watershed area, and in-channel sources of phosphorus (from stream bed and bank erosion generated from channel instability) represent about 40% of the phosphorus load entering the river. These in-channel legacy sources may result from prior agricultural runoff, or other land use disturbance resulting in channel instability. These results highlight the efficiencies that could be gained by targeting phosphorus control measures at these critical source areas and taking steps to achieve and maintain natural river channel stability.

The results from the project's report is currently being used by NRCS and VAAFM to prioritize areas for focusing efforts to encourage BMP adoption, including covercropping, grassed waterways and critical area seeding, manure incorporation, conservation tillage and other field practices.

The final report of the International Missisquoi Bay Study Board (established by the International Joint Commission) includes a number of findings and recommendations related to the critical source area study and its future implementation.
http://www.ijc.org/missisquoibayreport/ Also, the International Joint Commission's final report and recommendations about this project are about to be released.

USDA Agricultural Research Service (ARS) Bank Stability & Toe Erosion Model

In 2009, the VDEC River Management Program in partnership with the Ecosystem Restoration Program, (formerly Center for Clean and Clear) and the Lake Champlain Basin Program initiated a project with the USDA Agricultural Research Service (ARS) in Oxford, Mississippi to better understand the sediment and

nutrient loading caused by stream channel erosion. Previously load allocations had focused on wash-off from urban, agricultural, and forest land covers. Employing the Bank Stability and Toe Erosion Model (BSTEM), 30 sites were evaluated throughout the Missisquoi Bay watershed. Results show that stream bank erosion contributes approximately 29-42% of the total suspended sediment (TSS) load, and approximately 36% of total phosphorus (TP) at the mouth of the Missisquoi River. Best management practices were evaluated for reductions in TSS and TP load, and can achieve reductions of approximately 5-90% and 35-90%, respectively. These practices involve long-term protection of river corridors and riparian vegetation to achieve the highest load reductions over time. The final report, (Langendoen, E., 2012) will help in the development of projects that reduce erosion of stream channel.

Chapter 2 – Basin Description

The Missisquoi Bay sits at the northern end of Lake Champlain. The bay is shallow, with a maximum depth of approximately 14 feet. Its surface area is approximately 19,150 acres. There are three main rivers contributing to the Bay: the Missisquoi River, the Pike River and the Rock River. In all, more than 767,246 acres of land comprises the Missisquoi Bay watershed, with approximately 58% of the watershed located in Vermont and 42% in the Canadian Province of Quebec.

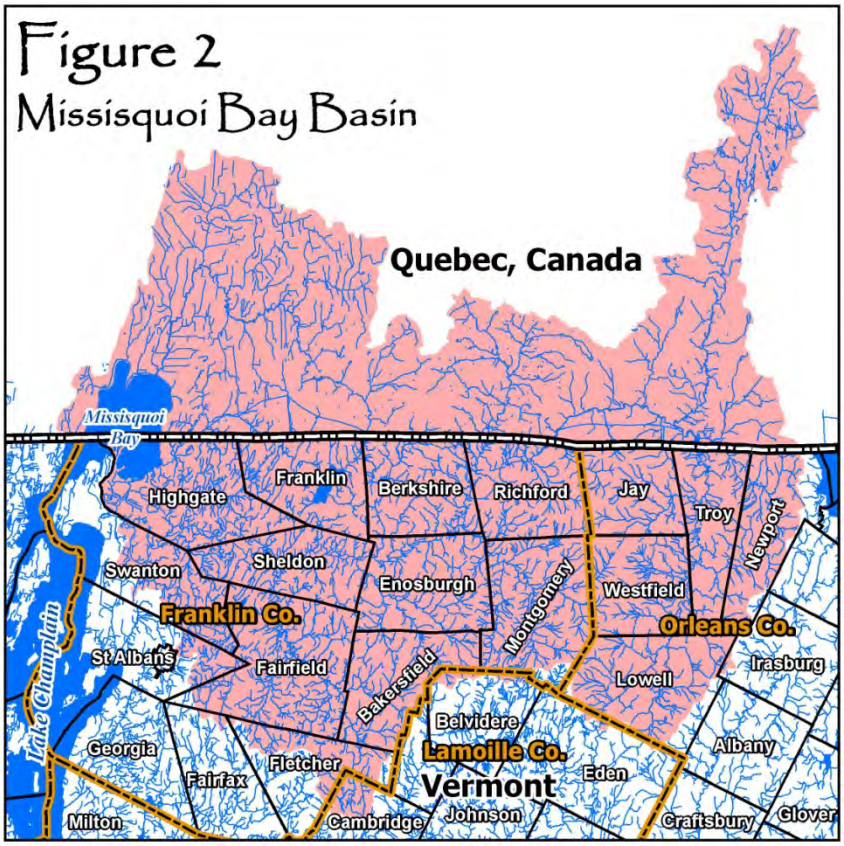


Figure 2
Missisquoi Bay Basin

In Vermont, the watershed is primarily in Franklin County, but extends "over the mountain" to Orleans County, and also includes small portions of Lamoille County. As shown in Figure 2, nine Vermont towns are completely in the watershed (Highgate, Franklin, Berkshire, Richford, Jay, Troy, Sheldon, Enosburgh, and Westfield), and another 14 towns are partially in the watershed (Newport, Lowell, Coventry, Irasburg, Lowell, Eden, Montgomery, Bakersfield, Fletcher, Cambridge, Fairfax, Fairfield, St. Albans, Swanton).

2.1 Sub-watersheds of the Missisquoi Bay

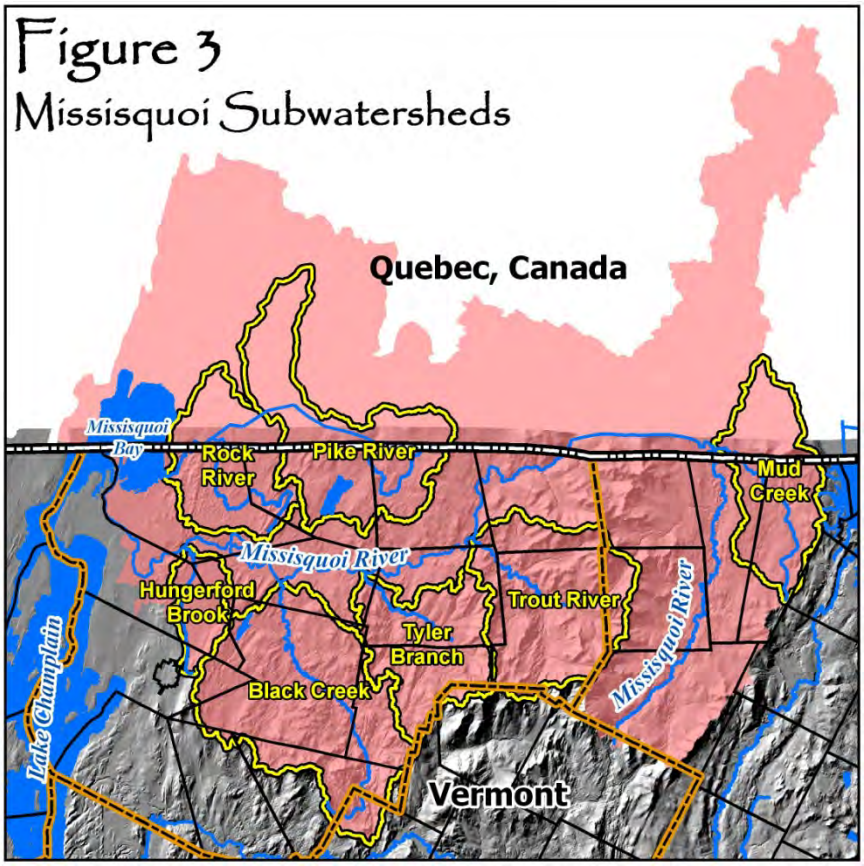
The watershed, or basin, is the distinct land area that drains into Missisquoi Bay, including rivers, streams, lakes, ponds, and wetlands. There are three main river systems located within the basin (Figure 3): The Missisquoi River, the Pike River and the Rock River. The Missisquoi has a number of important tributaries described below along with the Pike and the Rock. Fairfield Pond in the Missisquoi River watershed, and Lake Carmi in the Pike River watershed are the only major lake and pond in the watershed (surface area over 20 acres).

Missisquoi River

The Missisquoi River is the largest tributary of the Missisquoi Bay. The Missisquoi runs approximately 88 miles. From its headwaters in Lowell, Vermont, the Missisquoi River flows north into Quebec where the Missisquoi Nord joins the main stem at Highwater, QC. The river then returns to Vermont at East Richford and flows west to drain in Missisquoi Bay. There are five major subwatersheds that drain in the Missisquoi River: Hungerford Brook, Black Creek, Tyler Branch, Trout River, and Mud Creek.

Hungerford Brook

Hungerford Brook is a moderate size tributary of the Missisquoi River and drains approximately 19.5 square miles. With its confluence of the Missisquoi just below the Highgate Falls dam, the Hungerford Brook watershed is made up of parts of Highgate, Swanton, Sheldon, Fairfield, and Saint Albans towns. The main land use in the watershed is agricultural, however a growing number of residential houses and subdivisions have been built in the last few decades.



Black Creek

Black Creek is a large tributary of the Missisquoi River draining approximately 120 square miles. The watershed runs from where it meets with the Missisquoi just north of Sheldon south to the Bakersfield town line, nearly encompassing the towns of Sheldon and Fairfield with small portions of its tributaries also located in Saint Albans, Bakersfield, and Swanton. A large majority of the land use in the Black Creek watershed is agricultural.

Tyler Branch

The Tyler Branch is a tributary of the Missisquoi River, and its watershed covers approximately 58 square miles. Though the average elevation in the watershed is about 360 feet above sea level, the headwaters in the Cold Hollow Mountains near the Bakersfield/Belvidere town line are above 3,000 feet in elevation. The watershed drains parts of Sheldon, Fairfield, Enosburg, Bakersfield, Montgomery, Belvidere, and Waterville. The watershed is largely forested (74%), with smaller portions in agricultural (14%) and urban use (4%).

Trout River

The Trout River watershed encompasses approximately 86 square miles across the towns of Berkshire, Enosburg, Richford, Montgomery, and Westfield. Elevation in the watershed ranges from 400 feet above sea level near its confluence with the Missisquoi to more than 3,000 feet in the upstream end of some of its tributaries. Along the main stem of the Trout River, agricultural land use predominates, while the upper reaches above Montgomery Center are dominated by forest.

Jay Branch

Jay Branch drains an area of approximately 22 square miles, including the Jay Peak Mountain Resort. From the Green Mountains north of Jay Peak, it flows rapidly to the east through steep, mostly forested but

partially developed land for several miles before making a northeasterly turn. It continues northeasterly then north and after Crook Brook enters, east again for another few miles into the Missisquoi River.

Mud Creek

Mud Creek originates several miles south of Newport Center and flows north. The length of Mud Creek is approximately 10 miles and its watershed is approximately 37 square miles. Mud Creek crosses the Canadian border and joins the Missisquoi River in Quebec. Land use in the Mud Creek watershed is dominated by agriculture (29%) and forestry (61%) (Troy et al).

Rock River

The Rock River drains approximately 35.4 square acres in parts of Highgate and Franklin, and around 24.6 square acres in Quebec directly into the Missisquoi Bay. Land use in the watershed is nearly half agricultural and half forest, with a small portion in residential use.

Pike River

The Pike River originates in the hills of Berkshire then makes its way to Canada, arcing northeasterly and then southerly into the Missisquoi Bay. Canada contains 85% of the river's watershed. Agriculture is the dominant land use in the riparian corridor. In Vermont, the watershed includes Lake Carmi. The Water Quality of Lake Carmi is also threatened by many of the same issues facing Missisquoi Bay. In 2009, the VDEC developed phosphorus TMDL for Lake Carmi. The TMDL calls for reducing the annual phosphorus load from its current level (1,535kg/year) to 1,027kg/year in order to meet water quality objectives for the lake.

Table 1. Land Use Land Cover

Land Use Land Cover Type	Acres in Subwatershed	% of Subwatershed
BLACK RIVER SUBWATERSHED		
Urban	3,000.191	3.90%
Agricultural	16,487.202	21.45%
Forested	48,747.312	63.43%
HUNGERFORD BROOK SUBWATERSHED		
Urban	719.847	5.76%
Agricultural	5,502.815	44.04%
Forested	4,207.233	33.67%
MISSISQUOI RIVER SUBWATERSHED		
Urban	23,860.972	5.07%
Agricultural	112,551.512	23.91%
Forested	285,754.560	60.71%
MUD CREEK SUBWATERSHED		
Urban	1,564.163	4.27%
Agricultural	9,857.831	26.88%
Forested	22,254.546	60.68%
PIKE RIVER SUBWATERSHED		
Urban	2,653.204	4.85%
Agricultural	18,642.491	34.09%
Forested	27,750.450	50.74%
ROCK RIVER SUBWATERSHED		
Urban	1,980.524	5.49%
Agricultural	14,938.542	41.38%
Forested	14,322.252	39.67%
Wetland	2,545.534	7.05%
TROUT RIVER SUBWATERSHED		
Urban	1,503.046	2.81%
Agricultural	3,503.677	6.55%
Forested	45,109.362	84.35%
TYLER BRANCH SUBWATERSHED		
Urban	1,466.723	3.95%
Agricultural	5,309.906	14.31%
Forested	27,562.217	74.30%

2.2 Land Use

The land use in the Missisquoi Bay watershed is 66% forested, 25% agricultural, and 6% urban (Troy et al., 2007). Table 1 further breaks down landuse by subwatershed of the Missisquoi Basin. The health of a waterbody is dictated for the most part by the landuse in its watershed. A forested watershed provides the best protection as it absorbs or detains the precipitation that ends up as runoff into waterbodies in watersheds with significant agricultural and developed landuse. Stormwater runoff is a significant conveyer of pollutants to waterbodies, see Chapter 3 for a more in depth explanation of pollution sources. While runoff from developed land can provide disproportionate phosphorus loadings relative to land area (Troy et

al., 2007), the predominance of agricultural land in the basin makes it the primary source of phosphorus, the pollutant that supports algal blooms in Missisquoi Bay as well as a source of other pollutants. A more recent study by the Lake Champlain Basin Program (Stone Environmental, Inc., 2011), indicates that only six percent of the phosphorus load to the Missisquoi River and Bay are attributable to urban sources.

Trends in landuse change suggest that developed land will increase. Franklin County, which is almost entirely in the bay watershed, is one of the fastest developing areas of the state. With 6.1% growth in population from 2000 to 2006, Franklin County was second only to Grand Isle County at 12.3% (US Census Bureau, 2008); however, much of the urban and suburban development in the county is concentrated in and around St. Albans outside of the Missisquoi Bay Watershed (NRPC, 2007). The rate of development is expected to increase in western Orleans County as Jay Peak Mountain Resort is planning an expansion and an influx of economic development money is expected for the Newport area. The new development that falls under state regulations will include protections to water quality in part by managing stormwater and river corridor and wetland protection; however, a portion of the development will only be required to follow local ordinances, which do not include the same level of protection for waterbodies.

In Vermont, land use and development are largely regulated at the local level. Municipalities are authorized to create Town Plans, Planning Commission, and Land Use Regulations to regulate the development and subdivision of land. While Act 250 does have jurisdiction over larger land development (typically projects creating more than 10 housing units or commercial/industrial development of more than 10 acres) the majority of development in the Missisquoi Watershed is small-scale and regulated at the local level. Many local municipalities have protections for water resources within their land use regulations (Appendix A), but not all.

Franklin County continues to be one of the major agricultural centers of the state, along with Addison County. In the Vermont portion of the Missisquoi Bay watershed, there are 290 dairy farms, with 250 of them in Franklin County. Approximately 100 additional farms in the watershed are involved in other animal-related operations. Please see Appendix B for more information on agriculture in the watershed.

2.3 Water-Based Resources

Missisquoi Bay is one of the highlights of natural beauty in northwest Vermont and southern Quebec. Along with the streams, rivers, lakes, ponds and wetlands in its watershed, the bay is a major part of the economy of the region. The ecological and economic significance of the bay is threatened by high levels of nutrient pollution which cause algal blooms that disrupt the natural aquatic systems and impair human use and enjoyment. This water quality management plan describes strategies developed to restore and protect the values and beneficial uses of surface waters in the Vermont portion of the Missisquoi Bay watershed, such as swimming, boating, and habitat for aquatic organisms. A list of waterbodies where examples of some of these activities occur is included in Table 7 of Chapter 5.

Boating

The Missisquoi River and Lake Carmi provide more area for boating recreation than any other waterbodies in the basin. The 740-mile long Northern Forest Canoe Trail runs through parts of New York, Vermont, New Hampshire, Maine and Quebec, and uses the entirety of the Missisquoi River as a link in this waterway. The Lake Carmi State Park in Franklin offers boating access to the 1375-acre lake, the fourth-largest inland lake in the state of Vermont.

Geologic Features and Swimming

Swimming occurs across the Missisquoi Basin in Missisquoi River, Lake Carmi, and numerous other small streams with adequate swimming space in natural features such as waterfalls, cascades, and gorges. There are five sites with major waterfalls, cascades, or gorges (Jenkins and Zika, 1992; Jenkins and Zilka, 1985):

- Tillotson Mill on Lockwood Brook in Lowell
- Highgate Falls on the Missisquoi River in Highgate
- Sheldon Falls on the Missisquoi in Sheldon
- Bakers Falls on the Missisquoi in Troy
- Big Falls on the Missisquoi in Troy

Big Falls of the Missisquoi River are the largest undammed waterfalls on a major river in Vermont, with three channels dropping about 25 feet. Below the falls is a gorge over 200 feet long with 600-foot high walls. A 16-acre site that includes Big Falls is a State Natural Area.

Fish Habitat and Fisheries

There is a great amount of fish habitat with varying warm and cold water fisheries across the basin, and therefore there are significant opportunities for recreational fishing.

The Missisquoi National Wildlife Refuge (NWR) represents a great fishery located near the mouth of the Missisquoi River in the northwest corner of Franklin County. There are three Vt. Department of Fish and Wildlife fishing access areas in the Missisquoi Bay area, which are located in or around the Missisquoi NWR.

Significant Natural Communities and Rare, Threatened, and Endangered Species

The Missisquoi River watershed is home to significant examples of wetland and riverine communities, including swamps and floodplain forests. The Missisquoi River delta complex contains the largest floodplain forest ecosystem in Vermont and includes both riverine and lakeshore floodplain forests and is protected as a National Wildlife Refuge. The 900-acre Maquam Bog in the southern portion of the refuge is made up of an uncommon ecosystem, serving as the place for Vermont's largest populations of pitch pine, rhodora, and Virginia chain fern, a state-threatened species. The bog also serves as an important wintering area for white-tailed deer and provides feeding and breeding areas for numerous species of birds. Small pieces of land are rotationally clear cut in 8-10 year cycles to promote proper habitat for the eastern-declining populations of the American woodcock. In certain areas, grasslands are periodically hayed, mowed, or burned and water levels in areas are manipulated to keep a continuous mix of proper habitat for the species calling the refuge home. These refuge protections in combination with the natural ecosystem support the following wildlife highlights:

- The largest great blue heron rookery in Vermont is located on the refuge's Shad Island. This rookery fluctuates from about 250 to almost 600 nests each year.
- More than 20,000 ducks converge on the refuge each fall and find habitat for feeding and resting. A small percentage of these ducks use the refuge habitats for nesting.
- Most of Vermont's black terns (up to 99%) nest on the refuge.
- A significant percentage of Vermont's nesting ospreys are found on the refuge.

- Spiny soft shell turtles, a state-threatened species, use the refuge to feed and bask from April through September.

The Missisquoi River itself, especially in the stretch from Highgate Falls down to the mouth, is also home to a number of threatened or endangered aquatic species, including five endangered mussel species and several threatened or endangered fish, including the lake sturgeon and stonecat. The river has several groups of islands as well as single islands that are home to rare plants.

Another significant site is the Fairfield Swamp, a 1500-acre lake/wetland complex that includes a number of wetland community types: deep bulrush marsh, dwarf shrub bog, northern white cedar swamp, and red maple-northern white cedar swamp. In addition, three very rare plant species, one of which is state-threatened, and the least bittern, which is a species of special concern, are all part of the Fairfield Swamp complex.

Other significant sites include:

- Tamarack Brook Flats in Lowell and Troy is a site that has an extensive beaver pond at the headwaters and an undisturbed cedar swamp and spruce-fir flat south of the brook.
- West Sheldon-Red Maple Cedar Swamp is a small remnant (about ten acres) of a once large swamp at the headwaters of a small tributary to the Missisquoi in Sheldon, home to a state-threatened plant.

Public Surface Water Supplies

There are 18 public water supply systems located in the Missisquoi River Basin (Table 2). Sixteen of these systems access groundwater, while the remaining systems draw water from surface water sources such as Lake Champlain. The Agency of Natural Resources (VANR) has required mapping of buffer zones around potential contamination sources of public water sources. Under the 2002 Vermont VANR Wastewater Treatment System and Potable Water Supply Rules, water systems with increasing demand should begin planning for expansion when the system reaches 90% pumping capacity. Swanton addressed a growing capacity issue through completely metered billing of water use and by repairing leaks in the system.

Table 2

Public Water Supply Systems - Missisquoi Bay Watershed

System Name	Community	Pop. Served	Source	Max. Daily Demand (Gal/Day)[1]	Capacity (Gal/Day)[2]
Bakersfield F.D. #1	Bakersfield	446	Groundwater	40,000	140,000
East Berkshire	Berkshire	180	Groundwater	27,000	NA
East Fairfield F.D. #1	Fairfield	185	Groundwater	46,000	72,000
Enosburg Falls Water System	Enosburg Falls	1,700	Groundwater	400,000	850,000
Fairfax Water Department	Fairfax	1,600	Groundwater	55,000	58,000
Fairfield F.D. #2	Fairfield	130	Groundwater	70,000	100,000
Franklin F.D. #1	Franklin	400	Groundwater	33,000	87,000
Jay Peak Systems (4)	Jay	2,500	Groundwater	240,000	500,000
Montgomery Water System	Montgomery	550	Groundwater	45,000	100,000
Newport Center Water System	Newport	325	Groundwater	26,000	30,000
Newport City Water System	Newport	5600	Groundwater	1,100,000	1,440,000
North Troy Water System	Troy	750	Groundwater	235,000	265,000
Richford Water System	Richford	1,600	Surface	250,000	NA
Sheldon Water System	Sheldon	350	Groundwater	44,000	100,000
Sheldon Springs Water System	Sheldon	330	Groundwater	35,000	50,000
Swanton Village Water System	Swanton	4,400	Surface	725,000	1,000,000
Troy Water System	Troy	315	Groundwater	50,000	100,000
Westfield F. D. #1	Westfield	120	Groundwater	15,000	42,000

[1] *Based on actual metered usage if available or best estimate by Water Supply Division (full 24 hour day)*

[2] *Maximum daily yield, gallons per minute from all system sources*

Source: *Ken Yelsey, Water Supply Division, ANR, 2011*

Chapter 3 – Water Quality and Aquatic Habitat in the Missisquoi River Basin

Within the Missisquoi Bay watershed, there are 30 stream segments where water quality conditions have been documented to support very high ecological integrity. Surface waters that are so-identified are those which exhibit, based on biological monitoring of macroinvertebrates or fish, an assessment of very good to good or better. These surface waters are shown in Table 3. At the other end of the spectrum, VANR has listed 19 river or stream segments, Missisquoi Bay and Lake Carmi as impaired surface waters (Table 6). It has also identified additional reaches as altered or in need of further assessment. The problems associated with these waters are generally related to nonpoint source pollution, particularly in agricultural areas, as well as stream bank and channel instability. The list also includes those waters impacted by invasive species.

Table 3. Streams exhibiting very high ecological integrity documented using biological monitoring of macroinvertebrates and non-game fish.

Community, Macro-invertebrates or Fish	DEC SiteID	Location	Rivermile	Town	Condition	Most Recent Sampling Date	Number of years sampled
M	429306000006	Ace Brook	0.6	Lowell	Excellent	9/26/2011	2
M	423804040020	Beaver Meadow Brook	2	Bakersfield	Excellent	9/1/2004	1
M	428200000011	Beetle Brook	1.1	Troy	Very Good	9/7/2004	1
M	426000000012	Berry Brook	1.2	Richford	Excellent	9/11/2000	1
M	429500000026	Burgess Branch	2.6	Lowell	Excellent	9/6/2007	1
M	429500000039	Burgess Branch	3.9	Lowell	Very Good	9/3/2009	1
M	429508000003	Burgess Branch Trib 8	0.3	Lowell	Excellent	9/17/2007	1
M	427412000001	Buzzell Brook	0.1	Newport Town	Excellent-Very Good	9/25/2009	2
M	423111000025	Chester Brook	2.5	Fairfield	Excellent-Very Good	9/27/2011	2
M	429310000001	East Branch Missisquoi Trib 10	0.1	Lowell	Excellent-Very Good	10/11/2010	2
M	429308000002	East Branch Missisquoi Trib 8	0.2	Lowell	Excellent-Very Good	10/11/2010	2
M	423700000006	East Sheldon Missisquoi Trib	0.6	Sheldon	Excellent	9/11/2009	1
M	423600000009	Goodsell Brook	0.9	Sheldon	Excellent	9/11/2009	2
M	427808000001	Jay Branch Trib 8	0.1	Jay	Very Good	9/25/2009	4
M	427810000002	Jay Branch Trib 10	0.2	Jay	Very Good	9/25/2009	6
M	427812000002	Jay Branch Trib 12	0.2	Jay	Excellent-Very Good	9/26/2008	3

Community, Macro-invertebrates or Fish	DEC SiteID	Location	Rivermile	Town	Condition	Most Recent Sampling Date	Number of years sampled
M	427813000002	Jay Branch Trib 13	0.2	Jay	Excellent	9/30/2011	3
M	428600000002	Mineral Spring Brook	0.2	Troy	Excellent-Very Good	9/24/2004	1
M	420000000268	Missisquoi River	26.8	Sheldon	Very Good	10/18/2009	1
M	420000000333	Missisquoi River	33.3	Enosburgh	Excellent-Very Good	10/1/2004	1
M	420000000453	Missisquoi River	45.3	Richford	Very Good	9/23/2004	1
M	420000000530	Missisquoi River	53	Richford	Excellent	9/26/2000	1
M	420000000716	Missisquoi River	71.6	Jay	Very Good	9/8/2009	2
M	420000000726	Missisquoi River	72.6	Jay	Very Good	9/8/2009	1
M	423105060005	Swamp School Brook	0.5	Fairfield	Excellent	10/17/2006	2

VDEC's 2010 *Vermont Surface Water Management Strategy*[3] identifies the ten major stressors causing impairment of Vermont's water bodies. A description of the extent of each stressor found in the Missisquoi Bay Watershed follows:

3.1 Acidity

Waterbodies exhibit a range of acidity, primarily reflected by the acidity level (or pH) of the water. Natural factors affecting a waterbody's pH include its landscape position, landscape slope, watershed size, bedrock and soil composition. Human activities can alter the acidity of a waterbody through long distant transport and deposition of atmospheric pollutants (commonly referred to as acid rain) and/or through mining activities.

In the Missisquoi Watershed the causes of acidity are primarily atmospheric deposition, which is widespread throughout Vermont. The sources of atmospheric deposition include a wide variety of industrial and mobile sources that emit nitrogen oxides and sulfur dioxides. Industrial facilities such as coal-fired power plants, waste combustors, and utility boilers are all stationary sources of acidity to the atmosphere. Mobile sources such as cars and trucks account for over half of the nitrogen oxide emissions. Acidification is a primary source of impairment for King's Hill Pond in the Tyler Branch Watershed.

3.2 Invasive Species in Aquatic or Riparian Zones

Aquatic invasive species are nonnative plants, animals and pathogens that cause economic and environmental harm. The number of these in the Lake Champlain Basin has dramatically increased in the recent decades, a number causing significant change to the ecosystem. Aquatic invasive species frequently out-compete native species for food and habitat, and can affect the aquatic food web by imposing pressure from both the top down and the bottom up. Forty-nine aquatic invasive species have now been confirmed

[3] http://www.anr.state.vt.us/dec/waterq/wqdhome.htm .

in Lake Champlain and some of these have made their way into the Missisquoi Bay and River and other bodies of water in the Missisquoi Bay watershed including water chestnut, Eurasian watermilfoil, zebra mussels, and variable-leaved watermilfoil, the Lake's newest invader. Invasive species that live in wetland or riparian areas include common reed grass, purple loosestrife, Japanese knotweed, and reed canary grass. Both Metcalfe Pond and Fairfield Pond, in the Black Creek sub-watershed, are listed as altered due to the abundance of Eurasian watermilfoil.

Water chestnut had only been found in the southern portion of the Lake until its appearance was confirmed in the Missisquoi National Wildlife Refuge in 2006 when 12,000 plants were found and removed. A total of five water chestnut sites have been identified within the Refuge and all targeted with hand pulling efforts. On-going efforts are annual and have been successful in controlling water chestnut population in the bay. Water chestnut can outcompete and crowd out beneficial native plants, and clog waterways for recreational use, navigation and fish habitat.

3.3 Channel Erosion

Channel erosion is a natural process that benefits stream and riparian ecosystems. Erosion in naturally stable streams (i.e., streams that are in equilibrium condition) is evenly distributed and therefore minimized along the stream channel. However, as streams and floodplains are altered and impacted by development, the stream can enter a state of disequilibrium. Common symptoms of disequilibrium are increased volume and rate of flow, increased erosion and sedimentation, loss of stream habitat, and more potentially damaging flood conditions.

It is estimated that up to 75% of the waterways in the Missisquoi Bay Basin are undergoing channel adjustments due to historic modifications (NRCS, 2008). In the Basin, the most common causes of disequilibrium are dams, diversions, culverts, drainage practices including ditches and tile drains and channelization practices, such as dredging, berming, and armoring. A significant amount of legacy phosphorus and sediment loading is attributable to in-channel erosion (Stone Environmental, Inc. 2011).

Current and past tile drain installation in agricultural fields across the Basin and the state has generated concern over the practice's potential to intensify channel erosion as well as nutrient loading (see section 3.6). The water quality impacts of tile drainage warrant more discussion as the practice is known to transport phosphorus and nitrogen; however, it can also reduce overland erosion (see section 3.6) as it allows for the subsurface drainage of surface water, which could reduce overall phosphorus losses from fields. Aside from nutrients, buried tile drainage pipe also carries ground water. The rapid movement of accumulated flows through the pipe can be significant enough to cause channel erosion in receiving streams.

Details of the geomorphic stability of majority of streams and rivers in the watershed have been well-documented in Geomorphic Assessments and Corridor Plans sponsored by the VDEC River Management Program (Table 4). This information is available online using the Stream Geomorphic Assessment Data Viewer at http://maps.vermont.gov/imf/sites/ANR_SGAT_RiversDMS/jsp/launch.jsp?popup_blocked=true River corridor plans for the basin can be found at : https://anrnode.anr.state.vt.us/SGA/finalReports.aspx Additional information in also included in the USDA Agricultural Research Service (ARS) Bank Stability & Toe Erosion Model described in Chapter 1 (see also Langendoen, E. 2012).

Table 4. Subwatersheds with available geomorphic assessment data

Date	Stream Reach	Sub Watershed	Title*	Author
12/01/2005	Wanzer Brook	Black Creek Head	Wanzer Brook Watershed Phase 2 SGA	South Mountain Research & Consulting
4/01/2009	Black Creek	Black Creek Mouth	Black Creek Corridor Plan	Johnson Company
4/01/2008	Hungerford Brook	Hungerford Brook	Hungerford Brook Corridor Plan	Johnson Company
10/01/2006	Hungerford Brook	Hungerford Brook	Hungerford Brook Phase 2 Report	Carmi Consulting
3/01/2008	Missisquoi	Missisquoi - Canada to Trout	Missisquoi River Mainstem Phase 2 SGA	Arrowwood Environmental
1/26/2007	Rock River	Rock River	Rock River Phase 2 Report	South Mountain Research & Consulting
4/01/2007	Trout River Watershed Towns of Berkshire, Enosburg, Richford, and Montgomery Franklin County	Trout River Head	trout River Watershed Phase 2 SGA	Johnson Company
3/01/2007	Tyler Branch	Tyler Branch	Tyler Branch Corridor Plan	Johnson Company
6/02/2009	Tyler Branch	Tyler Branch	Tyler Branch Corridor Plan	Redstart Consulting
3/27/2008	Missisquoi Mainstem, Jay Branch, Mud Creek	Upper Missisquoi	Phase 2 Stream Geomorphic Assessment Missisquoi Mainstem, Jay Branch, Mud Creek	Arrowwood Environmental
9/30/2011	Upper Missisquoi	Upper Missisquoi	Upper Missisquoi River Corridor Plan	Arrowwood Environmental

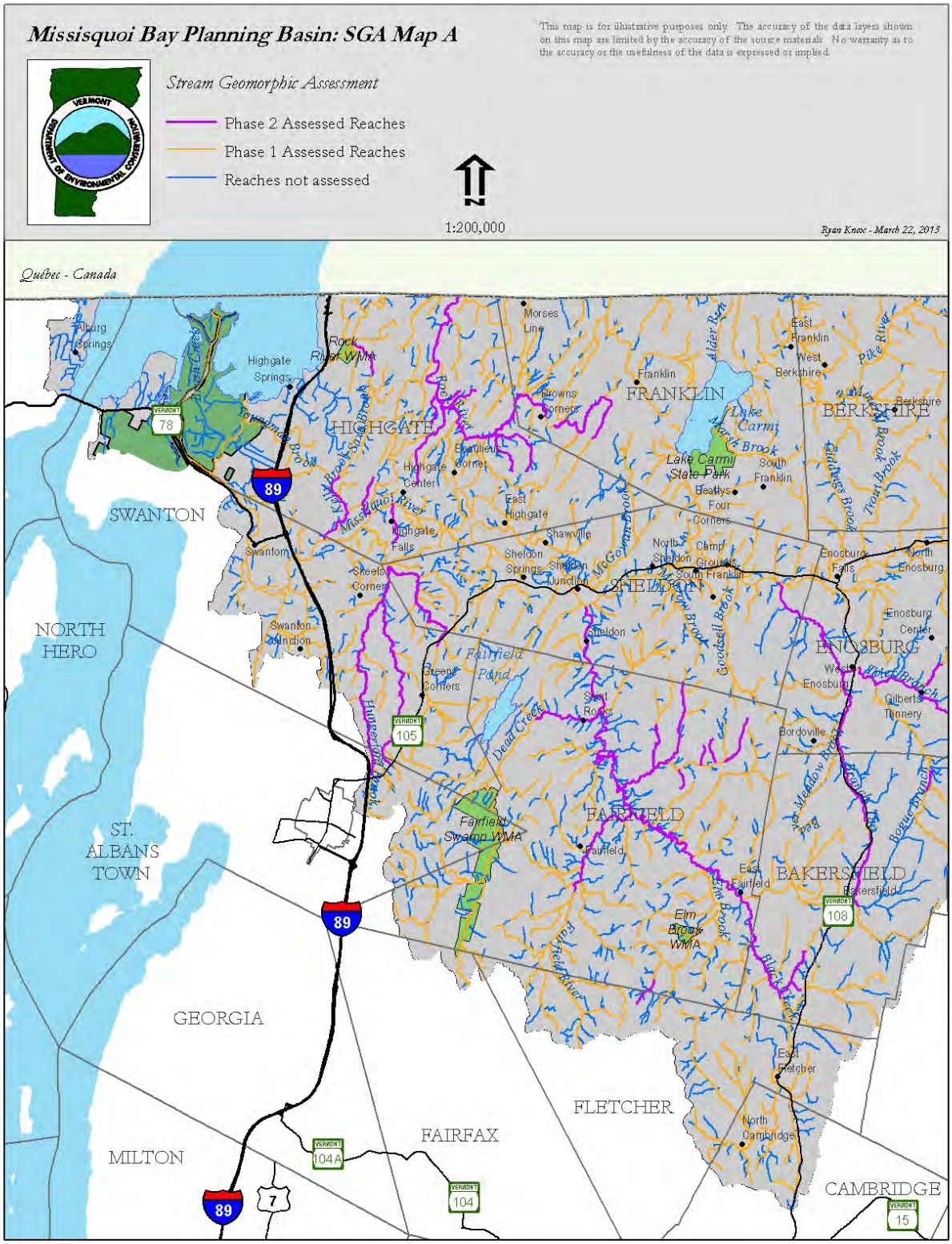


Figure 4. Stream geomorphic assessments completed for western half of Missisquoi Bay Basin

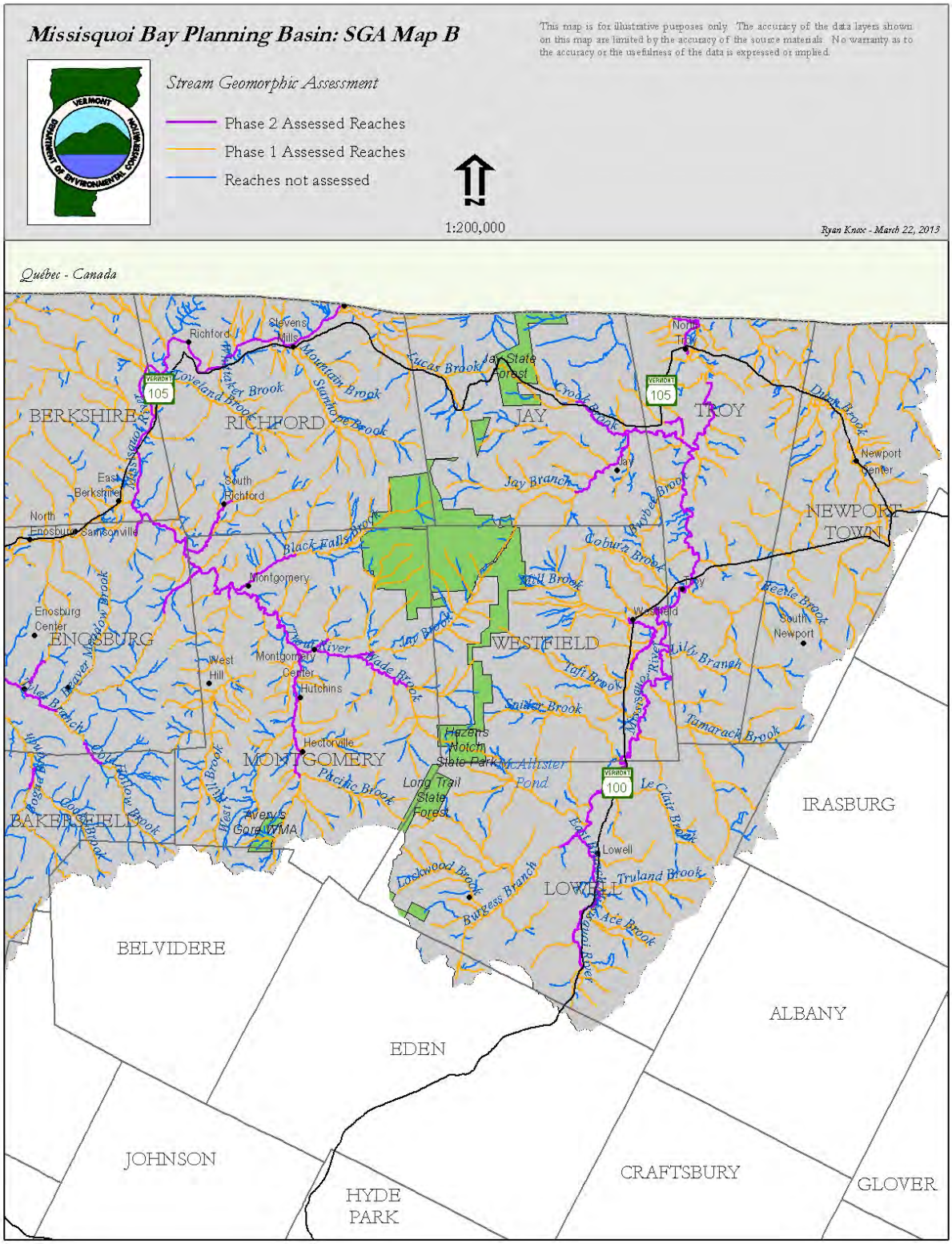


Figure 5. Stream geomorphic assessments completed for eastern half of Missisquoi Bay Basin

3.4 Encroachments

Encroachment is a term used to describe the placement of structures, roads, railroads, improved paths, utilities, and other development and fill, the removal of vegetation, or an alteration of topography in such natural areas as floodplains, river corridors, wetlands, lakes and ponds, and the buffers around these areas. These encroachments cause impacts to the functions and values of those natural areas, such as a decline in water quality, loss in habitat (both aquatic and terrestrial), disruption of equilibrium (or naturally stable) conditions, loss of flood attenuation, or reduction of ecological processes. Geomorphic assessments provide valuable information about the locations and types of encroachments on rivers and streams. Commons forms of encroachment include agricultural uses, transportation infrastructure, houses and other development. The NRCS has also analyzed the extent of stream buffers in the Missisquoi Basin. Vegetated stream buffers provide numerous water quality benefits by stabilizing stream banks, reducing thermal stress, creating habitat, filtering runoff, and otherwise "buffering" against the impacts of nearby land uses. Using 2003 orthophotography, the NRCS mapped the presence of 25-foot vegetated stream buffers along the Missisquoi River and its tributaries. (Twenty-five feet is the minimum buffer width required under NRCS standards for filter strips Of the 2,825 miles of stream bank assessed, approximately 919 (33%) did not have adequate stream buffers (Figure 6).

Historical surveys indicate a loss of 35% (121,000 acres) of Vermont's wetlands through encroachment and conversion prior to the 1980s. In 2007, VANR released the Lake Champlain Wetland Restoration Plan, which identified opportunities to restore wetlands and the benefits they provide. The plan identified approximately 16,000 acres of potential wetland restoration sites in the Missisquoi Watershed (Figure 7). These sites are now being targeted by the NRCS Wetland Reserve Program.

Shoreline encroachments also have a significant impact on the health of Missisquoi Bay and the other lakes in the watershed. According to the EPA National Lakes Assessment (2010), poor biological health is three times more likely in lakes with poor shoreline conditions. The degree of shoreline encroachment for lakes in the basin can be seen at VDEC's on-line Lake Score Card4 The card summarizes the available information for specific lakes over four different categories: water quality, habitat, AIS and atmospheric pollution.

[4] http://maps.anr.state.vt.us/kml/wq_scorecard/lp_lake_score_card_explanation.pdf and http://maps.anr.state.vt.us/kml/wq_scorecard/lp_lsc_googleearthlink.kml

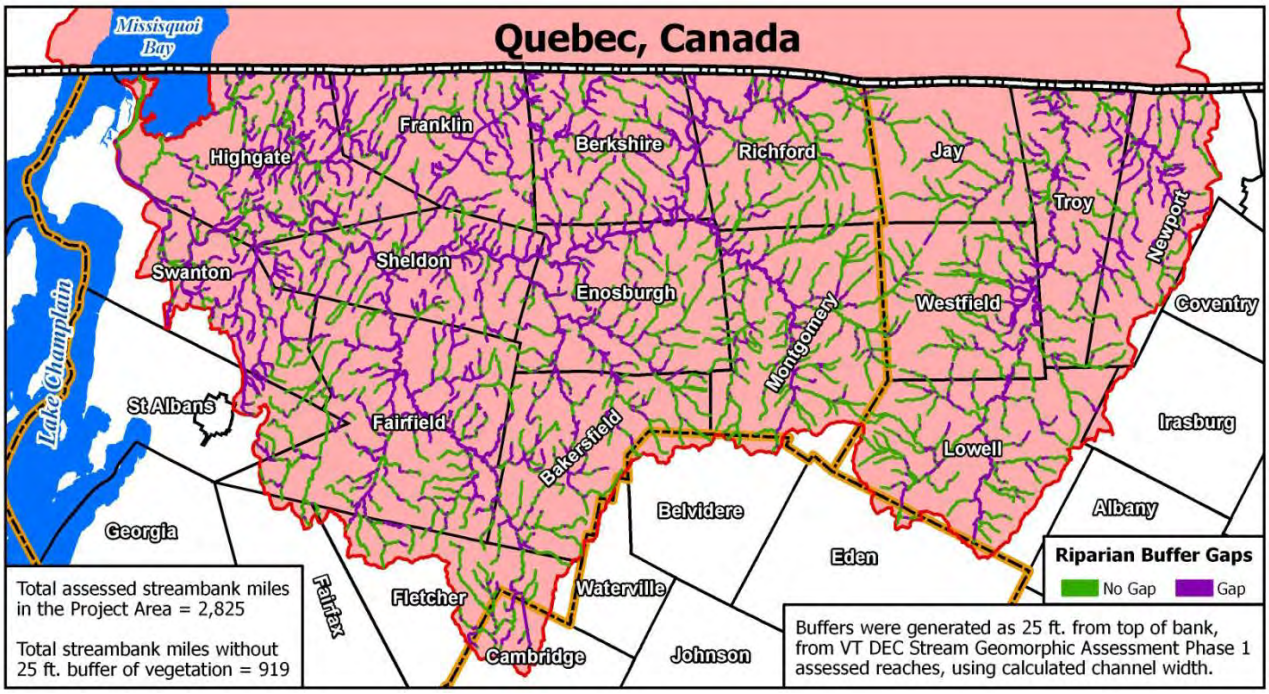


Figure 6 Riparian Buffer Gaps

Potential Wetland Restoration

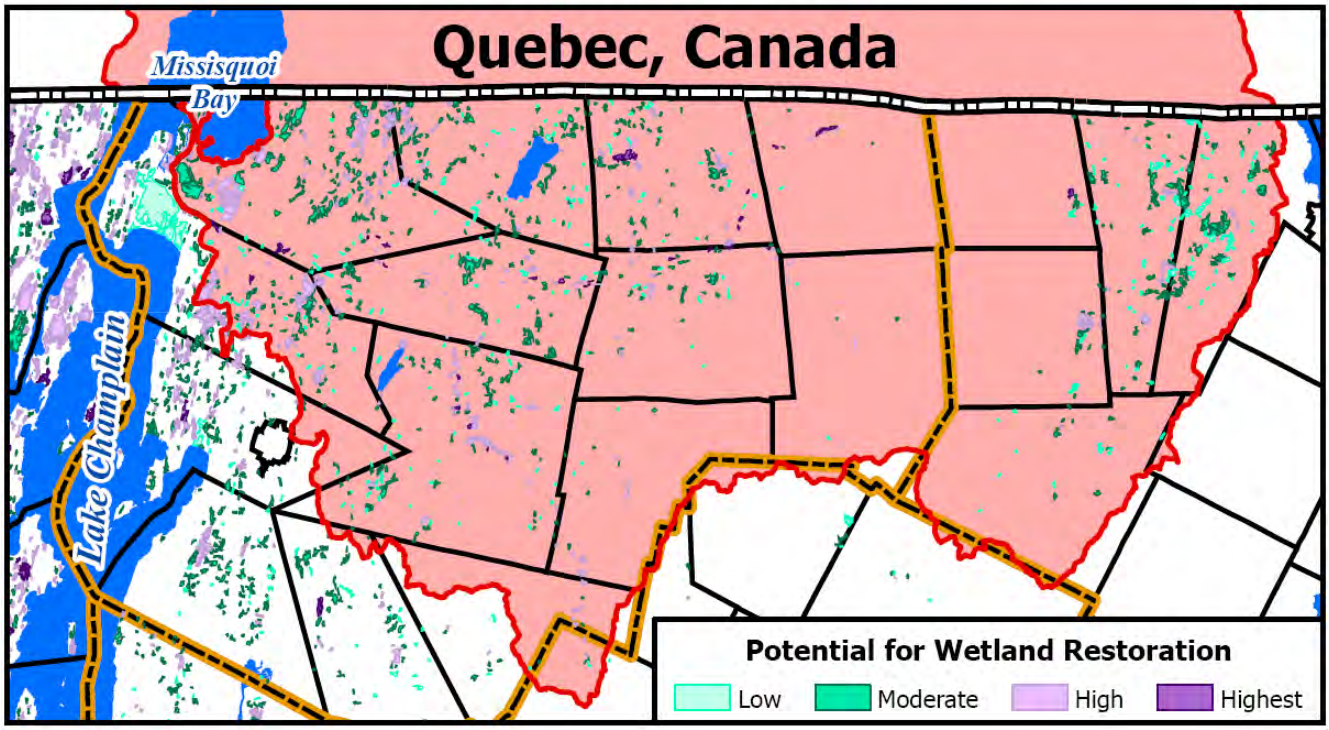


Figure 7 Potential Wetland Restoration sites in the Missisquoi Bay Watershed

3.5 Flow Alteration

Flow alteration is any human-induced change in the natural flow of a river or stream or water level of a lake or reservoir. Flow alteration is associated with instream structures and practices that regulate flows or water levels or withdraw water, i.e., activities that obstruct, dewater, or artificially flood aquatic and riparian habitats. Regulating flows impacts habitat and water quality, including changes to temperature and water chemistry (e.g., pH, dissolved oxygen, and toxicity), which may significantly lower habitat suitability for certain aquatic organisms. Flow alteration can also occur due to small-scale practices such as road culverts and ditches, up to large-scale dams, reservoirs and irrigation networks.

There are numerous small and large dams constructed on streams and rivers in the basin (Table 5). While some of these dams provide flood control, power generation, and recreational opportunities, others may be obsolete, providing little or no public benefit. Throughout Vermont, rising energy prices and concerns over the impacts of fossil fuels and foreign energy sources have sparked renewed interest in hydroelectric power. New technologies such as micro-hydro turbines may enable old or abandoned dams to be retrofitted to generate power. It is not anticipated that new dams will be constructed within the watershed.

Recently there has been a proposal to remove the Swanton dam located on the Missisquoi River between the Highgate dam and the mouth of the river. The first dam here was built in 1797 as a means of producing power. The dam was repaired and rebuilt many times until the mill was abandoned in the 1940s when its power supply potential dropped too low. Local concerns regarding removal of the historic dam include changing the appearance of the river and losing the potential to one day use the dam again to generate hydroelectric-power.

Table 5. Dams in the Missisquoi Bay Watershed

Dam Name	Stream	Town	Status	State ID
Swanton	Missisquoi	Swanton	In Service[5]	205.02
Highgate Falls	Missisquoi	Highgate	In Service	96.01
East Highgate	Missisquoi	Highgate	Breached	96.02
Enosburg Falls	Missisquoi	Enosburg	In Service	68.01
Sheldon Springs	Missisquoi	Sheldon	In Service	187.01
North Troy	Missisquoi	Troy	In Service	210.01
Bakers Fall	Missisquoi	Troy	In Service	210.02
Sheldon – 2	Goodsell Brook	Sheldon	unknown	187.02
Sheldon	Black Creek	Sheldon	unknown	187.03
Fairfield Swamp Pond	Dead Creek	Swanton	In Service	205.01
Fairfield Pond	Dead Creek-Trib	Fairfield	In Service	71.01
Webster (Lower)	Black Creek	Fairfield	Partial Breach	71.02
Webster (Upper)	Black Creek	Fairfield	Abandoned,	71.03
Fairfield	Fairfield River	Fairfield	Breached	71.05
East Berkshire	Missisquoi-Trib	Berkshire	Unknown	19.03
Trout Brook	Trout Brook	Berkshire	In Service	19.02
Johnsons Mill	Bogue Branch	Bakersfield	Unknown	9.01
Browns Pond	The Branch	Bakersfield	Abandoned	9.02
Guilmettes Pond	Missisquoi-Trib	Richford	In Service	165.03

[5] In Service means that the dam is mostly intact and hasn't been abandoned.

Jay Peak	Jay Branch Brook	Jay	In Service	106.01
Sleeper Pond	Mud Creek	Newport	Partial Breach	142.01
Bonneau	Mud Creek-Trib	Troy	Unknown	210.03
Coburn Brook	Coburn Brook	Westfield	Unknown	232.01
Vermont Asbestos Co.	Burgess Branch	Lowell	Unknown	116.01
Corez Pond	Burgess Branch	Eden	Unknown	66.03

Removal of the dam would reopen 7 ½ miles of fish habitat in the Missisquoi River. According to the US Fish and Wildlife Service, removal of the dam will allow native walleye and endangered lake sturgeon population to access more spawning habitat: 65 to 1,210 times more habitat for lake-run spawning walleye and an increase of 303 to 342 times the current level could be realized by lake sturgeon[6].

The Agency of Natural Resources and the USFWS have identified Swanton Dam as a high priority for removal, and will be engaging stakeholders in a process to identify issues and conduct the necessary studies to advance the project.

Local concerns over the deteriorating water quality in Missisquoi Bay have for some time focused on the Missisquoi Bay Bridge causeway, which has been seen as a contributing factor to this problem, with the causeway's removal (as part of the project to modernize the bridge) seen as a solution. The Missisquoi Bay Bridge and causeway on Vermont Route 78 in Swanton and Alburgh was originally constructed in 1938. The original structure had a 550 foot long steel drawbridge and approximately 3,500 feet of causeways split between the east and west sides of the bridge.

The circulation and water quality benefits of removing the Missisquoi Bay causeway were studied and the report findings endorsed by the International Joint Commission (IJC, 2005b). The report concluded that removing the causeway would have only a negligible impact on phosphorous levels in the Bay; however recommended pursuing removal of the causeway to avoid continuing distraction from other needed actions to reduce phosphorus inputs.

When a new bridge was completed in 2007, (with much shorter causeways on either end), the old bridge was closed and removed, as well as 330 feet of the old bridge's eastern causeway. Removal of the entire causeway is not possible because sections provide habitat for the spiny softshell turtle, listed as a threatened species in both Vermont and Quebec.

3.6 Land Erosion

Land erosion is another source of sediment and nutrients. While land erosion is a natural process, it can be greatly exacerbated by human behavior. Land erosion increases rapidly when vegetation and the intact "duff" or organic outer layer of soil are removed. Soil type, slope, and moisture are all factors that can influence rates of erosion. Land erosion becomes a water quality issue when it occurs near a water body or is conveyed by swales, channels, pipes, ditches, etc.

The most common causes of erosion in the Missisquoi Watershed are believed to be agricultural practices. Soil erosion from annually tilled corn fields is a significant concern, while permanent hayfields typically experience less erosion (NRCS, 2008). The NRCS conducted a Cropland Slope Analysis which found that two thirds of the total cropland (47,146 acres) is on slopes greater than 8%, and 40% of corn cropland is on slopes of 3 to 8%. The VAAFM and NRCS is presently using this information as well as a Critical Source

[6] http://www.vtfishandwildlife.com/library/Reports_and_Documents/Fish_and_Wildlife/Spawning_Habitat_Suitability_for_Walleye_and_Lake_Sturgeon_in_the_Missisquoi_River.pdf

Area Study (Stone Environmental, Inc., 2011) to target conservation practices, including grade stabilization structures, permanent seeding to grass, reduced tillage, cover crops, grassed filter strips, and riparian forest buffers.

Tile draining, the installation of subsurface drainage pipes, is another agricultural practice that can reduce land erosion by increasing infiltration rates of soils to reduce surface flows. The practice is popular because it increases field productivity; however, the practice may enhance nutrient loading to surface waters through the mobilization of soil nutrients to the tiles and increased channel erosion (section 3.3). The Lake Champlain Basin Program has funded a literature review with an expected release date of 2014 that will provide better understanding of both the advantages and disadvantages of the practice when used throughout the Lake Champlain Basin.

Other sources of land erosion include forestry, construction, and stormwater runoff from roads and development.

3.7 Nutrient Loading (Non-Erosion)

In addition to channel erosion and land erosion, nutrients can also be delivered directly to water bodies in stormwater from fertilized fields and lawns, subsurface tile drainage in agricultural fields and in the discharge of inadequately treated waste. There are currently eight municipal wastewater treatment facilities located in the Vermont portion of the Missisquoi Watershed (see Appendix C).

The Critical Source Area Study (Stone Environmental, Inc., 2011) estimated that 64% of the nonpoint source phosphorus entering the Missisquoi Bay was due to agricultural land uses. As previously mentioned, high phosphorus levels were identified as the primary issue and top priority of the Missisquoi Council. The Missisquoi Bay watershed is the largest contributor of phosphorus to the lake, compared to all other lake segments. Phosphorus concentrations in the bay from 2006-20011 have averaged 0.049 mg/l in Missisquoi Bay and 0.019 mg/l in the Northeast Arm. For comparison, the targets endorsed by the governments of Vermont, Quebec and New York are 0.025 mg/l for Missisquoi Bay and 0.014 mg/l for the Northeast Arm (IJC, 2002). It is estimated that over 90% of the phosphorus load to Missisquoi Bay comes from nonpoint sources.

Poorly managed animal waste, including undersized manure storage or improper spreading of manure can over-enrich soils with phosphorus and nitrogen and, in some cases, contribute direct discharge into surface waters. Similarly excess fertilizer on lawns and crops ultimately raises nutrient levels in our waterways.

Tile drains in the Basin's and the state's agricultural fields are one area where nutrients, especially nitrogen, can mobilize into surface water by leaching from subsurface soils. A better understanding is needed of available practices associated with tile drains that could minimize nutrient loss as well as the overall benefit tile drainage might provide to nutrient load reduction by reducing surface erosion from agricultural fields (see Section 3.6).

Internal phosphorus loading can also occur in lakes that have accumulated phosphorus in the sediment which can become re-suspended in the water column. This phenomenon has been identified in St. Albans Bay and may also be a factor in the Missisquoi Bay.

In the Missisquoi River Basin VTDEC completed a stormwater mapping inventory for all of the following urbanized areas: Swanton Village, Swanton Town around Swanton Village, Missisquoi Valley Union High School, Highgate Village, Sheldon Rock-Tenn Facility, Enosburg Falls Village, Richford Village, Montgomery Village, North Troy Village, and Troy Village. An illicit discharge and detection elimination (IDDE) survey to

find and locate discharges of municipal or industrial wastewater was conducted for all of the villages in 2010. The survey was unable to resolve 13 suspected discharges: Enosburg Falls (EN-100, EN-210, and EN-360), North Troy (NT-010, NT-060), Richford (RF-010X/RF-010Z, RF-045, RF-050 and RF-230), and Swanton (SW-140, SW-070, SW-150, SW-170). Additional survey and investigative work will be needed to resolve and eliminate these discharges.

3.8 Pathogens

Waterborne human pathogens include disease-causing bacteria, viruses and protozoa. The pathogens of greatest concern in the Missisquoi Watershed are those associated with fecal matter of humans and other mammals. The primary indicator of fecal material is *E. coli*. Sources of fecal matter include poorly functioning septic systems, combined sewer overflows associated with wastewater treatment facilities, domestic animals, nuisance wildlife, and agricultural runoff.

In the Missisquoi Basin, the following waterways are listed as impaired due to high levels of *E. coli* from agricultural runoff and currently have an EPA-approved TMDL for bacterial loading: Berry Brook (mouth to 1-mile upstream), Godin Brook, and Samsonville Brook. The Black Creek, Tyler Branch and Trout River are all in need of further assessment based on potentially high *E. coli* levels.

3.9 Thermal Stress

Thermal Stress is a term used to describe a temperature change that is severe enough to cause unfavorable or even lethal conditions for aquatic organisms, their populations, community structure or ecosystem. While the temperatures of waterways naturally fluctuate from season to season and year to year, certain land uses and activities can affect temperature beyond these natural variations and lead to thermal stress. The lack of stream buffers, the presence of dams, and climate change can all affect the temperature of waterways. Although, stream buffers are lacking and dams are present in the watershed, no impairments have been attributed to thermal stress.

3.10 Toxic Substances

“Toxic substances” includes a broad group of chemicals capable of causing harm to plants and animals including humans. The toxic substance of greatest concern in the Missisquoi Bay watershed is mercury. Mercury, a heavy metal, is emitted to the atmosphere by a wide variety of emissions sources, is readily bio-accumulated to hazardous levels in fish and fish-eating wildlife, and is a pollutant of global impact and concern. The Missisquoi Bay and the Missisquoi River from Sheldon Springs to the mouth are considered to be impaired due to mercury.

The asbestos tailings from an abandoned mine in Lowell have also contributed heavy metals, including chromium, nickel and manganese, to streams in the Burgess Brook watershed. The heavy metals as well as the fibers that contain them are harmful to aquatic biota, including fish. The preliminary data collected by WSMD BASS provide evidence linking the tailing piles both directly and indirectly to chemical and physical biological stressors in the streams. Elevated levels of chrysotile-fibers and associated metals in the water column and streambed sediment, and the resulting poor macroinvertebrate community assessments are likely the result of the tailing piles eroding asbestos bearing materials into adjacent waterways. The pollutant identified as the primary source of impairment is sediment. Areas of the stream are imbedded with deposits of the mine tailings, which include fibers, gravel and sand.

The largest use of pesticide in the basin is to control weeds in field corn. The pesticides of most potential concern to the basin's water quality are Atrazine and metolachlor, which dominate the corn herbicide market. Since 2001, VAAFM with assistance from VDEC and LCBP has routinely monitored these corn herbicides and selected breakdown products in Lake Champlain tributaries, including the Missisquoi River as well as portions of the lake itself. Trace amounts of herbicides and their breakdown products are routinely detected in water bodies in agricultural areas of the Missisquoi bay watershed, although generally at concentrations far below levels of concern to aquatic plants or animals. The highest concentrations of herbicides in the Lake Champlain watershed were detected after a large rainstorm shortly after corn planting and herbicide applications. The measured Atrazine concentrations certainly could have had an effect on individual plant species, and possibly a community level effect in the Pike River, but they are unlikely to have had a lasting effect. More details regarding the monitoring results appear in Appendix D.

Other regulated uses of pesticides include rights of way and roadways and aquatic nuisance control for macrophytes and lamprey. The largest category of unregulated pesticide use is among private applicators and homeowners, who apply herbicides, insecticides, and fungicides to lawns, gardens and home. The long term impacts to non-target organisms from many of these pesticide applications are not widely known.

Table 5. Vermont 2012 Priority Waters for the Missisquoi Bay Watershed

IMPAIRED SURFACE WATERS IN NEED OF TMDL			
Description	**Pollutant**	**Use Impaired**	**Problem**
Rock River – Mouth to VT/QUE Border	Nutrients, Sediment	AES	Algal Growth, Agricultural Runoff, Fish Kill
Rock River – Upstream 13 mi from VT/QUE Border	Nutrients, Sediment	ALS	Agricultural Runoff, Nutrient Enrichment
Saxe Brook – Mouth RM 1	Nutrients	ALS	Agricultural Runoff
Burgess Brook, RM 4.9 to 5.4	Sediment	ALS	Asbestos Mine Tailings Erosion, Asbestos Fibers
Burgess Brook trib. #11, mouth to RM .5	Sediment	ALS	Asbestos Mine Tailings Erosion, Asbestos Fibers
Berry Brook – Mouth to RM1	Sediment, Nutrients	ALS	Agricultural Runoff, Aquatic Habitat Impacts
Godin Brook	Sediment, Nutrients	ALS	Agricultural Runoff, Aquatic Habitat Impacts
Samsonville Brook	Sediment, Nutrients	ALS	Agricultural Runoff, Aquatic Habitat Impacts
Trout Brook – Mouth to RM 2.3	Nutrients	ALS	Agricultural Runoff
Wanzer Brook – Mouth to RM 4	Nutrients, Sediment	ALS	Agricultural Runoff
Chester Brook	Nutrients, Sediment	ALS	Agricultural Runoff
Coburn Brook – Mouth to RM .2	Nutrients	ALS	Agricultural Activity and Runoff
Mud Creek –VT/QUE Border to RM 6.5	Undefined	ALS	Agricultural Runoff, Nutrient Enrichment

(Table 5 cont.) IMPAIRED SURFACE WATERS – NO TOTAL MAXIMUM DAILY LOAD DETERMINATION REQUIRED			
Description	**Pollutant**	**Use Impaired**	**Problem**
Jay Branch – RM 8.3 Upstream 1.9 mi	Sediment	ALS	Erosion from Land Development Activities
Jay Branch – Tributary #9	Sediment	ALS	Erosion from Land Development Activities
SURFACE WATERS IN NEED OF FURTHER ASSESSMENT			
Description	**Pollutant**	**Use Impacted**	**Problem**
Youngman Brook – Mouth to 1.8 RM	Undefined (Sediment, Nutrients)	ALS	Agricultural Runoff
Black Creek – Mouth to East Fairfield	Sediment, E. Coli, Nutrients	AES, AH, CR	Agricultural Runoff
Tyler Branch	Sediment, E. Coli, Nutrients	AES, ALS, CR	Agricultural Runoff, Morphological Instability (W. Enosburg to Cold Hollow Brook)
Jay Branch – River Miles 8.3 to 5.6	Sediment, Stormwater	ALS, AES	Potential Impacts from Construction, Erosion, Watershed Hydrology
Impaired WATERS WITH COMPLETED & EPA-APPROVED TMDLS			
Description	**Pollutant**	**Use Impaired**	**Problem**
Lake Carmi	Phosphorus	AES, CR	Algae Blooms
Missisquoi Bay – Lake Champlain	Phosphorus[7], Mercury	AES, CR, FC	P Enrichment, Elevated Levels of Mercury in Walleye
Missisquoi River – Mouth Upstream to Swanton Dam	Mercury	FC	Elevated Levels of Hg in Walleye
Berry Brook, Mouth to and including N. Trib.	E. coli	CR	Elevated E. coli Levels
Godin Brook	E. coli	CR	Elevated E. coli Levels
Samsonville Brook	E. coli	CR	Elevated E. coli Levels
Kings Hill Pond, Bakersville	Acid	ALS	Atmospheric Deposition; extremely sensitive to acidification; episodic acidification

[7] EPA approved Lake Champlain phosphorus TMDL September 25, 2002 and later disapproved in 2011. EPA is developing a new TMDL which is expected 2013.

(Table 5 continued) WATERS ALTERED BY EXOTIC SPECIES			
Description	**Pollutant**	**Use Impacted**	**Problem**
Bullis Pond	Exotic Species	AES, ALS, CR, 2CR	Water Chestnut Infestation
Missisquoi Bay – Lake Champlain	Exotic Species	AES, ALS, CR, 2CR	Eurasion Watermifoil Infestation, Zebra Mussel Infestation
Metcalfe Pond, Fletcher	Exotic Species	AES, ALS, CR, 2CR	Locally Abundant Eurasion Watermifoil Growth
Fairfield Swamp Pond, Swanton	Exotic Species	AES, ALS, CR, 2CR	Locally Abundant Eurasion Watermifoil Growth
Fairfield Pond, Fairfield	Exotic Species	AES, ALS, CR, 2CR	Locally Abundant Eurasion Watermifoil Growth
WATERS ALTERED BY FLOW REGULATION			
Description	**Pollutant**	**Use Impacted**	**Problem**
Lake Carmi	Flow Alteration	ALS	Water Level Mgmt May Alter Aquatic Habitat
Missisquoi River – Below Enosburg Falls Dam	Flow Alteration	ALS	Artificial Flow Regulation & Condition by Hydroelectric Station
Loveland Brook	Flow Alteration	ALS	Possible Lack of Min. Flow Below Water Supply Withdrawal Point (Threat)
Jay Branch – 4.7 Miles	Flow Alteration	ALS	Artificial and Insufficient Flow Below Jay Peak Snowmaking Water Withdrawal. Jay Peak is evaluating expansion/alternatives
AES = aesthetics, CR = contact recreation, ALS = aquatic life support, FC = fish consumption, 2CR = secondary contact recreation			

Chapter 4 – Local Watershed Issues, Recommendations & Strategies

4.1 Missisquoi Bay Watershed Council

The basin planning process for the Missisquoi Bay watershed began with community meetings to identify local water resource concerns. The water quality concerns match those identified by state agencies and others ensuring that collaborative projects could be developed to protect and improve water quality in the bay and its watershed. The community's concerns can be summarized into three general categories:

- Algal blooms in Missisquoi Bay and Lake Carmi
- Declining fish and wildlife in streams and rivers
- Restricted swimming due to unsafe bacteria levels

The Missisquoi Bay Watershed Council, (see description of planning process in Section 1.2 of the plan) then developed strategies to address community concerns as well as the Agency of Natural Resources' water quality issues described in Chapter 3. The Council's strategies helped build the list of actions in the Chapter 6 Implementation Table. The associated text also provides useful background and status information.

In discussing the sometimes complex issues surrounding these strategies, the Council generally agreed on a series of over-arching considerations and challenges with regard to the strategies:

Considerations When Addressing General Categories and Specific Strategies

- Farming is important as a traditional means of livelihood for watershed residents, as a critical component of the local economy, and as opportunity for continued stewardship of the land.
- Appropriate growth and development should generally not be restricted.
- Landowners should remain free from overly restrictive regulations.
- The strategies present a voluntary approach, providing assistance to willing landowners.
- A goal is to achieve full compliance with all existing water quality regulations.
- Pollution must be reduced from all land use activities.

Challenges to Implementing Specific Strategies

- Informing landowners about the issues and gaining their voluntary participation, either on their own or in government programs.
- Determining needed water quality projects on private lands.
- Providing adequate funding for water quality improvement projects.
- Coordinating the water quality improvement activities being conducted by many groups and individuals.
- Prioritizing the most effective projects for implementation.
- Increasing the general public's awareness of each person's impact on water quality.
- Ensuring full compliance with current regulations.

4.2 Strategies Recommended by the Missisquoi Bay Council

Note: the following strategies are not presented in rank order.

1. Implement nutrient management planning and associated soil-based field practices.

Background: Nutrient management planning is a systematic approach to managing crop fields and pasture to optimize productivity in a cost-effective manner, while minimizing the loss of pathogens, soil, and nutrients to surface waters. Cover cropping, contour strip cropping, crop rotation, vegetated swales and other soil-based Best Management Practices (BMPs) are cost effective means of achieving nutrient management goals. Additional staff is needed to assist farmers in the development and implementation of nutrient management plans.

Status: Under the AAPs (the baseline set of rules which affect all farms regardless of size, type or location), all sources of nutrients need to be accounted for when determining recommended application rates for crops. Nutrient applications shall be based on soil testing by field and all fields receiving mechanical application of manure are to be soil tested at least once every five years. Records of soil tests from fields receiving nutrients are to be maintained for at least five years. Recommendations and applications may be adjusted based on manure testing and/or leaf analysis. Nutrient applications shall be consistent with university recommendations, standard agricultural practices or a nutrient management plan for the farm approved by the Agriculture Agency Secretary. For farms regulated under the State's large and medium farm operation rules, nutrient management planning and the application of nutrients consistent with the farm's nutrient management plan is required.

The State's Nutrient Management Incentive Grant Program provides funding assistance for nutrient management planning for farms of all sizes. The state Farm Agronomic Practices program provides cost share funding for field practices associated with nutrient management plans. From FY 2005 through 2009, 249 grants have been approved to receive cost-share funding for implementing nutrient management plans on more than 134,000 acres statewide. Other nutrient planning assistance is available through USDA-NRCS programs and has also been provided by UVM Extension and private businesses through grants from the state and the Lake Champlain Basin Program (LCBP).

More Information: Nutrient management planning section of AAFM website: *http://www.vermontagriculture.com/ARMES/awq/NMP.html*

2. Manage, restore, and protect river corridors. Reduce encroachments to sustain stream equilibrium conditions and maximize water quality, land, and infrastructure benefits.

Background: Unstable rivers and streams contribute large amounts of sediment and nutrients to receiving waters. Often, the instability is a result of historic and current human activities such as ditching and straightening and restricting the movement of the river channel to protect buildings, transportation infrastructure and arable land.

Actions:

- Conduct detailed river geomorphic assessments on all priority sub-watersheds in the Missisquoi Bay watershed. Use the assessment data to 1) identify opportunities for projects that will increase river stability, 2) evaluate landowner-proposed channel management activities, and 3) target related local, state and federal programs to increase river stability.
- Work with willing landowners, municipalities, regional/watershed conservation organizations, and others to design and implement river corridor protection projects consistent with increasing overall river stability.
- Provide enhanced incentives and resources for municipalities to permanently protect riparian corridors from new development through municipal land use ordinances and conservation easements and to restore existing corridors.

- Modify existing state and federal programs, or create new ones, to more effectively support riparian corridor protection and restoration. For example, create a program to examine the impacts of ditching and drainage
- Reestablish vegetated buffers along Vermont waterways in both developed and agricultural lands with state and federal programs and other mechanisms.

Status: Phase 1 geomorphic assessment has been completed in most of the Missisquoi Bay watershed, and Phase 2 assessments are either completed or underway in all of the major sub-watersheds. Major implementation projects have included lowering the rail bed along Black Creek to increase floodplain access and creating new floodplains and protecting river corridors at sites in Montgomery and Fairfield. Buffers have been established on agricultural lands through the combined state and federal Conservation Reserve Enhancement Program.

More Information: Vermont River Management Program website: *http://www.anr.state.vt.us/dec//waterq/rivers.htm* and the AAFM Division of Agricultural Resource Management and Environmental Stewardship website: *http://www.vermontagriculture.com/ARMES/index.html*

3. Enhance coordination and cooperation among federal, state and local stakeholders.

Background: Missisquoi Bay watershed stakeholders involved in the development of this plan gained an appreciation of the complexities of watershed-scale water quality management. With nonpoint sources as the dominant contributors toward pollutant loads, nearly every activity and every person in a watershed plays a role in water quality protection. As such, numerous government programs ultimately have some influence on decisions and behaviors that affect water quality, from public education to regulatory compliance. Stakeholders sought further coordination and cooperation in these efforts.

Actions:

- Increase coordination between the state agencies involved with implementing the Clean and Clear Action Plan, especially the Agency of Natural Resources and the Agency of Agriculture.
- Provide quarterly status reports at public meetings in Franklin County from the Secretaries of the Agencies of Natural Resources and Agriculture.
- Better define the roles and responsibilities of agricultural agencies such as VAAFM, NRCS, NRCDs, UVM Extension and others.
- Focus activities on sub-watersheds with impaired streams and areas with highest expected pollutant loads.
- Coordinate implementation of strategies through the Missisquoi Bay watershed council.
- Meet regularly with the Franklin and Grand Isle County legislative delegations to discuss water quality improvement initiatives and progress.
- Inventory and track completed and/or implemented restoration projects.

Status: The Center for Clean and Clear (CCC) (now the Ecosystem Restoration Program) was created to coordinate state water quality improvement efforts in the Lake Champlain basin, focusing initially on northern Lake Champlain. A workplan has been developed to guide the CCC's activities, including naming the St. Albans Bay, Rock River, Hungerford Brook watersheds as targeted areas for project development and implementation. ***More Information***: http://www.vtwaterquality.org/erp.htm

4. Investigate removal of the Missisquoi Bridge and Carry Bay causeways.

Background: Some stakeholders in the region have strongly supported removal of the causeway associated with the former Missisquoi Bridge between Swanton and Alburgh, believing that it does not allow for natural transport of sediment and nutrients out of the bay. An International Joint Commission Report recommended pursuing removal of the causeway to avoid continuing distraction from other needed actions to reduce phosphorus inputs, although it also concluded that removing the causeway would have only a negligible impact on phosphorous levels in the Bay.

Status: About 330 feet of the Missisquoi Bridge causeway was removed as part of the new bridge project. The existing causeway also provides a habitat for the spiny softshell turtle which is listed as a threatened species in both Vermont and Quebec. Because of this removal of the entire old causeway was not possible. The state is investigating the issues related to removing the Carry Bay causeway, including potential impacts on restoring the endangered spiny softshell turtle and the impacts of wind and waves on areas near the Carry Bay causeway.
More Information: International Joint Commission website: ijc.org and Vermont Department of Fish and Wildlife website: *www.vtfishandwildlife.com/*

5. Implement water quality Best Management Practices for road infrastructure construction and maintenance activities.

Background: Gravel roads can be a significant source of phosphorus and sediment to surface waters. Most of these roads are maintained by town governments, which may lack the funding or technical expertise to maintain them in a way that protects water quality.
Actions:

- Expand Better Back Roads program outreach and technical assistance to all Missisquoi Bay watershed towns.

Status: The Vermont Better Backroads Program promotes the use of erosion control and maintenance techniques that save towns money while protecting surface waters. It provides small grants to fix erosion problems and to develop road inventories and capital budgets. It also provides on-site technical assistance to towns. Funding for the program has been significantly increased as part of the state's Clean and Clear Action Plan. All watershed towns have been approached by the Better Backroads Program, which has invited town road commissioners and their crews to several workshops in the Missisquoi Bay watershed. In 2010, the Vermont Legislature passed Act 110 which requires VTrans to revise the current Town Road and Bridge Standards to incorporate practical and cost-effective practices to address transportation stormwater issues and pollution. Annual certification of compliance with the recommended Standards provides a 10% reduction in local match for municipal projects funded under the VTrans Town Highway Structures and Class 2 Town Highway Roadway programs (Sec. 18 19 V.S.A. § 309b.).
More Information: VANR Action Plan website: http://www.vtwaterquality.org/erp.htm and Vermont Local Roads website: *http://www.vermontlocalroads.org/*

6. Assess all farm operations in the watershed, especially small farms not covered by current programs, to determine need for water quality BMPs and provide information on available financial and technical assistance that can keep farms viable and improve water quality.

Background: Large and medium farm operations are now regulated under AAFM permit programs, yet smaller farms (less than 200 animals) may still be significant sources of nutrients and sediments to surface waters. Conservation and funding mechanisms are also needed for operations not served by USDA NRCS, i.e. farms which do not sell $2500 in agricultural products or produce food and fiber, i.e. owners of horses and stable operators.
Status: The state has provided funds to the Farmers Watershed Alliance and other watershed groups to conduct farm surveys, identify issues, and/or implement projects to address water quality impacts of farm operations.
More Information: AAFM Division of Agricultural Resource Management and Environmental Stewardship website: *http://www.vermontagriculture.com/ARMES/index.html*

7. **Using the VANR Lake Champlain Basin Wetland Restoration Plan[8] as a guide, work with willing landowners to identify opportunities to restore and conserve wetlands and their role in improving water quality and providing wildlife habitat.**

Background: Although an estimated 35 percent of Vermont's wetlands have been lost since colonial times, in certain cases it is possible to restore impaired wetlands, bringing back their water quality protection function. Vermont recently completed the Lake Champlain Basin Wetland Restoration Plan, which identifies impaired wetlands within the Vermont portion of the Lake Champlain Basin and prioritizes them for restoration. Work has begun on several restoration projects in the Missisquoi Bay watershed.
Status: In cooperation with the state river management program and other partners, the Department of Fish and Wildlife has identified several wetland restoration opportunities in the Rock River watershed, one of the priority watersheds named by the Ecosystem Restoration Program.
More Information: VANR Action Plan – Wetlands website: http://www.vtfpr.org/wprp/index.cfm

8. **Provide information to farmers about available financing for costs of conservation practices.**

Background: Most conservation programs require farmers to pay part of the costs of installing BMPs, either in cash or as in-kind services. Additionally, funding is usually provided to farmers on a reimbursement basis for costs incurred during project implementation. Often, it is difficult for the farmer to pay their portion of the cost-share or to wait weeks or months to receive reimbursement payments for expenses they have paid out of pocket.
Actions:
- Establish a program that provides 100% cost share for low-cost ($10,000 or less) and cost effective best management practices.
- Inform farmers of opportunities for low-interest loans to finance up-front costs for BMPs.
- Status: In spring 2012, farmland in the critical source areas of phosphorus to Missisquoi bay was eligible for enrollment in USDA programs with 100% cost share.

More Information: VT Agricultural Credit Corporation:
http://www.veda.org/interior.php/pid/1/sid/10

9. **Target additional water quality education and training to specific groups in the watershed through local media and other methods.**

Background: Increasing awareness of water quality issues and how to address them is vital since so many individuals and their activities play a role in nonpoint source pollution.
Target Audiences and Topics:

Residents/Homeowners/Businesses – stream corridor and shoreline management, soil testing prior to use of phosphorus in lawn fertilizers, reducing stormwater flows (native plant conservation landscaping, rain garden construction, rain barrel installation, etc.), septic system maintenance, stream crossing signage

Towns - development of policies, ordinances, and practices related to: septic (wastewater) systems, low-impact development, lawn care, erosion control for small construction projects, riparian and shoreline management, management of town land and facilities, State and Federal aquatic organism passage regulations, stormwater control, Better Back Roads management

Contractors - stormwater and erosion control training to contractors, developers, and engineers working in the region

[8] http://www.vtfpr.org/wprp/reportfinal.pdf

Teachers – train key teachers in each school system in the watershed and provide resources for them to incorporate watershed issues into the school curriculum and share their experience with other teachers

Farmers - hold informational workshops and training sessions on practices, programs, funding sources, and regulations focused on grazing land and/or cropland, agricultural production areas

Status: Information and technical assistance are available as part of the work of many water-quality improvement programs. General education is also provided by a number of groups in the watershed. For example, MRBA's Bugworks program is working with teachers in 11 of 14 elementary schools in the watershed, training teachers in how to connect their students with their local streams by examining aquatic invertebrate communities and other water quality parameters. A group of agency partners has also developed a "Don't P On Your Lawn" campaign to promote lake-friendly lawn care.

More Info: Lawn to Lake: *http://www.lawntolake.org/*, LCBP Champlain Basin Education Initiative: *http://www.lcbp.org/cbei.htm*, RSEP: *http://www.smartwaterways.org/index.html*

10. Reduce phosphorus and bacteria loads from failing septic systems.

Background: Although most phosphorus from septic systems is likely to attach to soil particles and not be transported to surface waters, systems that are hydrologically connected to surface waters may be a source of bacteria and phosphorus to surface waters, especially in shoreline and riparian areas. Bacteria released from failing septic systems to recreational surface waters can create potentially harmful conditions for human health.

Actions:

- Identify and prioritize areas where failing septic systems or direct discharge of sewage might be affecting water quality, including human health issues.
- Provide information to landowners on how to avoid potential septic system impacts on water quality.
- Provide incentives for landowners to address compromised septic systems.

Status: In 2007, the state assumed jurisdiction over all septic systems statewide, except for towns that have successfully petitioned for this authority to be delegated to them. No basin 6 towns have received delegation. New rules went into effect, requiring permits for all new systems and systems serving structures undergoing significant changes, among other requirements.

More Info: VANR Wastewater Management Division – On-site rules: *http://drinkingwater.vt.gov/poregionalofficesrules.htm*

11. Reduce stormwater flows and erosion from homes, businesses, and construction sites not currently covered under existing state and local rules.

Background: Land developed prior to current state stormwater rules are exempt from managing stormwater, which may be a significant source of phosphorus and sediment to surface waters. New development less than one acre are also exempt from state rules.

Actions:

- Identify critical areas in need of enhanced stormwater management.
- Design new stormwater controls for these areas, including green infrastructure techniques[9].
- Develop demonstration projects showing what individual landowners can do to control stormwater (e.g., rain barrels and rain gardens).

Status: The state has implemented new rules requiring stormwater permits for new impervious areas greater than one acre, or from expansions of greater than 5000 square feet where the total resulting impervious area is one acre or more. VANR is investigating opportunities to retrofit existing development for stormwater treatment and to revise stormwater BMP standards to ensure a greater level of treatment for phosphorus.

[9] http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm

More Information: VANR Action Plan website: *http://www.anr.state.vt.us/cleanandclear/* and Vermont Department of Environmental Conservation- Stormwater website: *http://www.anr.state.vt.us/dec/waterq/stormwater.htm*

12. Investigate/demonstrate in-lake methods for reducing the formation or impact of algal blooms.

Background: Despite progress in installing water quality improvement projects and practices around the Missisquoi Bay watershed, annual phosphorus loads have not decreased. Over the decades, phosphorus has also accumulated in sediments at the bottom of bay. This phosphorus can recycle into the water, adding another source to feed algal blooms for years to come, even if watershed inputs are significantly reduced.

Status: Phosphorus modeling research on Missisquoi Bay supported by the Lake Champlain Basin Program found that the movement of phosphorus from the sediments to the water is an important part of the phosphorus budget for the bay, especially during the low flow summer months, when additions of phosphorus to the water column can contribute to nuisance algal blooms. Research on the role of sediments and other factors in triggering algae blooms in Missisquoi Bay is on-going at the University of Vermont. To address a similar situation in St. Albans Bay, the state supported a preliminary feasibility study of the control of internal phosphorus loading. The St. Albans Bay study confirmed that there is a significant reservoir of phosphorus in the bay's sediments, and found that it might be feasible to use alum treatments to trap phosphorus in the sediments, and to remove sediments from wetland area at the mouth of Black Creek. However, these treatments would be ineffective or short-lived unless the on-going, excessive phosphorus loading from the watershed is first reduced. Reducing watershed inputs of phosphorus should remain the immediate priority in both Missisquoi Bay and St. Albans Bay. The state also supported a demonstration and evaluation of SolarBee water circulation devices in St. Albans Bay, but found there was no evidence that they reduced algal concentrations, improved water clarity, or inhibited blue-green algae.

More Information: Missisquoi Bay phosphorus mass balance model report http://www.lcbp.org/techreportPDF/65_PhosphorusMassBalanceModel_MissisquoiBay_2012.pdf
Feasibility Study for the Control of Internal Phosphorus Loading in St. Albans Bay http://www.vtwaterquality.org/erp/docs/StAlbansReport4-2-07.pdf.
SolarBee study http://www.anr.state.vt.us/dec/waterq/lakes/docs/lp_solarbeereport.pdf

13. Improve the recreational fishery in Missisquoi Bay watershed through habitat restoration and elimination of barriers to fish passage.

Background: All river fish migrate between feeding and spawning areas. Fish and other aquatic organisms have lost access to important habitat due to culverts, dams, and other artificial barriers that have been constructed over time. Many dams are obsolete and no longer function in the way they were intended. Road and rail culverts can also create barriers.

Actions:

- Inventory artificial barriers to fish passage within the watershed.
- Provide incentives to towns and private landowners to implement fish passage projects where appropriate.
- Identify and implement a fish passage demonstration project.
- Establish forested riparian buffers throughout the watershed (see river corridor strategy).

Status: Working in partnership with the interagency Vermont Dam Task Force, VANR, The Nature Conservancy and local groups, the USFWS Partners for Fish and Wildlife Program have assessed and evaluated over a thousand barriers to fish passage in the Lake Champlain Watershed. Several projects are in the design and fund-raising stage. USFWS is also working with VANR's River Management

Program and the Better Back Roads program to identify and repair or replace culverts that both barriers to aquatic organisms as well as causing geomorphic instability of the stream.
More Information: USFWS website: http*://www.fws.gov/northeast/vt.htm* and VANR Action Plan website: http://www.vtwaterquality.org/erp.htm

14. Further increase the number of engineers and technical assistants available to implement approved agricultural projects in the Missisquoi Bay Watershed.

Background: Agricultural water quality improvement projects must be designed or certified by professional engineers if they are being paid for by federal or state funds. A lack of engineers on staff at AAFM and NRCS has led to a backlog in design and construction of new projects.
Status: AAFM has hired a Land Treatment planner for the Missisquoi Bay region. With assistance from the Farmers Watershed Alliance, the AAFM and the NRCS have also teamed up to hire a new engineer dedicated to Missisquoi and St. Albans Watershed. The state provided $650,000 for contracted engineering services in the 2008 construction season and an additional $550,000 for the 2009 construction season,
More Information: AAFM website:
http://www.vermontagriculture.com/news/2008/cleanandclearApril8.html

Chapter 5 – Establishing Management Goals for Surface Waters

Each waterbody in the state has at least one management goal to protect one or more beneficial uses or values. In the basin plan, the Agency of Natural Resources can make or propose changes to management goals for particular bodies or stretches of waters through one or more of the following processes:

- Classification of waters and designation of water management types
- Designation of waters as Outstanding Resource Waters
- Designation of waters as warm and cold water fisheries
- Classification of wetlands
- Identification of existing uses

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 goals established for the associated surface water. Before the Agency recommends management goals 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 goals for Agency consideration at any time. When the public develops proposals regarding management goals, the increased community awareness can lead to protection of uses and values by the community and individuals.

5.1 Classification and Water Management Typing

Since the 1960s, Vermont has had a classification system for waters that establishes management goals. These goals describe the values and uses of surface waters that are to be protected or restored through appropriate management practices. The VANR works to implement activities that restore, maintain or protect the management goals. The current classification system includes three classes: A(1), A(2), and B.

Presently in all basins across Vermont, waters above 2,500 feet in elevation are classified A(1) by Vermont statute. In addition, the Water Resources Panel or members of the public can petition that high quality waters with significant ecological value below 2,500 feet be classified as A(1) based upon the public interest. In Basin 6, the only A(1) waters include those above 2,500 feet in elevation. The management objective for A(1) waters is to maintain their natural condition. There are several streams that have the documented excellent aquatic communities that could be considered for reclassification to Class A1 waters and these include Ace Brook, Buzzell Brook, Jay Branch Tributary 13, and East Branch Missisquoi River Tributary 8.

Waters that are managed for the purpose of public water supplies may be designated as Class A(2) Public Water Supplies. The class A(2) waters in Basin 6 that are actively used as a water supply or an emergency water supply are listed in Table 5.

All the remaining waters in the watershed below 2,500 feet in elevation are Class B waters. As part of the Water Quality Standards revisions in 2000, the system was changed to allow Class B waters be divided into three management types: B1, B2 and B3. This change was made to furnish a greater level of protection to existing higher quality waters and to recognize attainable uses that could be supported by improvements to

existing water quality. A simplification of the B1, B2 and B3 designations would be to say that the spectrum from B3 to B2 to B1 is described as representing "good," "better" and "best" aquatic conditions.

The revised Water Quality Standards require that all basin plans place Class B waters into one of the three water management types. However, considerable challenges over the past decade have limited VANR's ability to identify proposed water management types, and the Panel's ability to promulgate these designations. These challenges are listed in detail in VDEC's 2010 Report to the Vermont General Assembly on Basin Planning. As such, recommendations for water management types are not presented in this basin plan.

5.2 Outstanding Resource Waters

In 1987, the Vermont Legislature passed Act 67, "An Act Relating to Establishing a Comprehensive State Rivers Policy." A part of the law 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. The Big Falls of the Missisquoi River at Troy is a natural candidate for ORW in consideration of spectacular aesthetic value and swimming use.

5.3 Warm Water and Cold Water Designations

Beyond the classification and water management type assigned to each water body, lakes, ponds, rivers, and streams are designated as either warm or cold water fisheries habitat in the Vermont Water Quality Standards.

The following waters as well as all wetlands with open water are designated for management as Warm Water Habitat by the Vermont Water Quality Standards. This designation specifies a lower minimum required dissolved oxygen concentration than waters in the remainder of the basin:

- Lake Carmi, Franklin
- Cutler Pond, Highgate
- Rock River from the Canadian boundary to its confluence with Lake Champlain
- Metcalf Pond, Fletcher
- Fairfield Pond, Fairfield
- Fairfield Swamp Pond, Fairfield
- Missisquoi River from the outfall of the Enosburg Falls wastewater treatment facility to the Swanton Dam, Swanton

These warm water fisheries commonly support game species such as northern pike, large and smallmouth bass, walleye and many other species.

All other waters in the Missisquoi Bay watershed are designated as Cold Water Habitat (Water Resources Board, 2008). Many of these areas are mountain streams and brooks and beaver ponds, which often support a mixture of stocked and native brook, brown, and rainbow trout. The Basin Plan does not contain any recommendations for changing any of these warm water or cold water designations.

5.4 Classification of Wetlands

The Vermont Wetlands Rules adopted pursuant to 10 V.S.A. § 6025(d)(5), classify wetlands into three categories based on an evaluation of the functions and values set forth in statute and these rules. The level of protection provided by the state follows:

Class I wetlands are exceptional or irreplaceable in their contribution to Vermont's natural heritage and, therefore merits the highest level of protection. They are identified on the Vermont significant wetlands inventory maps or by a determination made by the Agency of Natural Resources. Any person may petition the Panel to classify any wetland as a Class I wetland, or to reclassify any Class I wetland to a lower classification, in accordance with the Vermont Administrative Procedures Act, 3 V.S.A. §§ 800-849, these rules and the relevant ANR Rules of Procedure.

Wetlands that may merit Class I designation include the Lake Carmi Bog, areas of the Missisquoi River delta in the Missisquoi National Wildlife Refuge, and portions of the Fairfield Swamp Wildlife Management Area.

Class II wetlands are presumed to be significant wetlands. The Secretary may, upon a petition or on his or her own motion, determine whether any wetland is a Class II wetland or a Class III wetland. The Secretary may establish the necessary width of a buffer zone of any Class II wetland as part of any wetland determination pursuant to these rules.

All activities in a Class I or Class II wetland or their associated buffer zones that are not considered an Allowed Use, require a Vermont Wetland Permit or Vermont General Wetland Permit. To receive a Vermont Wetland Permit, the applicant must demonstrate the proposed project will not have an undue, adverse impact on the functions and values of the wetland (Section 9.5a). Avoidance and minimization of impacts to the wetland or buffer zone is required (Section 9.5b).

Class III wetlands are neither a Class I nor a Class II wetland. See 10 V.S.A. § 902(8). They are not afforded protection under the Vermont Wetland Rules, but may receive protection at the federal or municipal level.

5.5 Existing Uses

During the Basin 6 planning process, VDEC collected sufficient information to document and determine the presence of existing uses for swimming, boating, and fishing on flowing waters using current VDEC procedures (Table 7). Waters used as active or emergency public drinking surface water supplies were also identified. The VANR presumes that all lakes and ponds that exist within the basin have existing uses of fishing, contact recreation and boating. This simplifying assumption is used because of the well-known and extensive use of these types of waters for these activities based on their intrinsic qualities and to avoid the production and presentation of exhaustive lists of all of these waterbodies across Basin 6. During the VANR's consideration of a permit application that might be deemed to affect these types of uses, this presumption may be rebutted on a case-by-case basis.

The list presented in Table 7 are not intended to represent an exhaustive list of all possible existing uses, Additional existing uses of contact recreation, boating and fishing on/in flowing waters and additional public drinking water supplies may be identified during the VANR's consideration of a permit application or in the future during subsequent basin planning efforts.

Table 7. Existing Uses in the Missisquoi Bay Watershed				
Area or Reach	**Waterbody**	**Town**	**Use**	**Info Source/ Comments**
Big Falls	Missisquoi River	Troy	Contact Recreation	(1) (2)
Highgate Falls Dam	Missisquoi River	Highgate	Contact Recreation	(1) (2)
Troy Four Corners	Jay Branch	Troy	Contact Recreation	(1) (2)
Hectorville Bridges	Trout River	Montgomery	Contact Recreation	(1) (2)
Hutchins Covered Bridge	Trout River	Montgomery	Contact Recreation	(1) (2)
Montgomery School House	Trout River	Montgomery	Contact Recreation	(1) (2)
Longley Covered Bridge	Trout River	Montgomery	Contact Recreation	(1) (2)
Kidder's	Tyler Branch	Enosburgh	Contact Recreation	(1) (2)
Creamery Covered Bridge	West Hill Brook	Montgomery	Contact Recreation	(1) (2)
Hippy Hole	West Hill Brook	Montgomery	Contact Recreation	(1) (2)
East Richford to Enosburg Falls	Missisquoi River	Richford/Enosburgh	Recreational Boating	(3) (4) (5)
Enosburg Falls to Highgate Falls	Missisquoi River	Enosburg/Sheldon/ Highgate	Recreational Boating	(3) (4)
Highgate Falls to Lake Champlain	Missisquoi River	Highgate/Swanton	Recreational Boating	(3) (4) (5) (6)
Upper Missisquoi River	Missisquoi River	Troy	Fishing	(3)
Swanton to Lake Champlain	Missisquoi River	Swanton	Fishing	(3)
Tyler Branch	Tyler Branch	Enosburg	Fishing	(3)
Riverside Cemetery (Swanton) to below Swanton Dam	Missisquoi River	Highgate/Swanton	Fishing	(7) Special Regulations
Swanton Dam downstream to water treatment plant	Missisquoi River	Highgate/Swanton	Fishing	(7) Special Regulations
Swanton Dam to Highgate Falls Dam	Missisquoi River	Swanton/Highgate	Fishing	(7) Special Regulations
Highgate Falls Dam to top of the Sheldon Springs Dam in Sheldon Springs	Missisquoi River	Highgate/Swanton	Fishing	(7) Special Regulations
Kane Road (TH-3) bridge to Enosburg Falls Dam	Missisquoi River	Sheldon/Enosburg	Fishing	(7) Special Regulations

Burgess Branch	Burgess Branch	Lowell	Fishing	(8) Stocked
Hazen Notch Brook	Hazen Notch Brook	Lowell	Fishing	(8) Stocked
Jay Branch	Jay Branch	Jay	Fishing	(8) Stocked
Mississquoi River-East Branch	Missisquoi River	Lowell	Fishing	(8) Stocked
Sheldon Rapids between Sheldon Jct and N. Sheldon	Missisquoi River	Sheldon	Fishing	(8) Stocked
Upper Missisquoi River	Missisquoi River	Troy/Westfield	Fishing	(8) Stocked
Bridge on TH-3 (Kane Rd) upstream to confluence with Tyler Branch	Missisquoi River	Enosburgh	Fishing	(8) Stocked
Confluence w/ Tyler Branch upstream to top of the dam in Enosburg Falls	Missisquoi River	Enosburgh	Fishing	(8) Stocked
The Branch		Enosburgh	Fishing	(8) Stocked
Trout River		Berkshire/Montgomery	Fishing	(8) Stocked
Tyler Branch		Enosburgh	Fishing	(8) Stocked
Stanhope Brook		Richford	Public Water Supply	(9)(10) Class A2
Loveland Brook		Richford	Public Water Supply	(9)(10)
Old Spring/Upper Reservoir		Troy	Public Water Supply	(9)
Fairfield Pond		Swanton	Public Water Supply	(9)
Mountain Brook and tributary		North Troy	Public Water Supply	(10) Class A2
Coburn Brook Reservoir and Tributaries		North Troy	Public Water Supply	(10) Class A2
Unnamed tributary to Trout River		East Berkshire	Public Water Supply	(10) Class A2
Hannah Clark Brook		Montgomery Ctr.	Public Water Supply	(10) Class A2
Trout Brook and Enosburg Reservoir		Enosburg Falls	Public Water Supply	(10) Class A2
Black Falls Brook		Montgomery Ctr.	Public Water Supply	(10) Class A2
(1) VDEC, 2004 (2) Jenkins and Zika, 1985 (3) DeLorme, 1996 (4) AMC, 2002 (5) Jenkins and Zika, 1992 (6) AMC, 1992 (7) VDFW, 2008 (8) VDFW Website (9) VDEC pers. Com (10) VTWRP, 2008				

Chapter 6 –Implementation of the Missisquoi Bay Basin Plan

Achieving the goals of the Missisquoi Basin Plan will require participation of the many local, state and federal partners working in the watershed, as well as those who live, work in the Basin. The key component of this plan is the following implementation table. It identifies specific actions that were derived from the strategies developed with the Missisquoi Bay Watershed council (see Chapter 4, which also includes background information.) The table is a working document that will evolve over the 5-year span of this planning document. As actions are completed, updates will be added to the table with the status of the action as an ongoing report card of work completed. The implementation table for the Missisquoi Bay Basin will be available online sometime during 2013.

Actions in the implementation table are organized by human activity on the landscape, including landuse or impacts to hydrology. The categories are further described in the Vermont Surface Water Management Strategy's[10] Appendix C. Each action includes the lead, which is the group that could be responsible for leading or helping to lead a project. The lead category includes groups and organization that have participated in similar strategies in the past or are interested in participating in a strategy. The list should not be considered all-inclusive and the VANR welcomes the assistance of other groups or individuals in the identification and implementation of strategies. The funding category includes funding sources listed in Appendix D of the Vermont Surface Water Management Strategy.

The VANR will facilitate implementation of these actions by working with partners in developing and implementing projects, establishing or continuing monitoring to help better identify source of problems, as well as promoting programs that encourage community members to adopt best management practices.

Other resources for meeting the goals and objective of this plan include the existing regulatory and nonregulatory programs in place to improve and protect water quality in Vermont. The Vermont Surface Water Management Strategy, Appendix D, summarizes the "Tool Kit."

In addition, the implementation of other plans mentioned in Section 1.4 will also be an important part of the effort to remediate waters in the basin.

6.1 Evaluation and Monitoring

The Agency will be responsible for tracking the accomplishments made toward achieving the basin plan goals and completion of the strategies in the implementation table. Results from the Agency's BASS laboratory monitoring program of water body health will be the ultimate measure of success for instream biological community health.

Additional mechanisms in place that provide valuable data to track water quality improvement include:

- Lay monitoring efforts by the MRBA and Lake Carmi Watershed Associations to provide water quality data
- A network of stream gauges operated by the USGS provides stream flow data.

[10] http://www.anr.state.vt.us/dec/waterq/wqdhome.htm .

- Annual progress reports provided by the Ecosystem Restoration Program provide information including participation in conservation programs, restoration projects completed, and estimated phosphorus reductions achieved.
- The Lake Champlain Basin publishes annual State of the Lake Reports, available online at www.lcbp.org

On an annual basis, the VDEC and key watershed and statewide partner organizations will meet to address the accomplishments made toward achieving the basin plan goals. They will also ensure efforts are moving forward and identify and address any obstacles that may prevent implementation. In addition, as the process continues and new information is made available strategies may be added, modified or targeted more specifically to areas of the basin where they will have greater impact. This review process will keep partners engaged and allow for accountability in achieving the goals laid out in this basin plan.

Implementation Table to Address Water Quality Problems in the Missisquoi Bay Watershed[11]

Land Conversion

Goals: 1. Preserve forest to maintain a landscape that protects wildlife and aquatic habitat, water quality and stream equilibrium and; 2. Protect the functions and values of existing wetlands and selectively restore human-altered wetlands			
Objective 1. Encourage stewardship of private land that leads to protection and restoration of natural landscapes. **Objective 2.** Assist communities in their efforts to maintain or restore natural landscapes.			
Action	**Lead or Partners**	**Budget[12]**	**Geographic scope[13]**
1. Encourage landowners to protect forest and wetland through education and financial incentives, e.g., CREP, State of Vt. Use Value Appraisal program, WRP	VFPR county foresters, RC&D NRCD, NRCS, USFWS, Audubon	USDA, US Forest Service, Watershed grants	

11 For the Lake Carmi watershed, additional strategies can be found in the Lake Carmi Phosphorus Reduction Action Plan (August 2008) developed to address the Lake Carmi Phosphorus TMDL completed in 2008.

12 Funds needed above and beyond VANR, VAAFM and other state and federal staff hours

13 Applies to waterbody, town, media, throughout basin, etc and/ or status. The action applies to the entire basin if cell is left blank.

2. Encourage communities to protect natural landscapes by addressing other potential interests in the community in addition to water quality protection, e.g., trout habitat, water supplies, swimming holes, floodplains, bird habitat. Tools for protection may include establishment of town forests; inclusion of priorities in town plans; zoning for woodland/woodlot, wildlife protection, scenic ridgeline designations; riparian/lake buffer regulations; information about importance of watershed protection practices in VDEC water supply division's letter to towns regarding Source Protection Planning process.	VFPR, VDFW, VDEC, NRCD, Regional Planning Commissions, Land Trusts, VLCT, Town Planning & Conservation Commissions.	319 grants, 604(b) grants, LCBP, Watershed grants.	
a. Educate municipal officials and community groups about natural resources and tools for protection.	Conservation commissions, VANR, UVM Sea Grant, watershed groups	LCBP, Watershed grants	
b. Assist groups in implementing the draft or final Wild and Scenic project management plan[14], including providing towns with information about outstanding resource values that benefit from forested landcover	VANR, Wild and Scenic steering committee		
3. Prioritize agriculturally altered wetlands for restoration based in part on ability to reduce phosphorus loads and encourage landowners to protect through the WRP	Ducks Unlimited, NRCS, VANR		

[14] The Wild and Scenic Study Committee is responsible for the creation of an upper Missisquoi and Trout Rivers river management plan to help determine the feasibility of Federal Wild & Scenic designation, (see Chapter 1 for more information about the designation process).

Stormwater Runoff from Development

Goals: Decrease the volume and pollutant load of stormwater runoff from pre and post construction activities			
Objective 1: Support municipal efforts to adopt local stormwater standards and manage stormwater runoff from existing impervious surfaces. Objective 2: Encourage individuals and businesses to adopt best management practices that reduce stormwater volume and pollutant load.			
Action	**Lead or Partner**	**Budget**	**Geographic scope**
1. Assist in implementation of the Vermont Agency of Natural Resources Green Infrastructure Initiative Strategic Plan 2011–2013	VDEC, VFPR, VLCT, VTrans, NRCD	ERP, LCBP, 319 grants	**Urban and village areas**
2. Assist municipalities in developing a strategic water resources management plan that identifies and prioritizes stormwater improvement projects as well as potential ordinances that could help reduce impacts from new development. Work with municipalities to connect the concepts of stormwater management, floodplain management, river corridor protection, and land use.	VDEC-WSMD, VTrans, municipalities, watershed groups including FNCL.	ERP, VTrans Enhancement, 319 Grants	**Swanton village and town, Highgate, Enosburg village and Falls and Richford**
a. Support stormwater retrofits as outlined in the VTDEC Missisquoi Basin Stormwater Mapping Project: http://www.vtwaterquality.org/erp/news/Missisquoi_FINAL_Report.pdf	Municipalities, watershed groups	See above	**Swanton, Highgate, Enosburg Falls, Montgomery, Troy, North Troy, Sheldon Springs and Richford**
b. Resolve illicit discharges and investigate stormwater treatment retrofit opportunities including the 13 specifically identified suspected discharges: Enosburg Falls (EN-100, EN-210, and EN-360), North Troy (NT-010, NT-060), Richford (RF-010X/RF-010Z, RF-045, RF-050 and RF-230), and Swanton (SW-140, SW-070, SW-150, SW-170). Additional survey and investigative work will be needed to resolve and eliminate these discharges.	Municipalities, watershed groups	See above	**Includes some old piping in the villages of Richford, and Enosburg Falls, Richford, and North Troy**

Agricultural Activities

Goals: Strategically apply best management practices and increase outreach programs to reduce sediment, phosphorus and pathogens from agricultural activities			
Action	**Lead and Partners**	**Budget**	**Geographic scope**
1. Increase use of soil health improvement practices for flood resiliency and water quality protection, including reduction of compaction.	FNRCD, NRCS, VAAFM, UVM Extension, NOFA, Farm operators, watershed groups	USDA-NRCS, VAAFM, VANR, UVM Extension, NOFA-VT, watershed organizations	
a. Promote practices that cover the soil, including cover crops, leaving crop residue and use of perennial crops. Cover cropping practice appropriate for the basin include interseeding and aerial seeding	See above	See above	
b. Promote crop rotation, manure incorporation and reduced or less intensive tillage practices	See above	See above	
c. Promote grazing practices that maintain or improve infiltration rates of soil	See above and Vermont Beef Producers Association, Vermont Grass Farmers Association, Vermont Horse Council,	See above	
2. Make available opportunities to share high-cost tillage conservation equipment	FWA, VACD, FNRCD, VAAFM, FSA, NRCS, UVM Extension, NOFA, VFB, Farm operators, FWR, Local dealers of custom applications	VAAFM, VANR, USDA-NRCS and RC&Ds	
3. Continue to work with all interested farmers to develop and implement Nutrient Management Plans (NMP)	VACD, VAAFM, FNRCD, ONRCD, NMP, NRCS, UVM Extension, NOFA, VFB, Farm operators	VAAFM, VANR, NRCS, TU, NOFA-VT, UVM Extension	**Berry, Godin and Samsonville Brooks and others**

4. Promote reduction of phosphorus content in animal feed. Support demonstration projects	FWA, UVM Extension, VAAFM, watershed groups,	USDA-NRCS	**Lake Carmi and others**
5. Promote use of AAPs and BMPs on small farms, including Small Farming Operations (SFOs) and equine operations. Include appropriate grazing and feeding practices that exclude livestock from streams and maximize feed production.	Vermont Beef Producers Association, Vermont Grass Farmers Association, VAAFM, VANR, NRCS, TU, UVM Extension, Vermont Horse Council, Watershed organizations	USFWS, NRCS,	**Berry, Godin and Samsonville Brooks and others**
6. Increase establishment of buffers on agricultural lands along surface waterways and wetlands. Include use of silvo pastures where fast growing woody vegetation can be harvested under a silvicultural plan	VAAFM, VACD, FNRCD, FSA, FWS, NRCS, VANR, UVM Extension, NOFA, VFB, Farm operators	FWS, VAAFM, VANR, TNC	**Berry, Godin and Samsonville Brooks and others**
7. Identify and encourage practices that have been successful in treating silage leachate.	FNLC. USDA-NRCS, VAAFM,		
8. Use Water and Sediment Control Basins, Wascobs[15] in agricultural land, in conjunction with other BMPs.	FNLC, VAFM, VANR,		
9. Provide additional local learning opportunities for farmers that support the above strategies	ARS, VACD, FNRCD, ONRCD, VAAFM, FSA, NRCS, UVM Extension, NOFA, VFB, Farm operators	VAAFM, VANR	
10. Focus agricultural technical and financial assistance on fields with high rates of phosphorus and sediment loading to rivers as well as watersheds impaired by agricultural runoff. Use the Critical Source Area study (LCBP, 2011) to prioritize areas for focusing efforts to encourage BMP adoption, including covercropping, grassed waterways and critical area seeding, manure incorporation, conservation tillage and other field practices.	MRBA, FNLC, NRCS, FWC, USFWS, UVM Extension, VDEC-WSMD, VAAFM, VACD,		**Rock River**

[15] A water and sediment control basin: a basin within a farm field drainage ditch meant to collect sediment to reduce sedimentation of receiving streams

11. Support the Targeted Watershed Implementation Initiative in the Rock River Watershed.	NRCS, FWA USFWS, UVM Extension, VAAFM, VDEC-WSMD	ERP	**Rock River**
12. Determine effectiveness of agricultural BMPs through edge of field water quality monitoring	American Great Outdoors Initiative partnership, Project Rock partnership, UVM Extension, VAAFM, NRCS	VAAFM, NRCS	
13. Encourage agricultural environmental management (AEM) assessments by NGOs, including watershed organizations by creating more benefits for farmer.	VACD, VAAFM	VAAFM	
14. Monitor bacterial concentrations in brook with Bacterial TMDLs.	Watershed groups		**Berry, Godin and Samsonville Brooks**

Forestry Management Practices

Goals: Strategically apply best management practices and increase outreach programs to reduce non point source pollution from forest management activities			
Objective 1: Assist community and forest industry in adopting sustainable logging practices that protect water resources			
Action	**Lead or Partners**	**Budget**	**Geographic scope**
1. Increase use of portable skidder bridges to protect water quality on logging operations. Continue renting bridges to loggers throughout the Orleans Natural Resource Conservation District. Transition the bridges at the Swanton BED chip yard facility from the Portable Skidder Bridge Loan and Education Program that will sunset in 2013 to start a rental program to be administered by the Franklin/Grand Isle NRCD.	ONRCD, VFPR, RC&D, private forestry consultants, loggers, NRCD and forest landowners	ERP, RC&D, LCBP	
a. Support outreach efforts to promote the use of portable skidder bridges by targeting forest landowners and consulting foresters. Invite area loggers to attend a Portable Skidder Bridge Workshop.	Cold Hollow Vocational Forestry Program, DFPR	LCBP, Watershed Grants	
2. Provide education and learning opportunities to forest landowners on forest management	VFPR, USFS, logger assn's, forestry assn's, Woodland Owners Assn, academic and vocational institutions	USFS grants, Watershed grants	

Hydrologic Modification: changes to river flows or water levels

Goal: Address dams and other hydrological alterations that impede fish movement, are responsible for decreased stream transport capacity, littoral zone health or degrade water quality			
Objective 1: Coordinate the efforts of federal, State, and local agencies to remove obsolete and non-essential impoundment structures. Objective 2: Reduce or eliminate hydrological modifications			
Action	**Lead and Partners**	**Budget**	**Geographic scope**
1. Identify dams that are not good candidates for removal because they provide significant public benefits and determine what steps can be taken to mitigate their environmental impacts.	VANR, VDFW, USFWS, American Rivers, and consultants		
a. Identify dams that have high restoration potential based on the results of The Nature Conservancy's Northeast Aquatic Connectivity Project and other assessments.	VDEC, Vermont Dam Task Force, The Nature Conservancy		
2. Evaluate individual dams with potential for removal and develop removal plans in cooperation with the dam owner, local community and other partners.	VANR, VDFW, USFWS, American Rivers, and consultants	ERP, NOAA, Trout Unlimited, Partners for Fish and Wildlife Program, WHIP	**Includes Swanton Dam**
3. Determine extent, timing, and Impact of Lake Carmi drawdowns. Water level monitoring was conducted in 2006 and 2007	VDEC		**Lake Carmi**
4. Address hydrological modifications in Missisquoi River due to upstream Enosburg Falls Dam during 2023 FERC relicensing	VDEC		**Missisquoi River below Enosburg Falls**
5. Investigate the Possible Lack of Minimum Flow Below Water Supply Withdrawal Point (Threat) in Loveland Brook	VDEC		**Loveland Brook**

River Corridor Encroachment and Channel Erosion[16]

Goals: Maintain a stream's access to its floodplain and its ability to achieve stream equilibrium over time while still protecting infrastructure from flood events.			
Objective 1. Prioritize stream corridor protection, stream stability restoration projects, Pre-disaster mitigation efforts, fluvial erosion hazard mapping, and enhancement of aquatic and riparian habitats for fish and wildlife. Use stream geomorphic and fish habitat assessments (VANR, 2007) https://anrnode.anr.state.vt.us/ssl/sga/finalReports.cfm			
Action	**Lead and Partners**	**Budget**	**Geographic scope**
1. Initiate Phase 2 geomorphic assessments	NRPC, FNLC, VDEC	ERP, LCBP	Consider Pike river
2. Encourage towns to include Flood Hazard bylaws, including NFIP, Floodplain Erosion Hazards and infrastructure considerations (roads, bridges and culverts susceptible to flooding).	VDEC, municipalities, NRPC, ORPC	ERP, Pre-Disaster Mitigation funds, LCBP	
3. Assist communities in developing and enhancing All Hazard Mitigation plans that identify flood hazard areas and potential mitigation steps to address those hazards.	Regional planning commissions, VTrans, VDEC		
4. Increase the establishment and enhancement of woody riparian corridors on stable reaches.	MRBA, VDEC, VDFW, NRCD, RPCs, watershed and angler groups, municipalities	ERP, LCBP, WHIP, CREP, USFWS, 319 grants, Watershed Grant	Black and Mud Creeks as well as others
a. Support a Trees for Streams program	MRBA, NRCS, NRCD, VDEC	See above	
5. Support efforts to conserve river corridor identified in VANR river corridor plans and other studies where significant deposition is occurring.	VDEC, Watershed groups	319 grants, ERP, LCBP, Watershed grants	Upper Hungerford Brook (see Master's Thesis - Dani Newcomb, 2007)[17]
6. Use the USDA ARS study in conjunction with Phase II SGA to target specific reaches where 1:2 bank cuts and riparian re-buffering will decrease in-channel erosion [18]	VDEC, Watershed groups	See above	Missisquoi mainstem, as well as other areas

[16] Also see strategies regarding culverts in Transportation infrastructure section
[17] http://www.lcbp.org/PDFs/IJC_MBBP/P_loading_Hungerford_Brook.pdf

Wetland and Lake Encroachment

Goals: Protect the integrity of lakes and wetlands			
Objective 1. Encourage landowners to create and maintain a vegetated buffer between the natural resource and landuse to enhance water quality and habitat. Objective 2. Assist municipalities in the protection of wetlands, lakes and their buffers through zoning and management of municipal property.			
Action	**Lead and Partners**	**Budget**	**Geographic scope**
1. Assist in efforts to conserve undeveloped lake and pond shorelands.	VDEC Lake Assessment Program, municipal conservation commissions, FWD,	ERP	
2. Review and strengthen regional and town plans and zoning bylaws relating to lake and wetland protection issues. a. Work with interested towns towards the adoption of lakeshore ordinances. Use model ordinance developed by VLCT.	VDEC, municipalities, VLCT Municipal Assistance Center, regional planning commissions, and lake associations	604(b) grants	Fairfield Pond and Lake Carmi
3. Reduce the impact of roads and parking areas. See Transportation infrastructure section in this chapter.	lakeshore and watershed associations and others	319 grants, ERP, LCBP, Watershed grants	

[18] USDA Agricultural Research Service (ARS) Bank Stability & Toe Erosion Model: A total of 30 sites were evaluated throughout the Missisquoi Basin. Results show that stream bank erosion contributes approximately 29-42% of the total suspended sediment (TSS) load, and approximately 50% of Total Phosphorus (TP) at the mouth of the Missisquoi River. Best management practices were evaluated for reductions in TSS and TP load, and can achieve reductions of approximately 5-90% and 35-90%, respectively. These practices involve long-term protection of river corridors and riparian vegetation to achieve the highest load reductions over time. (Final report 9/2012)

4. Increase the community's interest in the health of their lakes. a. Distribute and publicize the VDEC-WSMD Lake Score Card b. Assist in conducting lakeshore watershed surveys to identify nonpoint sources of pollution and publicizing results to community	VDEC, watershed and lake associations, residents, and municipalities	319 grants, Watershed grants,	
5. Encourage shoreline residents to implement BMPs through the VDEC Watershed Management Division's Lakewise program with technical assistance from the VDEC Water Supply and Ground Water Division Program.	VDEC, shoreland property owners, watershed and lake associations, Federation of Vermont Lakes and Ponds,	NRPC Shoreline Restoration Fund, 319 grants, ERP, LCBP, Watershed grants, New England Grassroots Environmental Fund	
6. Support shoreline restoration workshops based on the *Shoreline Restoration Manual for Lake Champlain and Inland Lakes*. The manual offers vegetative, non-structural methods for restoring shorelines.	NRPC, VDEC	319 grants, ERP, LCBP, Watershed grants, New England Grassroots Environmental Fund	**Missisquoi Bay, Lake Carmi**

Wastewater

Goals: Manage wastewater discharges from wastewater treatment facilities and onsite systems to protect water resources and their uses			
Action	**Lead and Partners**	**Budget**	**Geographic scope**
1. Assist towns to address aging wastewater treatment facilities and associated sewer pipes, see Appendix D for information on specific towns.	VANR	Clean Water Act Revolving State Funds	.
2. Assist groups in identifying high *E. coli* where swimming is a popular use downstream of village centers and work with villages to identify source.	Watershed groups, VDEC	ERP, LaRosa,	

Transportation Infrastructure: construction and maintenance

Goals: Reduce nonpoint source pollution from transportation infrastructure and ensure installation of stream crossing structures in a manner that reduces the public safety hazard and vulnerability to future flood loss as well as improving stream stability			
Objective 1. Assist municipal and state road maintenance entities and trail associated recreational groups in addressing erosion from roads and trails. Objective 2. Identify and address stream crossings that are not adequately sized or placed Objective 3. Reduce the amount of salt used and reduce the amount of winter sand that reaches waterways			
Action	**Lead and Partners**	**Budget**	**Geographic scope**
1. Address culverts identified as resulting in water quality problems in the Lake Carmi watershed stream assessment (2009)	FWC, VDEC, Town of Franklin	BBR, ERP, Watershed Grants, 319 grants	**Lake Carmi Watershed**
2. Assist towns who have not received a Better Back Roads application to identify a project and apply to the program for a grant.	BBR, VDEC, watershed groups	BBR	**Lowell, Albany, Troy, Jay, Westfield, Berkshire, and Highgate**
3. Encourage inventories and assessment of town transportation infrastructure. Use BBR assessment forms or a more detailed assessment for class 3 and /or 4 roads similar to those used in White River and Winooski River Basins	VDEC, VTrans, Local Roads Program, Vermont RC&Ds, RPCs, and municipalities	BBR grants, 319 grants, ERP, LCBP, Watershed grants	**Upper to mid watershed**
4. Provide BMPs for reducing impacts of roads, culverts, bridges and snow management on streams. Use information from the BBR manual as well as the final report for LCBP's Road drainage network impacts to Lake Champlain water quality. Help town use a Capital Improvement Budget process to fund.	BBR, Local Roads Program, Vermont RC&Ds, RPCs, and municipalities, VDEC, VTrans	BBR, LCBP, Watershed Grants	
a. Hold BBR workshops to educate town staff, committees, boards and interested community groups	VDEC-RMP, BBR, VT Local Roads and VTrans, RPCs,	BBR,LCBP, Watershed grants	**Orleans county**

5. Assist state, town and private property owners to assess and replace or retrofit stream crossing structures that pose significant passage limitations to improve fish and/or wildlife, sediment transport and stream stability.	VDEC, VDFW, RPCs, municipalities, lake and watershed groups	Town Highway (TH) Structures (bridges and culverts), TH Interstate Culverts, TH Class 2 Roadway, BBR grants, and TH Emergency funding programs; USFWS	
a. Compile assessment information for towns, including The Nature Conservancy's assessment, and assist them in understanding and using the information to replace or retrofit culverts and bridges where necessary.	VDEC, VDFW, municipal groups, TU	BBR, ERP, LCBP, Watershed grants	
6. Assist municipalities with the adoptions of new VTrans standards for roads and bridges and other standards that will help towns meet Act 110	BBR, Local Roads Program, NRPC, Community groups	604(b) ecosystem grants	
7. Investigate the interest and feasibility for a hydroseeder rental program that would be available to local town road crews for a nominal expense.	NRPC,	ERP, BBR	**Franklin County**

Invasive Species in Aquatic or Riparian Zones

Goals: Identify invasive plant management priorities to achieve the greatest ecological benefit while minimizing the total, long-term workload and project costs			
Objective 1. Increase volunteer involvement; Objective 2. Reduce spread of invasive plants; Objective 3. Control existing populations of invasive plants.			
Action	**Lead and Partners**	**Budget**	**Geographic scope**
1. Provide education and outreach about invasive species threats, spread prevention practices and applicable state laws prohibiting their transport. Target programs towards the public, landscaping professionals, town and state road crews and forest industry personnel.	VDEC , NRCDs, Municipalities, VFPR, TNC, USFS, logger assn's, forestry assn's, Lake associations/residents, VDEC	Aquatic Nuisance Control Grants-in-Aid, LCBP, USFS grants, Watershed Grants, NFWF.	
2. Support volunteer efforts to identify new aquatic infestations and removal through the support of the Vt. Invasive Patroller and other programs.	Conservation Commissions, Watershed groups, VDEC, TNC, Wild and Scenic steering committee	Aquatic Nuisance Control Grants-in-Aid	
a. Assist with volunteer recruitment and training, and support invasive plant control activities. See http://vtinvasives.org/plants/prevention-and-management/tools-resources	Community groups, TNC	Aquatic Nuisance Control Grants-in-Aid, LCBP,	
3. Inform river users about Didymo spread prevention techniques, as well as whirling disease and NZ Mud Snail. Include state restrictions on use of felt waders.	VDEC, VDFW, TU,	LCBP, Watershed grants	
4. Protect the integrity of the forested riparian zone by reducing knotweed populations and limit its spread. Encourage community groups to commit their efforts to particular areas for a number of years.	Community groups , Montgomery Conservation Commission, TNC	319 grants, LCBP, Watershed grants	
a. Focus efforts to manage knot weed in specific subwatersheds, include town road crews.	MRBA, Montgomery conservation commission, other watershed and community groups	319 grants, LCBP, Watershed grants	**Trout River watershed and others**

Enhancing the Community's Environmental Ethic

Goals: Increase communities' interest in water resources protection and involvement in best management practices and assessment and restoration projects.			
Objective 1. Assist community members in adopting stewardship practices that reduces erosion and discharge of pollutants into adjacent rivers and streams Objective 2. Provide opportunities for people to gain or expand their appreciation of the resource through better understanding of resource and increased water-based recreational opportunities			
Action	**Lead and Partners**	**Budget**	**Geographic scope**
1. Increase community's involvement in residential BMPs that protect water resources by developing programs that help people overcome barriers to adopting sustainable behaviors.	VDEC, UVM Seagrant,	LCBP, Watershed grants	
2. Develop signage to educate the community about Outstanding Resource Values (Wild and Scenic Study) and water- based recreational opportunities.	LCBP, Northern Forest Canoe Trail, Wild and Scenic steering committee	LCBP wayside program, Watershed Grants	
3. Help teachers connect students with water resources in their towns, e.g., MRBA's Bugworks, Champlain Basin Education Initiative's Watershed for Every Classroom.	CBEI, MRBA, VDFW,	LCBP, Watershed grants	
4. Assist community groups in developing and implementing volunteer monitoring and assessment programs as well as reporting results to community. Encourage high schools participating in UVM EPSCoR program to collaborate with watershed groups.	FWA, MRBA, UVM EPSCoR, VDEC, Wild and Scenic steering committee	LaRosa	
5. Increase availability of publically owned or easements to access for boating, swimming and fishing opportunities throughout the basin.	Northern Forest Canoe Trail, VFWD, RPCs, TU, VTrans, Wild and Scenic Steering Committee	VFPR trail fund; VDFW non motorized access money	

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Glossary

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 for Logging (AMP) - AMPs are voluntary practices intended to prevent any mud, petroleum products and woody debris (logging slash) from entering waters of the state. They are scientifically proven methods for loggers and landowners to follow for maintaining water quality and minimizing erosion.
Acceptable Management Practices (AMP) - methods of silvicultural activity generally approved by regulatory authorities and practitioners as acceptable and common to that type of operation. AMPs may not be the best methods, but are acceptable.
Aquatic biota - all organisms that, as part of their natural life cycle, live in or on waters.
Basin - one of seventeen planning units in Vermont. Some basins include only one major watershed after which it is named such as the White River Basin. Other Basins include two or major watersheds such as Basin 11 including the West, Williams and Saxtons Rivers.
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.
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 geomorphic equilibrium - the condition in which the physically dynamic nature of fluvial systems is freely expressed over time in response to the range of watershed inputs and climatologic conditions, and as influenced by topographic, geologic, and existing human imposed boundary conditions.
Impaired water - water that has documentation and data to show: a violation of one or more criteria in the Vermont Water Quality Standards, or conditions that cause lack of full support for any given designated use for the water's class or management type.
Low Impact Development (LID) - a set of innovative stormwater management techniques and design practices that infiltrate, filter, store, evaporate, and detain runoff close to its source through small, cost-effective landscape features located at the lot or development level that maximize natural areas. These include practices such as raingardens, dry wells, filter/buffer strips, grassed swales, downspout disconnections, and rain barrels.
Nonpoint source pollution - waste 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.
Point source - any discernable, 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.
Riparian – located on the banks of a stream or other body of water.
Riparian Buffer Zone - the width of land adjacent to lakes or streams between the top of the bank or top of slope or mean water level and the edge of other land uses. Riparian buffer zones are typically undisturbed areas, consisting of trees, shrubs, groundcover plants, duff layer, and a naturally vegetated

uneven ground surface, that protect the waterbody and the adjacent riparian corridor ecosystem from the impact of these land uses.

Runoff - water that flows over the ground and reaches a stream as a result of rainfall or snowmelt.

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.

Total Maximum Daily Load (TMDL) – the calculation of the maximum amount of a pollutant a waterbody can receive on a daily basis and still meet Vermont Water Quality Standards.

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, wetlands 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).

Appendix A - Local Planning and Zoning for Water Quality Protection

Many of the activities that impact water quality with the notable exception of agricultural use are regulated by town plans, ordinances, and zoning. Some of the specific measures that can be implemented at the town level to control phosphorus and generally protect water quality include the following:

- Streambank and lakeshore setback requirements
- Vegetated buffer protection
- Standards that minimize the creation of new impervious surfaces and support other low impact development practices
- Small construction site erosion control standards to minimize site disturbance and erosion
- Non-regulatory options such as the purchase of conservation easements, the re-planting of streambanks and shoreline, and educational events.

Table 1. reflects current municipal planning and land use regulation in place to protect water quality in Franklin County.

Table 1. Water Quality Protection in Local Planning and Zoning in Franklin County (Updated January, 2011)

	TOWN PLAN	LAND USE REGULATIONS (ZONING & SUBDIVISION)			
Municipalities	**Water Quality Goals?**	**Require Preservation of Natural Resources?**	**Stormwater Mgmt Standards?**	**Reference VANR Stormwater Manual?**	**Setback/Buffer Required?**
Bakersfield	Yes	Yes	Yes	Yes	Yes (110ft)
Berkshire	Yes	Yes	Yes	Yes	Yes (110ft)
Enosburg Falls	Yes	Yes	Yes	Yes	Yes (50-100ft)
Enosburgh Town	Yes	Yes	No	No	Yes (25-110ft)
Fairfax	Yes	Yes	Yes	Yes	Yes (50ft)
Fairfield	Yes	Yes	Yes	No	Yes (25ft)
Fletcher	Yes	Yes	No	No	Yes (25ft)
Franklin	Yes	Yes	Yes	No	Yes (50ft)
Georgia	Yes	Yes	Yes	No	Yes (50-200ft)
Highgate	Yes	Yes	Yes	No	Yes (100-150ft)
Montgomery	Yes	No	No	No	No
Richford	Yes	No	No	No	No
Saint Albans City	Yes	Yes	Yes	No	No
Saint Albans Town	Yes	Yes	Yes	No	Yes (15-75ft)
Sheldon	Yes	Yes	Yes	Yes	Yes (50ft)
Swanton Town & Village	Yes	Yes	Yes	Yes	Yes (50ft)

Appendix B - Agriculture in the Basin

(Prepared by the Vt. Association of Conservation Districts for the Vt. Agency of Agriculture, Food and Markets)

Summary

About 25% of the Missisquoi Bay Watershed (or basin) is in agricultural use. One in ten individuals is estimated to work in agriculture. Agriculture returns $115,435,000 to the local economy and results in secondary output and value added amounts which add another $100,000,000 to that figure – almost a quarter of a billion dollars.

The challenge is to 1) come to terms with consequences of past use of phosphorous, 2) implement practices which have been designed for the current environmental needs, and 3) continue to maintain the economic viability of the agricultural community along a range of management options, including advanced and innovative technologies.

Farmers have since 1996 implemented conservation practices at a total cost of $4,453,922. In doing so, farmers spent $1,415,416 of their own funds. There is an additional $5,026,759 committed to practices which are still to be implemented over the next three years. Farmers also implemented numerous conservation practices prior to 1996. These efforts and expenses have served to reduce phosphorus inputs into surface waters. An additional period of time will be needed for all small farms in the watershed to have implemented Comprehensive Nutrient Management Plans (CNMPs).

Farm Economic Data

Of the 770 farms listed in the 2002 Census in Franklin County, farming is the primary occupation of 65% of the farm operators. The total market value of the agricultural products sold in Franklin County in 2002 was $115,435,000, up 26% from 1997 (USDA Census of Agriculture, 2002 County Data). Added to this amount are secondary outputs of $38,730,026 and value-added dollars of $26,612,000, for a total economic Impact for the county of $210,540,026 (American Farmland Trust, 1998)

Agriculture – Farm Numbers and Types

Two hundred and fifty Missisquoi River Basin dairy farms are located in Franklin County, thirty eight dairy farms are in Orleans County, and two farms are in Lamoille County, for a total of two hundred and ninety.

> ***LFOs*** - Four Large Farm Operations (LFOs) are in the watershed, spanning Franklin County and Orleans County. There are 19 Large Farm Operations in the State of Vermont; 17 are dairy farms and one each poultry and beef operations. An LFO is defined as a dairy farm with 700 or more mature cows (dry or lactating), 1000 beef animals, 500 horses, or a poultry operation with over 30,000 birds.
>
> ***MFOs*** - There are approximately 200 Medium Farm Operations (MFOs) in Vermont. Of these up to 40 may be all or partially within the boundaries of the Missisquoi River Basin. This rule applies to farms with 200 or more mature cows (dry or lactating), 300 or more youngstock or heifers, 150 horses, 3000 sheep, or 9000 hens. The significant conditions of the general permit are two fold. First, there may not be a discharge from an MFO. This means no waste (manure, spoiled feed, milk house liquids, barnyard runoff etc) may leave the production area and enter surface water. Second, the MFO must follow a nutrient management plan for the land application of wastes and additional nutrients. Land application of wastes may not result in the primary or secondary groundwater standard being exceeded.

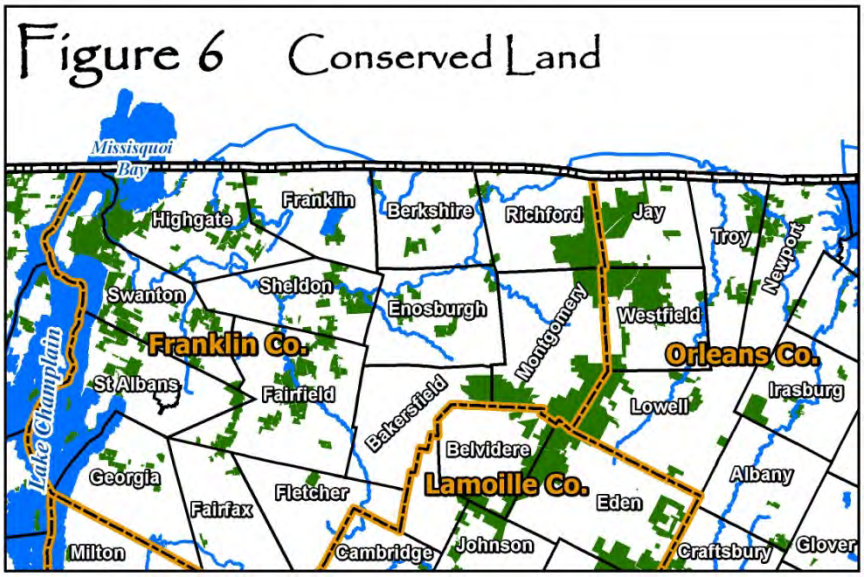
SFOs - There are approximately 6,000 Small Farm Operations (SFOs) in Vermont. This applies to farms with 199 or less mature cows (dry or lactating), 299 or less youngstock or heifers, 129 or less horses, 2999 or less sheep, or than 8900 or less hens. Of these up to 400 may be all or partially within the boundaries of the Missisquoi River Basin. Up to 245 may be dairy farms, including farms raising dairy heifers. More than 100 are non dairy farms involved in animal agriculture. The fastest growing segments of small farm operations are horses, including ponies. 40 per cent of the small farm operations in this watershed raise horses. Horse operations include a range of farms, including stables that board horses, breed horses or train horses, and riding stables. Beef cows and dairy heifers are next in the number of small farms. Sheep, goats, llamas, elk, and birds are raised on the smallest percentage of small farms.

The Small Farm Operation permit will also capture any farm with any number of animals of any kind. The number of operators in this group is estimated at the remaining number of dairy farmers, and all the beef farmers, horse, sheep, goat, llama farm operators, and individuals raising dairy replacements. These operations number in the hundreds, and when accounted for, could number a thousand in the watershed. Currently a portion of these small farms are receiving technical assistance from the conservation partners including USDA NRCS and the AAFM.

Organic Farms - There has been an increase in the number of organic dairy farms in the past few years. Of the estimated 6,000 farms in Vermont, 446 are currently certified organic with the Northeast Organic Farming Association (NOFA). As of 2006 there are currently an estimated 10 organic dairy farms in the Missisquoi River watershed (NOFA, 2007) and it is expected that number has continued to rise. Only one fourth of the certified organic farms in Vermont ship milk or make cheese. So it can be expected that an additional 30 farms in the watershed are certified organic with the majority selling vegetables, herbs and flowers or hay. These farms encompass 4,821 acres of farmland in organic hay and pasture. Another 304 acres of field crops are grown on two farms and approximately 424 acres has been certified as organic for the production of fruits and vegetables on 10 different farms.

Agricultural Conservation Easements

Land trusts came to be in Massachusetts more than 100 years ago, and now the Northeast has the greatest number of land trusts in the nation. Vermont is among the 10 states with the highest amount of conserved land and ranks sixth overall. Of the 290 dairy farms in the watershed, an estimated 100 are conserved (Figure 6). These lands are primarily in the Hungerford Brook, Rock River, Missisquoi River, and Black Creek watersheds.



Irrigated Land

In Franklin County, 34 farms irrigated 246 acres of farmland (2002 Census of Agriculture).

Conservation Practices In Place: Timeline and Implementation

Active federal involvement with soil conservation began in the 1930s. In 1993 the Soil Erosion Service within the Dept of the Interior started to conduct research. In 1935 the Soil Erosion Service was moved to the USDA. The Conservation Technical Assistance Program (CTA) was established in 1935. It was designed to assist farmers in planning and installing approved conservation measures to protect agricultural land from soil erosion. In 1944-45 the Agricultural Conservation Program began. During the 1970s the emphasis changed to focus on implementing multiple Best Management Practices (BMPs). The Food Security Act of 1985 mandated a conservation plan to receive payments. These early efforts were followed by three decades of implementation of conservation practices implemented in this basin (Uri, 1999).

Accepted Agricultural Practices

The Accepted Agricultural Practices Regulation passed in 1996 provided for on farm assistance to farmers to work towards voluntary non point source pollution reduction. Three technical staff were hired in partnership with USDA NRCS and the Vermont Association of Conservation Districts. Early efforts included assisting producers with the ban on land application of manure in winter, site assistance visits for spreading exemptions, and implementation of the Farm*A*System program, an early whole farm planning tool which in Vermont included testing the farm's drinking water.

To support the basin planning process, the Agriculture Resource Specialist (ARS) visited farms in the watershed. The ARS also participated in and hosted farmer meetings to discuss the goals of watershed planning, and phosphorous reduction goals for Missisquoi Bay.

Changes to the Accepted Agricultural Practices as of April 2006 include streamside buffers, new waste storage systems built to USDA NRCS standards and specifications, soil testing every five years, and increased management of stream banks where animals cross or water. Current efforts focus on education and outreach surrounding the changes.

BMP Cost Share Increase

A number of farmers started a conversation about how to best reduce phosphorus inputs to surface waters. The concern was stated that USDA NRCS whole farm fixes are so expensive that only a handful of farms are being treated every year even in the larger dairy counties. The Vermont Agency of Agriculture supported legislative changes to the BMP to increase cost share in the 2006 legislative session and received authorization to change cost share rates for some practices. The goal is to implement practices on farmland with more flexibility.

Environmental Quality Implementation Program (EQIP)

The 2002 Farm Bill consolidates and better targets the functions of the Agricultural Conservation Program (ACP) Environmental Quality Implementation Program (EQIP) in the 1990s and to the present. The main focus of this work was liquid manure storages, although some alternative systems were implemented including compost stacking pads, and a methane digester. In the 1990s there was an effort to include milk house waste water in the manure storages. The present challenge is to contain concentrated silage leachate from bunker silos and to retrofit that into the existing barnyard layout.

USDA NRCS EQIP funds committed in Franklin County since 1997 equal $3,465,567.09 including funds committed to the AMA program in 2005 and 2006. Practices funded include barnyard practices, field practices and transition to organic (AMA).

Currently Franklin County USDA NRCS office is working on 20 EQIP contracts for MFOs. Franklin County NRCS office is also working on 12 contracts for farmers transitioning to organic.

Table 1. Summary of Best Management Program Commitments

PART A - COMPLETED PROJECTS

Fiscal Year	Number	Phosphorus Reduction (lbs)	Actual Project Cost	Federal Funding Awarded	State Funding Awarded	Actual Land Owner Cost
1996	29	1,623	$320,411	$230,933	$33,423	$56,056
1997	12	324	$132,969	$81,624	$29,089	$22,256
1998	12	456	$285,683	$138,316	$69,540	$77,827
1999	27	991	$357,206	$188,255	$73,385	$95,565
2000	11	331	$301,415	$120,121	$93,231	$88,064
2001	18	613	$404,197	$109,197	$129,272	$165,728
2002	8	134	$208,774	$128,955	$40,238	$39,581
2003	25	1,025	$903,384	$196,304	$176,174	$530,906
2004	43	240	$337,135	$249,859	$36,749	$50,527
2005	29	783	$610,097	$251,316	$157,713	$201,068
2006	38	280	$257,275	$159,844	$57,613	$39,818
2007	21	1,694	$318,981	$215,010	$58,410	$45,560
2008	1	0	$16,395	$11,115	$2,821	$2,459
TOTAL	**274**	**8,494**	**$4,453,922**	**$2,080,848**	**$957,657**	**$1,415,416**

PART B - UNFINISHED PROJECTS

Fiscal Year	Farms Awarded Grants	Total Projects	Number	Est. Phosphorus Reduction (lbs)	Est. Total Cost	Federal Funding Committed	State Funding Committed	Est. Land Owner Cost
1996	22	29	0	0	$0	$0	$0	$0
1997	11	12	0	0	$0	$0	$0	$0
1998	8	12	0	0	$0	$0	$0	$0
1999	17	36	9	633	$27,571	$15,997	$7,437	$4,137
2000	9	17	6	54	$57,072	$37,039	$11,472	$8,561
2001	6	23	5	0	$41,540	$2,020	$31,414	$8,106
2002	9	23	15	718	$169,969	$92,239	$51,135	$26,595
2003	12	69	44	361	$328,707	$177,631	$76,503	$74,573
2004	10	107	64	280	$535,218	$390,489	$63,118	$81,611
2005	10	113	84	778	$673,606	$498,856	$74,783	$99,967
2006	8	137	99	1,222	$1,107,378	$573,829	$300,172	$233,377

2007	11	124	103	6,241	$1,515,060	$905,818	$378,510	$230,732
2008	7	106	105	45	$570,639	$348,313	$126,719	$95,606
TOTAL	**140**	**808**	**534**	**10,331**	**$5,026,759**	**$3,042,231**	**$1,121,262**	**$863,266**

Source: *Vermont Agency of Agriculture, Food and Markets/ARMES 2008.*

Table 2. Summary of Conservation Practices Applied in Franklin County

Practice	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	TOTAL
Field Border (ft)	10,900	2,475				**13,375**
Forest Stand Improvement (ac)	63	94	77	125	52	**411**
Nutrient Management (ac)	9,880	6,648	5,247	1,477	1,156	**24,408**
Pest Management (ac)	5,267	3,300	4,591			**13,158**
Prescribed Grazing (ac)	930	1,171	303	309	395	**3,108**
Residue Management, No Till/Strip Till (ac)	455	455	455			**1,365**
Residue Management, Seasonal (ac)	67	51				**118**
Riparian Forest Buffer (ac)	12	28	17	84	19	**160**
Streambank & Shoreline Protection (ft)	225	2,350	550			**3,125**
Tree/Shrub Establishment (ac)	83	36	15	9	36	**179**
Waste Storage Facility (#)	5	10	10	6	2	**33**
Wetland Restoration (ac)		118	1		19	**138**
Wetland Wildlife Habitat Management (ac)	167	168				**335**

Source: *http://ias.sc.egov.usda.gov/PRSHOME/*

Comprehensive Nutrient Management Plans

In an effort to assist Vermont farms comply with Federal Concentrated Animal Feeding Operation (CAFO) and State Medium Farm Operation (MFO) regulations, the Agency of Agriculture, Food, and Markets offered financial assistance for the development and maintenance of Nutrient Management Plans**.** Nutrient Management Plan Incentive Grants offer payment of soil and manure/waste testing and assistance for three additional years of Nutrient Management Plan updates. To date $1 million has been spent on CNMPs. It is anticipated that all the Medium Farms in Vermont will have plans in place by the end of 2008.

USDA Natural Resource Conservation Service (NRCS) requires CNMPs for farmers receiving technical assistance with cost share funds. NRCS completed an estimated 30 CNMPs for farmers in the watershed in 2006.

Plans are also being prepared by Technical Service Providers (TSPs) certified to work in Vermont. Working in Vermont are a Canadian firm, a New York state firm, a Vermont firm, and a number of individuals working with the NRCDs and independently.

NRCD Land Treatment Planners working in cooperation with NRCS and the Vermont Agency of Agriculture prepare the land treatment portion of 50 plans a year statewide.

UVM Extension Agronomist Jeff Carter is also available to assist farmers and their Technical Service Providers (TSPs). Jeff Carter will work with farmers to navigate the choices, with the goal to get a plan and be ready for the Medium Farm Operation regulation.

In 2007 the Lake Champlain Basin Program (LCBP) provided $200,000 to Bordeau & Bushey, Inc. to provide technical assistance to 30 small farms (less than 200 dairy cows) to create nutrient management plans.

UVM Extension has received grants from AAFM and LCBP to work with farmers interested in writing their own Nutrient Management Plans, in cooperation with the Franklin Natural Resource Conservation District planner.

Missisquoi Crop Management Services was formed at the inception of the Lower Missisquoi Water Quality Project in 1990. Nineteen farmers formed the Missisquoi Crop Management Association and worked with crop consultants Paul Stanley and Sarah Cushing to reduce total phosphorus fertilizer application by an average of 40%. Paul Stanley currently works with 30 farmers.

It is estimated that 100 CNMPs are known to be completed to date in the watershed, not including past work done by USDA NRCS, and 27 known to be in process.

Conservation Reserve Enhancement Program (CREP)

Vermont's Conservation Reserve Enhancement Program (CREP) program began in 2001. Thus far in Franklin County there are 22 CREP/CRP contracts with 276 acres enrolled. Statewide, there are 127 total CREP/CRP contracts covering 1,330.6 acres (December 2004).

Vermont Agriculture hired a CREP coordinator to work with individuals in the Lake Champlain watershed. The coordinator successfully worked through the Farm Service Agency to increase the rates paid for agricultural land in Franklin County placed into CREP. The CREP acreage signed up and progressing toward signup equals 99 acres total.

Farmland Protection Program (FPP)

Farms conserving land using funds from this program were encouraged to get a conservation plan written for their farm. Thirty conservation plans were written for Franklin County farmers conserving land.

Methane Digestion and Composting

Methane digestion and power generation has the potential to reduce one ton of phosphorus per year from the watershed by providing options for handling phosphorus-containing liquids and solids, as modeled on the Blue Spruce Farm operation in Bridport.

Two Methane Digestion and Power generation systems have since been implemented in the Missisquoi River Watershed: one in Berkshire, and one in Highgate and Swanton. Both sites are at large farms, the size farm where methane generation systems are most cost effective.

Alternative Manure Management Program

In 2006-2007 USDA NRCS and the Vermont Agency of Agriculture, Food and Markets announced a demonstration-based Alternative Manure Management program. Nine proposals were awarded representing a variety of technologies which would be trialed throughout the Lake Champlain watershed. One example in the Missisquoi Bay Watershed is a project at Diamond Hill Custom Heifers in Sheldon, Vermont. The farm constructed a manure and bedding composting facility that also recovered heat energy for hot water and heating/ventilation needs. Additional construction support came from an NRCS Conservation Innovation Grant. The Vermont Alternative Manure Management Program funded a grant to evaluate the operation of the new composting system in several ways in order to reduce nutrients in the

farm waste stream. Specifically, the compost mixtures were sampled and analyzed for their concentrations of total and soluble phosphorus, nitrogen and carbon through the composting process and ultimate application. Additionally, the project team set up several compost and compost blend utilization demonstration sites on the farm, at a nearby school and a local municipality for use in erosion control, re-vegetating disturbed sites and improving crop fields. Observations recorded improved erosion control through the compost applications. Compost mixtures, composting operations and compost uses were also noted for their practicality for farm operations and compost end-users (Vermont Alternative Manure Management Program Project Summaries, May 2007). The program is no longer funded.

Pilot Testing Performance Based Incentives for Agricultural Pollution Control

This is a study implemented by Winrock International in conjunction with the University of Vermont and Iowa State University Extension, supported by a Conservation Innovation grant from the USDA Natural Resources Conservation Service. Performance-based incentives are designed to provide flexibility for farmers to select actions that make NPS pollution control a good business decision. As such, farmers incorporate environmental management into their farm business decision-making and seek the most cost-effective strategies to reduce runoff.

First, by focusing directly on reducing estimated P losses from specific fields, this approach seems more likely to result in ambient water quality changes than current programs. Second, the technical- and cost-effectiveness varies greatly within, as well as across, management changes based on specific characteristics of each field. Numerous actions that are not explicitly identified in current USDA programs are showing themselves to be highly cost-effective, with some actions producing savings for the farm, indicating that greater flexibility in current programs is warranted. The most cost-effective actions on participating farms include changing manure spreading patterns across the farm, changing fertilization to reduce P, reducing P in the dairy ration, reducing tillage operations, and changing crop rotations. Third, motivating farmers, through increased profits, to find the most cost-effective actions for their farms also helps to increase farm viability, an on-going concern for rural communities, particularly in Vermont and the Northeast United States.

Appendix C - Wastewater Treatment Facilities in the Missisquoi Bay Basin

Discharges from wastewater treatment facilities (WWTF) compose the majority of Vermont's "steady-state" point source pollution[1]. In 1970's nearly half of the total load of phosphorus to Lake Champlain came from wastewater discharges; however, since 1990, significant funding for facility upgrades has yielded dramatic reductions in phosphorus and other pollutant loads. Flows from WWTF in the Missisquoi basin are still significant: the 8 WWTF are designed to discharge a maximum of 4.6 MGD to the river, which would represent 14% of total flow at the lowest river flows (7Q10). This is rarely realized; however, as these facilities operate well below design capacity (on average 62% of design), and by definition, flows only attain 7Q10 one week in ten years. Further as a result of facility upgrades in the Missisquoi Basin, wastewater discharges now contribute only 1.9% of the total wastewater load from Vermont, and less than one tenth of one percent of total phosphorus loading to the lake in aggregate. The goal of current permitting requirements and ongoing data collection is to ensure that the pollutant loads from discharges continue to be managed such that receiving waters remain high-quality, and meet Vermont water quality standards.

Regulation

The Agency of Natural Resources (VANR) administers the National Discharge Pollutant Elimination System (NPDES) permit program for discharges from WWTF to state waters. In addition, the agency implements the Vermont Toxic Discharge Control Strategy (TDCS) to quantify all NPDES discharges in Vermont and to establish water quality criteria and discharge permit limits that can be used to regulate discharges in a manner that will assure that Vermont water quality standards and receiving water classification criteria are maintained.

Data collection

To establish permit criteria that will meet Vermont water quality standards (WQS), the agency conducts monitoring and assessment of all the facilities' discharging to wadeable streams, as well

as all major Lake Champlain tributaries. In addition, all permittees are required to monitor regularly several core chemical constituents under their permits. Current data indicates that the facilities achieve a high quality of effluent that complies with WQS. Where data indicates problems exist, VANR assists towns in identifying WWTF needs and obtaining loans or grants from the Clean Water State Revolving Funds to upgrade municipal wastewater systems to reduce pollutant loads.

The 2002 Lake Champlain Phosphorus TMDL

A Lake Champlain Phosphorus Total Maximum Daily Load (TMDL) was approved in 2002, which established phosphorus wasteload limits for each WWTF in the basin. Current permit criteria for effluent limitations are based on the TMDL; however, in 2011, EPA remanded the TMDL as a result of legal challenge. New wasteload capacities for all or some WWTF in Basin 6 may be prescribed when EPA issues a new TMDL.

Table 1. Missisquoi Bay Basin Vt. Wastewater Treatment Facilities

Facility	Year	Annual Average Flow (mgd)	Maximum Permitted Flow Limit (mgd)	Measured Annual Phosphorus Load (mt/yr)	Phosphorus Load Limit under the prior 2002 TMDL (mt/yr)	Expiration Date	# CSO, which are not compliant with the State CSO Policy	Receiving Water
Enosburg Falls	2011	0.296	0.450	0.075	0.373	3/31/2013	0	Missisquoi River
Newport Center	2011	0.034	0.042	0.030	0.006	3/31/2009	0	Mud Creek
North Troy	2011	0.066	0.110	0.137	0.760	9/30/2013	0	Missisquoi River
Richford	2011	0.251	0.380	0.166	0.420	6/30/2014	0	Missisquoi River
Rock Tenn	2011	0.219	2.500	0.148	1.260	12/31/2013	0	Missisquoi River
Sheldon Springs	2011	0.020	0.054	0.058	0.373	6/30/2012	0	Missisquoi River
Swanton	2011	0.597	0.900	0.254	0.746	12/31/2008	0	Missisquoi River
Troy/Jay	2011	0.043	0.200	0.032	0.221	9/30/2014	0	Missisquoi River

Facility-specific information

Richford: facility upgrade is complete and operational.

Troy/Jay: The upgraded wastewater treatment facility was put online in 2012. To accommodate expansion of the Jay Peak Resort, as well as development in the Town of Jay, treatment has been increased from 200,000 gallons per day to 800,000 gallons per day. The enlarged facility is required to achieve a phosphorus concentration of 0.2 milligrams per liter at full capacity.

Swanton: The 2013 Municipal Control Projects Priority List identifies this facility for $250,000 in loan funds to complete planning for their required 20 year refurbishment evaluation.

Appendix D - Pesticide detection in Missisquoi watershed surface waters

The Missisquoi River watershed is a highly agricultural landscape, with dairy farming being the dominant agricultural activity. Herbicide use to control weeds in field corn used to feed dairy cows is therefore the largest pesticide use in the watershed. Although the specific pesticides in use are constantly changing, atrazine and metolachlor continue to dominate the corn herbicide market, and therefore are the pesticides of most potential concern for the surface waters of the Missisquoi Basin. In 2002, The Vermont Agency of Agriculture, Food, and Markets (VAAFM), in association with the Vermont DEC and the Lake Champlain Basin Program, began routine monitoring of these corn herbicides and selected breakdown products in the Missisquoi River and other Lake Champlain tributaries, as well as portions of the lake itself.

Trace amounts of herbicides and their breakdown products are routinely detected in water bodies in agricultural areas of the Missisquoi Basin, although generally at concentrations far below levels of concern to aquatic plants or animals. Atrazine is the pesticide which is generally found at the highest concentrations in the Lake Champlain basin, and is one of the most widely studied pesticides due to its widespread use on corn. EPA has listed several benchmark concentrations at which atrazine can be of concern in surface waters. At concentrations as low as 1.0 ppb, EPA has found that atrazine is acutely toxic to some nonvascular plants, (e.g., algae) while for vascular plants the acute concentration is 37 ppb. The chronic aquatic community benchmark for atrazine is 17.5 ppb according to EPA. With the exception of a small stream discussed below, the highest concentrations of atrazine found to date in the Champlain basin have been associated with a large storm across the northern tier of Vermont in June of 2002. This one storm led to atrazine concentrations in the Missisquoi River of 1-2 ppb for about a week, the Pike River peaked at 10.8 ppb, and Missisquoi Bay reached 0.9 ppb. Metolachlor levels were elevated after this storm as well, with a maximum concentration detected of 5.7 ppb in the Pike River, EPA's chronic benchmark for invertebrates is 1 ppb. It is difficult to interpret these data in comparison to the EPA benchmarks because the EPA acute numbers for vascular and nonvascular plants are based on less than 10 day averages while the Vermont data is based on individual grab samples. The atrazine concentrations after this 2002 storm event certainly could have had an effect on individual plant species, and possibly a community level effect in the Pike River, but they are unlikely to have had a lasting effect, or an effect within the lake system as a whole considering these levels have only been observed once in 10 years. The atrazine concentration of 0.9 ppb found in Missisquoi Bay in June of 2002 is the highest level detected in any portion of Lake Champlain

during 11 years of monitoring. Generally all herbicides and degradates are found below 0.10 ppb, if at all, in Lake Champlain.

Jewett Brook, within the St. Albans Bay watershed, is a small stream in a highly agricultural landscape and it seems to have chronic contamination with corn herbicides. Atrazine levels reached 33 ppb in June of 2010, with metolachlor concentrations of 18 ppb. These were extreme values, but concentrations exceed 1 ppb most years. These elevated levels are probably a result of Jewett Brook being a small stream in a highly agricultural watershed. Again, interpretation of these results is difficult without knowing how long the elevated levels persisted, but continued monitoring is warranted.

As mentioned above, the highest concentrations of herbicides in the Champlain watershed have been detected when there is a large rainstorm shortly after corn planting and herbicide applications. These situations are often due to localized downpours, and as such are restricted to individual watersheds. There is obviously no way to prevent downpours, so minimizing runoff from corn fields is the most effective means to minimize herbicide entry into the surface waters of Vermont. Maintaining intact vegetated buffers and following VAAFM Best Management Practices can minimize runoff of agricultural chemicals as a whole.

It should be noted that while agricultural activities comprise the largest use of pesticides in the basin, other pesticide uses occur that are not actively monitored over time. The largest category of unregulated pesticide use is among private applicators and homeowners, who apply herbicides, insecticides, and fungicides to lawns, gardens and home. Other uses include rights of way and roadways and aquatic nuisance control for macrophytes and lamprey. The long term impacts to non-target organisms from many of these pesticide applications are not widely known.

Appendix E - Responsiveness Summary to Pubic Comments Regarding:

Missisquoi Bay Watershed (Basin 6) Water Quality Management Plan

On December 6, 2012 the Vermont Department of Environmental Conservation (DEC) of the Agency of Natural Resources (ANR) released a final draft of the Basin 6 Water Quality Management Plan for a public comment period. The public comment period, which ended on January 23rd, 2013, included three public meetings.

Thursday, January 3, 2013 12:30 pm to 2:30 pm North Troy Village office 160 Railroad Street North Troy, Vermont	Thursday, January 3, 2013 4:30 pm to 6:30 pm Enosburg Emergency Services Building 83 Samsonville Road Enosburg Falls, Vermont	Tuesday, January 8, 2013 7:00 pm to 9:00 pm Swanton Emergency Services Building Swanton, Vermont

The DEC prepared this responsiveness summary to address specific comments and questions and to indicate how the plan has been modified. Comments may have been paraphrased or quoted in part. The full text of the comments is available for review or copying at the Essex Junction Regional Office of the Department of Environmental Conservation, 111 West Street, Essex Junction, Vermont 05452.

Comment: The following are comments regarding the implementation table:

Under Stormwater Runoff for Development: Action Item #1- Add regional planning commissions (RPCs) to partners list. The RPCs have a contract to complete specific training and GIS tasks to help implement the Green Infrastructure Initiative.

Under Agricultural Activities: Action Item #5 & 10- Consider adding the Friends of Northern Lake Champlain (FNLC) to the partners list.

Under Transportation Infrastructure- Objective 3 calls for a reduction in salt and sand use for winter maintenance but there are no action items addressing this issue. One action item could be to "Encourage municipalities to explore new technologies (such as salt brine) that can reduce the use of winter salt and sand."

Response: All suggestions were accepted and incorporated into the final draft.

Comment: The Friends of the Northern Lake Champlain are completing stormwater master planning for Fairfield and Sheldon as well as Georgia. The implementation table should reflect this work.

Response: The implementation table supports the work in the section entitled, Stormwater Runoff from Development, in action #2 and lists FNLC as a partner: *Assist municipalities in developing a strategic water resources management plan that identifies and prioritizes stormwater improvement projects as well as potential ordinances that could help reduce impacts from new development. Work with municipalities to connect the concepts of stormwater management, floodplain management, river corridor protection, and land use.*

Comment: The Plan seeks the removal of the Swanton Dam. As an alternative, we would propose that the plan acknowledge the "significant public benefits" which the dam provides to the people of Swanton Village and Town and to the many visitors who use and appreciate the quiet backwater which the dam provides. Indeed, the plan acknowledges that there are dams "that are not good candidates for removal because they provide significant public benefits". (See page 57, Action Item 1.) Reasons for keeping the dam include: removal would not lead to improvement of the water quality of Missisquoi Bay; Swanton Town, Swanton Village, Swanton Historical Society and the Swanton Chamber of Commerce have each passed resolutions against removal of the dam, favoring its preservation and utilization; listed on the State Register of Historic Places; the backwater above the dam is featured in the Northern Forest Canoe Trail; necessary resource for fire suppression in the downtown area of Swanton Village; surveys indicate that residents not in favor of removal; subject of a UVM graduate student treatise entitled "The Sound of Falling Water: A History of Water Use and Industry at Swanton Falls"; The Swanton Village Electric Department is pursuing utilization of the dam as a site for a small hydro project for renewable energy sufficient to provide electricity to approximately 100 homes; Swanton has preserved structures that depends on the backwater from the dam to provide historic context. Our dam is important to Swanton for the many reasons stated herein which constitute "significant public benefits" in our opinion.

Response: The plan describes the Agency's support of a study to identify benefits relating to dam removal or preservation. The Agency's list of proposed actions in the Implementation Table (see Hydrologic Modification), recommends in action 2, *Evaluate individual dams with potential for removal and develop removal plans in cooperation with the dam owner, local community and other partners.* Swanton Dam is included as a dam to evaluate in this manner.

The plan also provides background information about the Swanton Dam in Section 3.5. The following statement is made: *The Agency of Natural Resources and the USFWS have identified Swanton Dam as a high priority for removal, and will be engaging stakeholders in a process to identify issues and conduct the necessary studies to advance the project.* As the dam is owned by

Swanton village, it will be the village's decision as to whether or not the dam is preserved or removed. The Agency also appreciates the commenter's verbally-stated concern that identification of Agency support for removal in the Basin 6 plan is conclusive and indicates bias against preservation of the facility. Insofar as ANR's mission is currently focused in part on the challenges of habitat fragmentation and the need to make Vermont more resilient to flooding, the Agency supports the removal of the dam for specific fishery habitat reasons: Removal of the dam would reopen 7 ½ miles of fish habitat in the Missisquoi River. According to the US Fish and Wildlife Service, removal of the dam will allow native walleye and endangered lake sturgeon population to access more spawning habitat: 65 to 1,210 times more habitat for lake-run spawning walleye and over 300 times the current level could be realized by lake sturgeon (see http://www.vtfishandwildlife.com/library/Reports_and_Documents/Fish_and_Wildlife/Spawning_Habitat_Suitability_for_Walleye_and_Lake_Sturgeon_in_the_Missisquoi_River.pdf).

As was discussed at the Swanton public meeting on January 8th 2013, Dave Tilton, USFWS, announced that USFWS had received funding with help from U.S. Senator Leahy to support a Swanton dam study. The study is not intended to focus on dam removal, but to evaluate options, including preservation of the dam with or without hydroelectric capability. Tilton suggested that it may be beneficial for the study to be administered by a third party to ensure that the community sees the study as unbiased. The study would also most likely benefit Swanton's effort to determine the appropriateness of the dam as a hydroelectric facility, as the information requirements imposed by FERC for hydroelectric facilities are costly to fulfill, and the proposed study will fulfill certain of the core needs. Tilton indicated that the funding will be transferred to another river in the Champlain Basin if it is not used in Swanton this year. As such, and as outlined in the Implementation Table, The Agency is supportive of the initiation of a study that will provide both the dam owners and the resource agencies with all pertinent information for understanding the importance of the dam with regard to natural and cultural resources, and hydroelectric potential.

Comment: Other than the technical issues noted below this is a good plan. Lake Champlain International wants Vermont's water quality improved so that we in fact have a "swimmable, drinkable, fishable Lake Champlain." This can only be accomplished if the "real" problems driving degraded water quality conditions are accurately identified and then addressed with ample will power and resources to accomplish the task. Hence, modeling and data gathered to understand the source and nature of water pollution problems need to be reliable. Otherwise, resources may be expended on activities that will not accomplish the task of cleaning up the lake.

Response: ANR agrees and appreciates the need for good modeling and good data to target action. Hence the Plan highlights the most recent very detailed modeling work in the basin from LCBP and the NRCS Agricultural Research Service. We also contend that the Implementation Table of the Plan contains targeted actions that are specifically tied to on the ground monitoring

and assessment results stemming from the well-managed efforts of our own Agency, and our partners. LCI's technical comments (below) have been addressed as follows.

Comment: Lake Champlain International notes that the calculated phosphorus loads for urban non-point sources are based on a faulty analysis. The cited Troy et al., 2007 study purposefully omitted the Missisquoi Basin from their analysis. The 2011 SWAT analysis should have been used to identify these phosphorus loads.

Response: Precipitation-driven runoff is a significant conveyer of pollutants to waterbodies, and in other watersheds, runoff from developed land can provide almost 10 times as much phosphorus per acre than agricultural land (Troy et al., 2007), due to the runoff volumes. However, in the Missisquoi Basin, the most recent studies (LCBP, 2011) do indicate that agricultural land contributes 64% of overland phosphorus contributions, while developed lands only contribute 6%. The predominance of agricultural land in the basin makes it the primary source of phosphorus. This is not in dispute. The LCBP 2011 study was not available to our partners when this section of the Plan was drafted. The plan has been modified to reference phosphorus source attributions to the LCBP 2011 (aka SWAT) study.

Comment: Lake Champlain International is concerned about portrayal in Plan of SWAT in-stream P as not being specifically tied to agricultural sources. Agricultural phosphorus is responsible for in-channel/streambank phosphorus.

Response: This may be largely correct, but it is impossible to totally distinguish between sources of phosphorus from legacy agricultural activity and non-agricultural sources within streambank locations. Stream geomorphic assessments indicate significant deposits of legacy sediment that date from land clearing (Barry Cahoon, ANR Stream Alteration Engineer), which would also have contributed to in-channel sources. The relevant text on Page 17 and 26 was updated to reflect the nuance that in-channel legacy sediment and phosphorus may result from agricultural or non-agricultural sources.