Missisquoi Bay Watershed Basin 6 Tactical Basin Plan

October 2021 | DRAFT

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

Approved:

_____ _____

X Commissioner Date

Department of Environmental Conservation

_____ _____

X Secretary Date

Agency of Natural Resources

Plan prepared by: Karen E. Bates, Water Investment Division

GIS & Mapping support: Phillip Jones, Water Investment Division and Sean Regalado, Watershed Management Division

Cover Photo: Missisquoi Bay by Karen E. Bates

Missisquoi Bay Watershed (Missisquoi Basin) Municipalities

Alburgh*	Fairfax*	Lowell	Troy
Bakersfield	Fairfield	Montgomery	Waterville*
Belvidere	Fletcher	Newport Town	Westfield
Berkshire	Franklin	Richford	
Cambridge	Highgate	Sheldon	
Eden*	Irasburg*	St. Albans Town*	
Enosburg	Jay	Swanton	

*A *small area of the municipalities is in the watershed*

Contents

Executive Summary

The Missisquoi Bay Tactical Basin Plan is a surface water management plan to protect and restore the basin's rivers, lakes, and wetlands to ensure the sustained ecological health and community's use by meeting or exceeding the Vermont Water Quality Standards

The Vermont Clean Water Act requires the development and adoption of Tactical Basin Plans for each of Vermont's 15 river basins on a five-year rotational cycle. These plans integrate watershed modeling, water quality monitoring, sector-specific pollution source assessments, and stakeholder input to document geographically explicit actions and help ensure that state and federal funds are directed to the highest merit implementation opportunities.

The Missisquoi Basin covers the Vermont portions of the Missisquoi, Rock and Pike River watersheds as well as the Lake Champlain shoreline within the Missisquoi Bay. The basin's surface waters provide recreational opportunities, drinking water and support for wildlife habitat and plant communities. The five chapters in this plan are a framework for understanding the Missisquoi Basin's unique characteristics and water quality issues, and where and how to implement projects to protect and restore water quality in the basin.

The DEC-supported assessments and monitoring results described in Chapter 1 identify the pollutants or processes most responsible for degraded water quality and habitat. Pollutants include phosphorus, sediment, pathogens, and toxins as well as aquatic invasive species. The excessively high phosphorus levels in the Missisquoi Bay, as well as its watershed, lead to frequent algal blooms.

In Chapter 2, the plan identifies priority waters for protection with near pristine water quality or that provide uses that would be supported by upward reclassification or designation.

Chapter 3 includes achieved and targeted phosphorus reduction information (or Phase III content) for the Lake Champlain Phosphorus Total Maximum Daily Load (TMDL) that augments Phase II content initially presented in the 2016 Missisquoi Bay Tactical Basin Plan. Following the Phase II's established target phosphorus load reductions, Phase III describes progress made to date and sets incremental, five-year phosphorus load reduction targets.

Chapter 4 describes protection and restoration efforts underway or recommended for each source sector. A more detailed list of priority strategies and the geographic focus is included in Chapter 5 in the Implementation Table (Table 14). A summary table of the strategies by sector is found in Table 1. Also included is a list of surface waters needing additional monitoring to improve the Agency's understanding of surface water conditions in the basin. Individual projects are listed in the Watershed Projects Database. With the state's allocation of $30 million in American Rescue Plan Act (ARPA) funds for clean water projects to be spent within the five years covered by this plan, strategies will also help identify appropriate funding opportunities to assist in ensuring funds are effectively spent before the 2024 deadline.

Table 1.Priority Strategies with focus areas for the Missisquoi Basin

Focus Areas (HUC12 unless stated)		Priority Strategies
Agriculture	**Rock River, Enosburgh Falls-Missisquoi, Headwaters Pike River (Lake Carmi), Black Creek, Fairfield River, Hungerford Brook; agric-impaired streams;**	• Increase compliance with Required Agricultural Practice including Nutrient Management Plan Implementation, • Implement Farm and Field Best Management Practices (BMPs), • Enhance soil health • Coordinate with agricultural service providers to enhance delivery of services
Developed Lands – Stormwater	**Stormwater-impaired streams. Lake Carmi, Fairfield Pond; Towns of Enosburgh, Fairfield, Highgate, Sheldon, and Swanton**	• Develop and implement stormwater management plans • Improve functionality of stormwater infrastructure • Assist landowners with Three-Acre General Permit compliance • Use social marketing-based programs[1] to encourage adoption of residential Best Management Practices • Adopt winter ice management practices that reduces Chloride use
Developed Lands – Roads	**Very high- and high-ranking road segments in road erosion inventories, towns with high percentage of roads in these categories; Upper Missisquoi, Trout River(crossings)**	• Complete Road Erosion Inventories (REIs) and implement BMPs • Manage stormwater from private roads • Upgrade culvert culverts • Increase availability of road maintenance equipment to towns
Wastewater	**Basinwide**	• Upgrade and optimize phosphorus removal from WWTF to meet TMDL allocation • Improve onsite wastewater treatment • Improve septic system maintenance
Rivers	**Stream Geomorphic Assessment corridor plans and other assessments, outcome of Functioning Floodplain Initiatives**	• Develop and implement river corridor remediation projects including shoreline reforestation, floodplain restoration, dam removal • Protect floodplain, river corridor buffers
Lakes	**Lake Carmi, Fairfield Pond**	• Identify and Implement BMP in lake's watershed to reduce erosion • Prevent and manage aquatic invasive species spread
Wetlands	**Class I Wetland Candidate Conserve: Wetlands adjacent to Vermont Wildlife Management Areas Restoration, see the DEC RCPP Wetland Restoration Site Prioritization Map**	• Identify boundaries for a potential Class I designation • Restore and conserve wetland • Map wetland natural communities • Collect quantitative data on restored wetlands
Forests	**Forest Road Inventory high and very high outcomes for road segments, sugaring operations,**	• Identify and remediate erosion from logging roads and landings • Increase use of Acceptable Management Practice and Current Use Program

[1] https://www.epa.gov/sites/production/files/2016-09/documents/socialmarketingguide_overall.pdf

What is a Tactical Basin Plan?

A Tactical Basin Plan (TBP) is a strategic guide produced by the Vermont Agency of Natural Resources (ANR) to "protect the best and restore the rest" of Vermont's surface waters. The TBPs target resources to those actions that will have the greatest influence on surface water protection or restoration.

Figure 1. Five major policy requirements that feed into the tactical basin planning process

Tactical basin planning is carried out by the Water Investment Division (WID) in collaboration with the Watershed Management Division (WSMD) and in coordination with watershed partners. Tactical basin plans are developed in accordance with the Vermont Surface Water Management Strategy (VSWMS) and the Vermont Water Quality Standards (VWQS) to protect, maintain, enhance, and restore the biological, chemical, and physical integrity of Vermont's water resources. The plans also incorporate the U.S Environmental Protection Agency's 9-element framework (Environmental Protection Agency, 2008) and meet obligations of the Vermont Clean Water Act (Figure 1).

The water quality goals, objectives and strategies described in the TBPs protect public health and safety and ensure public use and enjoyment of Vermont waters and their ecological health.

The TBP process (Figure 2) allows for the issuance of plans for Vermont's fifteen basins every five years, as required by statute 10 V.S.A. § 1253. The planning process includes the following steps:

1. Monitor water quality;
2. Assess and analyze water quality data;
3. Identify strategies and related projects to meet surface water goals;
4. Gather and incorporate public input on the plan; and
5. Implement plan priorities and track accomplishments.

Figure 2. Steps comprising the five-year basin planning process.

The resulting tactical basin plans present an overview of surface water conditions that support the subsequent identification of surface waters as priorities for protection and remediation. The plan identifies strategies to meet surface water goals including special state designations, conservation of the natural landscape and actions for addressing pollutants and stressors (Figure 3). The plans also set out pollutant reduction targets necessary for restoring water quality (Total Maximum Daily Loads[2]) and document progress. To assist with implementation, strategies are organized by land use or natural resource sector and include eligible federal and state-funding sources and partners interested in assisting in implementation. Additional funding available during this planning cycle includes the State's allocation of $100 million in American Rescue Plan Act (ARPA) funds for clean water to be spent by 2024.

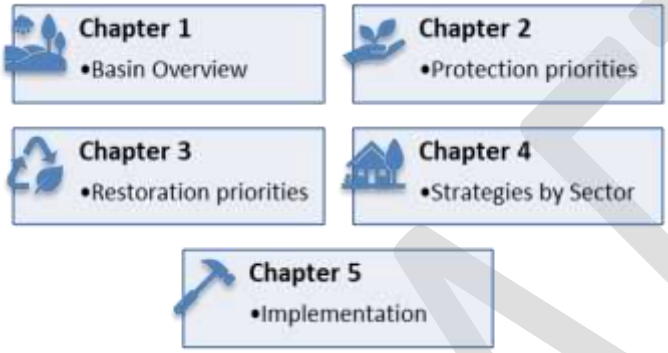


Figure 3. Key roles of the five chapters in Tactical Basin Plans

A successful basin planning process depends on a broad base of partnerships with other state agencies, federal, regional, and local governments, and organizations, including citizens and non-profits groups and academic institutions, (see Appendix A for Basin 6 partners). The partnerships strengthen the Agency's programs by attracting new ideas and input, increasing understanding of water quality issues, and building commitment to implementing solutions. Chapters 3 and 4, including Lake Champlain Phosphorus TMDL Phase III content, describes the formal and informal means to develop, maintain and enhance these partnerships.

The plan identifies strategies that will serve as the next five-year game plan, targeting individual projects that are tracked via its online counterpart, the Watershed Projects Database (WPD) and the Watershed Projects Explorer. The ANR's Clean Water Portal is an online platform, housing the above to assist partners with project development. Also linking to the Clean Water Portal is the Vermont Clean Water Initiative Annual Performance Report that outlines progress in implementing clean water practices by basin and includes report cards to EPA on strategy implementation. Another resource for viewing the annual performance report is the Clean Water Interactive Dashboard, a data visualization tool that allows users to filter and customize Vermont's clean water data presented in the report.

[2] Total Maximum Daily Loads (TMDL) establish a pollution reduction budget for phosphorus, that requires the reduction of pollutants through regulatory programs as well as voluntary restoration opportunities. See Chapter 3 for detailed explanation.

Chapter 1 – Basin Description and Conditions

A. Basin 6 Overview

Lake Champlain's Missisquoi Bay covers 19,150 acres, but only reaches a depth of 14 feet. The bay's watershed includes 767,246 acres with approximately 58% of the watershed located in Vermont and 42% in the Canadian Province of Quebec (Figure 4). In Vermont, the watershed extends over most of Franklin County, and parts of Orleans and Lamoille Counties.

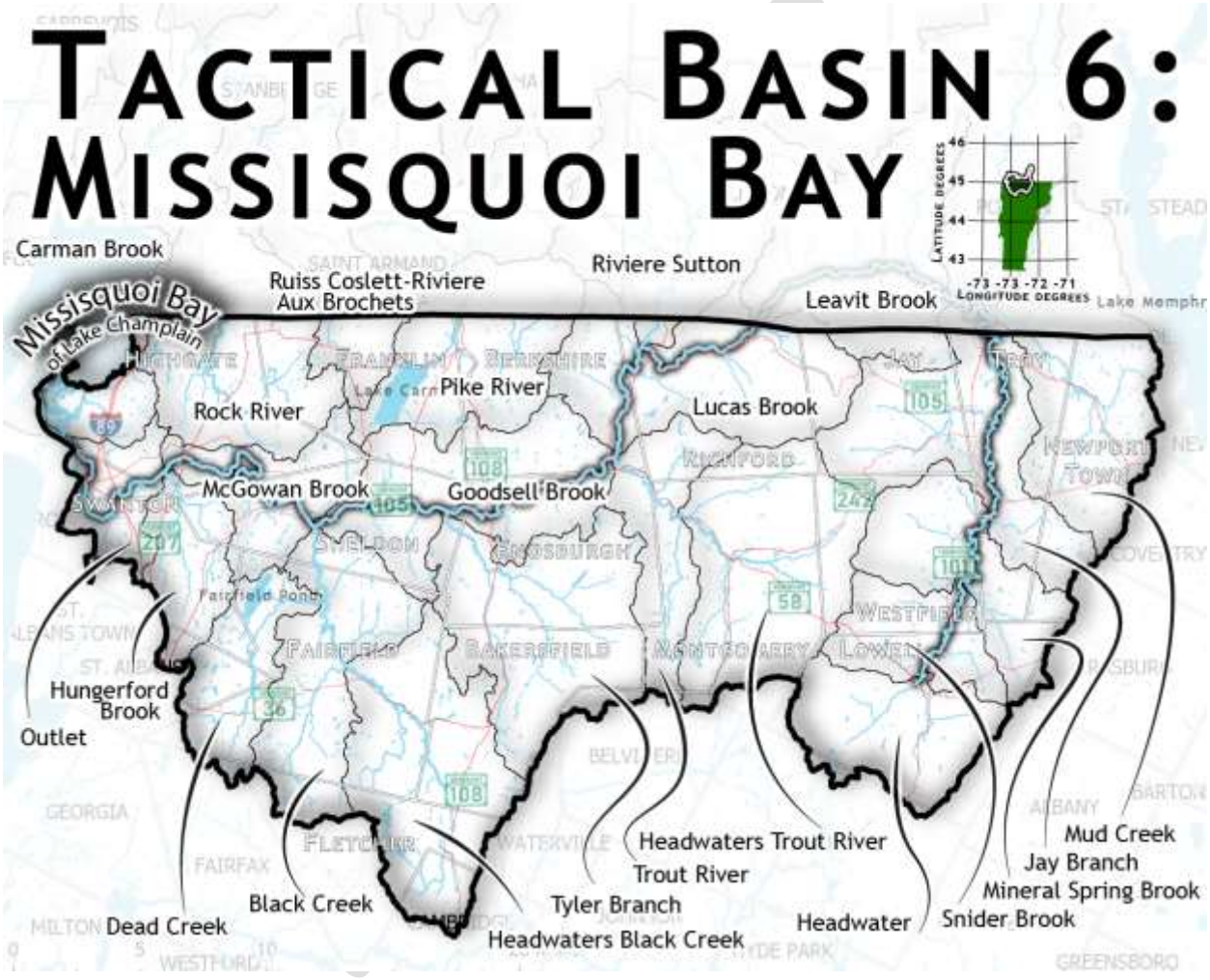


Figure 4. The Missisquoi Basin and subbasins (HUC12)

Major Tributaries and Subwatersheds

The Missisquoi River is the largest tributary of the Missisquoi Bay, followed by the Rock and Pike Rivers. The major Missisquoi River tributaries include Black Creek, Tyler Branch, and Trout River (Figure 5) and the Hungerford in the lower tributaries and Mud Creek in the Upper Tributaries (Figure 4). A detailed description of the bay's major tributaries are contained in the DEC Basin 6 Water Quality Assessment Report. The basin is also broken down into hydrologic-unit code HUC12s (Figure 4, Table 2) or subbasins because the modeling completed to identify detailed annual load (kg/yr) of phosphorus pollution and areal loading rate (kg/ha/yr) estimates for the basin are displayed by land use for each HUC12 (see Lake Champlain Phosphorus TMDL in Chapter 3). HUC12s are a hydrologic unit used for modeling landscape processes that affect water quality.

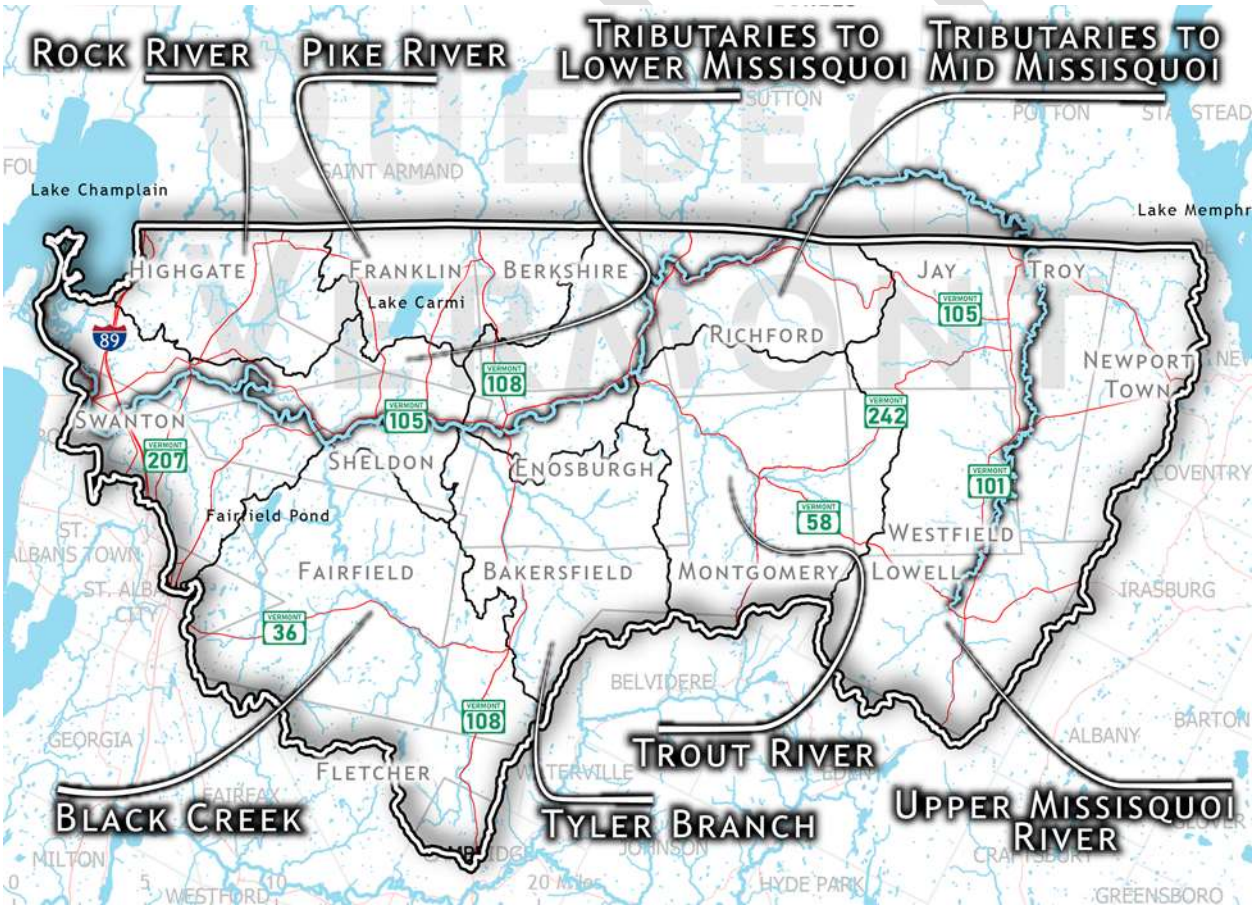


Figure 5. Major Tributaries to Missisquoi Basin

Table 2. Subbasins, streams, town, adjacent lake segments and HUC12s of the Missisquoi Basin

Major Tributaries (see Figure 5)	Lakes and ponds (20 ac or more)	Town (significant portion included)	**HUC12[3](see Figure 4)**
Rock River	Cutler	Highgate, Franklin	**Rock River**
Pike River	Lake Carmi, Little Franklin Pond	Franklin	**Pike River**
Black Creek	Fairfield Pond, Fairfield Swamp	Fairfield, Sheldon, Fletcher	**Headwaters Black Creek, Black Creek, Dead Creek**
Tyler Branch	Metcalf, Beaver Meadow Brook Pond	Bakersfield, Enosburgh	**Tyler Branch**
Trout River		Montgomery, Berkshire	**Trout River, Headwaters Trout**
Upper Missisquoi	McCallister	Lowell, Westfield, Troy, Newport Town, Jay	**Headwaters Missisquoi River, Mineral Springs Brook, Snider Brook, Jay Branch, Mud Creek**
Tributaries to Mid Missisquoi		Richford, Berkshire, Enosburgh	**Leavitt Brook, Goodsell Brook, Lucas Brook, McGowan Brook, Riviere Sutton**
Tributaries to Lower Missisquoi		Sheldon, Swanton, Highgate	**Hungerford Brook, Outlet Missisquoi,**

[3] Modeling results for Phosphorus loading (see Chapter 3) are provided at the HUC12 level. Chapter 4 identifies priority areas for remediation, including HUC12s with high Phosphorus loading.

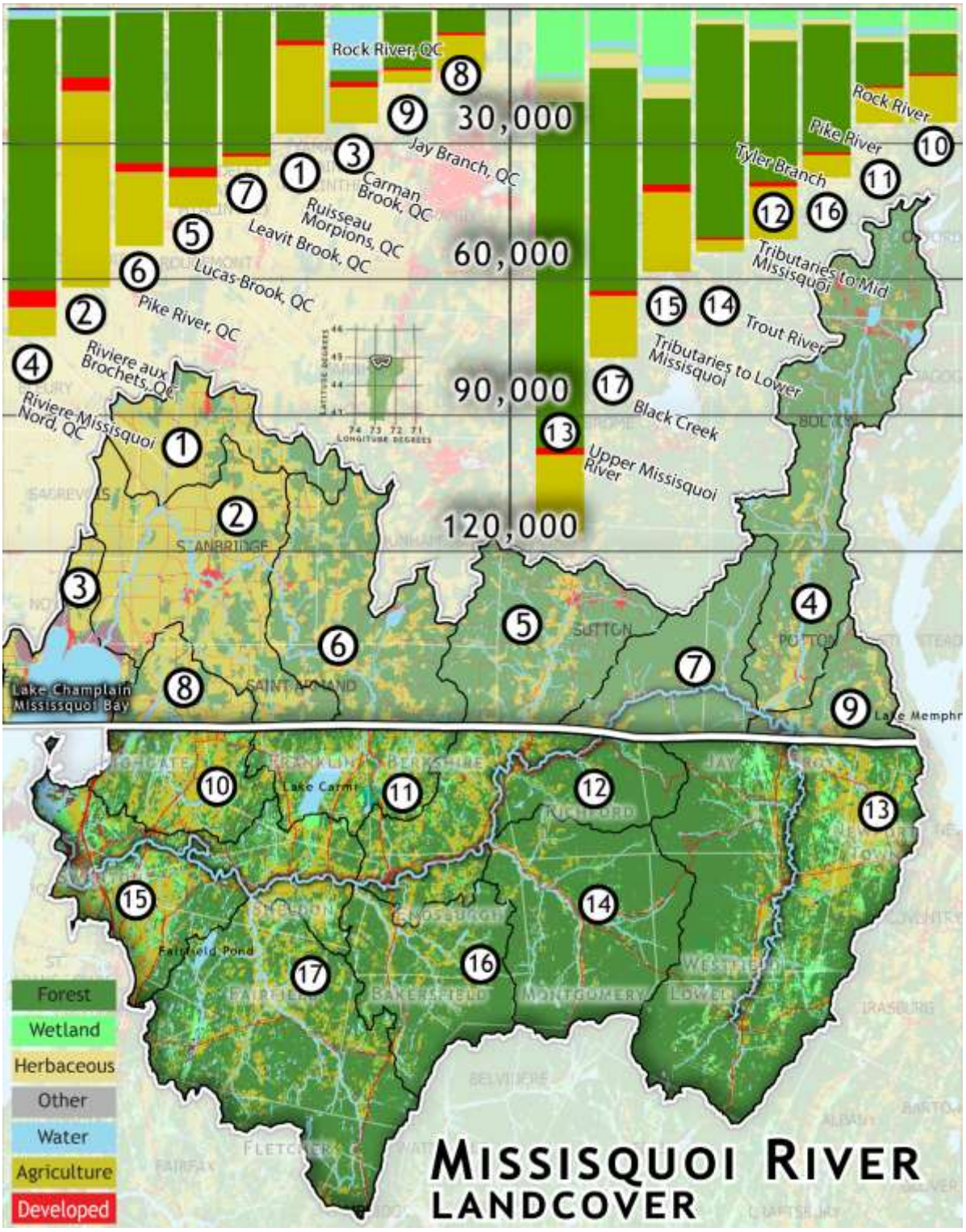


Figure 6. Missisquoi Basin land cover by basin and subbasin. The Quebec land cover data allows for only a rough comparison with U.S's[4].

The land use on the American side of the Missisquoi Bay watershed is 66% forested, and 25% agricultural. Developed land, including transportation infrastructure, occupies approximately 6% of land in the Basin (Figure 6). The health of a waterbody is controlled, for the most part, by the land use or land cover in its watershed. A forested watershed provides the best protection as it absorbs or detains the precipitation, with the Upper Missisquoi and Trout River subbasin as an example. Whereas, in landscape dominated by developed or agricultural land use, like the Rock and the Pike, impervious surfaces or compacted soils are responsible for sending polluted stormwater runoff to waterbodies. When comparing the land-use map, Figure 6, with the degraded waters map, Figure 13, the degraded waters are often adjacent to these developed and agricultural-managed landscapes.

Climate Change Implications for Water Resource Management

Adapting how we manage and use our surface waters in the face of climate change is one of the chief overarching challenges for Basin 6 and beyond (State of Vermont, 2021). Climate is defined by long-term weather patterns, which in turn influence human and natural systems. In Vermont, climate change is causing increases in storm intensity and total precipitation (Betts, 2011) (National Oceanic and Atmospheric Administration, 2013). These increases will likely lead to a rise in flooding, water quality and ecosystem impairments, and reduced water-based recreational availability to Vermonters (Pealer & Dunnington, 2011).

The 2014 Vermont Climate Assessment established state-level climate change information with implications for local surface waters. The Since 1941, Vermont average temperatures have increased 2.7° F with warming occurring twice as fast in winter (Galford, 2014). The latter results in earlier thaw dates for rivers, lakes and ponds, and mountain snowpack. Average annual stream flows are increasing, which is expected to continue in the future. High flows now happen more frequently, leading to increased inundation flooding and fluvial erosion (stream-related erosion) all of which can be exacerbated or alleviated by land-use management decisions.

Aquatic habitats affected by increased runoff and streamflow could experience increases in sediment mobilization, nutrients and scouring in addition to increased water temperature. In response, local freshwater plant and animal species may shift their geographic ranges and alter their abundance and seasonal activities (Stamp J, 2020).

Monitoring data also indicate changing drought conditions in the region. It is important to note these trends reflect what has been observed in the past, and in some cases these trends may or may not persist into the future. For example, many models and the information in the 2014 Vermont

[4] US data: LCBP 1m High-Resolution Land Cover Mapping of the Lake Champlain Basin . Canada data: 30m 2015 Land Cover of Canada

Climate Assessment suggest an increased frequency and severity of low-flow, drier conditions for Vermont due to predictions of longer periods between heavy rainfall events in future decades.

Maintaining habitat connectivity, river and lake riparian buffers, and stream equilibrium conditions will help reduce the impacts of climate change on Vermont's rivers, lakes and ponds, and wetlands. Protective measures, such as strategic land acquisition and limitations on development in riparian areas, may be the most economical solution to address the challenges presented by climate change and to achieve healthy surface waters (Watson, Ricketts, Galford, Polasky, & O'Niel-Dunne, 2016) (Weiskel, 2007). But where pollution from historic and current land use occurs, strategies are identified in this plan that will complement protective measures, such as river corridor easements, riparian area plantings, floodplain and wetland restoration, dam removals, and agriculture, forestry, and stormwater best management practices. Ongoing efforts to identify and support recommendations strengthening ecological resiliency and the role of natural infrastructure in protecting built communities can be found on the Climate Change in Vermont website.

B. Water Quality Conditions in Basin 6

Assessment Methodology

The Agency's Watershed Management Division (WSMD) in the Vermont Department of Environmental Conservation (DEC) collects and uses monitoring data to assess the health of individual surface waters in relation to the Vermont Water Quality Standards per the 2019 DEC Assessment and Listing Methodology (VDEC, 2019). Vermont's monitoring approach is described in the Vermont Water Quality Monitoring Program Strategy 2011-2020, (VDEC, 2015).

The WSMD water quality monitoring work includes the Monitoring and Assessment Program's (MAP) biological monitoring of macroinvertebrate and fish communities as well as targeted chemistry sampling around various pollutant sources. MAP also supports the Acid Lakes Long-Term Monitoring Program. The Rivers Program supports stream geomorphic assessments of geomorphic and habitat conditions of rivers. The Lakes and Ponds Management and Protection Program supports the Spring Phosphorus and Lay Monitoring Programs to evaluate nutrient conditions and trends on lakes, as well as shoreland condition, and in-depth lake assessments and surveys for aquatic invasive species. Additionally, the Wetlands Program conducts chemical and biological assessments of wetlands.

In addition to the WSMD programs, the Vermont Fish and Wildlife Department (FWD) conducts fishery assessments and water temperature monitoring to assess health of recreational fish populations and habitat restoration opportunities. The Agency of Agriculture, Food and markets conducts statewide pesticide monitoring with sampling site throughout Vermont. AAFM also runs he the State Ambient Surface Water Study to establish baseline levels of pollutants and to monitor

the presence of neonicotinoids, glyphosate, corn herbicides, and nitrates in Lake Champlain and its contributing tributaries. DEC Drinking and Groundwater Protection Division and WSMD monitor Per and Polyfluoroalkyl (PFAS) in ground water and surface waters, respectively. Stream flows are monitored using a statewide network of stream gages funded and operated by the USGS and the DEC collaborative streamflow gage program including Vermont Agency of Transportation and Vermont Department of Public Safety. The University of Vermont is also currently involved in collecting water quality data along the water column profile in the bay as part of an EPSCoR funded project.

Volunteer Monitoring Programs

The WSMD's surface water assessments benefit from results obtained through surface water sampling by volunteers. The DEC programs that support volunteer monitoring include the WSMD Lay-Monitoring Program and the LaRosa Partnership Program (LPP). While the Lay-Monitoring Program focuses on identifying nutrient levels in lakes, the LPP supports sampling of streams for total phosphorus, total nitrogen, and total chloride. The volunteer groups that are identified on a WSMD created interactive map include the Franklin Watershed Committee (FWC) in sampling the Lake Carmi tributaries, the Missisquoi River Basin Association (MRBA) in sampling sites throughout the basin and the Friends of Northern Lake Champlain in sampling sites to determine effectiveness of agricultural BMPs. The results are available in this WID Power BI and downloadable data is available through the Vermont Integrated Watershed Information System, IWIS. An analysis of the data collected by the FWC and the MRBA between 2004 and 2014 is also available (Gerhardt, 2015).

Cyanobacteria monitoring

Cyanobacteria monitoring of lakes in Vermont also depends on volunteer-collected data. The program is managed collaboratively by the Vermont Department of Health, the Lake Champlain Committee, DEC and Vermont State Parks with additional funding though the Lake Champlain Basin Program (LCBP).

Documented cyanobacteria conditions contribute to the state's understanding of bloom frequency and are available through the Vermont Department of Health's interactive cyanobacteria tracker map of Vermont lakes and DEC's Annual Cyanobacteria Monitoring Report. Numerous sites on Lake Champlain, including Missisquoi Bay, and Lake Carmi are included in the program. Drinking water supplies are also regularly tested for cyanobacteria-based toxins.

Monitoring and assessment results can be viewed on the **Vermont ANR Natural Resources Atlas.** For a more detailed description of monitoring results see the **Vermont Integrated Watershed Information System online data portal**. Additional monitoring and assessment are needed to address gaps in the understanding of the basin's surface waters and outlined in Tables 15 and 16.

The following is an overview of water resource health in the Missisquoi Basin based on the above monitoring and assessment work. More detail is provided in Chapters 2 and 3. Chapter 2 includes

waters where values and uses exceed current classifications, while Chapter 3 includes the list of rivers and lakes that do not meet Vermont Water Quality Standards (VWQS) or other ANR criteria. In addition to the VWQS, ANR lake and wetland assessment results are used to assess the condition of those waterbodies.

Condition of Rivers

Stream biological assessments

The biological assessment of streams in Vermont is carried out by the WSMD using biological indices that measure the health of streams by looking at multiple structural and functional aspects of the macroinvertebrate and fish communities. Biomonitoring is used for detecting aquatic life impairments and assessing their relative severity, and for recognizing streams at or near a reference level condition that may be suitable for higher levels of protection through upward reclassification. The ratings for the community assessments range from Poor - not meeting Vermont Water Quality Standards (VWQS) - to Excellent - exceeding VWQS. The DEC Basin 6 Water Quality Assessment Report and the 2015 update describe monitoring results between 2004 and 2014. Information discussed below for the Missisquoi Basin was collected between 2016 and 2020.

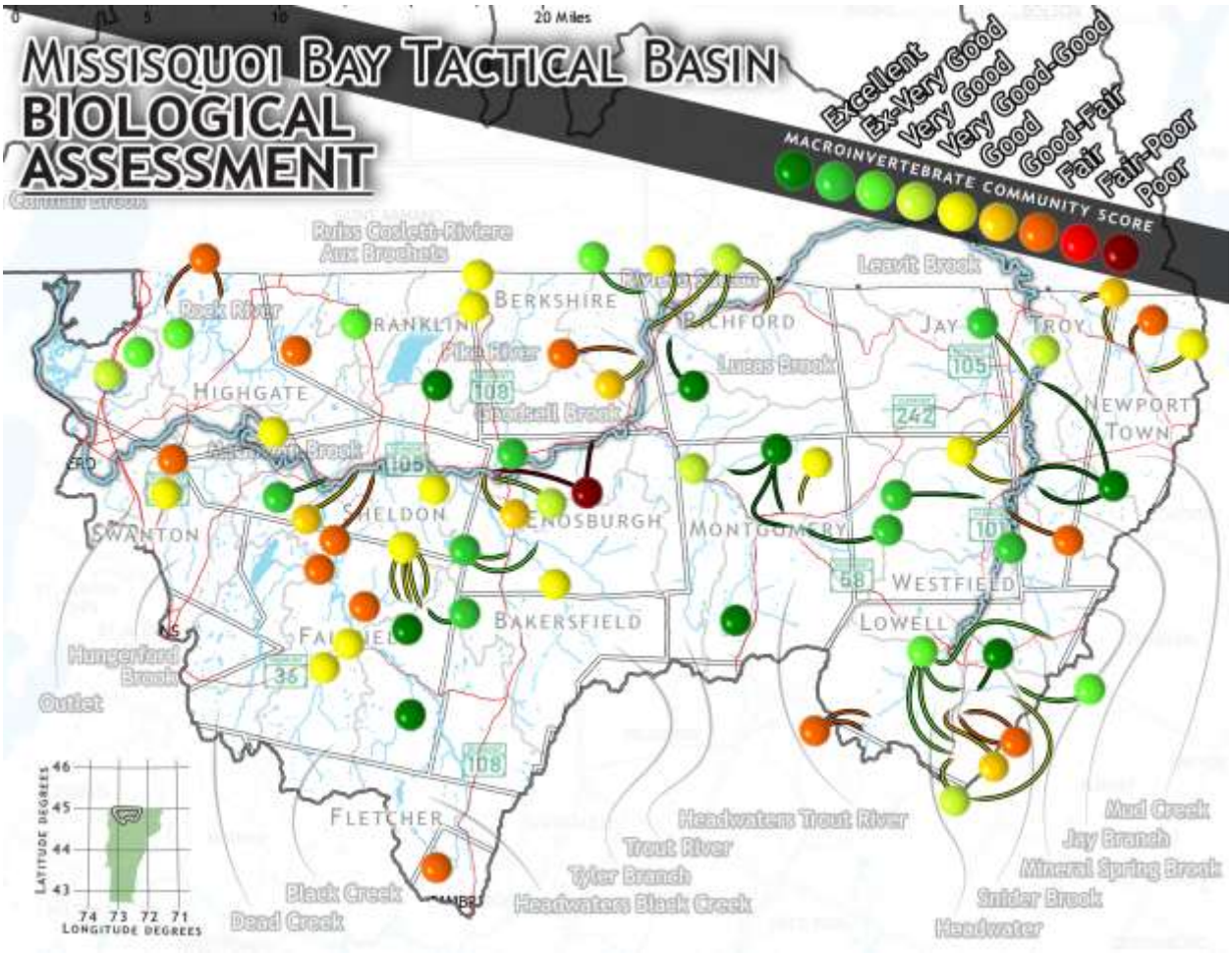


Figure 7. Macroinvertebrate biological assessment results for sites sampled 2016-2020

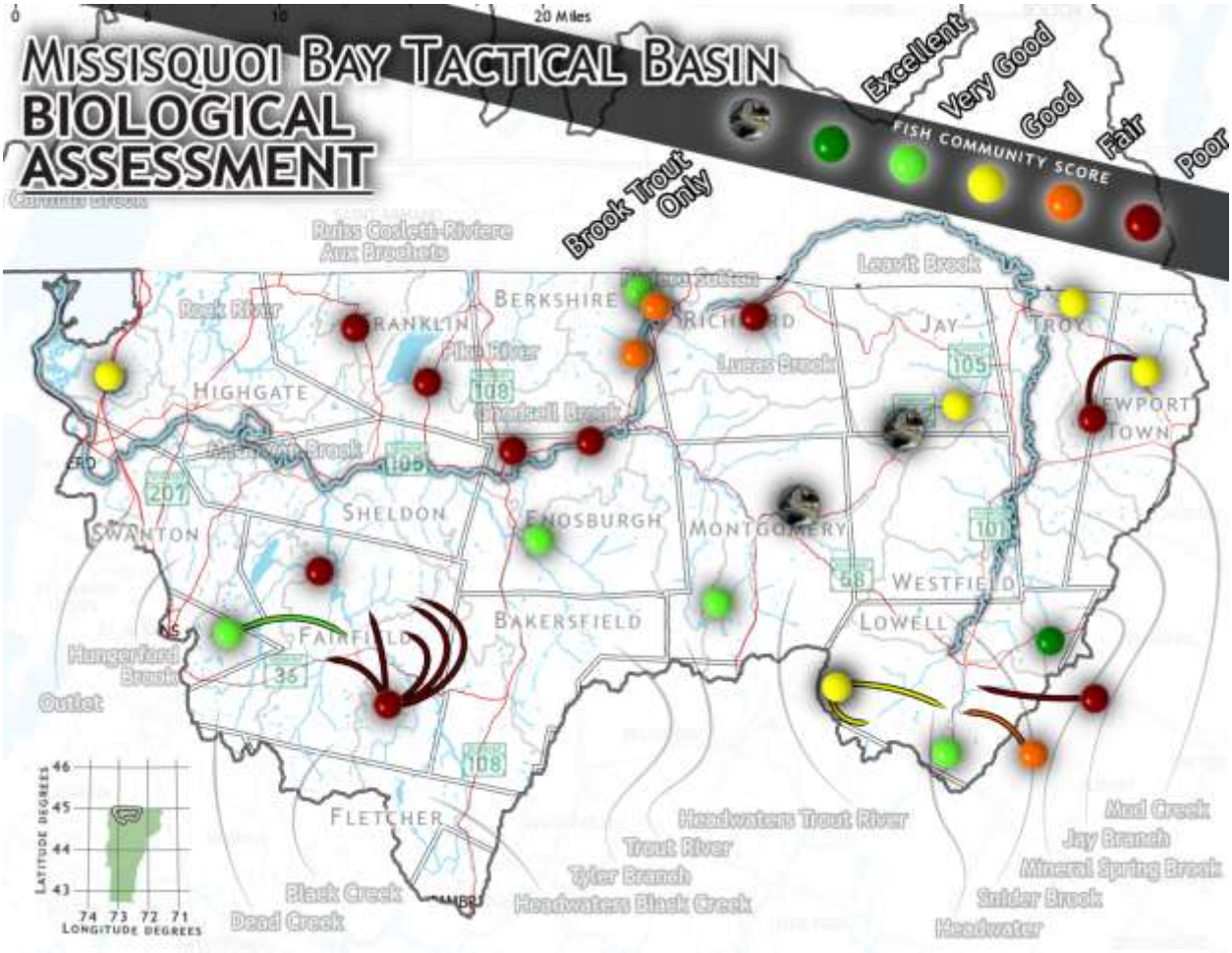


Figure 8. Fish biological assessment results from sampling completed 2016-2020

The vast majority of stream miles in Vermont maintain biological communities that are "very high quality" waters, reflecting the reference condition, or minimal changes, according to the 2013-2017 Probabilistic Assessment of Wadable Streams (VDEC, June 2019). While most of Vermont streams meet VWQS based on biomonitoring results, the Missisquoi Basin's biomonitoring assessment results do not reflect the same overall condition (Figures 7 and 8). This is due to the higher density of land uses in the basin associated with impacts to surface waters, including agricultural and developed land when compared to Vermont as a whole. See IWIS database for DEC water quality data. Biomonitoring sites in the basin are also predominantly located in developed or agricultural landscapes, which may trend assessments towards lower ratings than if part of a randomized study.

As in the rest of the state, biomonitoring sites in the basin with predominantly forested watershed assess Very Good to Excellent, except where concentrated human activity exists. The latter is true for the headwaters of Jay Branch, where Jay Peak Resort is a source of stormwater runoff. In addition, in the Upper Missisquoi River, Burgess Branch and some of its tributaries, which receive

runoff from the closed asbestos mine on Belvidere Mountain, differ from other streams in predominantly forested areas, typically being assessed as Poor or Fair.

Increased management of stormwater at Jay Peak Resort over the last 15 years (Jay Peak WQRP) coincides with improvement of stream health in the main stem and some improved ratings in South Branch (Figure 9). Biomonitoring results from 2011 to 2017 demonstrate improvements in the composition of aquatic biota in Jay Branch and Tributary 9. Both segments, which had not been meeting the VWQS benchmarks for macroinvertebrate density and composition, steadily improved at all sampling locations until reaching the full suite of attainment benchmarks in 2016 (Figure 9). These data demonstrate that the resort's remediation practices reduced sediment delivery and improved in-stream habitat for aquatic organisms in both streams. Because the streams are now consistently meeting VWQS, both Jay Branch and Tributary 9 were removed from the CWA section 303(d) list of impaired waters in 2018.

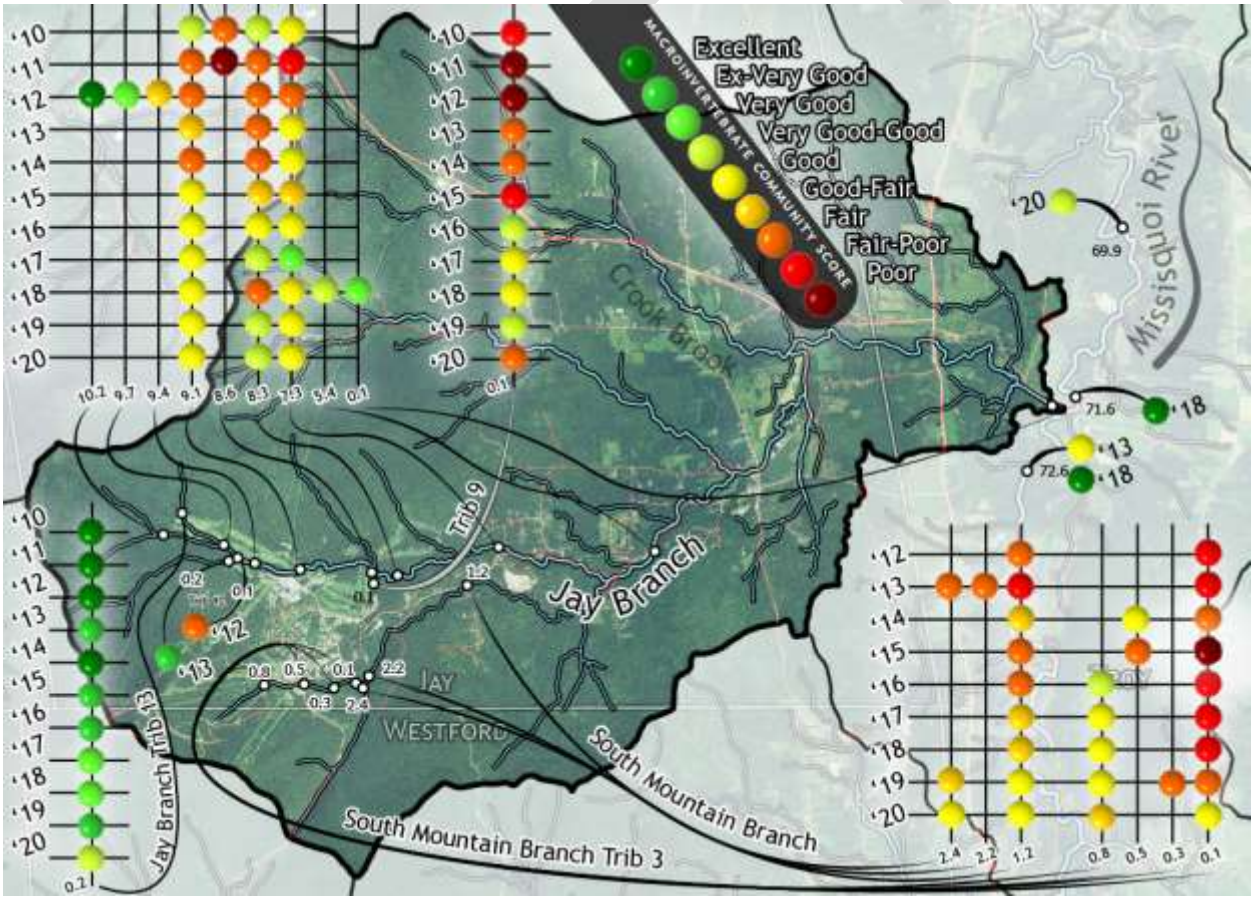


Figure 9. Jay Branch biomonitoring results from 2010-2020 for South Mountain Branch and Trib.3, Jay Branch and Trib. 9 at river miles identified on x axis.

For the remainder of the Missisquoi Basin's biomonitoring sites, most sites meet or exceed VWQS.

Many of the streams that lack biomonitoring assessments for the basin are at higher elevations, on steeper terrain, and tend to be forested (Figure 10). Sites with low percent of agricultural or developed land (and therefore high percent of protective land cover like forestland) are assumed to meet standards, if not reference condition. Many of these areas are a priority for assessment to confirm expected reference condition, which would inform protection efforts (see Chapter 2). A few of these areas are a priority for assessment based on proximity to water quality threats, such as developed or agricultural land use. These and other priority areas for assessment are identified in Tables 15 and 16.

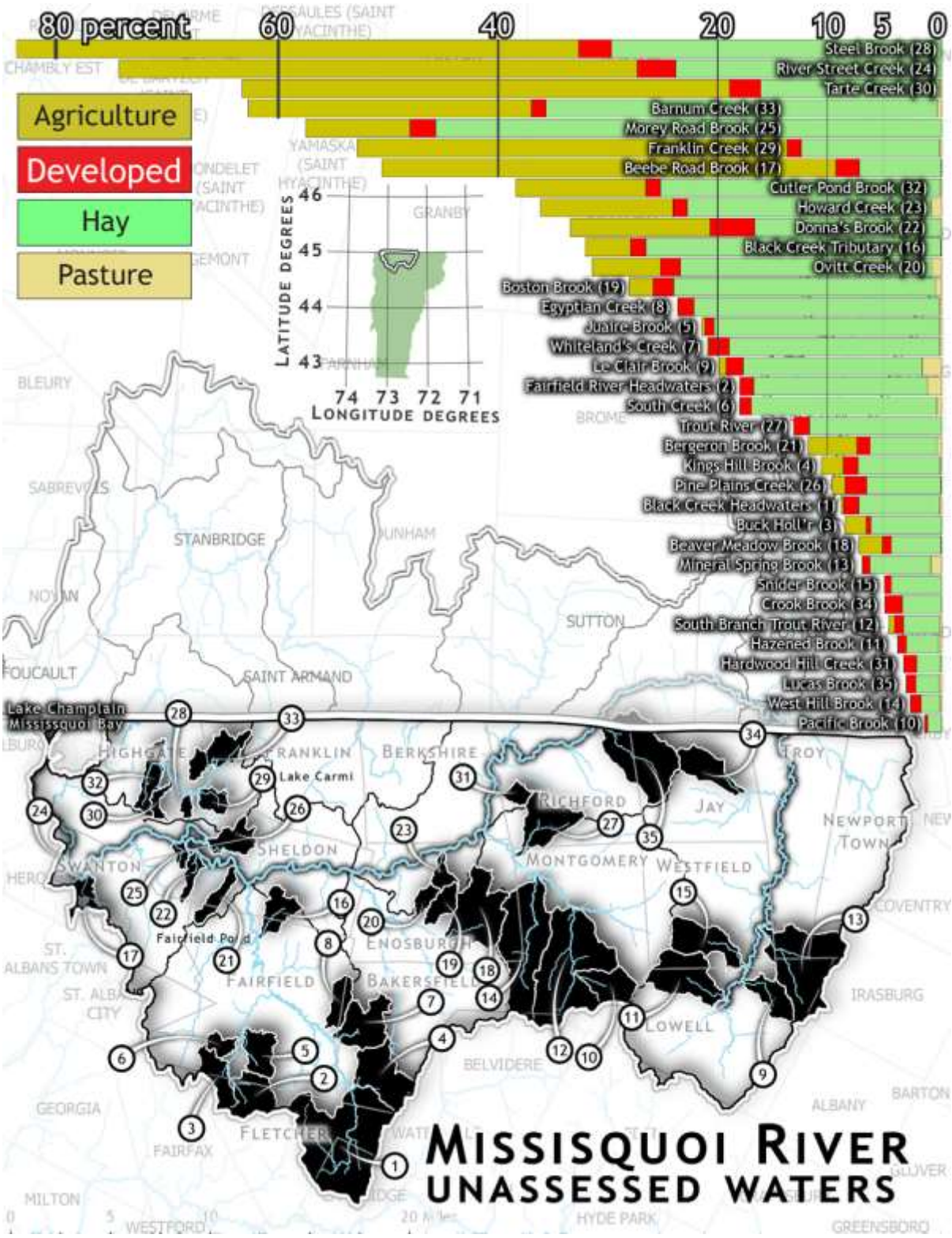


Figure 10. Rivers and streams lacking recent biological monitoring data and association with high impact land uses.

For rivers that do not meet VWQS for aquatic biota, sediment and nutrients are the most prevalent pollutants in basin 6[5], as is true for most state waters. Prominent stressors on aquatic biota include land erosion, channel erosion, and nutrient runoff. Physical alterations are also present throughout the watershed, ranging from habitat alteration, general stream channel instability, and encroachment into the flood hazard zone. The next most prevalent stressors are thermal modification, which are linked to physical habitat alterations, and pathogens. More isolated stressors specific to particular reaches[6] include toxics from a landfill and flow alteration.

Subwatersheds with higher percentages of forest cover tend to support a higher percentage of streams meeting standards than subwatersheds with low percentage of forest cover, see Figures 6 and 13. Subwatersheds with a high percentage of forest cover include the Upper Missisquoi and Trout Rivers, which are both federally designated Wild and Scenic Rivers based on their unique cultural, scenic, and recreational qualities. In addition, the Big Falls of the Upper Missisquoi River at Troy is known for its spectacular aesthetic and is a popular swimming area. Big Falls is an obvious candidate for Outstanding Resource Water for aesthetics and recreation (see Chapter 2).

Stream Geomorphic Assessments

Geomorphic assessments measure and assess the physical dynamics of an entire watershed or collection of river reaches. Physical aspects of river dynamics are assessed using maps, existing data, and windshield surveys (Phase 1), using field observation and simple measurements (Phase 2) and/or using surveying techniques and quantitative analysis (Phase 3 or River Corridor Plans). See Vermont River Management Section - Geomorphic Assessment for more information. Most large streams in the basin have complete geomorphic assessments. Completed SGAs and associated recommended priority actions are listed in Table 19, Appendix B.

The assessments confirm that like the rest of Vermont, streams in the Missisquoi Basin are experiencing incision and subsequent and ongoing planform adjustments in lower reaches. It is estimated that up to 75% of the waterways in the 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 (Lake Champlain Basin Program, 2011).

[5] Definition of these pollutants can be found in VSWMS http://www.anr.state.vt.us/dec/waterq/wqd_mgtplan/swms_appB.htm.
[6] The waters and associated problems are listed in the EPA and state lists (see Table 4)

Condition of Lakes and Ponds

The Missisquoi Basin drains to Lake Champlain and encompasses 19 lakes and ponds, 10 acres or larger. The increase of three waterbodies since the 2016 basin plan is due to a recalculation with higher resolution Geographic Information Systems.

DEC lake assessments[7] indicate that the basin's lakes (ponds included) are overall healthy with almost half or 42% (8 out of 19) supporting in-lake uses. Except for Metcalf Pond, these lakes are also considered wetlands or have stretches of shoreline that are wetland. These wetland lake complexes have intact shorelines with minimal to no shoreland human disturbance. Two of these lakes (Little in Franklin and South Richford:) are listed as stressed for pH and one is listed as stressed for phosphorus (Cutler). Low pH conditions on these first two ponds may be due more to the leaching of organic acids from natural wetlands than to stress from acid deposition. The high phosphorus on Cutler Pond may also be related to wetland sources as opposed to nutrient runoff in the watershed, although the watershed score from the DEC Lakes Scorecard is "Highly Disturbed," denoting a greater proportion of developed land. All in all, this basin harbors a high proportion of what appear to be high quality wetland lake complexes. Additional information about these complexes can be found in the Wetland section.

The predominant stressor for lakes in the basin is human disturbance within their watershed, with over half scored as poor. Those lakes with the additional stressor of human disturbance along the shoreline tend to have elevated total phosphorus, including Lake Carmi and Fairfield Pond and possibly Bullis Pond. Carmi is listed as impaired, and Fairfield is listed as stressed for these elevated nutrient levels. The one spring total phosphorus reading at Bullis Pond is high and the watershed score is "highly disturbed," suggesting that this pond may also be stressed for phosphorus. In contrast, Metcalf Pond, where human disturbance in the watershed is minimal, water quality meets current standards with a trend score of "good" based on monitoring through 2012.

Aquatic Invasive Species (AIS) alters habitat and degrades recreational opportunities in at least five inland lakes with Eurasian Water Milfoil, *Myriophyllum spicatum*, the predominant species of concern (Figure 11).

All the Missisquoi Basin lakes, along with all other lakes in Vermont, are under a Vermont Department of Health Fish Consumption Advisory for exceeding the USEPA mercury limits in fish, with defined consumption limits by fish species and subpopulation. Mercury is a chemical that becomes toxic at high concentrations. As big fish eat smaller fish, the mercury concentrations increase in the fish tissues, and through this process of bioaccumulation, mercury levels can become unsafe for human consumption of the fish.

[7] Table 23 shows the good] (blue), fair (yellow) and poor (red) scores for each lake according to the Vermont Lake Score Card (https://dec.vermont.gov/watershed/lakes-ponds/data-maps/scorecard). White denotes insufficient data.

Of note for this basin is that other than the four lakes for which there is enough water quality data to determine if there are increasing nutrient trends (see Table 23), none of the lakes are seeing statistically increasing nutrient trends, which is unlike trends currently being observed in other parts of the state, in particular the Northeast Kingdom. Having said that, Lake Carmi and Missisquoi Bay, the basin's most important lake / lake sections, are both impaired for phosphorus with a TMDL, and Fairfield Pond has a high but stable summer average total phosphorus concentration. Additional work to reduce external phosphorus loading is needed to achieve TMDL phosphorus loading reduction targets.

The Missisquoi Bay Basin also includes inland lakes notable for their healthy ecosystems. For example, Metcalf Pond may be eligible for reclassification to B(1) or very good status based on its summer mean total phosphorus concentration, although more data is needed to make this statement conclusively. Outside of a low pH value, Little Pond in Franklin falls is in the top 25% of Vermont lakes with excellent water quality, intact shoreline, high biodiversity, and scenic features. McAllister Pond and Lake Carmi (notwithstanding the lake's high phosphorus levels) both are in the top 20 and 25% respectively for biodiversity.

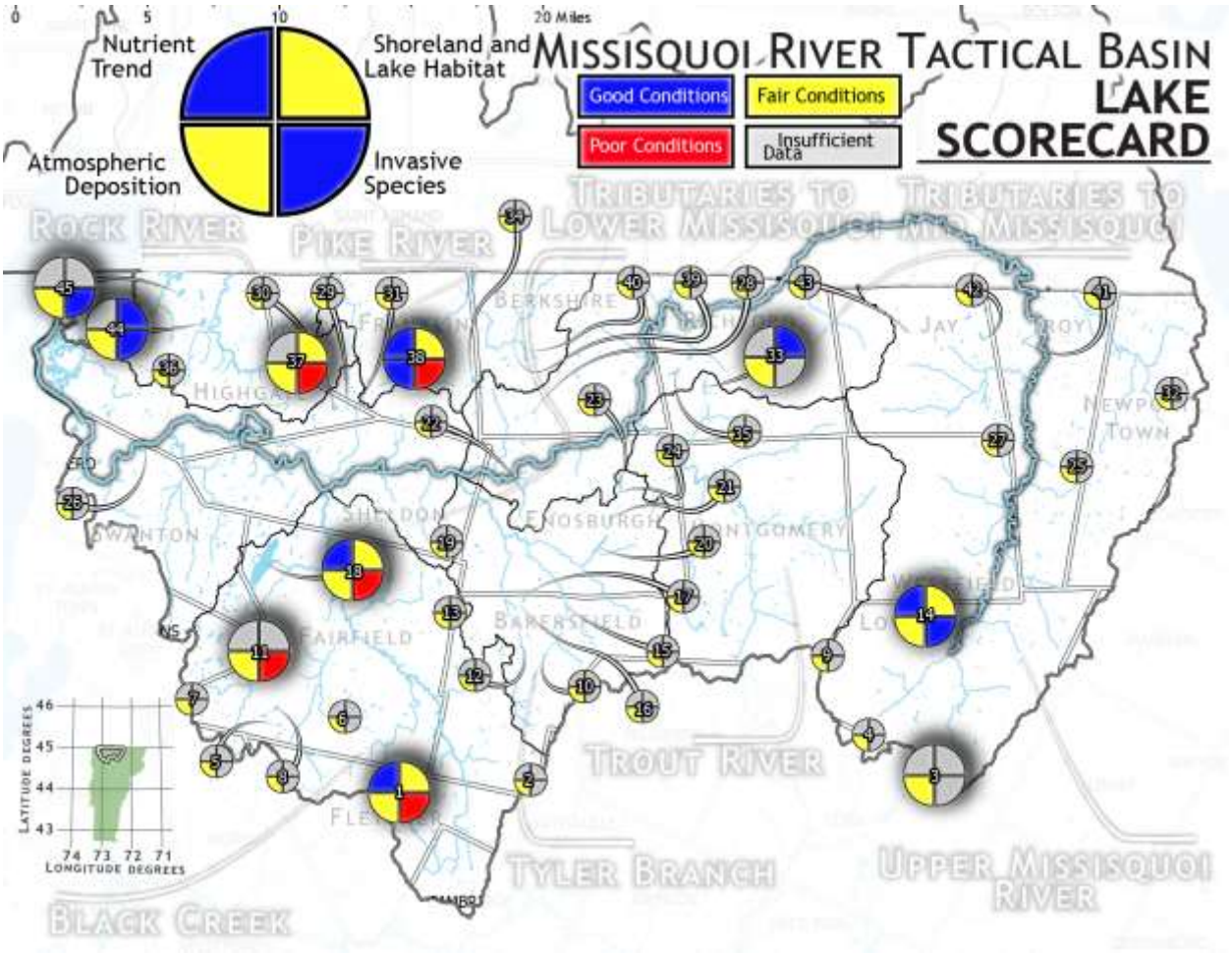


Figure 11. Scorecards for the Missisquoi Basin lakes and ponds. The large score cards are for partially to fully assessed lakes including: 1: Metcalf Pond; 11 Fairfield Swamp; 14 McAllister; 18. Fairfield Pond; 33. Guillmette;37. Lake Carmi 38. Little Pond, 44. Cutler Pond 45, Proper Pond. The names of the other unassessed lakes can be found in Table 23, Appendix B.

In addition to the inland lakes in the basin, the Missisquoi Bay, itself, is a lake segment of Lake Champlain. Lake Champlain assessment information is provided in Table 4.

In addition to phosphorus, PCBs, (polychlorinated biphenyls), and mercury levels in Lake Champlain's Missisquoi Bay are concerns.

A summary of additional information about the Lake, including the Missisquoi Bay lake segment is provided by the State of the Lake Report (Lake Champlain Basin Progran, 2021). The report includes a summary of certain assessment results as ecosystem indicators status and trends.

Condition of Wetlands

Wetland Monitoring

The Vermont Wetlands Program uses its Bioassessment Project to gather data about the health of Vermont wetlands. Based on a 2017 analysis of bioassessment data, the principal factors that correlate with poor wetland condition are:

- presence of invasive species,
- disturbance to the wetland buffer or surrounding area,
- disturbance to wetland soils, and
- disturbance to wetland hydrology (how water moves through a wetland) through ditching (e.g., agricultural), filling (e.g., roads) and draining (e.g., culverts).

The Wetlands Program also uses the Vermont Rapid Assessment Method (VRAM) to rapidly assess both wetland condition and function (Tier I Assessment). A total of 42 VRAMs were completed since 2016 in the Missisquoi Basin. While these are not evenly distributed through the basin, they do include assessments at several wetland types at varying elevations. Out of a scale of 100, scores ranged from 19 to 90 with a mean of 60. Current levels of sampling in the Missisquoi are not yet sufficient to provide an overall picture of wetland health in the basin. The Wetlands Program will train volunteers to help increase number of assessments conducted in the basin over the next five years.

Wetlands in the basin represent a diversity of wetland types from open-water marshes to forested swamps as shown on the 2019 National Wetland Inventory (NWI) map layer[8]. Wetlands representing significant natural communities include the Missisquoi Delta, Franklin Bog and Fairfield Swamp (DEC Basin 6 Water Quality Assessment Report. The Missisquoi Bay and Delta wetlands complex was recognized as Wetlands of International Importance under the Ramsar Convention on Wetlands in 2013. A series of peat-accumulating open-water wetlands identified as potential significant natural communities by DEC staff during a desk top survey of wetlands in 2020 will be included in the next round of wetland assessments conducted in the basin.

Condition of Fisheries

The rivers, lakes, ponds, and wetlands in the Basin support aquatic life and habitat and provide recreational opportunities through their fisheries, swimming beaches, boating runs, and aesthetics.

[8] The 2019 NWI revisions significantly increased mapping accuracy regarding extent and type

In addition, these surface waters provide drinking water and irrigation supplies. The fundamental purpose of protecting water quality in Vermont is to enhance these and other beneficial uses and values of the water. See here for a list of documented uses in the basin for swimming, boating and fishing. The following information on fisheries provides an example of a use that is supported through the protection of surface waters.

In addition to macroinvertebrate and fish community assessments, the availability of fisheries data for the basin provides useful information about the health of the fisheries in the watershed and potential threats that should be addressed.

The Missisquoi Basin supports a diverse range of fisheries and fish communities with habitat ranging from high elevation, cold, head-water streams to low-gradient, warm-water rivers flowing into Lake Champlain.

Wild trout populations are abundant throughout tributaries higher in the Missisquoi watershed. Brook trout tend to dominate streams in headwater areas where forest canopy cover maintains cooler water temperatures while brown trout become more abundant at slightly lower and warmer elevations. Wild, naturalized rainbow trout are also present in a few tributaries in the watershed. Sections of the mainstem of the Missisquoi River are also stocked with brown trout and trophy rainbow trout to provide additional recreational fishing opportunities in areas where water temperature and instream habitat are not suitable for maintaining abundant wild trout populations year-round.

Lower in the watershed, warm-water fish communities are abundant, including largemouth and smallmouth bass, northern pike, chain pickerel, and yellow perch. Muskellunge have also been periodically stocked in the Missisquoi River since 2008 to restore a self-sustaining population in the lower portion of the river. Lake Carmi and Fairfield Pond, also warm water fish communities, support self-sustaining populations of Walleye, and are popular with anglers.

Several rare (R), threatened (T), or endangered (E) fish species are also present in the Missisquoi River including lake sturgeon (E), eastern sand darter (E), stonecat (E), American brook lamprey (T), greater redhorse (R), and silver redhorse (R) as well as many other Species of Greatest Conservation Need (SGCN).

Many species of fish from Lake Champlain make spawning runs into the lower Missisquoi River including walleye, lake sturgeon, and white and redhorse suckers among others. These fish historically traveled upstream to Highgate Falls; however, upstream movement is blocked by the Swanton Dam. The primary spawning habitat for these species is limited to the area immediately downstream of the Swanton Dam where coarse substrate and suitable water velocities required by spawning fish is available but limited. Removal of the Swanton Dam would allow migratory fish to access abundant spawning habitat upstream. This would not only increase the amount of available suitable spawning habitat, up to 342 and 1,210 times more than what is currently available for lake

sturgeon and walleye, respectively (Lyttle 2004), but would also ensure suitable spawning habitat is available over a broader range of depth and flow conditions.

Chapter 2 – Priority Areas for Surface Water Protection

The state protects lakes, wetlands, and rivers by establishing and supporting surface water management goals. In this chapter, the Agency identifies surface waters that consistently attain a higher level of quality and value based on their ability to meet certain physical, chemical, and biological criteria. These waters are prioritized for reclassification or designation, which could lead to enhanced management objectives and support of strategies to protect their current condition.

Agency monitoring and assessment data indicate that the four Missisquoi Basin surface waters listed in Table 3 (see also Figure 12) meet criteria for protection through upward reclassification or designation. Additional protection strategies include enhanced community stewardship, municipal protection, and conservation easements (see Chapter 4). Additional surface waters with preliminary data suggesting a higher level of water quality are priorities for supplemental monitoring (see Table 15). Additional pathways such as land stewardship programs, local protection efforts, conservation easements, and land acquisition, are also used to increase protection of priority waters. These are described in Chapter 4 - Strategies for Protection and Restoration.

A. Surface Water Reclassification and Designations

Surface waters may be protected by the anti-degradation policy of the Vermont Water Quality Standards (2017) or by upward reclassification or designation through one of the following pathways:

- Reclassification of surface waters
- Class I Wetland designation
- Outstanding Resource Waters designation

These legal mechanisms guide the Agency's permitting processes to ensure that regulated activities on the landscape protect the condition of surface waters[9].

In addition to identifying surface waters that meet criteria for a higher classification, the VWQS also require that the tactical basin plan identifies surface waters that support existing uses and cold-water fisheries. Current lists for both exist at this link. No additions or changes are included in this plan. More detailed information can be found in the Vermont Water Quality Standards.

[9] See the 2016 Missisquoi Bay Tactical Basin Plan Chapter 4 for descriptions of reclassification, Class 1 Wetlands and Outstanding Resource Water designations.

Table 3. Listed surface waters meet criteria for following class of surface water or wetland, with any potential for a different classification or designation based on monitoring or assessment data.

ID on Fig. 12	Waterbody (location identified in Fig. 12)	Town	Current Classification	Monitoring and assessment data suggests surface water meets criteria for a different classification/designation
1	Missisquoi Delta and Maquam Bog at Missisquoi National Wildlife Refuge	Highgate	Class II Wetland	Class I Wetland
2	Upper Tyler Branch (RM 5.3)	Enosburgh/ Bakersfield	B2 all uses	B(1) for aquatic biota
3	Jay Brook	Montgomery/ Westfield	B2 all uses	B(1) for fishing
4	Big Falls	Troy	B2 all uses	Outstanding Waters Designation

Setting Management Goals

While the Agency typically relies on the publication of tactical basin plans to identify candidates for reclassification, the public may also present a proposal or petition for establishing management objectives for the Agency's consideration at any time. The Agency's Department of Environmental Conservation (Department) is developing and updating relevant procedures, forms, and guidance documents, as necessary, to enable submission, evaluation, and implementation of petitions to reclassify streams and lakes, and to designate Outstanding Resource Waters, see the WSMD Stream Reclassification web page.

The Department has already developed these procedures and documents for Class I wetlands: those wetlands that satisfy criteria for designation may be proposed for such designation through departmental rulemaking authority, and as consistent with the Vermont Wetland Rules. Regardless of who presents the proposal, public input is a required component of the process.

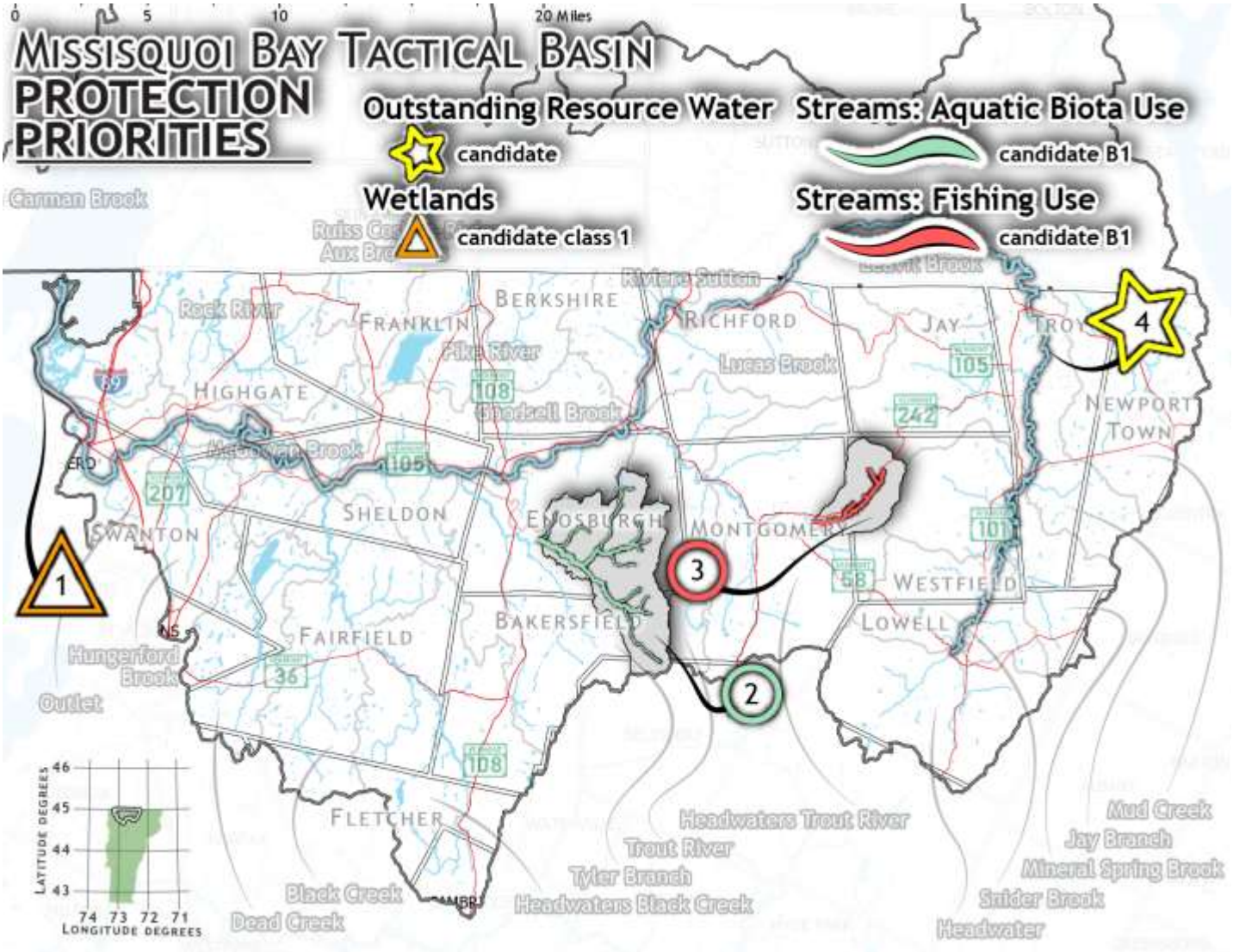


Figure 12. Missisquoi Basin surface waters which are a priority for protection, see Table 3.

Chapter 3 – Priority Areas for Surface Water Restoration

A. Stressed or Impaired Surface Waters

DEC monitors and assesses the chemical, physical, and biological status of surface waters to determine if they meet the VWQS per the 2019 Vermont Surface Water Assessment and Listing Methodology (Methodology) (Vermont Department of Environmental Conservation, 2019). The assessment results are the basis for the biennial statewide 303(d) List of Impaired Waters and List of Priority Surface Waters Outside the Scope of 303(d) (Table 4) as well as the priority waters for protection for the aquatic life support (Chapter 2). The lists identify stressed, impaired, or altered waters and includes preliminary information on responsible pollutant and/or physical alterations to aquatic and riparian habitat, the stressor and, if known, the source. Stressed, altered, or impaired waters become a priority of restoration. See page 13 of the Methodology for a detailed explanation.

Figure 13 and Table 4 list the impaired, stressed, and altered rivers, along with status regarding progress made towards remediation. Additional remediation strategies are listed in Chapter 5 Implementation Table. Chapter 3 provides additional information regarding streams in the basin that are impaired but under an EPA-approved management plan (Total Maximum Daily Load or TMDL or Alternative).

Update to Listings

New monitoring and assessment data collected since the release of the 2016 tactical basin plan indicate that the Jay Branch, Tributary 9 and South Mountain Branch Tributary 7 have recovered sufficiently to meet VWQS, allowing their removal from the impaired waters list.

Waters that were identified as impaired during this time include the Giddings and Morrow Brooks and Mud Creek, Tributary 10, Hungerford Brook, Tributary 4, Dead Creek from North Street were identified and subsequently listed as stressed (see Table 4 for additional information).

The Missisquoi River, Mouth Upstream to Swanton Dam (#16 in Table 4), currently identified in the 2020 listing as stressed, was an inadvertent listing on the 2020 Stressed Waters List. This segment of the river is currently not considered stressed due to a lack of sufficient data to make an assessment determination. As further data is collected, this river segment will be re-assessed.

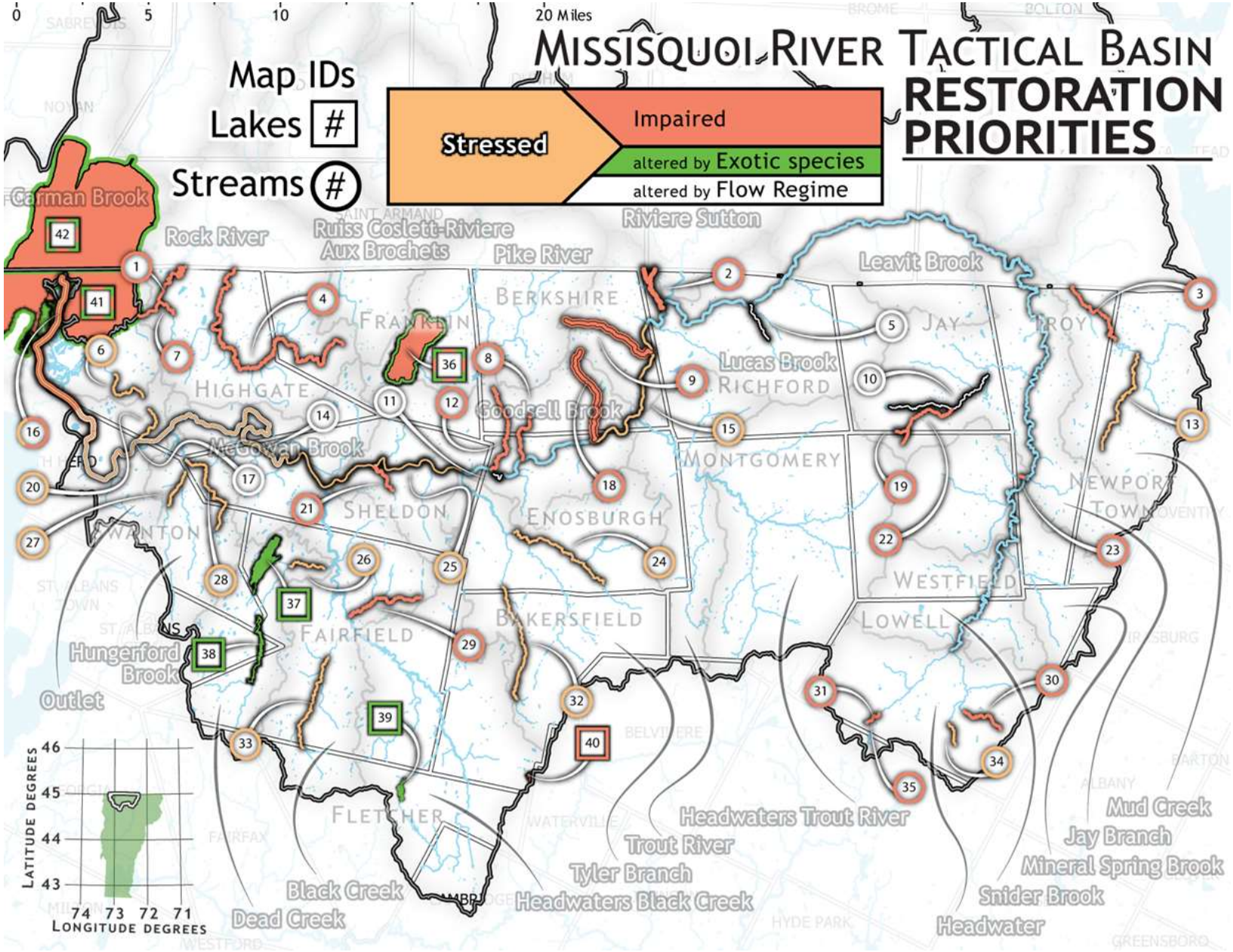


Figure 13. Impaired, stressed and altered waters in the Missisquoi Basin. See Table 4 for additional information regarding the numbered streams and lakes.

Table 4. Impaired, stressed, and altered surface waters in the Missisquoi Basin (DEC, 2020). For more information including associated degraded uses, see 2020 listings. See Figure 13 for map. The TMDLs mentioned are described in Chapter 3B.

LISTING	MAP #	NAME	POLLUTANT(S)	Problem	Status
IMPAIRED	2	Berry Brook, Mouth Up to and Including N. Trib (Approx. 1 Mile)	Escherichia coli (E. coli)	Elevated E. coli levels	Bacterial TMDL
	9	Godin Brook	Escherichia coli	Elevated E. coli levels	Bacterial TMDL
	18	Samsonville Brook	Escherichia coli	Elevated E. coli levels	Bacterial TMDL
	16	Missisquoi River, Mouth Upstream to Swanton Dam (Approx. 8 Miles)	Mercury In Fish Tissue	Elevated levels of mercury in walleye	Mercury TMDL: Support EPA's efforts to control emissions from Vermont and other states
	3	Mud Creek, from VT/Quebec Border Up to rm 6.5 (Approx. 3.2 Miles)	Nutrients, Sedimentation/Siltation	Agricultural runoff; nutrient enrichment impacts macroinvertebrates	Agricultural alternative restoration plan in development
	4	Rock River, Upstream from Quebec/VT Border (Approx. 13 Miles)	Nutrients, Sedimentation/Siltation	Nutrient enrichment; agricultural runoff	Agricultural alternative restoration plan in development
	7	Saxe Brook (Trib to Rock River) from Mouth Upstream 1 Mile	Nutrients	Agricultural runoff	Addressed under Lake Champlain Phosphorus TMDL (LC P TMDL)
	8	Trout Brook, Upstream from Mouth for 2.3 Miles	Nutrients	Agricultural runoff	Agricultural alternative restoration plan in development
	9	Godin Brook	Nutrients, Sedimentation/Siltation	Agricultural runoff, aquatic habitat impacts	Agricultural alternative restoration plan in development
	12	**[10]Giddings Brook from Its Confluence with the Missisquoi Upstream 4 Miles	Pollutants In Urban Stormwater, Nutrients	Runoff from agricultural and developed lands	DEC developed summary of stormwater discharges and possible stormwater retrofit locations. See Chapter 5. Stormwater strategies

[10] New listing since 2018

LISTING	MAP #	NAME	POLLUTANT(S)	Problem	Status
	18	Samsonville Brook	Nutrients, Sedimentation/Siltation	Agricultural runoff, aquatic habitat impacts	The LC P TMDL to address
	21	**Morrow Brook from Its Mouth Upstream 2 Miles	Nutrients	Agricultural runoff	The LC P TMDL to address
	22	Jay Branch Tributary #7 (2.2 Mi.)	Sedimentation/Siltation	Erosion from parking areas and on-mountain activities	Implementation of Jay Peak WQRP for trib 3 should help this reach too. However, there are indications of sediment inputs from above the resort that may be contributing. See latest plan report.
	23	Coburn Brook (Mouth to rm 0.2)	Nutrients	Agricultural activities and runoff	Addressed under LC P TMDL; 2019 RCE on agricultural land to mouth with 50 ft forested buffer minimum and wetland protection
	29	Wanzer Brook (Mouth to rm 4.0)	Nutrients, Sedimentation/Siltation	Agricultural runoff	Agricultura alternative restoration plan in development
	30	Ace Brook (rm 0.7 to Headwaters) 1 Miles	Sedimentation/Siltation	Sediment discharges and hydrologic change from logging activity	DEC Biomonitoring assessment planned
	31	Burgess Brook (rm 4.9 to 5.4)	Sedimentation/Siltation, Asbestos	Asbestos mine tailings erosion; asbestos fibers	Resources could be obtained from EPA as Superfund site when town is willing. Landowner presently maintaining EPA installed erosion control. Natural Resources Damage Assessment funds provided to Lowell for road improvements in 2019.
	35	Burgess Brook Tributary# 11, (Mouth to rm 0.5)	Sedimentation/Siltation, Asbestos	Asbestos mine tailings erosion; asbestos fibers	See above

LISTING	MAP #	NAME	POLLUTANT(S)	Problem	Status
	19	South Mountain Branch, Tributary #3 (Mouth to Rm 0.5)	Sedimentation/Siltation	Erosion from parking areas and on mountain activities	Focused targeted monitoring ongoing to ID sources. Ongoing project ID and implementation. See latest Jay Peak WQMP
	36	Lake Carmi	Phosphorus	Algal blooms	EPA-approved TMDL April 13, 2009
	40	Kings Hill Pond (Bakersfield)	pH	Atmospheric deposition; extremely sensitive to acidification; episodic acidification	EPA-approved TMDL September 30, 2003
	41	Missisquoi Bay - Lake Champlain (Alburgh)	Mercury In Fish Tissue, Phosphorus	Elevated levels of mercury in walleye	EPA-approved regional mercury TMDL on December 20, 2007
STRESSED	6	Youngman Brook (1.8 Mi Above Mouth to Headwaters)	Sedimentation/Siltation, Nutrients	Agricultural runoff	Continue monitoring, and project ID
	13	Mud Creek Trib 10 from Its Confluence with the Mainstem Upstream	Temperature, Nutrients	Runoff from agricultural lands, lack of woody riparian vegetation	LC P TMDL to address
	15	Missisquoi River, from Samsonville Bk to rm 45.3	Sedimentation/Siltation, Temperature, Nutrients, Turbidity	Agriculture and stream bank erosion	LC P TMDL to address
	16	Missisquoi River, Mouth Upstream to Swanton Dam (Approx. 8 Miles)	Toxicity	Aquatic community diversity diminished by pesticide application	Inadvertent listing on the 2020 Stressed Waters List. The river is currently not considered stressed because of a lack of sufficient data to make an assessment determination. As further data is collected, this river segment will be re-assessed.

LISTING	MAP #	NAME	POLLUTANT(S)	Problem	Status
	20	Kelly Brook, Downstream from Youngs Landfill	Toxicity	Landfill	VT Brownfield program and NRPC supporting a Supplemental Phase II Environmental Site Assessment to assess contaminant levels in soil, groundwater, and surface water. Scheduled for August 2021
	23	Hungerford Brook, rm 2.9 upstream	Sedimentation/Siltation, Nutrients	Agricultural activities	LC P TMDL to address
	24	Tyler Branch	Nutrients, Sediment, Escherichia coli (E. coli)	Agricultural runoff, morphological instability (West Enosburgh to Cold Hollow Brook)	LC P TMDL to address; Stream Geomorphic Assessment (SGA) update
	25	Missisquoi River, Mouth Upstream to Tyler Branch	Nutrients, Temperature, Sedimentation/Siltation, Turbidity	Agriculture, lack of riparian vegetation, and stream bank erosion	LC P TMDL to address
	26	Dead Creek (Fairfield) from North Rd Upstream	Nutrients	Runoff from agricultural lands	LC P TMDL to address
	28	Hungerford Trib 4 from Its Confluence with the Mainstem Upstream	Nutrients, Sedimentation/Siltation	Runoff from agricultural lands	LC P TMDL to address
	32	The Branch, Beaver Meadow Brk Up to Bridge E Bakersfield Rd	Habitat Alterations, Sediment	Streambank erosion, channelization	SGA update planned
	33	Fairfield River from Vt Route 36 Upstream	Sedimentation/Siltation, Nutrients	Runoff from agricultural lands, lack of woody riparian vegetation	LC P TMDL strategies apply
	34	East Branch Missisquoi River, Gravel Pit Access Downs to Cheney Rd	Sedimentation/Siltation, Temperature	Eroding streambanks, pasture with no buffers, road to gravel pit	SGA update planned
ALTERED FLOW	5	Stanhope Brook	Possible lack of minimum flow below water supply withdrawal point	Richford water supply	Monitoring of flow proposed in Table 22

LISTING	MAP #	NAME	POLLUTANT(S)	Problem	Status
	10	Jay Branch (4.7 Miles)	Artificial & insufficient flow below Jay Peak snowmaking water withdrawal	Partial support 4.7 mi (8.7 mi total length); Jay Peak evaluating expansion/ alternatives	Jay Peak is evaluating alternative sources for snowmaking, including the construction of a new intake on the Missisquoi River in Troy.
	11	Missisquoi River, Below Enosburg Falls Dam (0.1 Mile)	Artificial flow fluctuating and condition by hydropower production	FERC license expires 2023	Enosburgh has proposed to change operations to run-of-river and increase the conservation bypass flow. Enosburgh filed its Final License Application with FERC in April 2021
	14	Missisquoi River Between Sheldon Springs and Highgate Falls	Artificial flow fluctuating and condition by hydropower production	FERC license expires 2024	Central Rivers has proposed to change operations at the project to run-of-river. Central Rivers will begin the second year of study in 2021.
	17	Missisquoi River Between Swanton Dam and Highgate Falls	Artificial flow fluctuating and condition by hydropower production	FERC license expires 2024	Swanton has proposed to maintain peaking operations for the next license. Swanton will begin its second year of study in 2021. Data indicates the flow alterations caused by Highgate Falls operations extend downstream of Swanton Dam, likely to the Missisquoi Rivers confluence with Lake Champlain
Altered Exotic Species	37	Fairfield Pond	Locally Abundant Eurasian Milfoil (EWM) Growth.		Ongoing Management Plan That Includes Dosh, Benthic Barriers, And Hand-Pulling.
	38	Fairfield Swamp Pond	Locally Abundant EWM Growth.		No Active Management.
	39	Metcalf Pond	Locally Abundant EWM Growth.		No Active Management.
	36	Lake Carmi	Locally abundant EWM growth		Ongoing management plan that includes mechanical harvesting efforts.
	41	Missisquoi Bay - Lake Champlain (Alburg)	EWM, water chestnut, zebra mussels,		Active hand-pulling efforts for water chestnut, ZM are ubiquitous.

B. Basin Specific Total Maximum Daily Loads and Alternative Plans

A mechanism to address an impaired water is the development and promulgation of a Total Maximum Daily Load (TMDL). The Agency employs TMDLs when pollutant loading and an allocation of those pollutants among sources can be reasonably conducted and is useful for implementation. Under certain circumstances, there are alternative restoration approaches that may be more immediately beneficial or practicable in achieving Vermont Water Quality Standards than pursuing the TMDL approach in the near-term. An alternative restoration approach is a near-term plan, or description of actions, with a schedule and milestones, that is more immediately beneficial or practicable to achieving VWQS.

A Total Maximum Daily Load (TMDL) is the calculated maximum amount of a pollutant that a waterbody can receive and still meet Vermont Water Quality Standards. In a broader sense, a TMDL is a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards. The identified reductions become the goal for subsequent planning and implementation efforts as required under the federal Clean Water Act . TMDL Implementation Plans may also be part of overall restoration planning. These plans are more specific than the TMDL itself in terms of what non-point source and point source pollution control actions will occur in what areas to achieve the goals of the TMDL. The plans also provide reasonable assurance that the waterbody will meet target load reductions by a specific date.

The following TMDLs or alternative restoration plans are associated with the Missisquoi Basin (Figure 13):

- 2003 TMDL for 30 Acid Impaired Lakes in Vermont
- Northeast Regional Mercury Total Maximum Daily Load
- 2011 Vermont Statewide Bacterial TMDL
- Jay Peak Water Quality Management Plan
- 2021 Agricultural Alternative Restoration Plan
- 2018 Lake Carmi Phosphorus TMDL
- 2016 Lake Champlain Phosphorus TMDL

The plans to meet the TMDL targets for Acid and Mercury-impaired waters are primarily focused on regional efforts to reduce atmospheric deposition and as a result are not described in greater detail beyond the links provided above. The Jay Peak Water Quality Management Plan is an EPA-approved remediation plan that is available at the above link. A general description of the 2021 Agricultural Alternative Restoration Plan is provided below. The other TMDLs are also described

below. This Tactical Basin Plan takes the next step of ensuring pollutant targets are met with existing resources by identifying and directing funding towards the highest priority projects to achieve specific TMDL goals, see Chapter 5.

Statewide Bacterial TMDLs

Twenty-one of Vermont's waters are impaired at least in part due to bacterial contamination associated with human health risk. The bacteria, ***Escherichia coli, (E. coli)*** is an indicator for the presence of fecal material from warm-blooded organisms and can be correlated with the presence of waterborne pathogens. Three *E. coli*-impaired waterbodies are in Basin 6 (see Figure 13 for map) and include:

- 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

A Vermont Statewide Bacteria TMDL Report supports bacteria reduction and watershed restoration throughout Vermont, including the river segments listed above. The TMDL, which established bacterial targets for each impaired waterbody, was completed in September 2011. The report's appendices include specific data monitoring and watershed information about each of the impaired waterbodies.

Agricultural land represents a significant portion of the watershed area of the three Basin 6 streams with dairy production as the predominant activity that contributes to the bacteria load. The TMDL report supports the implementation of agricultural-related practices including land treatments that reduce runoff of animal waste into streams and excluding livestock from riparian buffers.

As Berry and Godin Brooks are also nutrient- impaired predominately due to agricultural activity, both the Agricultural Alternative Restoration plan described below as well as the Lake Champlain Phosphorus TMDL Implementation Plan directs efforts towards these streams. The associated TBP strategies that will reduce nutrients and sediment, specifically those associated with managing animal waste and organic debris, will also serve to reduce bacteria loading in all three streams. The bacteria concentrations of each listed stream will need monitoring to show improvements once implemented.

Alternative Restoration Plan

A high priority for watershed restoration is placed on those waters impaired by nonpoint sources of nutrients and sediment. Restoration of these waters will benefit not only the local stream but also help reduce phosphorus loading to Lake Champlain. In the Missisquoi Basin, these types of impairments are located primarily in agriculturally dominated land use areas.

EPA supports a complementary approach to TMDL development called an Alternative Restoration Plan (ARP). This approach includes defining a maximum estimate of pollutant loading the water can receive and remain in compliance with the VWQS, and identification of actions needed to reach compliance like a TMDL, but rather than assigning loading allocations to certain sources as in a TMDL analysis, remediation relies more on scheduled implementation of beneficial actions to alleviate the problem. If water quality goals are reached within anticipated timeframes, no TMDL will be needed. For six nutrient impaired waters in the Missisquoi Basin, this approach is currently being undertaken by DEC. Other similarly impaired streams exist in the Missisquoi Basin but were excluded from this analysis either because the watersheds were deemed too small to rely on the modeling or because they were identified as impaired after the loading analysis was conducted. Total phosphorus loading targets are being developed for the six watersheds to identify the "level of effort" needed for restoration and the Missisquoi Bay TBP provides the specific strategies available for the necessary project implementation.

The applicable waters in the Missisquoi Basin for which the target setting analysis is being conducted are listed below. The number in parentheses corresponds to that stream listed in Table 4 where more information is located. While there are other high priority nutrient impairments in the Missisquoi Basin, these are the waters for which the loading analysis is being conducted.

- Rock River (4)
- Berry Brook (2)
- Godin Brook (9)
- Trout Brook (8)
- Mud Creek (3)
- Wanzer Brook (29)

The other, similar, high priority nonpoint source waters for remediation, which are not included in this analysis include:

- Samsonville Brook
- Saxe Brook
- Morrow Brook
- Coburn Brook

The underlying approach to develop these total phosphorus target loads is called the "attainment watershed approach." Essentially, phosphorus loading for biologically impaired watersheds can be estimated by determining the phosphorus loading in similar watersheds that currently comply with the biological criteria or are in attainment. The loading for the attainment watersheds is then applied to the impaired watersheds, normalized by area. That then becomes the loading target for the impaired watersheds on the premise that what is an acceptable phosphorus loading regime in a biologically healthy watershed should be sufficient to restore and maintain biological health in the impaired watershed. This approach utilized two previously conducted modeling exercises to estimate the loading for both the impaired and attainment watersheds.

This analysis is ongoing to better determine the appropriate level and types of BMPs needed in each watershed. The final analysis will be submitted to EPA under a separate cover and ultimately be incorporated into the ongoing planning efforts for remediation of these impaired watersheds. Following submittal and approval by EPA, the ARP analysis will ultimately be available on the DEC Watershed Management website.

Lake Carmi Phosphorus TMDL

The Lake Carmi TMDL was approved by USEPA in 2009, and subsequently DEC completed the Lake Carmi Phosphorus Reduction Action Plan, 2008. In 2018, the State designated Lake Carmi as a "Lake in Crisis" and released the 2018 Lake Carmi Crisis Response Plan., and an update in 2021. Between 2016 and 2020, the State invested $1.4 million into clean water projects. DEC updated the list of critical path projects in 2021 with assistance from partners, as well as releasing a 2019 Lake Carmi Progress Report.

Based on models. state and federal watershed investments reduced loading of P by an estimated 251 kilograms (kg) in 2019, which is approximately 41% of the phosphorus reduction required to meet the Lake Carmi Phosphorus Total Maximum Daily Load. Nearly all the estimated phosphorus reductions currently quantifiable in the Lake Carmi watershed have been associated with the agricultural sector. Estimated phosphorus reductions reported are expected to accelerate substantially in the coming years, as the State of Vermont is expanding its ability to estimate phosphorus reductions for all clean water project types. New regulatory programs will drive additional phosphorus reductions from developed lands and agricultural sources.

As it will take time for land management practices to reduce phosphorus loading, ANR is supporting a demonstration project to reduce input of legacy phosphorus from lake sediments by aerating the lake bottom. The expected benefit is fewer cyanobacteria blooms than would otherwise occur. UVM scientists are monitoring lake profile to enable assessment of aeration project,

beginning in 2020 and continuing to 2021 with Agency funds. 2020 results indicate that aeration increased oxygen level sufficiently to result in a reduction of internal phosphorus loading.

A DEC webpage, Restoring Lake Carmi, serves as a central location for information about monitoring and management of Lake Carmi's water quality.

Lake Champlain Phosphorus TMDL (Phase 3 Content)

Lake Champlain is 125 miles long, but only 12 miles at its widest, with depths as great as 400 feet. In contrast its watershed spreads across 8,234 square miles, draining nearly half the land area of Vermont (56%), as well as portions of northeastern New York (37%) and southern Quebec (7%). The Lake's large land to water ratio (20:1) has resulted in significant phosphorus loading from land-use activity in the watershed, the predominant source of the lake's phosphorus impairment (LCBP 2021). The Lake's phosphorus impairment causes cyanobacteria blooms and unpleasant odors, and leads to low dissolved oxygen concentrations, impaired aquatic life, and reduced recreational use.

In 2016, the United States Environmental Protection Agency (EPA) established a revised Total Maximum Daily Load (TMDL) for phosphorus loading into 12 Vermont segments of Lake Champlain, (Phosphorus TMDLS for Vermont Segments of Lake Champlain). Although some of the lake segments have measured near or below targeted limits, the Missisquoi Bay along with St. Albans Bay, the Northeast Arm, and South Lake have phosphorus concentrations that are often above these limits. These shallow bays see nutrient contribution from both legacy phosphorus released from lake-bottom sediments as well as the tributary loading (LCBP 2021).

TMDLs were developed for all 12 Vermont lake segments due to the interconnectedness among the segments. To meet the targets, Vermont developed and is fine tuning a restoration plan for Lake Champlain and its tributaries. The ongoing planning process follows an EPA-approved schedule to develop successive phases focused at the basin level to enhance Vermont's ability to direct resources for maximum phosphorus reductions and account for those reductions.

This section, along with Chapters 4 and 5, fulfils EPA's expectations for the TMDL's Phase 3 implementation plan (Phase 3).

Phases 1, 2 & 3 of the Lake Champlain TMDL

The Lake Champlain Phosphorus TMDL Phase I Implementation Plan (2016) addresses all major sources of phosphorus to the Lake and proposed new and increased efforts from nearly every sector of society, including state government, municipalities, farmers, developers, and homeowners. The EPA-approved plan includes the state's policy commitments relating to regulatory changes or new programs that provides the platform for long-term success. The Vermont Clean Water Act of 2016

created the statutory authority to implement all provisions of the Phase I Plan, which was deemed by EPA to be completed as of September, 2020.

The Phase 2 content was then developed for each tactical planning basin (see 2016 Missisquoi Bay Tactical Basin Plan) and included downscaled Phosphorus allocations for each basin (see Table 5) as well as prioritized catchments for remediation based on highest modeled load reductions. The Agency's tracking and accounting mechanisms were also introduced.

The Phase 3 content is incorporated into this 2021 Missisquoi Bay Tactical Basin Plan and describes the state's current progress since 2016 towards meeting sector-specific Phosphorus targets and state programmatic commitments, as well as projections of sector-specific target reductions for the next five years. This Phase 3 accounting fulfills requirements of the Lake Champlain TMDL Accountability Framework.

Chapter 4 of this plan includes additional details on progress towards addressing state commitments (Phase 1) including changes to programs to address any identified barriers to implementation of phosphorus reduction practices. The resulting strategies identified in Chapter 5 help target the work of the Agency and its partners to maximize facilitate phosphorus reductions over the next five years.

Missisquoi Bay and Watershed Load Reductions

The Missisquoi Bay is one of the twelve TMDL segments where phosphorus reductions are required to restore Lake Champlain and meet Vermont's Water Quality Standards. The Missisquoi Bay is the northern most segment and its watershed includes portions of Quebec (Figure 1). Like the Lake, recovery is challenged by a high land to water ratio that supports the highest estimated baseloads (delivered loads) of all the lake segments. The Missisquoi Basin provides more than double the phosphorus delivery of the other mesotrophic lake segments to Lake Champlain (LCBP 2021). Recent scientific analyses highlight the importance of internal phosphorus recycling from Bay sediments at increasing summertime in-lake phosphorus concentrations and related cyanobacteria and algae blooms (Isles, Xu, Stockwell, & Schroth, 2017).

The total phosphorus annual watershed load to Missisquoi Bay from Basin 6 is 151,327 kilograms (Table 5). The watershed load is different from the delivered load to Missisquoi Bay because as in all other basins only a portion of the phosphorus mobilized in the Basin makes it to the Lake (i.e., some is captured by floodplains, some is taken up by plants). This plan uses watershed loading values.

To meet the Lake Champlain Phosphorus TMDL expectations, total annual phosphorus loading into Missisquoi Bay from the Basin is required to be decreased by 66 % or by approximately 100 metric tons (100,429 kg) per year (Table 5).

Three interactive online reports are included in this Phase 3 section to further illustrate loading and reduction estimates for the TMDL relative to Basin 7 and the agricultural sector where an ample

tracking information allows for more detailed estimations. Each of these reports is provided below and within the text of the following sections.

1. *Estimated TMDL TP Loading and Reduction* online report
2. *Missisquoi Basin Agricultural Phosphorus Loading & Reduction* online report
3. *Missisquoi Basin Agricultural Tracking & Target Setting* online report

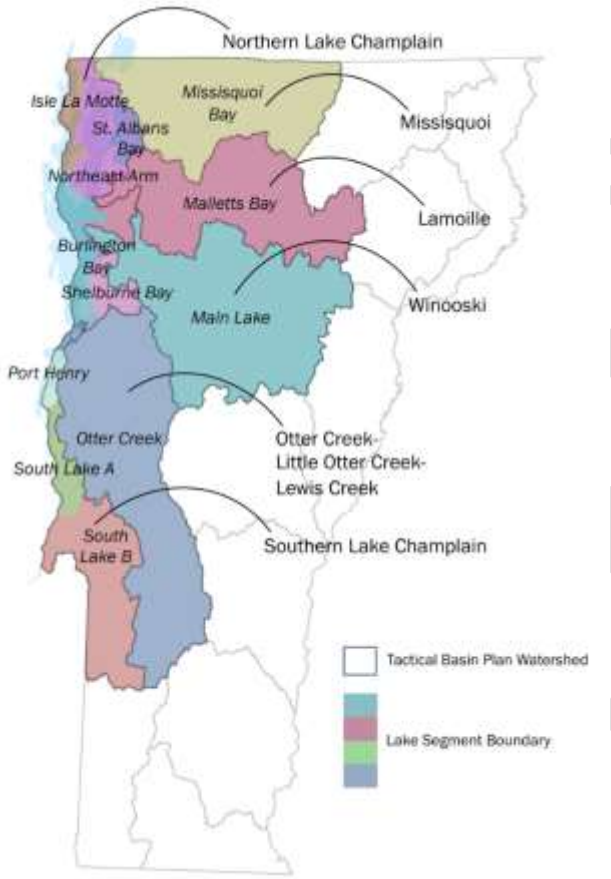


Figure 14. The 12 TMDL lake segments and their watersheds, including the Missisquoi Bay.

Sub-basin scale phosphorus loading and reduction estimates for HUC12 watersheds within Basin 6 can be examined and compared with other watersheds using the *Estimated TMDL TP Loading and Reduction* online report, which displays estimates for all land use sectors and HUC12 watersheds in the Lake Champlain basin. The first page of the report summarizes estimated baseline phosphorus

loading by HUC12 watershed; the second page of the report summarizes estimated TMDL target reductions by HUC12 watershed.

Table 5. Summary table of total phosphorus watershed annual loading, total annual reduction targets and required reductions by sector for Basin 6

Source	Category	Allocation Category	Total Load (kg/yr)*	Total Annual Reduction Goal (kg/yr)	% Reduction Required for Basin
Agriculture	Fields/pastures	Load	59,316	49,114	82.80%
	Barnyard Production Areas	Wasteload	3227	2581.6	80.00%
Developed Land – Road & Stormwater	**Summary**		21,554	7,371	34.20%
	VTrans owned roads and developed lands	Wasteload			
	Roads MRGP	Wasteload			
	MS4	Wasteload			
	3-Acre General Permit	Wasteload			
Wastewater	WWTF discharges	Wasteload	1,500**	779	51.90%
	CSO discharges	Wasteload	NA	NA	NA
River	All streams	Load	44,810	30,695	68.50%
Forest	All lands	Load	22,829	11,415	50.00%
		Total	151,327	100,429	

* Terrestrial load, as opposed to delivered load at lake segment

** Delivered load estimate to Missisquoi Bay lake segment

Measuring Progress Against TMDL Targets

The Agency measures progress towards meeting the TMDL using tracking and accounting methods and reports on progress towards meeting statewide and basin pollution reduction goals in the Vermont Clean Water Initiative Performance Report, (VCWIPR). In addition, the Agency writes interim and final report cards for each Tactical Basin Plan that summarize progress made towards the basin's goals at 2.5- and 5-year increments. The 2021 VCWIP will include the 2016-2020 final report card for Basin 6, the time-period covered by the 2016 Missisquoi Bay Tactical Basin Plan. The Agency continues to develop and improve reduction efficiency methodologies to capture phosphorus reductions from additional land use practices across all sectors.

The TMDL mandates Total Phosphorus (TP) reductions from specific land use sectors by 2036 (Table 5). Between 2016 and 2020, the annual calculated phosphorus reductions in Basin 6 have generally increased every year (Table 6 and Figure 15). Annual totals are not cumulative, and the same volume of reductions must be achieved every year to meet the 2036 target. The agriculture lands sectors show the greatest progress towards meeting 2036 targets in 2020, with field and

pasture area and barnyard production area meeting 14% and 31 % of their targets respectively. Road sector had the next highest reduction as well as progress towards target, meeting 1.5% of its target as of 2020.

Table 6. Estimated total phosphorus (TP) reductions per year for each sector by kilograms from 2016 to 2020

Sector	Kg of TP Reduced Annually				
	2016	2017	2018	2019	2020
Field/Pastures	2958	4286	5191	6287	7017
Barnyard Production Areas	0	109	368	566	878
Stormwater	0	3	3	3	3
Road	2	4	15	32	68
River	0	0	12	26	44
Forest*	0	-	-	-	-

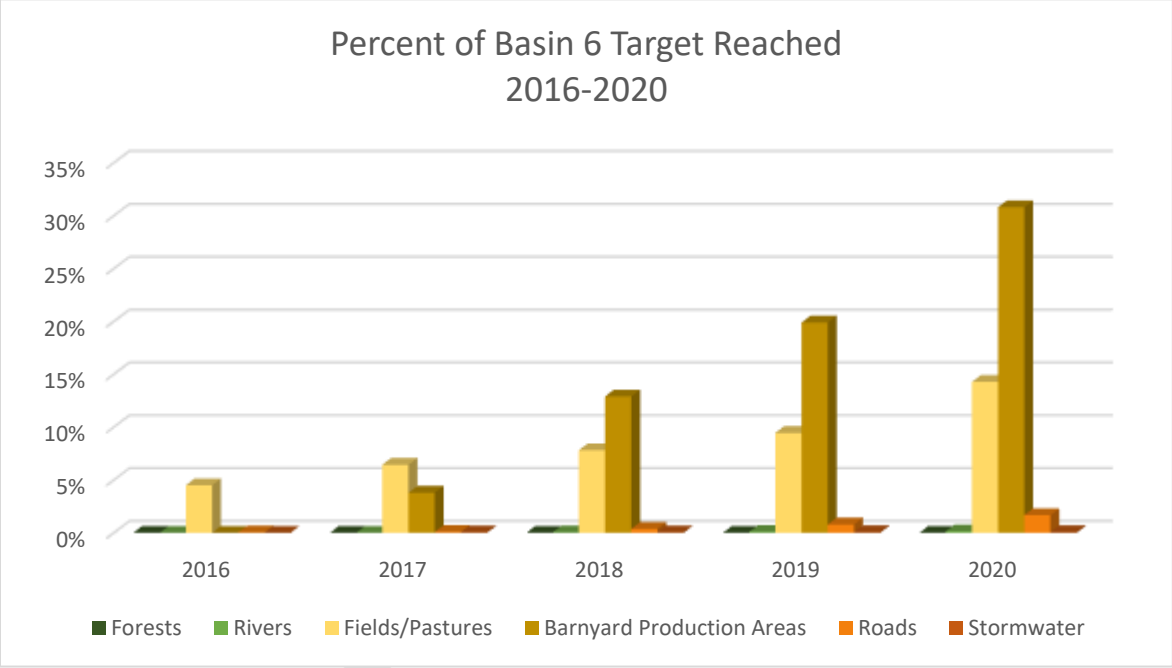


Figure 15. Percent of the Basin 6 TMDL 2036 target achieved annually for each sector from 2016 and 2020

The factors leading to the substantial increase in phosphorus load reductions from the agricultural sector in contrast to the minimal reductions seen in the others may include earlier regulatory compliance dates and focused efforts by partners. The Agency expects to see increases in reductions across all sectors in Table 6 in the next five years and beyond as associated regulatory programs are implemented more comprehensively and particularly as reduction efficiency methodologies are developed and established for all clean water project types. The final section of this Phase 3 - TMDL

Sector Status of Achieving Targets - provides a description of the planned improvements and progress.

Five-year phosphorus load targets for 2021-2025 are shown in Table 7 for each sector as they relate to achieving the TMDL. The five-year target setting is obtained by subtracting the current-year reduction estimates for each sector from the overall TMDL sector goal and dividing the remainder into five-year segments. The 2026 Missisquoi Bay Tactical Basin Plan will report progress on achieving the targets suggested in this plan and address any challenges or gaps in achieving those targets.

Table 7. Prospective five-year and final year (2036) total phosphorus reduction (kg/yr) for the Missisquoi Basin.

Sector	2025 Target (kg/yr)	Final Target (kg/yr)
Fields/Pastures	14000	49,114
Barnyard Production Areas	890	2850
Stormwater	1514	7371
Roads	1247	
Rivers	9578	30695
Forests	3578-	11415

Commitment and Strategy to Meet Targets

To meet TMDL targets, the state of Vermont has implemented initiatives that include both regulatory and non-regulatory approaches. These initiatives include creation of the state's engagement strategy to develop, maintain and enhance the Agency's partnerships; the passing of Act 76– the Clean Water Service Delivery Act in 2019, which supports those partnerships as well as securing project funding; and finally, program advancements in each sector (Table 8), including additional accounting methods to obtain an accurate reflection of phosphorus reduction through land use practices. These initiatives are described below and in detail in Chapter 4.

Table 8. Phase 3 regulatory program update by source sector.

Source* Sector	Permit Program	Reporting Scale	Efficiency	TP Loading Scale	Implementation Timeline Information
Agriculture	Required Agricultural Practices (RAPs) / Large Farm Operation (LFO) & Medium Farm Operation (MFO) Rules and Permits	HUC12	SOP (to be developed in November 2021)	Implemented and tracked at HUC12 scale	Estimates completed at HUC12 scale per farm size inspection cycle. Certified Small Farm Operations (CSFOs) at least once every 7 years, MFOs at least once every 3 years, and LFOs annually

Source* Sector	Permit Program	Reporting Scale	Efficiency	TP Loading Scale	Implementation Timeline Information
Developed	Operational 3-acre Permit	HUC12	35% reduction	Can estimate once 3-acre GIS layer is finalized	Stormwater Program has list of when each parcel is due for permitting; once issued, site will have five-year period to implement
	Municipal Separate Sewer System (MS4) General Permit	MS4 jurisdiction	SOP	Determined by MS4	Phosphorus control plans due 4/2/2021; methods due to be published 11/2021
Roads	Municipal Roads General Permit (MRGP)	Town, but have access to GIS road segments; should be possible to aggregate at HUC12 scale	SOP	Stormwater Program will provide estimate of total expected reduction Q1 2021	Towns must report road erosion inventories (REI) by 12/31/2020; all work to be completed by 12/31/2036; reduction timeline likely to be somewhat frontloaded due to focus on priority road segments.
	Transportation Separate Storm Sewer System (TS4) Permit	Lake Segment	TBD	TBD	Stormwater Program currently reviewing draft VTrans phosphorus control plan.
Forest	Acceptable Management Practices (AMPs)	HUC12	TBD/RFP	Completed at HUC12 scale	Assumes that lake segments with 5% forest reduction will be achieved via increased AMP compliance.

* While no river state regulatory programs have been promulgated to achieve TMDL targets, municipal River Corridor Bylaw adoption is encouraged for target towns in Chapter 4 and Chapter 5.

Act 76 Framework to Meet Non-Regulatory Targets

The 2019 Vermont Clean Water Service Delivery Act (Act 76) has provided the funding and project delivery framework to ensure essential water quality projects to achieve Vermont's clean water goals. The Act accomplishes the following four primary tasks.

Act 76 satisfies a significant milestone in the TMDL by securing long-term funding to achieve Vermont's clean water goals. The Clean Water Fund revenue will support clean water projects, which in turn will leverage other funding sources.

The Act makes it easier to prioritize and fund non-regulatory projects. Non-regulatory projects include small-scale green stormwater management practices, conservation initiatives on Vermont farms, and natural resource restoration projects such as conservation easements, wetland and floodplain restoration, and tree and shrub plantings along riparian areas. While not required, these projects are essential to achieve the water quality goals spelled out in both the Lake Champlain and Lake Memphremagog TMDLs.

In addition, the Act provides a greater emphasis on achieving phosphorous reduction targets set for each watershed that will be supported by the establishment of Basin Water Quality Councils (BWQCs) led by regional Clean Water Service Providers (CWSPs). CWSPs are responsible for partnering with BWQCs to identify, implement, operate, and maintain non-regulatory projects to meet non-regulatory interim phosphorus reduction targets for the Lake Champlain TMDL, and for other impaired waters in Vermont as pollution budgets are established. BWQCs will be formed and operational by 2022.

Lastly, Act 76 requires formula dispersal of funds for non-regulatory projects in the Lake Champlain Basin. The formula is based on interim phosphorus reduction targets and a standard cost per unit phosphorus reduced, consistent with "pay for performance" models. CWSP interim phosphorus reduction targets are under development and will be published in 2022 as a subset of the targets presented in Table 7. The approved Clean Water Service Provider for Basin 6 is the Northwest Regional Planning Commission.

Engagement Strategy

Crucial to the development and future implementation of Phase 3 is the collaborative approach taken to engage partners. This approach focuses on impacts and projects at the local level, with the state as a committed partner in the effort. Vermont's engagement strategy, including ongoing as well as new approaches, includes three dimensions:

1. Widespread collaboration with multiple partners from multiple sectors and localities in developing, writing, and implementing Tactical Basin Plans (TBPs);
2. Strategic inclusion and engagement with different sectors and localities throughout the TMDL "Phase 3" planning process to ensure that all concerns, needs, and goals are addressed throughout the planning process; and
3. Strategic communication efforts to ensure understanding of and support for the plan among key stakeholders as well as throughout the watershed.

The engagement strategy is under development. These extensive efforts have facilitated widespread improved understanding of the requirements for Phase 3, in diverse and sustained collaboration, and in new partnerships. As a result, Phase 3 has widespread shared ownership, is well informed by those working on the ground, and enhances reasonable assurance that Vermont will achieve improvements in local water quality and the 2026 Champlain TMDL targets.

TMDL Sector Status of Achieving Targets

Agricultural Sector

The Lake Champlain TMDL phosphorus allocations for the agricultural sector in Missisquoi Bay are 49.11 metric tons (MT) for non-point agricultural field sources and 2.58 MT for production area sources. These allocations represent percent reductions over the modeled 2001-2010 baseline phosphorus loading estimates of 82.8% and 80%, respectively (Table 6).

Sub-basin scale phosphorus loading and reduction estimates for HUC12 watersheds within Basin 6 can be examined in this TMDL interactive online report, which displays estimates for all land use sectors and HUC12 watersheds in the Lake Champlain basin. Agricultural sectors are broken into three classes in this report: field crops (hay and cultivated crops), pasture, and farm (barnyard production areas) practices. The report summarizes total load phosphorus estimates and load reduction targets.

Agricultural Mitigation, Tracking, and Accounting Efforts

Phosphorus loading from agricultural sources is currently being addressed by several state agencies, regulatory programs, and partner groups. These efforts include the implementation of Best Management Practices (BMPs) to reduce pollution, as well as the tracking and accounting of expected phosphorus reductions from management actions. Results from tracking and accounting efforts are used to measure progress in meeting state and federal phosphorus reduction goals. Examples of mitigation, tracking, and accounting efforts in the agricultural sector include:

- The Vermont Agency of Agriculture, Food, and Markets (VAAFM) has developed a series of Required Agricultural Practices (RAPs) to minimize agricultural impacts on water quality. These practices are expected to greatly reduce phosphorus loading from agricultural sources. Tracking and accounting efforts are being recorded in a multi-partner planning database.
- Act 76 reserves 10% of agricultural phosphorus loading for mitigation by Clean Water Service Providers (CWSPs), who are regional watershed partners with the resources to address local water quality pollution sources. Act 76 also includes provisions for CWSPs to address any TMDL phosphorus reduction targets not met by existing regulatory programs.
- The Clean Water Initiative Program (CWIP) coordinates the funding, tracking, and reporting of clean water efforts for federal and state partners, including VAAFM and CWSPs. Tracking and accounting methods as well as standard operating procedures (SOPs) for phosphorus reduction estimation are described here.

Basin 6 Agricultural Tracking and Accounting Results

A summary of agricultural tracking and accounting work in Basin 6 is available in *Missisquoi Basin Agricultural Phosphorus Loading & Reduction* online report which details agricultural land use, phosphorus loading estimates, BMP implementation, and estimated phosphorus reductions.

- In 2020, over 13,100 acres of agricultural BMPs were *newly* implemented in the basin (several BMPs have multi-year lifespans and are counted in the year they are first implemented, then carried forward for the design life of the BMP); this represents a slight decrease from 13,500 newly implemented acres in 2019. Cover crops represent the most acreage in 2020, with over 7,400 acres, followed by conservation tillage with 2,400 acres.
- Approximately 7,895 kg of agricultural phosphorus were estimated to have been reduced in 2020 by agricultural BMP implementation in the basin This figure represents an increase of over 1,000 kg over 2019. Cover cropping, conservation tillage, and crop to hay, each with unique practice lifespans and reduction efficiencies, collectively provided the largest annualized reductions.

Agricultural Target Setting

The Lake Champlain TMDL mandates reductions from agricultural sources of terrestrial phosphorus. The amount of reduction depends on the lake segment to which a watershed drains. Although reductions are reported at the basin scale, for tracking and target setting purposes these reductions were downscaled at a HUC12 scale. These HUC12-scale targets can be compared to reported reductions to assess progress, identify new strategies, and prioritize future funding and management actions. In addition, the TMDL requires reporting on the 20-year goal in five-year increments. This five-year target setting is obtained by subtracting current-year reduction estimates from the overall TMDL sector goal and dividing into five-year segments.

These data are summarized in the following *Missisquoi Basin Agricultural Tracking & Target Setting* online report. The first page of the report summarizes estimated reductions and target reductions by HUC12 subwatershed for each TMDL year, as well as the percentage of the TMDL target achieved at both a HUC12 and basin scale. The second page of the report details a five-year target reduction for agricultural TP.

Key highlights:

- Basin-wide in 2020, 34% of the total farm/barnyard production area reduction goal was met, and 14.3% of the crop and pasture field practice reduction goals were met. The TMDL mandates that 100% of these goals are met by 2036.
- Based on current year data, an annual cumulative increase in reductions of 2.62 MT of phosphorus (or 2,620 kg) from agricultural crop and pasture practices are required each year from 2020 to 2036 to meet the TMDL goal. The five-year reduction target for 2025 is 20.14 MT of phosphorus. This represents an increase of 13.12 MT of phosphorus over what was achieved in 2020.
- Based on current year data, an annual cumulative increase in reductions of 0.0108 MT of phosphorus (or 10 kg) from farm/barnyard production area practices is required from 2020 to 2036 to meet the TMDL goal. The five--year reduction target for 2025 is 0.93 MT of

phosphorus. This represents an increase of 0.05 MT of phosphorus over what was achieved in 2020.

Developed Lands Sector

The Lake Champlain TMDL phosphorus allocations for the developed lands sector in Missisquoi Bay are 7371 kg for paved and unpaved roads as well as other developed areas. These allocations represent percent reductions over the modeled 2001-2010 baseline phosphorus loading estimates of 34% (Table 6). The annual 2020 reduction in the Basin for developed lands was 72 kg (1.4% of the final target).

Sub-basin scale phosphorus loading and reduction estimates for HUC12 watersheds within Basin 6 can be examined in this *TMDL interactive online report*, which displays estimates for all land use sectors and HUC12 watersheds in the Lake Champlain Basin. The developed lands sectors are broken into 3 classes in this report: paved, unpaved, and developed. The first page of the report summarizes estimated phosphorus loading by HUC12 watershed; the second page of the report summarizes estimated TMDL reductions by HUC12 watershed necessary to achieve targets.

Stormwater-related phosphorus sources are identified in the Lake Champlain TMDL Phase 1 Implementation Plan and include runoff from National Pollutant Discharge Elimination System (NPDES) regulated point sources and nonpoint sources, and non-regulated small construction sites, and unregulated back roads. These are aggregated into the waste load allocation (WLA) category of developed land sources. In addition, some stormwater discharges from developed land may in the future become subject to NPDES permits (through the exercise of residual designation, for example), and include the loads within the WLA consistent with EPA's guidance on stormwater management. Phosphorus loading from developed land was estimated using the SWAT model. The WLA portion of these TMDLs includes a category for developed land sources, while recognizing that this category incorporates both point sources that require NPDES permits and point and nonpoint sources that do not require such permits. An explanation of why EPA established an aggregate WLA for developed land sources can be found in the approved Phase 1 Implementation Plan (Department of Environmental Conservation, 2015).

Watershed modeling used in the Lake Champlain TMDL classifies developed lands into several land use classes, including industrial/commercial, residential, paved road, unpaved road, and private road/driveway. Several regulatory programs address TP from developed lands.

- The Three-acre permit addresses runoff from parcels that include 3 or more acres of impervious surface
- The Municipal Roads General Permit (MRGP) sets standards for town roads that minimize erosion near surface waters
- The VTRANS TS4 Permit guides standards for state highways

- MS4 permits help towns address stormwater runoff and subsequent impacts on local streams

Estimated TP reductions from these regulatory programs have been calculated for the Three-acre general permit, MRGP, and TS4. These estimates were subtracted, at the appropriate spatial scale, from TMDL TP reduction goals for developed lands. TP load reduction from developed lands that is not addressed by regulatory programs will be assigned to Clean Water Service Providers (CWSPs) for mitigation. Based on the most current calculations, 63% of the roads 5-year target (1247 kg/yr) will be met through regulatory (MRGP and TS4) actions. However, the Three-acre general permit is not expected to result in measurable reductions for the Missisquoi Basin's developed lands sector within this same period.

The work of the Clean Water Service Provider (described above) will support the implementation of non-regulatory practices needed to fill the anticipated gaps between these interim five-year targets for roads and developed lands and phosphorus reduction achieved through other sector-based regulatory programs. The amount of Agency funding to support the achievement of non-regulatory targets will be established via interim targets set for the CWSPs during these next 5 years. If five-year targets for developed lands are to be achieved, approximately 92 kg/yr and 303 kg/yr would need to be reduced through non-regulatory work (CWSPs) cumulatively for roads and stormwater respectively. Accounting and target setting will be an evolving and live process, updated periodically in proceeding TBPs and the Vermont Clean Water Initiative's Annual Performance Reports.

It is worth noting that the area attributed to roads in the Lake Champlain TMDL SWAT model was based on older land-use data and exceeds more recent and precise estimates of impervious road area based on newer land-use data published by the Lake Champlain Basin Program in 2011 (LCBP 2011). The original larger TMDL road surface area results in larger estimates of phosphorus loading, and associated load reduction potential than current tracking and stormwater permit reduction estimates, which are based on the smaller areas from the LCBP 2011 impervious surface analysis. Further analysis based on the LCBP 2016 1-meter resolution land use/ land cover dataset is expected to further refine the current road surface areas, associated loading, and load reduction potential through MRGP implementation and may provide more clarity on the magnitude of refinement needed. This issue came to light late in the plan drafting process and so DEC has not had time to fully evaluate options for how to refine loading estimates and targets but will be working to do so in the near term

Wastewater Sector

While Vermont wastewater treatment facilities (WWTF) account for only three percent of phosphorus loading to Lake Champlain, WWTFs will require an average reduction of 42.1% in the Lake Champlain Basin to meet Vermont's phosphorus reduction TMDL goals.

Reductions in waste load allocations are targeted only to WWTFs in those lake segment watersheds where the permitted wastewater load as of 2016 represents a significant (defined as being 10% or greater) portion of the total phosphorus load to that segment from all sources and/or where wastewater upgrades would meaningfully reduce the phosphorus reduction burden placed on non-wastewater (non-point) sources. The Missisquoi Basin meets the latter criterion.

Towards meeting wastewater's goal of a 51.9% reduction in Phosphorus, the Agency has reissued permits to seven of the eight facilities in the Missisquoi Basin in accordance with the TMDL. The exception, the Newport Town WWTF, will no longer discharge to surface waters and instead be regulated through an indirect permit. Permits contain the WLA as an annual load limit and a requirement to keep track of TP loading and optimize its removal. A Swanton WWTF upgrade is currently in progress to better meet its WLA. All other WWTF are meeting their WLA.

Rivers Sector

The Lake Champlain TMDL phosphorus allocations for rivers is 30.69 MT. These allocations represent percent reductions over the modeled 2001-2010 baseline phosphorus loading estimates of 68.5%. (Table 6). Sub-basin scale phosphorus loading and reduction estimates for rivers by HUC12 watersheds within Basin 6 can be examined in this *TMDL interactive online report*, which displays estimates for all land use sectors and HUC12 watersheds in the Lake Champlain basin

Rivers sector reductions are expected to be achieved by implementing projects identified in River Corridor Plans and the Functioning Floodplain Initiative tool, and through the adoption and implementation of municipal regulations to protect river corridors.

Stream Stability Restoration through the Functioning Floodplains Initiative

Assessing stream and floodplain function supports the valuation of ecosystem services and the potential for natural resource restoration opportunities. Societal benefits such as safe swimming, fish and wildlife, public safety and property protection may be categorized under the general ecosystem services of water quality, ecological integrity, and flood resilience.

The Functioning Floodplains Initiative (FFI) was launched in 2019 to contract with a consulting team of professional practitioners and researchers. The goal of the FFI is to provide practitioners, program managers, and policymakers with the maps and data they need to protect and restore highly valued streams, wetlands, riparian areas, and floodplains in the Lake Champlain Basin.

The FFI team is developing methodology for a project credit scoring system that rewards phosphorus load reducing practices, as derived from the Lake Champlain TMDL baseload allocations, for stream instability using the Soil Water Assessment Tool (SWAT). This will result in a phosphorus crediting system that quantifies the gains made towards river system equilibrium.

There are three types of river and floodplain load reduction credit types for river instability. They are:

- Stream stability reconnection credits for projects on the reach and watershed scale
    - Looking at reductions over time (e.g., 10 lbs./year over 10 years)
    - River Corridor Easement (RCE) projects to achieve equilibrium and pollution reduction credits over time.
- Storage attenuation credits for projects that reconnect floodplains and wetlands
    - Driven by the deposit of sediment/nutrient when floodplains flood
    - Longer-term pollution reduction credits may diminish over time
- Sediment removal credits for projects that physically remove sediment when a floodplain feature is constructed, especially along incised channels (first year credit only)

The river instability baseload will be distributed to the reach scale by using TMDL sub-watersheds as the components of each HUC12 to develop the total HUC12 allocation. The HUC12 load allocation then gets downscaled to the reach level using an "area weighted" reach assignment.

The FFI project team established a relationship between connectivity score and phosphorus allocation, whereby the higher the connectivity score, the more the phosphorus reduction target is achieved. This relationship demonstrates that repairing the most disconnected reaches will achieve the most phosphorus reduction. From a target-setting perspective, project implementers (under the Act 76 framework) should target those reaches where we expect to see the highest pollution reductions. This crediting system will consider "stacked" practices (e.g., protection + riparian buffers). DEC will devise how this will be quantified and reported on in our tracking and accounting systems.

Going forward, the river instability phosphorus scoring, and crediting system will be based on the increments of restored and protected connectivity, with the highest project credits awarded in areas with higher baseload allocations. In other words, the size of the connectivity credit awarded to a project is commensurate with degree to which geomorphic equilibrium is restored.

Forestland Sector

The Lake Champlain TMDL phosphorus allocations for forests is 11.41 MT. These allocations represent percent reductions over the modeled 2001-2010 baseline phosphorus loading estimates of 50%. (Table 6). Sub-basin scale phosphorus loading and reduction estimates for forests by HUC12 watersheds within Basin 6 can be examined in this *TMDL interactive online report*, which displays estimates for all land use sectors and HUC12 watersheds in the Lake Champlain basin.

The Agency expects to meet forestland reduction targets through AMP compliance for most basins; however, as the forest targets associated with the Missisquoi Bay are higher than for the other lake

segments, additional reductions are expected to be achieved through restoration and maintenance of current and historic logging roads.

Targeting forestland best management practices (BMP) in areas contributing the highest phosphorus and sediment loads is challenging. In other sectors, such as the developed land sector, source areas are well understood and characterized by the benefit of spatial data with a high degree of accuracy. Additionally, these areas are generally accessible and have the advantage of unobscured aerial imagery to allow verification of mapped conditions. As a result, BMPs can be located to manage high loading areas on developed lands with precision. However, for the natural resource sectors (forestland and rivers), conducting higher resolution spatial data analysis is variable and other methods and analytical tools are in development to enhance project identification and prioritization.

Mapping Critical Source Areas & Identifying Legacy Erosion

As an outcome of the requirements of the Clean Water Service Delivery Act (Act 76 of 2019), and with support from the Lake Champlain Basin Program, the Agency of Natural Resources has contracted with a consultant team to identify and map critical source areas of forestland and establish a method to estimate the potential for phosphorus and sediment reductions associated with forestland BMPs the AMPs. This consultant will assist the State of Vermont in identifying forestland phosphorus and sediment reduction potential using remote sensing, a GIS-based (LiDAR) landscape analysis of erosion risk potential, and critical source area (CSA) mapping of forest roads, trails, and log landings in Vermont. These features will be prioritized based on their erosion risk potential. An additional element of this work is to establish forestland best management practice (BMP) phosphorus and sediment accounting methods to estimate phosphorus and sediment load reductions associated with forestland BMP implementation and AMP implementation on lands in the Use Value Appraisal Program (see Chapter 4 for more information).

A second phase of this consultant work, anticipated to commence in the fall of 2021, will further assess forestlands to identify and prioritize legacy erosion associated with the critical source areas and to ground truth and calibrate the analytical and prioritization tools. The ground truthing of the landscape analysis is intended to calibrate the prioritization framework of critical source areas, as well as to develop a prioritization framework to address legacy erosion in high priority basins (i.e., South Lake Champlain and Missisquoi Bay) to achieve target load allocations for lake segments that will not meet reduction targets through Vermont AMP compliance alone.

Forestland Accounting

Until this consultant work can be completed, the calibration of the phosphorus and sediment accounting methods, to estimate phosphorus and sediment load reductions associated with forestland BMP implementation, will be in development. As such, this iteration of the Phase 3 will not include the projected forestland BMP reduction estimates or forestland BMP targets. In lieu of having specific forestland BMP implementation targets, other than AMP compliance, DEC will provide natural resource targets on the major river basin scale (i.e., HUC-08, Lamoille River Basin)

that is inclusive of all natural resource restoration categories (e.g., including river corridor and floodplain restoration and protection, wetland restoration and protection, riparian and lakeshore restoration and protection, natural woody buffer establishment) as well as forestland AMP and BMP implementation.

Chapter 4 – Strategies to Address Pollution by Sector

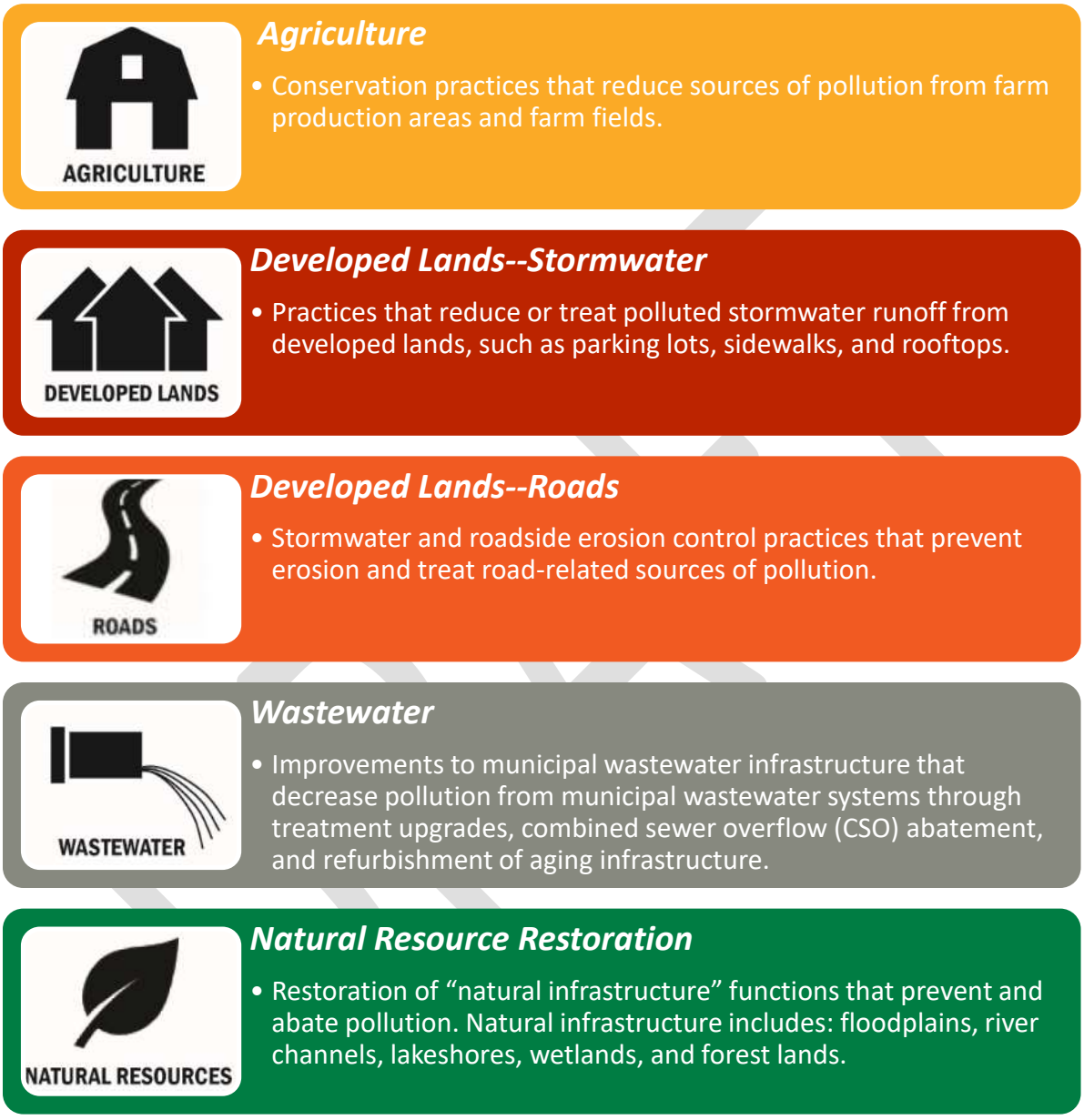
Tactical basin plans address water quality by land use sector (Table 9). The following sections provide specifics about protection and restoration efforts underway or recommended for each source sector to meet water quality objectives. A detailed list of priority strategies by source sector is included in Chapter 5 with a summary provided in Table 1.

The Agency uses regulatory tools in the remediation of degraded surface waters and protection for all other surface waters. In addition, the agency works with partners to provide technical and financial assistance to incentivize implementation[11]. This plan provides additional direction to improve effectiveness of technical and financial assistance based on modeling results, data analysis as well as observations collected from partners during the tactical basin planning process.

The chapter is organized by land use and natural resource sectors. Land use improvements to meet surface water goals are achieved through regulatory compliance as well as the communities' voluntary actions. Although, natural resources receive protection through Agency regulations, this chapter focuses on the restoration and conservation that happens primarily through voluntary actions.

[11] The Vermont Surface Water Management Strategies provides a comprehensive list of actions taken by Agency to remediate degradation to surface waters from land use activity as well as an overview of pollutants and sources.

Table 9. Summary of objectives/outcomes by sector. Strategies in Table 14 address these objectives as well as additional stressors responsible for impairments or physical alterations to the water bodies identified in Table 4



*Project leaders and partners, funding and specific activities are identified in Chapter 5.

A. Agriculture

The agricultural landscape in the Missisquoi Basin is managed predominantly by livestock and dairy operations to raise animals and grow corn and hay. Other agricultural operations in the basin grow fruit and vegetables, and more recently, hemp. In addition, sugaring operations cover a significant area of forested land with the majority in Franklin County. This section will focus primarily on livestock and dairy operations, although strategies will be relevant to other field crops and agricultural operations. The forestry section addresses sap production.

Without proper management of fields and farmsteads, agricultural land use can be a source of nutrients, sediment, pathogens, and toxins to surface waters. Improving the soil health of fields as well as managing application of nutrients through use of Agricultural Best Management Practices (BMPs) help address water quality concerns and protect surface waters. Examples of field BMPs that improve soil health are reduced tillage and the use of cover crops to increase organic matter, reduce compaction, promote biological activity, and reduce erosion. On farmsteads, BMPs such as improved waste storage facilities, clean water diversions, and improved barnyard production areas can help reduce nutrient laden runoff to nearby surface waters.

The ANR and AAFM address agricultural water resource impairments by collaborating with federal, local, and regional partners to target agricultural BMP implementation in the watershed to achieve greatest pollutant load reduction for dollars spent.

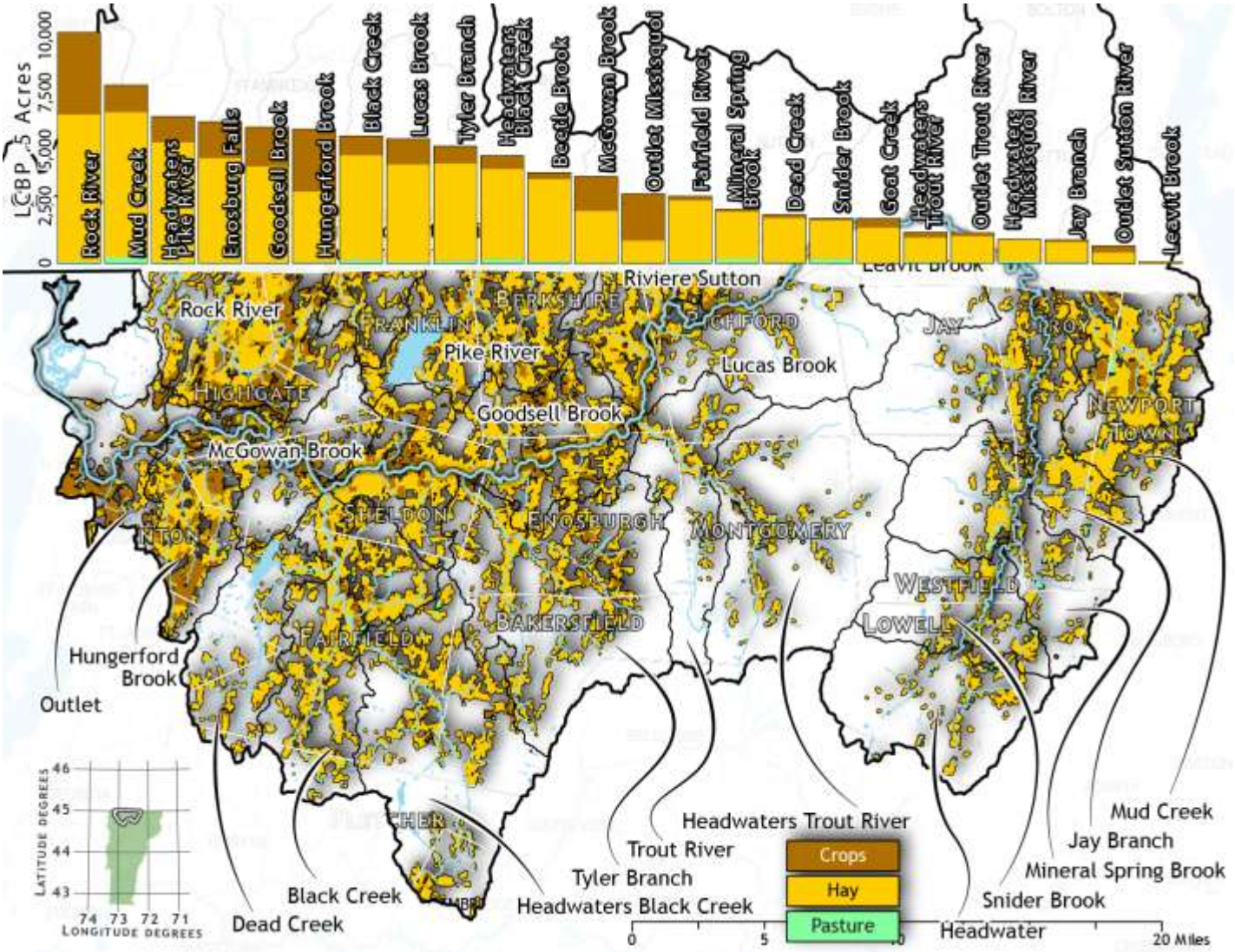


Figure 16. Map of agricultural land use aggregated by acreage of crops, hay, and pasture by HU12 watershed

Geographic targets for BMP implementation include areas with high phosphorus loading from agricultural land use. The top five HUC12s with the highest P loading from agricultural land are displayed on page 2 of the basin's *Missisquoi Basin Agricultural Phosphorus Loading & Reduction* online report.

In addition, watersheds of agricultural-impaired streams are priority areas for the purpose of expediting their recovery and subsequent removal from the 303(d) List of Impaired Waters (see also Chapt. 3 Agricultural Alternative Restoration Plans). Additional geographic priorities include Hungerford Brook for suspected degradation from agricultural runoff (listed as Stressed in Table 4) and predominance of agricultural land cover (Figure 16); and Lake Carmi as a phosphorus-impaired lake with a significant TMDL calculated agricultural contribution. These target areas for BMP implementation are listed below:

- Top 5 HUC12s with the highest P loading from agricultural land: Rock River, Enosburgh Falls-Missisquoi, Headwaters Pike River, Black Creek, Fairfield River (see Figure 4 or page 2 of *Missisquoi Basin Agricultural Phosphorus Loading & Reduction* online report)

- Agricultural-impaired watersheds (streams in bold have Agricultural Alternative Restoration Plans) See Figure 13 and Table 4 (Map Id from Table and Figure follows stream name): **Rock River (4), Berry Brook (2), Godin Brook (9), Trout Brook (8), Mud Creek (3), Wanzer Brook (29),** Saxe River (7), Morrow Brook (21), Samsonville Brook (18), Coburn Brook (23).
- Agriculture assumed or identified as significant source (Table 4): Lake Carmi (36), Hungerford Brook (18).

Other resources that will be used to identify priority areas include assessments, enforcement investigation, or agricultural source mapping. The state agencies prioritize these areas for financial and technical assistance resources that support the agricultural community in complying with regulations or voluntarily adopting BMPs that protect and improve water quality in the Missisquoi Basin.

Vermont Agency of Agriculture, Food, and Markets (AAFM) regulatory programs play a significant role in protecting surface waters by setting required farm management practices to ensure environmental stewardship. In addition to the Required Agricultural Practices (RAPs), Vermont farms are regulated by additional sets of rules promulgated by the AAFM based on farm animal numbers (see Table 10). The permit program requirements also aim to reduce the amount of phosphorus and other nutrients entering state waterways. Although the Large and Medium Farm Operation (LFO and MFO) Programs have been operating under permit programs for more than 10 years, the Certified Small Farm Operations (CSFO) program began on July 1, 2017. The CSFO certification expands farm operation oversight and regular inspections to farms that meet the CSFO threshold. The RAPs also expand requirements for Small Farm Operations (SFOs), who do not need to certify. Increased regulatory oversight and required agricultural practices are expected to lead to enhanced field and farmstead management throughout the Basin. In total as of the writing of this plan, the AAFM has identified 259 agricultural operations ranging in size from SFOs to LFOs in the Missisquoi basin that need to comply with the RAPs.

Table 10. Information by farm size in the Missisquoi Basin as of 6/21/2021 (AAFM).

Farm size	Animal units	Inspection	Facilities/ Operations (#)
Large Farm Operation (LFO)	700 or greater mature dairy cows or equivalent	Annually	31/9

Medium Farm Operation (MFO)	200-699 mature dairy cows or equivalent	Every 3 years	46/22
Certified Small Farm Operation (CSFO)	50 -199 mature dairy cows or equivalent; or Growing more than 50 acres of annual cropland; or growing more than 50 acres of vegetable	Every 7 years[12]	99/84
Small Farm Operation (SFO)	Operate 4 or more acres for farming; or Annual gross income more than $2,000; or have filed a 1040(F)tax form once in the last 2 years	N/A	142/138

Progress and Opportunities for Improvement

The farms in the Missisquoi Basin are adopting BMPs to both meet regulatory requirements and voluntarily improve water quality in adjacent lakes and rivers. The progress made by the agricultural community in BMP implementation and associated phosphorus reduction is displayed in a summary of agricultural tracking and accounting work in Basin 6 available in this *Missisquoi Basin Agricultural Tracking & Target Setting* online report. The report details agricultural land use, phosphorus loading estimates, BMP implementation, and estimated phosphorus reductions. The data reporting starts in 2015, although 2016 is the start of the 20-year TMDL implementation period.

While the agricultural land is predominately in hay, with crops following at 22% and pasture at 2%, the predominant BMPs implemented are associated with corn cultivation. These BMPs are responsible for most annual phosphorus reductions achieved, followed by production area compliance. Key data include:

- In 2020, over 13,100 acres of agricultural field BMPs were implemented in the basin, a slight decrease from 13,500 implemented acres in 2019. Cover crops represent the most acreage in 2020, with over 7,400 acres, followed by conservation tillage with 2,400 acres. Farms have also begun to increase use of manure injection. Conservation crop rotation is also implemented, although does not cover as many acres as the other practices.

- Approximately 7,895 kg of phosphorus was estimated to have been reduced in 2020 through agricultural BMP implementation in the basin. This figure represents an increase of over 1,000 kg compared to 2019. Approximately 7,895 kg of agricultural phosphorus were estimated to have been reduced in 2020 by agricultural BMP implementation in the basin This figure represents an increase of over 1,000 kg over 2019. Cover cropping, conservation

[12] CSFO inspections will be prioritized in critical areas of the watershed due to the 7-year inspection cycle, whereas MFOs and LFO frequency of inspections ensure with more frequent inspections will not.

tillage, and crop to hay, each with unique practice lifespans and reduction efficiencies, collectively provided the largest annualized reductions[13].

- Production Area Compliance has also increased since 2015, with significant reductions of phosphorus resulting, coming in third behind cover crops and conservation crop rotation.
- Although pastures represent a minimal percent of agricultural land, acres managed with appropriate grazing practices has increased steadily over the years.

The Phase 3 report for the LC P TMDL included in Chapter 3 provides a summary of those accomplishments in terms of progress towards meeting phosphorus reduction targets. This section will focus on success of programs towards facilitating the adoption of BMPs that led to reductions as well as expected improvements to programs.

This section provides an overview of technical and financial assistance available to support BMP adoptions along with improvements made or expected in delivery of resources. In addition to understanding where phosphorus reductions were achieved, partners have provided information regarding barriers as well as incentives that affect community adoption of BMPs. The following four themes with opportunities to improve programs and advance agricultural water quality work were identified during discussions with partners:

- Supporting RAP compliance with a focus on CSFOs and SFOs, although NMP implementation would be encouraged for all farms
- Supporting Field BMP Implementation; technical outreach and financial assistance
- Improving Soil Health
- Enhancing Partnerships

Supporting RAP compliance

As described above, AAFM will continue to implement its regulatory program through routine inspections and investigations to ensure compliance with the RAPs. To help better align AAFM regulatory staff with partnerships and the Tactical Basin Plan's water quality priorities, AAFM has structured regulatory staff geographic coverage by basin. AAFM has also assigned multiple inspectors to basins with a high density of farms, including the Missisquoi. Another focus of AAFM outreach are farms identified at the SFO threshold and below to help operators understand the applicable RAP requirements.

[13] The annual phosphorus reduction for a conservation practice is based on the practice's effectiveness in reducing phosphorus runoff (reduction efficiency) as well as the expected lifespan of the practice. For example, acres enrolled in a conservation crop rotation practice will be reflected in the data for the year of enrollment, but the phosphorus reduction achieved over the next five years will be annualized and therefore also contribute to the phosphorus reduction data in each of the five years of the practice's lifespan.

While regulation of agricultural operations provides a legal mechanism for farm oversight, AAFM's outreach, education, and assistance programs are intended for farmers to increase compliance with regulations and improve and protect water quality. AAFM's Water Quality Division administers multiple technical and financial assistance opportunities for farmers in Vermont, while supporting partners to provide educational programs and technical assistance to farmers, as well as to engage in innovative nonpoint source reduction activities. More information about AAFM technical and financial assistance programs can be found here, as well as federal NRCS programs found here. The Vermont Housing Conservation Board (VHCB) has also made financial assistance available for farms implementing farmstead BMPs or acquiring innovative field equipment. In addition, AAFM's new Vermont Pay-for-Phosphorus Program will be launched in the next year as a funding strategy for incentivizing and valuing farmer's agricultural land stewardship efforts, helping to fill gaps where funding is a barrier to voluntary actions.

An RAP required practice successfully advanced in the basin over the last five years through technical and financial resources is the adoption and use of Nutrient Management Plans (NMP). NMP development courses and technical assistance from Conservation Districts, NRCS, and UVM Extension has led to widespread development of NMPs in the CSFO community. With the majority of CSFOs now having NMPs, correct implementation of the NMP was identified by partners as a focus area. Partners recommended that farms receive a continuous 4-year period of support around NMP implementation.

AAFM trainings have and will continue to increase ability of partners and custom applicators to assist farmers in following NMP nutrient recommendation and keep records. The AAFM launched a Custom Applicator program in 2016 to train and certify custom operators in nutrient application and RAPs. Additionally, the RAPs are in the process of being updated to include a Technical Service Provider (TSP) Certification program, which is expected to enhance providers' ability to provide education, outreach and technical assistance related to NMP implementation and BMPs for all sized farms.

Outreach in the Basin and financial support for farmstead practice implementation has also contributed to increasing barnyard or production area compliance numbers since 2015, as well as voluntary adoption of farmstead BMPs by farm operators. Waste storage was identified by partners as an important BMP to continue to encourage.

Supporting Field BMPs Implementation

In the Missisquoi Basin, the upward trend between 2016 and 2020 in annual acreage in cover crops, conservation tillage and using manure injection *Missisquoi Basin Agricultural Phosphorus Loading & Reduction* online report indicates consistent if not increasing popularity of these field BMPs. Although state and federal assistance programs provide support, partners also believe that the farming community's increasing awareness of benefits to soil health and water quality has also been part of their motivation.

Increasing acreage in BMPS by engaging farms that have not yet adopted BMPs is an important strategy. With even the most popular field BMP, cover cropping, covering 36% of cornland in 2020, there is adequate room for additional implementation. Partners stated that farmers are most likely to engage in a conservation practice if they understand economic benefits. In addition, they need to know that there is financial compensation to cover potential losses as well as receive technical support to ensure success. Understanding that adoption of BMPs can provide other co-benefits for the farm, such as improved management and efficiency or related costs, can also be a motivation. To persuade an operator to take the economic risk of adopting new practices during tight fiscal times, partners will need to continue to work together to provide creative and persuasive approaches when offering education, outreach, technical assistance. Suggestions included making the economics of the practices part of the conservation planning effort.

On annual cropland, partners advised that the following practices could be encouraged to ensure effective implementation of cover crops: shorter day corn varieties, interseeding, manure injection, use of innovative equipment, a multi-species cover crop.

As hayland is the predominate agricultural land use in the Basin (Figure 16), it has also been identified as a target area for outreach, education, technical, and financial assistance to increase hayland BMP implementation. These BMPs would address soil compaction, which contributes to high nutrient and sediment loads to surface waters, by improving soil health. Improving soil health to increase soil infiltration rates and water holding capacity would reduce runoff from agricultural fields. Soil health assessments to increase awareness and action by farmers is being supported by UVM extension.

Partner recommendations are to follow these assessments with technical assistance to encourage adoption of practices that reduce soil compaction, erosion, and nutrient runoff as well as moderating nutrient input to reduce nutrient loading. The following practices are examples that would support both: appropriate harvest management (e.g., increased mower height), grassland injection, aeration where needed, nutrient application timing, and manure spreader calibration. Manure application associated practices would also benefit cropland as well.

The injection of manure on crop and hayland may be held back due to high initial investment costs of the specialized equipment as well as gaps in operator knowledge and experience. In FY18, AAFM began cost sharing specifically on the manure injection practice, rather than incorporation of manure more broadly, through the Farm Agronomics Practices (FAP) program and cost sharing manure injection equipment through the Conservation Equipment Agricultural Program (CEAP).

Pasture management was another area that partners identified as needing improvement. Although pasture makes up a small percentage of agricultural land, the work can be done in conjunction with improving forested riparian buffers. Acres of riparian forested buffer planting is expected to increase as the AAFM and partners promote riparian forest buffer plantings beyond the RAP requirement through the Vermont CREP (Conservation Reserve Enhancement Program). Where pasture exists,

CREP can also support exclusion fencing. Additional grazing planning assistance is available from the state, federal, and local service providers to create grazing management plans that can be used in tandem with pasture improvement programs.

Improving Soil Health

Soil health is currently understood by partners and many farmers to benefit crop yields and field management, not only water quality. Increasing farmers knowledge through field assessments that are followed up with technical assistance to identify appropriate BMPs is supported by partners as an effective approach to gaining farmer buy in. The NRCDs are working to increase their capacity to serve as soil sample service providers as part of their NMP services to farms.

Partners noted areas in the Basin with high erosion potential of soils, including the Rock River watershed, where outreach, education, and implementation of BMPs could address erosion risks and improve water quality. To identify soils more likely to cause erosion, the AAFM developed and is using a Critical Source Area (CSA) map layer that quantifies the relative risk of erosion and runoff to surface waters from agricultural fields. The soil properties assessed are slope gradient, runoff potential (hydrologic group), erodibility (Kw factor) and flood frequency class. AAFM uses the map to prioritize field assessments during AAFM regulatory inspections. The map is also available to partners through the Partners Database.

Enhancing Partnerships

The AAFM assists with coordinating agricultural partners throughout the watershed to streamline outreach to farmers where multiple resources may be available through the Multi-Partner Agricultural Conservation Practice Tracking and Planning Geospatial Database (Partner Database) launched in 2019.

Partner coordination is also supported by the Vermont Agricultural Water Quality Partnership (VAWQP). The coalition of state and federal organizations is dedicated to improving agricultural water quality in Vermont by coordinating efforts to provide education, technical and financial assistance to the farming community. The Partnership collaborates to strategically leverage unique resources, funding mechanisms, technical expertise, outreach techniques, and more.

The VAWQP, with support from partner member organizations, began supporting regional positions to coordinate partner workgroups in 2021, including the Natural Resource Conservation Districts in Franklin County and Orleans Counties. Their goal is to improve agricultural water quality in Vermont by coordinating partner efforts to provide education, technical and financial assistance to the farming community.

Suggestions from partners for strategies to enhance collaboration included the development of a farm management team approach to conservation planning service and the development of a

communication plan. The following ideas were discussed that could be included into development of the plan:

- Identify groups that haven't been engaged and identify barriers and incentives
- Develop a unified communication strategy for partners to use to inform farmers to ensure effective messaging.
- Understand the current/modern farmer/landowner barriers to implementation.
- Continue to survey customers on the effectiveness of programing and how to distribute information.
- Improve delivery and effectiveness of education to farmers in basin by identifying specific gaps in information available to farmers (part of strategy above).

Partners that are assisting agricultural landowners with natural resource restoration and protection have also identified strategies to enhance collaboration that are included in the Natural Resource sector under Rivers.

Summary

The Chapter 5 Implementation Table strategies describe the state's plan to continue supporting efforts that lead to BMP implementation and RAP compliance. The recommendations provided by partners contributed to strategy development.

B. Developed Lands

Urban, Residential Nonroad

Stormwater runoff from developed land contributes pathogens, sediment, nutrients, and toxins to waterways, as well as driving stream channel erosion if stormwater is not managed to reduce volume and pollutant loads.

While developed lands comprise only 6% of the basin, densely developed areas or large contiguous areas of impervious surfaces have potential to be source of surface water impairment. Giddings Brook and Jay Branch are two examples (see Table 4). Some of these areas in the basin are identified in the Agency's list of parcels three acres or more with insufficient stormwater management. Concentrated stormwater discharges may also lead to sedimentation by initiating or exacerbate slope instability resulting in gullies and landslides, such as occurs in Highgate.

Most of the management of stormwater is achieved through State and federal regulations. Areas developed before stormwater permitting, and therefore lacking effective stormwater management practices is a focus. As described in the next section, increased pollutant removal is expected through new or revised regulatory processes. The Agency's support of partnerships will help community meet and exceed regulatory compliance.

Resources to improve management of stormwater are directed towards:

- Municipality and school properties three acres or over without adequate stormwater management, as well as identified surface water impairments or assessment or modeling data that indicate high pollutant loading potential:
- Surface water assessment data indicates impairment from stormwater – Giddings Brook (Enosburgh)
- High phosphorus loading modeled - (see Figure 19 in 2017 Basin 5 plan).
- Mapped areas showing high concentrated of gullies and landslides in developed areas: Highgate Center (see Highgate Hazard Map and Report, 2016: VG2016-4 Report.

The following sections provide an update since 2016 of the Agency's and partner's work that will continue over the next five years.

Regulations

In addition to developing the three-acre permit program described below, the agency further enhanced pollutant removal through the 2017 Vermont Stormwater Management Manual (VSMM) revisions to increase the use of green stormwater infrastructure practices in regulated development.

The Agency will also provide assurance that BMPs implemented on the ground are properly functioning throughout their useful design life. DEC-CWIP is setting up a verification program for Clean Water Funded projects that will include support of partner trainings to increase capacity for BMP verification. The Stormwater Program will also continue to require an inspection and recertification program for regulated projects.

Operational Three-Acre Impervious Surface Permit Program

The General Permit 3-9050 serves as the "Three-Acre General Permit" as required under the Vermont Clean Water Act. A three-acre site includes three acres or more of impervious surface that has never had an operational stormwater permit, or was permitted to standards in place prior to the 2002 Vermont Stormwater Management Manual .

To date, the DEC Stormwater Program has identified affected three-acre parcels in the Lake Champlain Basin, including the Missisquoi Basin and Lake Memphremagog basin and notified owners of the permit requirements. The Missisquoi Basin parcels, along with others in the Lake

Champlain Basin, will need to obtain permit coverage as early as January 2022. General Permit 3-9050 includes a schedule for submitting the required application.

Stormwater-degraded streams in the Missisquoi Basin will benefit from additional treatment when the expected acreage comes under the 3-acre permit. A calculation of all the untreated acres within 3-acre parcels in the watersheds of stormwater-degraded streams shows that an additional 210 impervious acres over 33 lots could receive treatment. Towns with the majority of lots include Swanton, Richford, Enosburgh, and Jay. The increase in stormwater treatment in these areas with concentrated development will reduce potential for associated streams to fall into the stormwater-impaired category where municipalities must manage their recovery under a stormwater TMDL.

Resources

DEC has partnered with regional planning commissions, natural resource conservation districts and watershed groups to offer training, technical assistance, outreach, and funding to assist community with regulatory compliance as well as voluntary efforts to improve management of stormwater. The focus of partnerships includes development of stormwater master plans and design and implementation of priority projects, technical assistance to increase use of Green Stormwater Infrastructure and use of social marketing practices to facilitate adoption of environmental stewardship practices. For three-acre sites, DEC is developing a funding program, which for SFY 2022 is supported by an infusion of American Rescue Plan Act funds, with activities to commence fall, 2021.

Green School Initiative

In the Missisquoi Basin, Swanton Elementary, Missisquoi Valley High School and Enosburg Falls Central School are eligible to participate in DEC's Green School Initiative. DEC and LCBP are supporting work through the Clean Water Fund to have stormwater design and permitting work on behalf of schools in the Lake Champlain basin. Public schools and colleges in the Lake Champlain basin that need to get a Three-Acre permit will be able to sign up to receive technical and financial assistance for stormwater design and get help applying for the permit.

DEC's Green School Stormwater Initiative will also partner with Lake Champlain Sea Grant to provide schools with watershed and stormwater lesson plans and teacher trainings. In addition, Lake Champlain Sea Grant will help schools identify ways to maximize the additional benefits of green stormwater projects, such as creating pollinator habitat and outdoor classrooms. An additional educational opportunity would include the initiative by the MRBA and Abenaki Council to rename a stream beginning at the Missisquoi Valley Union to reflect the community's Abenaki heritage.

Public Private Partnership

Through a pilot project, DEC is currently investigating how best to assist private landowners with the 3-acre permit compliance where it will also result in public entities meeting other water quality or public-interest goals or by limiting the volume of public runoff and runoff impacts from publicly managed stormwater systems. This Public Private Partnership project seeks to identify partnership opportunities with the goal of moving ten properties that come under jurisdiction of the 3-acre permit forward to the 30% design phase. These can then be shared as models on how to bring private properties closer to compliance with the new rule while simultaneously meeting some outcomes for public good. A Swanton village property, the village offices has been chosen. Improved stormwater management is expected to relieve localized flooding in the area

Stormwater Master Planning - Lake Wise and other Outreach Efforts

The Agency contributes to voluntary efforts to manage stormwater primarily by supporting assessments that identify and prioritize projects. The DEC assessments include stormwater master planning, Vermont Lake Wise certification program[14] and Illicit Discharge Detection and Elimination (IDDE) studies. The Agency and partners also provide technical and financial assistance for voluntary implementation of projects including lake friendly landscaping practices.

Partner organizations that play an important role in encouraging the adoption of voluntary practices within the community include the Friends of Northern Lake Champlain, Lake Champlain Basin Program, Lake Champlain Committee, Northwest Regional Planning Commission, Franklin, and Orleans County Natural Resource Conservation Districts. These partners provide education and outreach as well as technical and financial resources.

Stormwater master plans provide a list of prioritized projects that property owners could adopt to improve stormwater management voluntarily. Towns with completed plans are identified in Table 11. The NRPC and FNLC have been instrumental in assisting towns with project implementation. Completed projects can be found in the Watershed Projects Database. Additional plans could be considered for Bakersfield, Lowell, Montgomery, Jay, and Troy. Where appropriate, these plans could also identify sources of runoff from agricultural landscapes that intersect with developed land. The need for additional stormwater master plans will be assessed by the Agency upon request. Fairfield pond lake watershed action plan with FNLC and the Pond Association

[14] The Lake Wise Program is focused on improving lake health and includes addressing stormwater. More about this program is addressed in Chapter 4, Section H.

Table 11. Municipality progress in addressing stormwater

Municipality	Streams of focus	Stormwater Mapping	Stormwater Master Plan	IDDE Report Date/suspected discharge found and addressed
Bakersfield		2015		2009 2 found and eliminated
Belvidere		NA		
Berkshire		2018	Proposed	2021 1 found but enforcement not an option.
Cambridge		2012/2018	2022	
Enosburgh	Giddings Brook	2009/2021	2013	2020 3 found 2 eliminated
Fairfield		2015	2014. Also in development: Fairfield Pond Lake Watershed Action Plan	2019/1 found in East Fairfield
Fletcher		NA		
Franklin	NA	NA	2015	
Highgate		2009/2021	2013	2011
Jay	Jay Branch and tribs	2020	Ski Area has a WQRP Proposed for town	Currently in progress
Lowell		2017	Proposed	2019
Montgomery		2009/2019	Proposed	2011/Current
Newport Town		2015		2019

Richford	2009	2018	2011, 4 found
Sheldon	2018/2021	2014	2019/2 found and 1 eliminated
Swanton	2009	2013	2011/2 found and eliminated
Troy	North Troy (2009) and Troy Village (2019)	Proposed	2011 (N Troy);3 found and eliminated/2019 current
Westfield	NA		

Illicit Discharge Detection

An illicit discharge to a municipal stormwater system or water of the state includes any connection that is not predominantly stormwater. This can include the dumping of paint or oil down a street stormwater catch basin, a connection between a floor drains or wastewater pipe to the storm water system, or a break in a pipe that causes contamination to reach the stormwater system. Eliminating these discharges can remove 4 to 7 kg/yr of TP per residential or commercial source to waterways. Study results and identified sources still needing to be addressed are listed in Table 12.

Table 12. Identified discharges needing to be addressed

Town	*Identification*[15]	*Description and Year ID'd*
Berkshire	Berk 3	2019 -Leaking septic system into public storm drain, not a failing system.
Enosburg	EN-210	2021-Elevated E. coli (1900), between School ST and Depot ST and above Stebbins St
Richford	RF-010X	2010 - Unresolved sewer leak from old discharge pipe,
Richford	RF-045	2010 - Sewer manhole overflow needs to be plugged. On watch.
Richford	RF-230C	2010 – Blue Seal Feeds roof top pipe with highest TP due to Pigeons connected to sewer. On watch.
Richford	Main St Pump Station overflowing manhole	2010 - Manhole pumped out and line camera'd. Owner of bakery at 101 Main St notified to reduce grease inputs, clean grease trap. On watch.
Sheldon	SHLD-33-Bridge	2019 - Leaking mound system. On watch.
Sheldon	SHLD-90-Church	2019 – high E. coli in open drainage ditch
North Troy	141 Main St/NT060	2011- Needs further assessment

Collaborative outreach efforts in the basin have facilitated adoption of green stormwater infrastructure, as well as environmental stewardship practices around landscaping. Partners and the Agency often include social marketing practices to engage the community. Examples of collaborations are listed below:

- The Vermont Green Infrastructure Toolkit helps municipalities in the adoption of Green Infrastructure policies and practices. (The ten Regional Planning Commissions of the Vermont Association for Planning and Development Agencies, DEC-WID.
- "Raise the Blade" and "Don't P" on your Lawn campaigns (DEC and partners)
- The Franklin County Stormwater Collaborative.
- The Green Infrastructure Round Table supports the use of Green Stormwater Infrastructure through (Partners facilitated by Lake Champlain Sea Grant and DEC)
- Resource for landslide or gully stabilization, Lake shore stabilization handbook led by NRPC (DEC and LC Sea Grant assistance,); and The Landslide Handbook by USGS, and Regenerative Stormwater Conveyance designs

[15] See illicit discharge and detection elimination survey for the town report and additional location information

Roads

Stormwater runoff from roads is a source of sediment and nutrients to streams, lakes, and wetlands as well as a driver of stream channel erosion if roads are not designed or maintained to shed stormwater. Road infrastructure can also impinge on stream floodplains and be a barrier to aquatic organism passage (AOP) when bridges culverts are not adequately sized. In addition, improper winter management practices contribute excessive Chlorides in the form of winter deicing salts that degrade aquatic habitat.

Roads along with other developed land in basin comprise 6% of the basin's land cover. The transportation network includes state and municipal road as well as private roads and driveways. Private roads comprise a significant percentage of the road network in a town (an example?). The roads most likely to contribute sediment and nutrients are hydrologically connected to surface waters.

The Agency primarily addresses public road-related discharges through regulation. Working with partners, the Agency also provides guidance and financial assistance to facilitate compliance. Partners have helped the community reduce use of winter road salt as well as improve stormwater management on private roads and reduce natural resource conflicts with culvert crossing. State resources are directed towards hydrologically connected roads, and priority road segments identified in road erosion inventories. Giddings Brook, listed for a stormwater impairment, would be another priority area based on density of roads in its watershed. The following sections provide an update since 2016 of the Agency's and partner's work that will continue over the next five years.

Regulations

Municipal Roads General Permit

The 2015 Municipal Road General Permit (MRGP) is a stormwater permit for non-MS4 Vermont cities and towns and is intended to achieve significant reductions in stormwater-related erosion from paved and unpaved roads. Most towns in the basin have met the permit requirement to conduct a road erosion inventory (REI) of hydrologically connected roads to determine if they meet MRGP standards. Bakersfield has yet to complete a REI and Fairfield's is incomplete. Hydrologically connected roads are those municipal roads within 100' of or that bisect a wetland, lake, pond, perennial or intermittent stream, or a municipal road that drains to one of these water resources. These road segments represent roughly 60% of municipal roads and can be viewed using the "Municipal Road Theme" on the ANR Natural Resource Atlas. Road segments are assessed as *Fully Meeting*, *Partially Meeting*, or *Not Meeting* the MRGP standards.

Towns will update their REI each five- year MRGP cycle and use the results to prioritize road upgrades with goal of all municipal roads meeting the MRGP standard by 12/31/2036. The next MRGP cycle is 1/2023-1/2028. All towns in the basin are currently involved in addressing non-compliant roads to meet the MRGP by increasing knowledge of road maintenance practices and implementing upgrades on applicable road segments to meet required practices. Towns are required to bring 15% of non-compliant segments up to the MRGP standards by 12/2023. As a result, the Agency expects an acceleration in the rate of road segments improved annually. For progress, see MRGP Implementation Table Portal. Towns with the highest percentage of road segments needing to be addressed under permits are a focus for assistance (See Figure 17).

Going above and beyond the MRGP requirements, all towns in the basin have also voluntarily adopted the most current version of the VTrans administered Vermont Road and Bridge Standards (see Municipality Protection Matrix). Towns adopting the Vermont Road and Bridge Standards, coupled with other requirements, may be entitled to higher cost share rates in federally declared flood event reimbursements.

Transportation Separate Storm Sewer System General Permit – TS4

The Transportation Separate Storm Sewer System (TS4) General Permit covers stormwater discharges from all Vermont Agency of Transportation (VTrans) owned or controlled impervious surfaces. The TS4 general permit combines the stormwater requirements for VTrans associated with its designated regulated small municipal separate storm sewer systems (MS4s); industrial activities, commonly regulated under the Multi-Sector General Permit (MSGP); and previously permitted, new, redeveloped, and expanded impervious surface, commonly regulated under State-Operational Stormwater permits.

As required by the permit, VTrans has an approved Phosphorus Control Plan (PCP) that achieves on average 25% of the total phosphorus reduction to Lake Champlain in each four-year period. The plan meets the requirements of the Lake Champlain Phosphorus TMDL as well as ensuring water quality protection across the entire state. The 2021-2024 Phosphorus Control Implementation Plan (PCIP) documents how VTrans will work over the next four years to advance the first phase (25%) of its work to reduce P loading from roads, rights-of-way, and facilities subject to the PCP by over 20% within the next 20 years (by June 17, 2036). A VTrans Story Map outlines VTrans' process towards developing the PCP, with a VTrans factsheet providing additional information.

Over the term of this TBP plan, VTrans' first PCIP is expected to be completed and although focusing on the Missisquoi Bay Basin, does not expect to complete all expected work in the Basin. VTrans also anticipates continued pursuit of emerging and innovative strategies, including enhanced correction of gullying or large areas of culvert outlet erosion and implementation of floodplain restoration and other natural resource restoration projects.

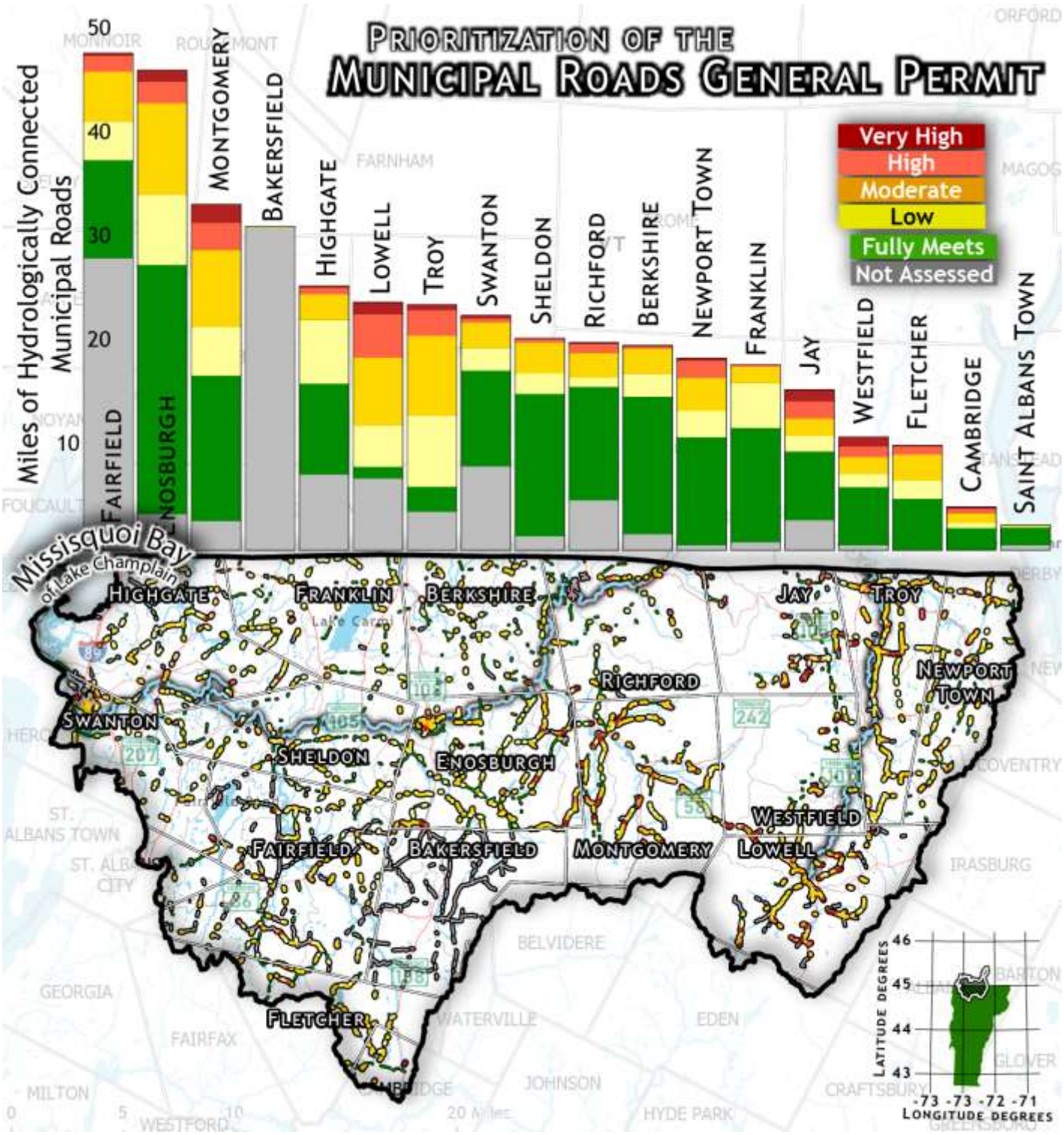


Figure 17. Results of Town road erosion inventory that identify priority road segments (high and very high) for remediation (DEC database accessed through the online [MRGP Implementation Table Portal).]

Resources

DEC has partnered with regional planning commissions, natural resource conservation districts and watershed groups to offer training, technical assistance, outreach, and funding for REIs, road upgrades, and equipment purchases to assist municipalities. The Agency and partners also support municipalities and private road owners in addressing road-associated pollution. This collaboration will assist the Agency in meeting regulatory and non-regulatory programmatic commitments to meet LC P TMDL, as well as other VWQS needs.

VTrans Grant-in-Aid Program

Clean Water funding through the VTrans Better Roads and the ANR's/VTrans Municipal Road Grants-in-Aid programs support the development of municipal REIs, project implementation and purchase of equipment like hydro seeders.

Partners have assisted municipalities in applying for these grants helping the municipalities take advantage of financial assistance to address non-compliant roads since 2018. All the towns in the basin have taken advantage of the Grants-in-Aid Program to address hydrologically connected roads

Administration of the Grant-In-Aid BMP construction program is transitioning from the Agency of Natural Resources to the Agency of Transportation. Regional Planning Commission staff continue to work directly with municipalities to help identify priority projects from REIs to construct with the funding from this program. See below for additional change relating to funding of equipment.

Lowell also benefited from a $70,000 grant to address road erosion and address a culvert on Irish Hill Road as a one time from settlement from the former owner of the state's closed asbestos mine at the headwaters of Missisquoi and Lamoille River.

Individual and Regional Sharing Equipment Programs

Administration of the equipment purchase program remains at the Agency of Natural Resources. Equipment that are eligible for municipal purchase through the Grant-In-Aid equipment program: leaf blowers, haybale shredders plate compactors, roller compactors, shoulder disks, hydro seeders, and stone screeners. Towns in the basin that didn't purchase equipment during their initial round of eligibility (FY19) may have another opportunity to do so in FY22.

Through state funding, the NRPC has coordinated a hydroseeded rental program for Franklin County towns. The program led to reduced erosion after ditch cleanings by accelerating revegetation. With the enactment of MRGP, the window between ditch cleaning and reseeding

shortened, making it more difficult for towns to successfully schedule the hydroseeded. To address, the Grant-in-Aid program now provides opportunities for towns to buy their own. The larger hydroseeded managed by NRPC is still available. Equipment purchases were supported for Enosburg, Highgate, Montgomery, Fairfax, Fairfield, Fletcher, Newport City

The rock screener is another piece of equipment that towns have identified as necessary to meet MRGP. NRBP noted that the availability and cost of trucking stone has been an area of concern for the NRPC Transportation Advisory Committee (TAC) since at least 2017. In FY22, the Grant-In-Aid program included rock screeners as an option. Although DEC offered equipment purchase to Basin 6 in the FY 2019 Municipal Roads Grants in Aid program. left over equipment funding this year or subsequently may result in an opportunity to offer the basin's towns the opportunity to purchase additional equipment.

Road Workgroups

Most towns in the basin rely heavily on the VTrans, DEC and the NRPC and NVDA for technical support in meeting MRGP standards and improving roads to address water quality issues in this basin. Collaborative efforts have driven much of the distribution of assistance, see below: In 2020, tactical basin planning grant became available to regional planning commissions and where interested NRCDs and watershed groups to support their outreach to municipalities.

Northeast Kingdom (NEK) Rivers and Roads work group – Three Northeast Kingdom NRCD, NVDA staff, D7 and D9 VTrans staff and DEC staff coordinate technical assistance and outreach to towns. The NorthWoods Stewardship Center also contributes assistance to address Class 4 roads. They identify gaps in service and assistance to towns and address through identifying cost sharing opportunities, targeted trainings, and as well as other outreach, technical and financial services. The region, including the Orleans County portion of the Missisquoi Basin is a priority for technical assistance as towns tend to need more resources than the others in the region because of limited staff while having less access to planning assistance.

NRPC Transportation Roundtable

NRPC transportation planner coordinates group to provide technical support training on MRGP requirements, assistance prioritizing road BMPs, help to develop Capital Improvement Plan (CIP) budgets, and apply for funding to implement projects

Upper Missisquoi Aquatic Organism Passage Working Group

In Franklin and Orleans Counties, a new group focused around enhancing Aquatic Organism Passage as well as geomorphic compatibility of culverts and bridges. They assist towns and private

landowners in improving road crossings by evaluating structures and providing the 30% design for high priority projects. Their work includes Membership includes USFWS, DFW, Upper Missisquoi Wild and Scenic, MRBA, NRPC and the FCNRCD and OCNRCD. By focusing on increasing Brook Trout habitat, the group brings national grant opportunities focused on habitat restoration to towns to support culvert projects.

Private Roads Outreach

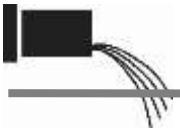
Private roads can comprise a significant percentage of the road network in a town. The agency's approach has been to support partners in providing education and outreach to landowners to encourage them to adopt effective maintenance practices. Partners have engaged landowners in discussion by describing economic benefits of reducing overall maintenance costs as well as the protection of local streams, lakes, and wetlands.

The Agency's most recent tool is expected to benefit the private roads by allowing identification and prioritization of hydrologically connected road segments. The Agency's road erosion inventory App for forest access roads is now available for private road driveways assessments, with a demonstration project initiated around Lake Carmi in 2020. Project implementation will continue to be supported through trainings and factsheets, including those developed by the DEC Vermont Lake Wise Program for gravel road maintenance and the Vermont Better Roads manual..

Outreach efforts since 2016 has engaged communities around two lakes. The DEC Lakes and Ponds Programs worked with Fairfield Pond Association to implement private driveway improvements through the Lake Wise Program (see Lake section). In addition, the NRPC with LCBP and DEC support is currently working with the community to improve private roads around Lake Carmi. The project included the demonstration of the Agency's Road Erosion Inventory (REI) APP to inventory and prioritize roads in 2021. The inventory will be followed by outreach, technical and financial assistance to install Better Road practices. In addition to reducing pollutant loads from private roads, another goal is to increase overall capability in community to continue to install and maintain these road practice.

Both the municipalities and VTrans are meeting timelines for respective permit compliance. In addition, the tools developed to facilitate permit compliance have and will continue to assist private landowners' voluntary management of their roads.

Chapter 5 Implementation Table strategies support the partnerships and target areas for highest pollutant reductions on developed land.



C. Wastewater

Unlike the other sources described in this plan, wastewater discharges to surface waters represent a regulated and readily measurable and controlled source of pollutants to waters in the state. Potential pollutants include bacteria and pathogens and nutrients. The Agency of Natural Resources supports improvements made to municipal wastewater infrastructure that decrease nutrient (e.g., phosphorus and nitrogen) and other pollutant loading from municipal wastewater systems through treatment process upgrades, optimization, combined sewer overflow (CSO) abatement, and refurbishment of aging infrastructure. This chapter also describes opportunities to improve management of onsite wastewater systems. The American Rescue Plan Act (ARPA)funds may benefit towns or residents in the basin within the following program areas:

- Reducing sewer overflows;
- Improving water and sewer infrastructure in mobile home parks and providing financial assistance to low-income homeowners with failed on-site water and wastewater systems; and
- Developing community sewer systems in some of the more than 200 villages that currently lack such systems.

Controlling Phosphorus from Wastewater Treatment Facilities and Other Industrial Discharges

Most municipal wastewater, originating from a combination of domestic, commercial, and industrial activities, is conveyed to centralized wastewater treatment facilities (WWTF), and treated to established standards identified in permits[16] before discharge into a receiving water. Seven of the eight facilities in the Missisquoi Basin have been reissued permits in accordance with the Lake Champlain Phosphorus TMDL (LC TMDL). Newport Town's system permit will be changed to an indirect discharge permit, with permit conditions that will be based on protecting ground water, see Table 13 and subsequent narrative below.

To ensure the LC TMDL allocations for WWTF are met, the DEC Wastewater Management Program maintains a tracking system for each facility's phosphorus loading so that a facility approaching, or over, 80% of the annual mass limit in its permit can be identified. Explanation of the calculation is provided here. WWTFs in the Lake Champlain watershed with existing discharged

[16] National Pollutant Discharge Elimination System (NPDES) Permits

loads of phosphorus already at, or above, 80% of their current annual mass limits are identified in Table 13.

To ensure that all facilities are operating as efficiently as possible, all reissued wastewater discharge permits under the 2016 TMDL will require facilities to develop a Phosphorus Optimization Plan (POP). The intent of these plans is for WWTFs to maximize phosphorus removal efficiency by implementing optimization techniques that achieve phosphorus reductions using primarily existing facilities and equipment. Facilities will be given 12 months following permit issuance to engage in optimization techniques for the removal of TP.

With support from the Lake Champlain Basin Program, DEC initiated a wastewater optimization and technical assistance program in 2018. Although no Missisquoi Basin permittees requested assistance with their POPs, the following permittees did: Pittsford, Hardwick, Marshfield, Fair Haven, Northfield, Burlington North, Richmond, and Winooski. In addition to the POP, all permits will require facilities' phosphorus discharge to be evaluated by the Agency Secretary relative to the 80% threshold (explained above) after the optimization period and based on the prior 12 months. The 80% evaluation continues on a rolling 12-month basis thereafter. If a facility is at, or reaches, 80% of its annual mass limit, the permittee must develop a Phosphorus Elimination/Reduction Plan (PERP) to ensure that the facility will comply with its annual mass limit.

Eliminating Combined Sewer Overflows

Occasionally, because of precipitation events that surpass the capacity of the sewer collection system, combined sewer overflows (CSOs) may occur. The Agency is working with communities to eliminate CSOs. Communities with CSOs have been issued §1272 orders directing them to prepare a Long-Term Control Plan (LTCP). A guidance document that provides additional detail beyond the existing EPA guidelines and the requirements of the CSO Rule is available and the LTCPs prepared by municipalities will be evaluated against it. DEC works cooperatively with the communities to ensure that comprehensive plans with a high probability of success will be created.

The Village of Enosburg Falls is the only municipality in the Missisquoi Basin (see Table 13) with a collection system that includes CSOs. Richford eliminated its CSO noted in the 2016 TBP. Enosburg Falls prepared a CSO LTCP in 2020 and has been issued a new 1272 order that includes deadlines for CSO abatement project implementation. Projects included in the order include a duckbill valve to prevent the Missisquoi from backflowing into the sewer system, installing a level sensor in the CSO tank, using cameras to evaluate the condition of sewer lines to determine the best mode of rehabilitation, replacing old sewer lines that suffer from infiltration problems and coordinating with private property owners to disconnect roof drains from the combined sewer. The roof drain disconnections have the potential to redirect a volume of water approximately equal to the existing CSO tank but present a significant funding and coordination challenge.

Table 13. Summary of permit requirements for the wastewater treatment facilities in the Missisquoi Basin. MGD -Million Gallons/day; WLA – Waste Load Allocations.

WWTF Facility (permit[17] ID)	Permit expiration date	Planned permit re-issuance year	Design flow MGD	Current permitted load (mt P/yr)	TMDL WLA (mt P/yr)	2020 Avg Flow (MGD)/ % of Design Flow	Treatment type	Receiving water
WestRock Converting (Sheldon) (3-1118)	**6/30/23**	**2023**	**1.500**	**0.691**	**0.691**	**0.221 / 14.7%**	**Aerated lagoon**	**Missis-quoi River**
Sheldon Springs (3-1108)	**6/30/23**	**2023**	**0.054**	**0.373**	**0.373**	**0.020/ 36.7%**	**Extended aeration**	**Missis-quoi River**
Swanton Village (3-1292)	**6/30/23**	**2023**	**0.900**	**0.249**	**0.249**	**0.368/ 40.8%**	**Aerated lagoon**	**Missis-quoi River**
Enosburg Falls (3-1234)	**6/30/23**	**2023**	**0.450**	**0.124**	**0.124**	**0.238/ 52.8%**	**Extended aeration**	**Missis-quoi River**
Richford (3-1147)	**6/30/23**	**2023**	**0.380**	**0.105**	**0.105**	**0.190/ 49.9%**	**Aerated lagoon**	**Missis-quoi River**
North Troy (3-1139)	**6/30/23**	**2023**	**0.110**	**0.122**	**0.122**	**0.071 / 64.5%**	**Extended aeration**	**Missis-quoi River**
Troy/Jay (3-1311)	**6/30/23**	**2023**	**0.800**	**0.221**	**0.221**	**0.063/ 15.8%**	**Sequential batch reactor**	**Missis-quoi River**
Newport T (3-1236)	**3/31/09**	**Indirect Permit expected 7/21**	**0.042**	**0.006**	**0.116**	**0.015/ 36%**	**Sand filtration and GW infiltration**	**Mud Creek**

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

Since 2016, facility improvements have included CSO removal in Richford. In addition, all facilities except Newport Towns' have been optimizing for phosphorus. Swanton and North Troy are planning for improvements. The total cost of these upgrades has been/was estimated at a cost of

[17] See following website to view permit: https://anrweb.vt.gov/DEC/IWIS/ReportViewer2.aspx?Report=WWActiveNPDESPermits&ViewParms=False

$3M. Other facilities in the basin are subject to customary operations and maintenance requirements, and periodic performance engineering analyses as described below:

Facility–specific information

WestRock- Converting

The WestRock Converting facility is engaged in the production of recycled boxboard using corrugated and non-corrugated furnishes. The discharges are treated process wastewater combined from paper process wastes and miscellaneous cooling waters. The wastewater treatment system includes a 120-foot diameter primary clarifier and a 20-million-gallon aerated lagoon which has an area dedicated to settling.

Sheldon Springs WWTF

The Sheldon Springs WWTF is an extended aeration plant which provides secondary treatment of domestic wastewater. Disinfection is completed by the addition of chlorine. The latest twenty-year evaluation was done in 2020 with only minor issues to address.

Swanton Village WWTF

The Swanton Village WWTF consists of two partially aerated facultative lagoons followed by phosphorus removal in two solids contact clarifiers. Disinfection is accomplished by ultraviolet light. A CSO elimination/combined sewer separation project was completed in the 1990's resulting in no known sewer overflow points in the collection system. Necessary upgrades to the Swanton facility to provide advanced phosphorus control have been estimated to have a construction cost of ~$2.9M. Pilot testing has been completed and the Village is considering design alternatives.

Enosburg Falls WWTF

The Village of Enosburg Falls owns and operates this WWTF, which is an extended aeration/activated sludge treatment system servicing the Village of Enosburg Falls. The facility discharges secondary treated, chlorinated/dechlorinated wastewater. There is one CSO discharge at the Route 108 Bridge. In December 2011, Enosburg installed an offline emergency tank, upgraded the headworks, and added a second chlorine contact chamber at the WWTF to handle the peak flows. According to an Effectiveness Study conducted in 2012/13, the improvements are working as intended and have prevented overflows. A Long-Term Control Plan was completed in 2020 and includes several recommendations for projects to continue to eliminate CSO events. The recommended projects total $229,000. One event occurred recently during the Halloween Storm of 2019, which caused CSO events throughout the state.

Richford WWTF

The Richford WWTF utilizes the aerated lagoon process of biological treatment to achieve secondary treatment of domestic wastewater via two lagoons. Total phosphorus removal is achieved through chemical treatment using alum. Disinfection is achieved through a chlorination and dichlorination process. Richford is utilizing a cerium-based chemical to precipitate phosphorus and is working through system optimization issues. Two CSOs associated with the collection system – Playground pump station and River Street have been addressed since 2016.

Newport Town WWTF

The Newport Town WWTF consists primarily of a 60,000-gallon septic tank where the treatment process is initiated. From the septic tank, effluent flows to the effluent filter tank and then the dosing siphon tank. In the dosing tank, effluent is stored until a specified volume is reached whereby it is then released to one of two sand filters. Within the sand filter beds is where the final effluent treatment is performed prior to distribution to the disposal fields. Ultimately, effluent is released to the groundwater and in turn Mud Creek. This facility applied for coverage under an Indirect Discharge permit in the summer of 2021.

North Troy WWTF

The North Troy WWTF utilizes an extended aeration process which is a modification of the conventional activated sludge treatment process and chlorine is used for disinfection. The treated sludge is pumped to drying beds and eventually the dried solids are landfilled. Necessary upgrades to the North Troy facility are estimates at $875K to provide for advance phosphorus control.

Troy/Jay WWTF

The Troy/Jay Wastewater Treatment Facility replaced its four aerated lagoons with a new facility that started up on May 14, 2012. The new WWTF consists of headworks with a mechanical fine screen and aerated grit chamber, two Sequencing Batch Reactors (SBRs) with a fine bubble aeration system, chemical precipitation with polyaluminum chloride for total phosphorus removal, and an ultraviolet light disinfection system. The sludge handling consists of an aerated sludge storage lagoon with a new mixer, centrifuge, and solar greenhouse with two robotic tillers for sludge dewatering/drying.

Assistance for TMDL compliance

The DEC WSMD Wastewater Management Program assists municipalities in permit compliance, information can be found on the Program's TMDL page, including a list of grant and loan opportunities.

Municipalities have and will continue to upgrade WWTFs to meet the TMDL and optimize performance with assistance from state and federal loan and grant programs through Clean Water State Revolving Fund, Vermont Pollution Control Grants, USDA Rural Development's Water

Environment Program, the Lake Champlain Basin Program, and the Vermont Clean Water Fund. Priorities highlighted above for each of the wastewater treatment facilities, with municipal support, will be included in future drafts of the Project Priority List articulated in the DEC's "Intended Use Plan" as developed by the Water Investment Division. The Division has expectation that Swanton and Enosburg Falls WWTF upgrades and/or associated infrastructure will be included for consideration in future lists.

Septic Systems

Inadequate or poorly maintained on-site septic systems can leach pollutants to surface waters. If a system is not functioning correctly and leachate is directly entering waters, recreational users may be exposed to high bacteria levels. Potentially disease-causing organisms and nutrients can move through the soil to the river or lake.

The State of Vermont adopted universal jurisdiction over the design, permitting, and installation of all new wastewater disposal systems and potable water supplies including septic systems in 2007. All new wastewater disposal systems and potable water supplies must obtain a Wastewater System and Potable Water Supply Permit for activities such as subdivision of land; construction of a new building that needs a wastewater system or water supply; and repair and/or replacement of a failed wastewater system or water supply. Wastewater systems that have wastewater surfacing, backing up into the building or discharging to the waters of the State are considered failed systems. A permit is also required for certain modifications of use of an existing system.

Systems installed before July 1, 2007, and systems installed or receiving increased flows after 2007 that did not receive a permit could potentially discharge into surface waters if the system was not installed correctly and is in close proximity to a river, lake, or wetland. Failed or poorly functioning systems can contribute *E. coli*, phosphorus, or nitrogen to surface waters.

While necessary to protect surface waters, addressing failed systems is not always easy. Failed systems that discharge pollutants into surface waters are difficult to identify without landowner permission and no regulatory tool exists that requires inspections of pre- or post-2007 wastewater systems on a regular basis unless specified in their permit.

Although replacement is still a barrier, state financial assistance is available to qualifying homeowners for system upgrades and will be augmented in 2021 through ARPA funding. Town Health Officers is a resource in the community to provide education as well as to help investigate citizen concerns about failed septic systems.

Village Wastewater Solutions

Many villages in rural communities lack community sewer systems, instead depending solely on individual septic systems. Small village lots or properties near nearby wells and water bodies often limit the ability to install new or replacement septic systems and leach fields. As a result, village revitalization efforts are hampered and onsite systems that are aging out of their design life or failing altogether, can lead to bacterial contamination and excess nutrients entering surface and groundwater.

DEC supports communities in planning and installation of wastewater solutions. In general, new village wastewater solutions are decentralized and often involve in-ground disposal systems (leach fields) though numerous options are available. Projects can range in size from serving just one property to connecting the entire village. An example in the basin includes the Lake Carmi State Park's innovative natural systems that provides a zero discharge The advantage of this new technology includes reduced operations and maintenance costs.

In the Missisquoi, Highgate and Montgomery have begun planning to support community onsite systems. They like other dense systems around lakes or village areas along rivers are priority areas for alternative wastewater treatment solutions. Highgate village is completing the preliminary engineering for their Village Core in Summer of 2021 and moving into final design for the first phase of their project. Montgomery and Montgomery Center villages are undergoing hydrogeological analysis in the Summer of 2021 in preparation for their final design and permitting. Montgomery residents have passed a bond vote in support of the project. The project plans for construction in 2022.

Resources available for assisting municipalities include the Clean Water State Revolving Fund (CWSRF), as well as ARPA funding. Montgomery is included in the CWSRF Project Priority List articulated in the FFY20/FFY21 DEC's "Intended Use Plan" as developed by the Water Investment Division. The Highgate project is included in subsequent table regarding expected future needs.

Assistance in planning is also available through the Vermont Engineering Planning Advance Program. The loan program is available to municipalities without existing municipal water or sewer systems for conducting a feasibility study for community-based drinking water and/or wastewater solutions. Consulting engineers assess the town's needs and goals offering treatment options. DEC has supported development of community wastewater study in 2012 for Franklin with focus around Lake Carmi; however, further action has not been taken

To support towns with limited staff for supporting wastewater studies, Vermont has formed an interagency Village Wastewater Initiative Committee (VWIC) led by the Department of Environmental Conservation (DEC). The committee meets biweekly to discuss progress of the

villages, development of tools and resources, and coordination between funders and service providers. VWIC has designed a workbook to help in organizing a village wastewater committee first step in initiating solutions.

A current collaboration between DEC and partners and the villages of Wolcott, East Burke, and West Burke to identify cost effective wastewater solutions is being supported through a Northern Border Regional Commission (NBRC) grant. The project is expected to provide a model for other villages throughout Vermont. An overview of the project is available here.

Septic Socials

Communities around lakeshores have expressed concerns about failing systems and in response, the Agency has provided technical assistance to the community through Septic Socials. Community interest as well as aged systems, lot size and soils that limit adequate treatment are priority areas for outreach. The agency and partners have coordinated with interested communities around Lake Carmi to support several events.

Septic socials are neighborhood gatherings where homeowners learn about the options for a well-functioning septic system and good maintenance practices, including household products that are kind to septic systems. The event provides an informal opportunity for people who may never have seen a septic system to learn about them and their importance to water quality protection. A septic system specialist discusses operation and maintenance of septic systems using the host homeowner's system as the demonstration model. Attendees are provided with brochures and other resource materials to take home.

The Chapter 5 Implementation Table includes strategies that supports the Agency's efforts described above.

D. Natural Resources -- General

Natural resource projects restore ecological functions of green infrastructure. Forests, lakes, ponds, rivers, floodplains, and wetlands are all examples of green infrastructure that provide continuing benefits both socially and ecologically. Natural resources restoration projects help to prevent and reduce nutrient and sediment pollution, improve flood resiliency by mitigating flood hazards, enhance habitat function, and support Vermont's outdoor recreational opportunities. Economically, restoration and protection of natural infrastructure offers a cost-effective, long-term means to

mitigate water quality and the effects of climate change and enhances the ecosystem services these natural resource provide.

Most restoration work supported by the Agency seeks to reestablish the hydrology of a natural resource and/or buffers the surface water from stormwater runoff and stabilize shorelines with woody vegetation. In addition, municipalities play a role in protection by directing development through ordinances to avoid adverse impacts to natural resources.

The Agency prioritizes natural resource restoration projects based on phosphorus reduction potential as well as ability to restore stream geomorphic compatibility. Associated plans or assessments are included the following sections. In addition, prioritization of natural community protection or restoration can be completed through the Water Quality Blueprint, a tool found in the Agency's Clean Water Road Map.

Three new sources of funding since the last TBP are or will soon be available. They include the Agency's Water Infrastructure Sponsorship Program (WISPr). State funding appropriated through Act 76, which will support natural resource protection through CWSP Formula grants, as well as Enhancement and Protection Program funds.. In addition, ARPA funding will also contribute towards natural resource restoration. See Chapter 5 for additional information.

Although Agency regulatory programs protect natural resources, the following sections focus on the Agency and partners' work to support landowner interest in natural resource restoration. A challenge that crosses all-natural resources is limited landowner interest in natural resource restoration. While dollars may be the limiting factor in one situation, in another it may be a sense of responsibility to earlier generations who cleared the forests and managed the arable landscape. Partners in the Missisquoi Basin have found success using a collaborative approach with multiple partners to ensure that all available resources and options for natural resource restoration is brought to a landowner by a partner with a working relationship to landowner. Increased support this type of collaboration is recommended.

Forest

Forests provide multiple environmental benefits that contribute to the protection of surface waters. In addition, the forests provide economic benefits by supporting silviculture, sugaring, and recreational opportunities. Landowners and businesses who include forest management practices that control stormwater runoff and protect river channels are likely to ensure that forestland supports both benefits.

The forestland in the Missisquoi's Basin makes up 66% of the land cover, contributing significantly to clean water and a healthy environment. This is reflected in the Upper Missisquoi and Trout River watersheds where a high percentage of forest cover (Figure 6), is accompanied by water quality assessment results supporting near pristine conditions (Figure 7). Most of the forest is privately owned with the large forest blocks supporting active forest management and sugaring operations. In the Franklin County portion of the basin, the hardwood forest is predominantly managed for map sap (per DFPR county forester, Nancy Patch)

While forests support healthy surface waters, forest roads, trails and log landings can reduce soil permeability, increase soil erosion, and divert and concentrate water flow, leading to gullying. Concentrated water flow as well as road crossings can also erode stream banks. Without proper management of forest infrastructure, increased sediment, and nutrient loads, as well as stream channel encroachments and thermal modification can result.

The highest phosphorus loading from forest activities are expected in areas with steep slopes and thin soils that are prone to erosion (Figure 18). Stream crossings during harvesting also have the potential to result in significant impact to water quality (2017 Vermont Forest Action Plan). In addition, sugaring operations may also contribute phosphorus at a higher rate than forests managed primarily for sawtimber because of the timing for road use. Roads used to manage taps are used annually, which can reduce limit establishment of vegetation and results in wear of erosion control structures, and therefore, if not maintained appropriately, may pose an elevated risk of being a source of sediment, compared to skid trails and logging roads, which are often used periodically.

The focus of the Agnecy's DFPR is to assist private landowners, who own most of the large forest blocks (Figure 19), in adopting stewardship practices to meet the Acceptable Management Practices for logging jobs[18]. In addition, DFPR works to reduce the conversion of forest cover to other uses through promotion of the UVA and other landowner incentives to maintain forest as forest as well as improve management. The DFPR's is also responsible for managing State Forest roads.

The following sections provide an update since 2016 of Agency's work to meet the regulatory programmatic commitments. In addition, updates are provided on the resources available to landowners and businesses to assist with regulatory compliance as well as voluntary adoption of forest stewardship practice over the next five years.

[18] The DFPR Forest Action plan includes Agency strategies that extend beyond those associated with water quality protection discussed in this section.

Regulations

Vermont Department of Forest, Parks, and Recreation (DFPR) oversees a regulatory program that works to protect water quality by reducing soil erosion from logging jobs, primarily through the use of the Acceptable Management Practices for Logging Jobs, (AMPs). The AMPs provide sound practices for loggers, foresters, and landowners to utilize, before, during, and after logging operations to comply with Vermont's Water Quality Standards. The AMPs are standard practice on state lands and required for Forest Legacy program lands and forest lands enrolled in the Use Value Appraisal Program (UVA) representing about 60% of forestland which is required or expected to follow AMPs during silvicultural activity. If the AMPs are not correctly implemented and a discharge occurs, there is a violation of the AMPs and therefore a water quality violation.

The DFPR's 2018 update of the AMPs included an improved set of practices. Revisions have made compliance with stream crossing requirements clearer than previous versions of AMP standards by providing specification for easy sizing of culverts and bridges for temporary and permanent crossings on intermittent streams (AMPs Table 2A). The required sizing of culverts or bridges can be determined by landowners, foresters, and loggers when the watershed drainage area or active channel width is known.

Resources

The DFPR, the DEC, and partner organizations facilitate regulatory compliance as well as voluntary implementation of the AMPs through education and outreach and by offering technical and financial assistance. The collaborative approach will assist the Agency in meeting regulatory and non-regulatory programmatic commitments to meet LC P TMDL, as well as other VWQS needs. The following includes updates to programs that focus on road maintenance and stream crossings.

Portable skidder bridges

DFPR promotes and demonstrates the use of portable bridges during timber harvesting operations and has provided technical training in the construction, use and close out of temporary portable bridges. Starting in 2018, the DFPR has been providing cost-share funding for loggers and foresters to receive temporary portable skidder bridges. Statewide, the DFPR distributed 12 free wooden bridges in 2018 and administered 9 cost-share grants for bridges in 2019 and 2020. DFPR expects to distribute over 25 bridges in 2021. In addition, the DFPR Watershed Forester administers a rental program for 5 heavy duty steel bridges for crossing larger rivers. The portable wooden skidder bridge program offered by some Vermont conservation districts, including the OCNRCD has slowed down due to a lack of available bridges, but that program will continue when those bridges are replaced.

Forest Road Assessments and Management

The management of State Forest roads to meet AMPs is a priority for the State. The Agency has supported the development of a forest road erosion inventory (REI) system to facilitate assessment and prioritization of forest road improvements. Assessment priorities and completed projects can also be tracked now in a state forest road database. A State-wide ANR forest road assessment project will take place over the next 3 years piloting the REI. The first round of roads to be assessed has been identified, but don't include any forest roads in the Missisquoi. While these road assessments are forthcoming, the DFPR has already prioritized a Jay State Forest road for improvement and DFPR has been actively improving permanent stream crossings on state forest roads to improve compatibility with stream geomorphic conditions.

On private lands, the DFPR county foresters and partners are continuing to provide landowners with technical assistance to properly manage forest roads. County foresters also work to ensure landowners are aware of financial assistance, which is most readily available through NRCS EQIP or RCPP practices.

In addition, to complement the new AMP Manual (2019) the Agency is developing an AMP App for use by forest managers (public and private) to provide continuous access to the AMP Manual and equip forest managers with tools to quickly determine how to best implement the Acceptable Management Practices on specific sites.

Unless a road erosion inventory is available, assistance to private landowners to improve forest roads and associated stream crossing may be prioritized based on modeled phosphorus loading for area. In addition, a focus area would include sugaring operations. Roads to manage taps are used annually, posing an elevated risk of being a source of sediment, compared to skid trails and logging roads, which are often used periodically. The pattern of road installation and frequency of use that the AMPs consider is much different and therefore sugaring operation may require additional guidance for installation and management.

Regional Conservation Partnership Funds

Regional Conservation Partnership Program (RCPP) funding has been increased for five additional years and provides increased flexible opportunities for forest water quality improvement including forestry practices and easements with larger forestland options. Funds will become available in late 2021 or early 2022. Funding will be available to "close-out" eroding historic logging roads/trails and improve permanent stream crossings required on sugarbush and forestry roads/trails. This funding augments existing Clean Water Funds as well as Natural Resource Conservation Service cost-share programs.

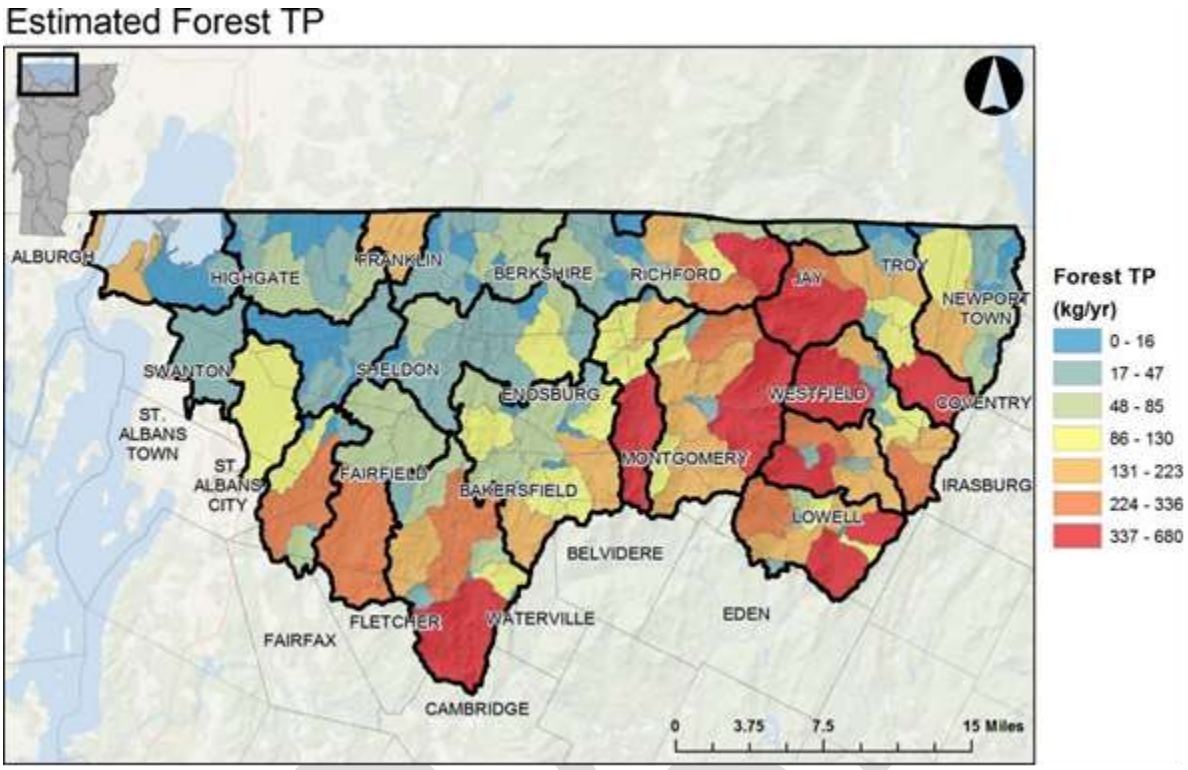


Figure 18. Modeled phosphorus loading from forest landscape (See 2016 Missisquoi Tactical Basin Plan for additional explanation)

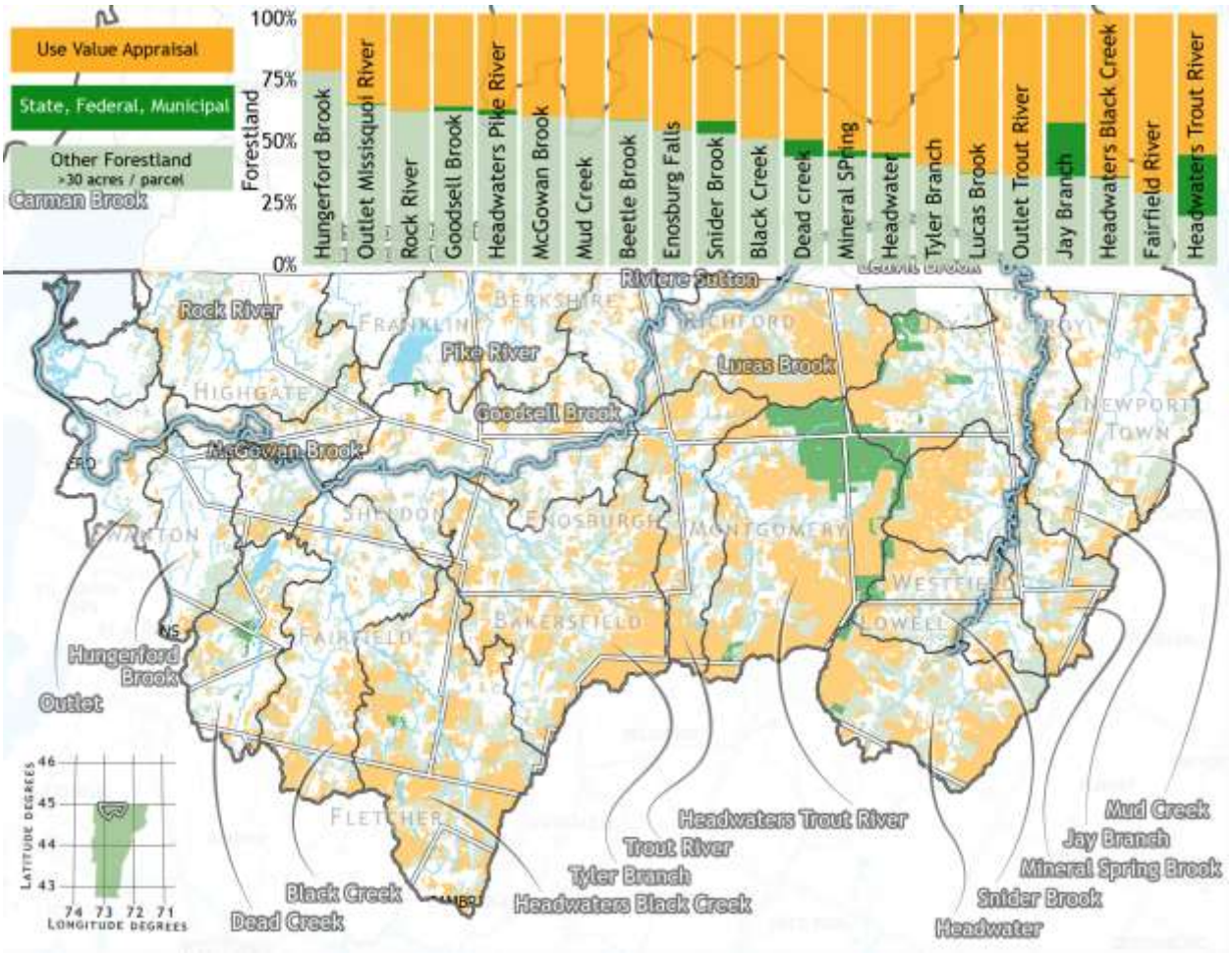


Figure 19. Concentration of UVA lands and other privately owned land as well as public lands owned by state, federal or municipal entities.

Use Value Appraisal Program (UVA)

The UVA program encourages forestland protection, as well as use of best forest management practices. Forestland enrolled in the UVA program statewide has grown by more than 150 parcels and approximately 20,000 acres in each of the last 5 years. Most large-forested blocks in the Hungerford, Rock, and Pike Rivers are not enrolled in UVA (Figure 19). In contrast, the Trout and Fairfield Rivers and the Black Creek are examples of areas with a high percentage enrolled.

Vermont's UVA Program enables eligible private landowners who practice long-term forestry or agriculture to reduce overall costs of protecting land as forest. The program allows land to be appraised based on the property's value of production of wood or food rather than its residential or commercial development value.

Compliance with Vermont's Use Value Appraisal program (UVA) requires that the AMPs be employed to the maximum practicable extent on enrolled forestland. If the AMPs are not employed on UVA enrolled forestland but no discharge occurs, it can still affect UVA eligibility without presenting a water quality violation.

The forest management plan required by UVA becomes another technical resource for landowners, and in conjunction with program standards, facilitates implementation of AMPs. An exception to AMP requirements for UVA enrolled forests includes forests enrolled in UVA as agricultural lands. Forests managed as sugarbush is an example. Under the agricultural land category, land management is required to follow the Required Agricultural Practices, which do not address road runoff associated with sugarbushes and do not require a forest management plan unless under NOFA certification.

Forest Carbon Markets

Forest Carbon offset projects provide a new opportunity for forest landowners to benefit from protecting and enhancing their forestland and incentivize new opportunities for management and stewardship. Selling forest carbon offsets can provide an additional source of revenue to a landowner and the long-term commitment keeps forests intact. A new climate forester position was established within FPR in 2020 to provide technical guidance on management and develop these opportunities in ways that advance the many values forests provide. Work to date has included the development and distribution of a new guide: Forest Carbon Markets for Vermont Landowners.

In the Missisquoi Basin, small woodlot owners, who could otherwise find it difficult to participate at the early stages of the forest carbon markets, have become part of the first forest carbon cooperative in the US with assistance from Vermont Land Trust and Cold Hollow to Canada. Landowners in the Missisquoi Basin and other northern basins that are part of the Cold Hollow Mountain region are helped to enroll in the voluntary carbon market and finding buyers for the carbon credits.

Cold Hollow to Canada, a Regional Conservation Partnership supports the community in protecting forestland in the Cold Hollow Mountain region. The organization works with forest landowners in seven towns in Franklin, Lamoille, and Orleans counties. Efforts like those of CHC to help provide private landowner access to carbon markets, or those of UVA to incentivize active management for sawtimber, helps prevent conversion to non-forest conditions and, in turn, maintain water quality.

Town Forest Stewardship

Municipalities can also assist in the protection of forestland through the creation of town forests. In the basin, the towns of Fairfield, Sheldon, Enosburgh, Berkshire, Richford, Montgomery, Troy (see map of town forests in Vermont) own forested parcels. Town forests can also be demonstration sites for forest management. The DFRP provides resources to assist communities in creation and management of town forests through the Vermont Urban and Community Forestry Program and its county foresters.

Chapter 5 Implementation Table strategies support partnerships and directing of resources to achieve water resource goals.

Lakes

Naturally vegetated shoreland prevents water quality degradation, maintains healthy habitat, and promotes flood resilience. The conversion of forested shoreland to lawns, houses and driveways may contribute more runoff, TP, and more sediment to lakes than undeveloped sites. Remediation and restoration practices along developed shorelands can reduce impacts through the management of stormwater runoff and restoration of native vegetation.

The DEC WSMD promulgates protection regulations primarily through the Shoreland Protection Act[19], but also facilitates restoration in partnership with watershed groups and lake associations.

Protection

Effective July 1, 2014, the Vermont Legislature passed the Shoreland Protection Act (Chapter 49A of Title 10, §1441 et seq.), which regulates shoreland development within 250 feet of a lake's mean water level for all lakes greater than 10 acres in size. The intent of the Act is to prevent degradation of water quality in lakes, preserve habitat and natural stability of shorelines, and maintain the economic benefits of lakes and their shorelands. The Act seeks to balance good shoreland management and shoreland development. Shoreland developed prior to July 1, 2014, is not required to retroactively meet standards.

[19] regulates shoreland development within 250 feet of a lake's mean water level for all lakes greater than 10 acres in size.

Resources

Shoreland Restoration

The Lake Wise Program, an Agency initiative that awards lake-friendly shoreland property, including that of state parks, town beaches, private homes, and businesses, is available to lakeshore owners and Lake Associations to assess shoreland property for improvements that benefit water quality and wildlife habitat. The program also promotes bioengineering techniques to address shoreline erosion through contractor training and demonstration projects.

The five Basin 6 Lakes with a fair shoreland score (Table 23) will benefit from implementing Lake Wise Program best management practices. Where water resources issues exist, further priority is given to shorelines where lake associations are interested in supporting a community stewardship ethic and have helped to promote the program. Lake Carmi and Fairfield Pond haves been a focus for this reason. Areas along Lake Champlain where there has been some involvement with the program could gain additional participants if it were to be promoted again, as involvement could be fueled by initial efforts to develop a community norm.

To increase capacity to help, the program also trains Lake Wise Evaluators, individuals qualified to help residents identify sources of runoff and address those through the implementation of best management practices. Lake Carmi's Franklin Watershed Committee is currently supporting a Lake Wise Evaluator.

Development of Lake Watershed Action Plans

DEC is supporting Fairfield Pond Lake association in the development of a Lake Watershed Action Plan (LWAP) that identifies sources of nutrient and sediment loading to lakes, prioritize sources based on various environmental, economic, and social criteria, and design projects to mitigate those sources. The LWAP results in a prioritized list of projects and strategies to address the sources of pollution and habitat degradation identified in the assessment. The plan may also contain recommendations to preserve natural features and functions, encourage use of low impact green stormwater infrastructure, and maintain the aesthetic and recreational uses of lakes. The plan developed for Lake Carmi for purposes of meeting the Lake Carmi P TMDL was an early version of the action plan.

Aquatic Invasive Species Detection, Response, and Eradication Efforts

Lake Champlain, as well as three inland lakes and ponds, support Aquatic Invasive Species (AIS), including Lake Carmi, Fairfield Pond, and Bullis Pond (Table 4 and Figure 13). The specific AIS (both plant and animal) and associated strategies to address existing population can be found in Table 4 and the WSMD Lakes and Pond Program AIS Map.

Once any aquatic invasive becomes established in a waterbody, eradication becomes difficult. The Agency's strategy is to reduce spread to new waterbodies through monitoring to allow for early detection measures and possible eradication. Since the last TBP, Lake Champlain has seen the introduction of the Fishhook water flea. No additional spread to inland lakes or ponds has been identified. Current monitoring and outreach messages are focused on current threats, including, but not limited to zebra mussels and the spiny and fishhook water flea.

Strategies to support AIS spread prevention efforts include regular and expanded AIS monitoring, initiating AIS Greeter Programs, and AIS spread prevention through signage or Vermont Invasive Patroller program. Current greeter programs exist at seven boat launches in the basin, and as resources allow, should be expanded to all public boat launches.

For established AIS population, the Agency provides financial (DEC Grant-in-Aid Program) and technical assistance to lake associations and municipalities to manage populations to allow for continued recreational uses. Removal efforts are prioritized based on interests of community groups, except for the removal of water chestnut, where the Agency coordinates efforts to reduce northward advancement of populations. Current management efforts that have received support from Agency include:

- Community groups coordinate long-term management harvesting operations for Eurasian watermilfoil (*Myriophyllum spicatum*) in Lake Carmi
- The Agency coordinates hand pulling harvesting operations for water chestnut (*Trapa natans*) in Lake Carmi, Missisquoi National Wildlife Refuge, and Bullis Pond.

Cyanobacteria

In addition to degrading water quality and habitat, increased nutrients and surface water temperature provide cyanobacteria a competitive advantage over other algal communities, leading to an increase in blue green algal blooms. The Agency, the Vermont Department of Health and partners have worked collaboratively to help communities identify and avoid contact with these toxic blooms. Strategies that support these efforts in addition to strategies to improve surface waters are included in the basin strategies (see Chapter 5 Implementation Table). Volunteer monitoring is supported throughout the basin, including 2 sites on Lake Carmi and at multiple sites in and around Missisquoi Bay.

Strategies in the implementation table will support Agency's work in following areas: provide landowner education and trainings to encourage voluntary adoption of shoreline restoration and protection practices; assists with development of watershed plans for individual lakes to identify priority projects and address Aquatic Invasive Species (AIS), as well as supports monitoring for cyanobacteria blooms and distribution of results.

Natural Resources - Rivers

In natural riparian systems, streams meander and have access to their floodplains. In response to historic intensive channel management as well as current activity, floodplain and riparian corridor encroachments, and watershed land use change, Vermont streams are actively adjusting their shape, size, and course as they seek to re-establish equilibrium. Consequently, streams have become channelized and lost connectivity with their floodplains. The eroded sediment from the incised stream channels leads to nutrient loading and the loss of floodplains threatens the flood resilience of communities. In addition, the hydrologic changes and sedimentation have degraded habit in both the channel and the associated floodplain.

The ANR River Management Program manages instream activities and riparian land uses to achieve vertically stable streams and naturally functioning floodplains, with riparian corridor protection as a primary tool.[20] Stream geomorphic assessments supported by the program identify priority areas for protection or restoration. An Agency supported Functioning Floodplain Initiative aims to further refine assessment processes to meet river corridor goals. An additional funding source available to support protection of floodplains as well as other actions to address flood hazards is available until 2024. Included in the state budget for fiscal year (FY) 2022, which starts July 1, 2021, nearly $5 million of American Rescue Plan Act (ARPA) funds are allocated for mitigating flood hazards and supporting implementation of the State Hazard Mitigation Plan

[20] The Lake Champlain Phase I Implementation Plan supports the protection of stable streams with naturally functioning floodplains as well as their restoration to achieve the phosphorus load reduction targets. Protection efforts through municipal protection of flood plain and river corridors are discussed at the beginning of the chapter.

Stream Geomorphic Assessment

The Rivers Program's first step in protecting or enhancing a river corridor includes assessing the physical integrity of rivers followed by development of management strategies in support of stream equilibrium. The Missisquoi Basin stream geomorphic assessments and River Corridor plans (see Figure 20 and Table 19) cover most of the tributaries to the main stem, are over a decade old. New or updated SGAs are under contract for the Rock and Pike Rivers, including the Canadian side as well.

Over the next five years, the Rivers Program has prioritized the assessment work to update or conducting new Phase 2 SGA on streams that are impaired by sediment or nutrients due to in part from channel erosion processes, including streams in agriculturally impaired watersheds (Table 19).

In addition, the program is supporting a new approach to geomorphic assessment in hydrologically modified agricultural landscapes. The assessment considers agricultural field drainage networks as part of the overall system that is delivering sediment and nutrients to the stream system. Outcomes will be used to target areas for technical assistance to support effect management of agricultural drainage networks. Consideration of road ditch drainage and culvert impacts will also be included. The Rivers Program is currently assessing a Rock River agricultural parcel with assistance from FCNRCD and VLT as a demonstration project.

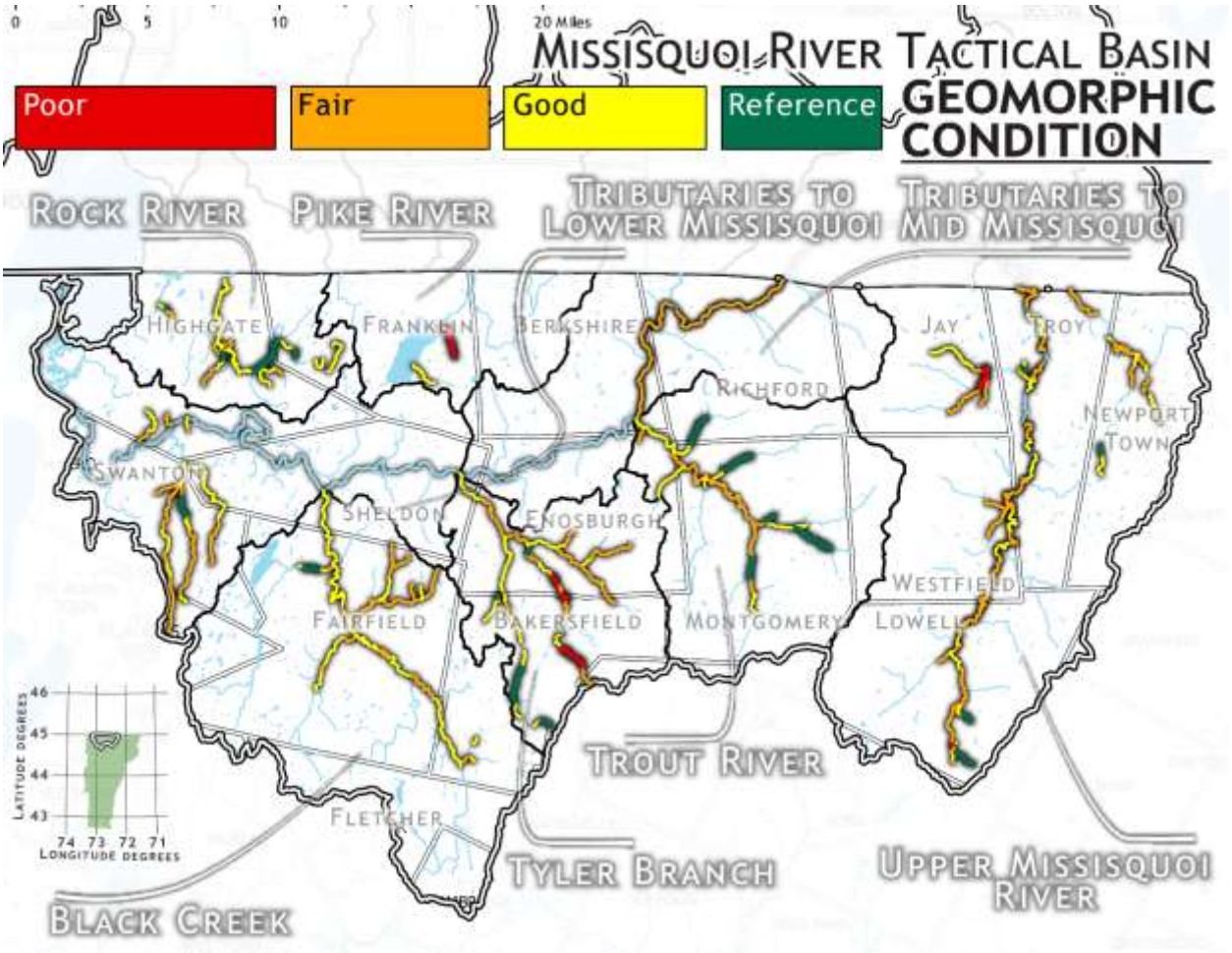


Figure 20. Geomorphic condition in assessed rivers

To augment river corridor protection and restoration efforts, the Agency is supporting the Functioning Floodplain Initiative. The initiative will help communities and watershed organizations identify and track priority projects through the development of floodplain connectivity mapping and hydrology-hydraulics mapping framework. Completion is expected by 2023.

Protection

The program coordinates with partners to deliver technical and financial assistance to encourage riparian corridor protection on municipal as well as private lands.

A River Corridor Easement Program

The Agency prioritizes river reaches that are identified as high priority sediment and nutrient storage area for conservations. Opportunities for protection include purchasing river corridor easements to avoid future encroachment and flood damage as well as restricting channelization. The highest concentration of river corridor easements exists in the Upper Missisquoi mainstem due to the work of partners, including the VLT, upper Missisquoi Wild and Scenic and VRC.

These partners have found that developing a long standing, respectful relationship with the landowners as well as providing multiple opportunities to protect or restore natural resources is the most successful approach. DEC's Rivers Program works closely with state and federal farm service agencies, the Vermont Housing and Conservation Board (VHCB) and land trust organizations to combine corridor easements with other land conservation programs. The easement ensures that watercourses and wetlands are not manipulated to alter natural water level or flow or intervene in the natural physical adjustment of the water bodies.

Priority areas for assessments include continuing work with neighboring landowners of existing easements. New areas would include priority areas identified in assessments, as well as the Upper Missisquoi, Trout Rivers and Tyler Branch are good candidates because of disequilibrium (high level of sensitivity and incision rates). Soils are also not as cohesive as in other areas, allowing for stream channel movement over a shorter time period than in areas with finer soils. Providing protection to the river corridor through property easement will support the movement of these streams towards an appropriate planform over time. The protection of the river corridor in the Black Creek watershed is appropriate to protect existing floodplain access.

Restoration

Where intervention is required, the program restores function through removal of berms and dams, improved geomorphic conformance of culverts and floodplain restoration. Other tools that the River Program supports includes beaver analogues, strategic wood addition, and floodplain terracing , which provides additional flood plain connection in agricultural landscapes.

Success in restoration projects in this basin over the last five years can be attributed to the successful engagement of landowners, the increased funding to enhance landowner compensation, partners knowledgeable in natural resource restoration, increased project opportunities over last five years as well as the strengthened relationships developed between partners and landowners. Opportunities to strengthen the existing collaborative processes in the basin as well as increasing landowners understanding of project benefits from flood resilience and less land management is expected to lead to increase awareness and more momentum as these practices continue.

DEC Rivers Program is still in the learning stage about these projects in terms of best places to apply them and what results to expect in terms of nutrient attenuation. The program is supportive of

efforts that increase learning through demonstration projects or other learning exchanges. In addition to SGA identified projects, the Functioning Floodplain Initiative will also help guide identification of priority reaches for floodplain restoration but will be more limited and only suggest broad categories of floodplain restoration practices.

Restoration is also realized through replacement of culverts with geomorphologically compatible ones or bridges where resources allow. An additional goal includes the improvement of Aquatic Organism Passage. The Rivers Program is currently partnering with the USFWS, Northwest Regional Planning Commission and the Franklin, Orleans County Natural Resources Conservation District, MRBA, to support an AOP work group in the upper Missisquoi subwatersheds of Franklin and Orleans County. With technical assistance provided by the Rivers Program and the USFWS, the road/stream work group began to work in the basin in February 2021 to identify, prioritize and replace culverts to increase brook trout passage and thereby increase their habitat range. As geomorphic compatibility. At least one project is expected to be completed over the next five years.

Riparian Buffer Enhancement

Riparian plantings are a priority where a mature woody buffer can establish itself without significant loss from channel erosion. In addition to sites identified in SGAs, priority includes planting sites on the Rock and Pike Rivers based on stable condition of reach as well as high potential for overland runoff.

The USFWS and the USDA Farm Service Agency partners with the Vermont Agency of Food Farm and Markets to deliver the Conservation Reserve Enhancement Program (CREP). CREP had been dormant the last couple of years due to policy language associated with the Vermont's Required Agricultural Practices.

The restoration of AAFM CREP funding in spring 2021 will support buffer enhancement beyond the RAPs on agricultural land. The 60 acres of riparian habitat that was protected soon after reactivation indicates landowner interest in the program and therefore room for substantial increases in enhanced riparian protection over the next five years.

The Trees for Streams program is also available to non-agricultural landowners. Supported by NRCDs and MRBA, with assistance from USFWS, four projects (10 acres) are underway in the watershed in 2021.

Current barriers to seeing successful riparian planting include difficulty in locating adequate stock, with larger riparian and forest planting projects (per DFW County Forester, Jared Nunnery and UVM Sea Grant Watershed Forestry Partnership survey). FCNRCD has begun to investigate developing a small willow nursery for their own plantings and implementation of projects.

Japanese knotweed (*Fallopia japonica*), a terrestrial invasive, is another barrier to riparian buffer protection. The plant tends to invade riparian habitat and overwhelm all other nearby plant species making this species a cause for concern as it affects the integrity and function of streambanks and lakeshores throughout Vermont. Recent storm events that modified many riparian areas resulted in significant relocation of the species into what had been previously un-infested riparian areas. The MRBA is currently supporting projects to remove Japanese knotweed, using community volunteers. They are also investigating methods to reduce new infestations using trial plots. Currently, most of the funding to remove the species is only available through stewardship practices supported after tree plantings. USFWS is looking at removal techniques prior to planting as well as managing post planting.

Partners had identified need for additional collaboration, including information sharing and targeting outreach at the subwatershed level. To address this need, the UVM Sea Grant Watershed Forestry Partnership initiated a state-wide meeting of the Vermont Riparian Buffer Partnership in March 2021. A model for targeted outreach for CREP for basin partners to consider would be the collaboration among the VTFWD, Northwoods Stewardship Center and the Orleans Country NRCD for the Willoughby and Barton Rivers.

Expanding Protection through Municipal Action

Municipal zoning bylaws or land development regulations, town plans, policies and municipal programs can provide community-specific protections and guidance to maintain and enhance local water resources. In addition, the community involvement in decision-making processes that protect surface waters can result in increased awareness of the importance of watershed protection. Municipal protections may include requiring a treed buffer between surface waters and development activities or extending additional protections to wetland, floodplain, and river corridor protection beyond those afforded through state and federal wetland regulations.

A detailed review of municipal ordinances completed by the NVDA and Northwest Regional Planning Commission in 2021 provides an overview of existing types and level of protection in the Basin. The Agency and the RPCs use the Municipal Protectiveness Matrix to identify opportunities and the potential timeframe for providing resources to help municipality improve surface water protection.

Municipalities in the Basin are encouraged and often receptive to adopting floodplain protection more often than other natural resource protection. The protections help to maintain floodplain connection to rivers, which in turn, increases the community's flood resilience. DEC and partners help by identifying flood attenuation zones, e.g., floodplains, river corridors, forests, and wetlands, and recommending municipal actions and policies that serve to protect these functions and reduce the risks facing existing development. The Agency's Flood Ready website hosts supportive materials

for municipal officials including community data on the River Corridor Protections Summary Report and Expanded Community Reports.

DEC River Corridor and Floodplain Protection Program has prepared model flood hazard bylaws to assist municipalities in the development of their flood hazard regulations. DEC recognizes that Vermont's historic settlement patterns has resulted in a significant level of river corridor encroachment in densely developed areas. As a result, the DEC model hazard bylaws contain provisions to facilitate infill and redevelopment in designated centers and densely developed areas within river corridors and flood hazard areas. DEC regional floodplain managers routinely provide technical assistance to municipal and regional planning staff on incorporating these provisions into town regulations. These bylaws have been pre-reviewed by the Federal Emergency Management Agency (FEMA) and meet or exceed the requirements of the National Flood Insurance Program (NFIP). In addition, the option and enforcement of Section D, River Corridors, qualifies communities for enhanced cost share under the Emergency Relief and Assistance Fund (ERAF).

ERAF provides state funding to match Federal Public Assistance after federally declared disasters. Eligible public costs are reimbursed by federal taxpayers at 75%. The State of Vermont contributes an additional 7.5% toward the costs. For communities that take specific steps to reduce flood damage the state will contribute 12.5% or 17.5% of the total cost. Of the 18 municipalities that include significant area in the basin, 18 municipalities are participating in the National Flood Insurance Program and have adopted the Town Road and Bridge Standards, and 13 have adopted a Local Hazard Mitigation Plan. By adopting river corridor protection, 2 of the 18 municipalities, Bakersfield and Montgomery have been granted "early adopter" status by the DEC, qualifying for the 17.5% contribution (see Municipal Protectiveness Matrix).

The Northwest Regional Planning Commission and the Northern Vermont Development Association and DEC Regional Floodplain Managers have assisted municipalities in their consideration of adopting or increasing floodplain protection for both flood resilience and improved water quality. To date, all communities in Basin 6 have bylaws in place that allow them to participate in the National Flood Insurance Program (see Municipal Protectiveness Matrix for town updates). Two communities – Bakersfield and Montgomery have adopted standards to protect Special Flood Hazard Areas from new encroachments. Because Bakersfield and Montgomery acted to protect flood hazard areas at a time when river corridor maps were not yet available, they are recognized as providing river corridor protection based on the best available data. Under the criteria for Vermont's Emergency Relief and Assistance Fund (ERAF) the actions of Bakersfield and Montgomery are recognized as proving river corridor protection on an "interim" basis.

Six towns in the basin provide additional river corridor protection through adoption of River Corridor Protection. The work with interested towns begins with introduction of opportunity by the regional planning commissions and the Rivers Program during the revision of the town plan. If

Swanton is interested, their town planning process in 2022 and 2023 may provide an opportunity to begin the discussion. Towns like Jay that are concerned about infrastructure damages associated with flooding may be open to discussions as well. The towns of Troy and Westfield have also expressed interest.

Dams of the Missisquoi Basin

While dams are used to generate energy and recreational opportunities such as boating, fishing, and swimming, dams change free-flowing streams to unnatural impoundments, impacting species that depend on riverine habitat for their survival and altering ecosystem processes. Removal is considered when dams no longer provide benefits or have become structurally unsafe. The list of dams in the basin, Table 20, includes dams that may no longer be serving a useful purpose and have a significant ecological impact based on an analysis by The Nature Conservancy (TNC). Most will require further evaluation and consultation with the owner before determining potential for removal. If the owner is interested in removal, state funding may be available. Collaborative efforts are behind most dam removals in the watershed, with experienced state-wide partners assisting community-based partners. In 2021, the Franklin County Natural Resources Conservation District and USFWS completed the removal of Johnsons Mill dam in Bakersfield. Those two organizations as part of the Upper Missisquoi AOP working group (see Developed Lands – Roads Sector) initiated discussions with Bakersfield and landowner about potential of a feasibility study around the safety of structure and alternative's analysis for the Browns Pond dam. The FCNRCD and USFWS have installed loggers around pond in meantime. In addition, the MRBA is coordinating with the town of Newport on the Sleeper Dam removal. To encourage community and landowner acceptance of dam removal, the Agency supports additional outreach to municipalities and communities on the benefits to free-flowing rivers.

Hydroelectric dams in the watershed are regulated to balance energy production with offsetting alteration to ecosystem processes. The Agency regulatory oversight includes certification of hydroelectric dams pursuant to a Section 401 of the federal Clean Water for FERC-regulated facilities, or for State-owned generating facilities, 2018 Act 161. Hydroelectric dams and their current licensing status are described in Table 21 as are a description of flow altered streams in Table 22.

The Implementation Table strategies support the programs and activities described above by the Agency and partners, and will contribute to the enhancement of river channel stability and floodplain connection

Natural Resources—Wetlands

Wetlands filter sediments, attenuate nutrients, and store flood water and stormwater, as well as provide benefits to the ecosystem and public including critical wildlife habitat and recreational value. The Agency's goals include increasing Vermont's wetland acreage and function as well as increasing phosphorus attenuation through wetland restoration.

Protection

The Wetlands Program plays an integral role in protecting the State's surface water through wetland regulatory, protection, and monitoring activities. The Vermont Wetland Rules protect wetland functions and values through a permit process. Continued outreach and education to landowners about the Rules also works towards enhancing protection. The FCNRCD and NRCS have received training that has allowed them to assist with outreach about regulations as well as restoration opportunities. To enhance targeting of information, the program plans on identifying trends associated with types of wetland violations as well as geographic area based on program experience and the ANR enforcement annual reports and the Wetland Programs Trends Report and Regulatory Updates

The Wetlands Program relies on wetland mapping to help preliminarily identify the locations of regulated wetlands (Class II and Class I). National Wetland Inventory mapping, updated in 2019, has significantly increased knowledge about location of Missisquoi Basin wetlands and will be used to predict wetland condition and function as funding allows. The program is working towards supporting additional mapping through the contributions of DEC-trained citizen scientists.

The northwestern section of the basin supports peatland pond complexes that could be afforded additional protection of its features as state-significant natural communities (Vermont Natural Heritage Database) through assessment and mapping. Peat accumulating wetlands are uncommon in Vermont and are at risk for degradation from increasing temperature and periodic drought conditions brought about by the changing climate. Although these conditions can bring about increased peat decomposition, a healthy watershed would buffer temperature changes and dry conditions.

Lakes and Pond Program's assessments indicate that some examples of peatland pond complexes appear to have minimally disturbed watersheds, making them a focus of protection efforts in the basin. They include Shawville, Little Franklin, Adams, Proper and Fairfield SE Ponds. A state-significant natural community designation through assessment and mapping could support protection through the Vermont Wetland Rules or support higher prioritization during considerations for financing conservation easements or purchase.

Additional protection, in the form of a Class I wetland designation, can be afforded to wetlands that have been determined to be exceptional or irreplaceable in their contribution to Vermont's natural heritage, based on their functions and values. Areas of the Missisquoi National Wildlife Refuge, including includes the Missisquoi Delta and the Maquam Bog are candidates for Class I designation. As the refuge has multiple management goals, involving federal and state resource staff in identifying appropriate boundaries for the designation is recommended. DEC will provide technical support to any community members interested in developing a Class I wetland petitions for the Agency's review.

Wetland Mapping & Restoration

Given that approximately 35% of Vermont's wetlands were drained or filled prior to 1980, there is a large opportunity to increase wetland natural pollution attenuation through restoring those wetlands historically lost. Reconnecting wetland hydrology, restoring topography, and planting native vegetation provides for more spaces for water to settle and nutrients to be absorbed by diverse vegetation. To meet Lake Champlain Phosphorus TMDL goals, the Agency directs restoration resources towards projects with highest phosphorus removal potential.

The 2018 DEC RCPP Wetland Restoration Site Prioritization Map identifies potential wetland restoration areas in the Missisquoi with the highest likelihood of phosphorus attenuation.

The Wetlands Program works collaboratively with partners to benefit restoration. A wetland round table meets annually to identify highest priority sites for contractor outreach and partner collaboration. The Agency as well as partners including NRCDs, NRCS, VLT, TNC and DFW use the above maps and a subset of project packets to help target wetland restoration outreach.

The Wetlands Program works with the wetlands round table to identify restoration opportunities around Vermont as well as direct resources to contractors and other partners. In the Missisquoi Basin, the group targets outreach using the 2018 DEC RCPP Wetland Restoration Site Prioritization Map to ensure highest likelihood of phosphorus attenuation. Partners include NRCDs, NRCS, VLT, TNC and DFW.

Collaborative partnerships support successful restoration projects. An example of a long-standing relationship, the USFWS continues to work closely with NRCS to deliver the technical aspects of the Wetland Restoration Easement portion of the Agricultural Lands Easement Program. An 87 acres restoration projects was completed in the upper watershed in 2019. The success of an ongoing project, like many others, depends on landowner interest.

As opportunities for restoration is largely on agricultural land, the challenge of obtaining landowner agreement requires addressing the demand and value of agricultural land coupled with deep cultural ties to agriculture. Building on existing partner and landowner relationships is a successful strategy as

portrayed by the Vermont River Conservancy who used the relationships built during a Missisquoi main stem river corridor restoration project to successful add a one-acre wetland restoration project in 2019.

Recently acquired resources have allowed DFW to initiate wetland restoration and acquisition with funding from EPA through the Lake Champlain Basin Program. The primary focus of this project is wetland restoration on new and existing DFW acquisitions with a goal of 40% lands restored

In addition to sufficient conservation funding and effort, partners have identified need to enhance collaboratives efforts by formalizing a process to share knowledge to continue to strengthen and build from existing landowner and partners relationships. Initial discussions were supported as part of the tactical basin planning process to strengthen partnerships and begin development of strategies to enhance collaboration.

Wetland restoration techniques are improved through review and reassessment. The Wetlands Program is expanding on adaptive management efforts by providing wetland assessment data to inform wetland restoration practices. Results allow increased understanding regarding gaining efficiencies through ID best restoration practices, cost efficiencies, and justifying ecological wetland restoration for phosphorus and carbon reduction.

Chapter 5 – Strategy Implementation

A. Progress in the Missisquoi Basin

The Missisquoi Basin TBP addresses the impaired, stressed, and altered waters in the basin as well as protection needs for high and very high-quality waters. The list of strategies in the Implementation Table (Table 14) covers projects that protect or remediate surface waters. The Monitoring Needs Table (Tables 15 and 16) describes assessment and monitoring needs.

The process for identifying strategies and associated projects includes a comprehensive compilation and review of both internal Agency monitoring and assessment data and reports (see Chapter 1), and those of our watershed partner organizations (see Appendix A). Modeling of high phosphorus loading areas by sector (see Chapter 4) provides the priority subbasins or catchments for sector-specific project implementation. The monitoring and assessment reports include additional priorities at a finer spatial level. They include, but are not limited to, stormwater mapping reports, geomorphic assessments, river corridor plans, bridge and culvert assessments, Hazard Mitigation Plans, agricultural modeling and assessments, road erosion inventories, TMDL reports, biological and chemical monitoring, lake assessments, fisheries assessments, and natural communities and biological diversity mapping.

The Watershed Projects Database, and the Implementation Table are resources to Missisquoi Basin stakeholders in their efforts to pursue and secure technical and financial support for implementation of high priority projects. These resources cover location information, project description, the assessment report of the project if a sector-based assessment supports the project, any partners that may have expressed interest in implementing the project, and potential funding sources. The database allows for the addition of new actions as DEC identifies them with the assistance of partners.

The Vermont Clean Water Funds are expected to provide a significant source of support to project implementations. As projects are developed, priority for state grants supported with Vermont Clean Water Funds will be given to those projects that achieve the highest phosphorus removed benefit per cost ratio. Additionally, projects that provide cumulative benefits (i.e., flood resilience, water quality improvement, water resource protection, aquatic organism passage) will receive additional consideration for prioritization.

Keeping track of progress

The Water Investment Division's Clean Water Initiative Program (CWIP) funds, tracks, and reports on priority projects to restore Vermont's waters, and communicates progress toward meeting water quality restoration targets outlined in the Total Maximum Daily Loads (or TMDLs). CWIP also coordinates funding, tracking, and reporting of clean water efforts for federal and state partners, including Clean Water Initiative partner state agencies – the Agencies of Agriculture, Food and Markets; Commerce and Community Development; Natural Resources; and Transportation – and

the Lake Champlain Regional Conservation Partnership Program of the Natural Resources Conservation Service.

The Division's reporting on progress occurs annually for the basin regarding financial investments made and phosphorus loads addressed. The 2020 summary for the Missisquoi Basin is found on page 70 of the Vermont Clean Water Initiative 2019 Performance Report. In addition, an interim basin report will be submitted to EPA on progress towards meeting Lake Champlain TP TMDL commitments in 2023. Progress made in addressing all the strategies in the Implementation Table will be reported on in the next tactical basin plan scheduled for 2025.

B. Coordination of Watershed Partners

There are several partner organizations undertaking watershed monitoring, assessment, protection, restoration, and education and outreach projects in Basin 6. These partners, listed in Appendix A are non-profit, private, state, and federal organizations working on both private and public lands. Partnerships are crucial in carrying out non-regulatory projects to improve water quality. The groups are active in:

- providing outreach and education to local stakeholders, private landowners, and municipalities.
- developing stream and floodplain protection and restoration projects (e.g., river corridor easements, tree plantings, culvert and bridge upgrades, dam removals, stream channel habitat restoration).
- developing stormwater projects (e.g., stormwater master plans, road erosion inventories, implementation of town road BMPs).
- monitoring water quality (e.g., lay monitoring program on lakes, *E. coli* and nutrient monitoring in rivers).

Partners active in working with farms in the basin developing and implementing BMPs for water quality include Natural Resource Conservation Service (NRCS), Agency Agriculture Food and Markets (AAFM), the NRCDs, DEC, VLT, TU, and the University of Vermont Extension Service.

The large amount of work that is necessary to meet water quality targets in this basin require collaborations among all these groups to maximize the effectiveness of watershed partners. Without funding or partners, little of this work would be possible. The Agency is grateful for the active engagement and long-term commitment of so many Missisquoi Basin partner organizations and interested citizens.

C. Implementation Table

The strategies in the Implementation Table (IT) are organized by the sectors described in Chapter 4. The Chapter 4 discussions and recommendations for each of the sectors provide background and support for the strategies. Specific projects identified by the agency or partners to address the strategies are located in the online Watershed Projects Database (WPD). Not all strategies or associated projects are expected to be completed over the next five years, but each strategy is expected to be addressed and reported upon in subsequent phases of TMDL implementation plans and attendant interim and final TBP report cards included in annual Clean Water Performance Reports.

In relation to the Lake Champlain Phosphorus TMDL, IT strategy progress will be measured against the 5-year total phosphorus reduction (TP) targets for each sector, outlined in Chapter 3. These reduction targets are addressed through both the regulatory programs described in Chapter 3 and the prospective reductions assigned to Act 76 Clean Water Service Providers and guided by the IT strategies. The effectiveness of those strategies and related implementation efforts will be measured according to TP reductions estimated for each sector. Clean water project tracking and accounting carried out by CWIP will estimate the mass of pollutants reduced from projects supporting IT strategies that will help monitor progress towards achieving those strategies and the 5-year target milestones. Progress achieved through outreach, technical assistance, and project funding will inform DEC's gap analysis related to each subsequent phase of TMDL implementation, each annual Clean Water Performance Report, and attendant interim and final TBP report cards.

As projects are developed, priority for CWIP funding will be given to those projects that achieve the highest water quality benefits. Additionally, projects that provide cumulative benefits (i.e., flood resiliency, water quality improvement, water resource protection, aquatic organism passage) will receive additional consideration for prioritization. For these priorities to be achieved, partners and stakeholders must help to carry out the strategies identified in the basin plan.

Table 14. Implementation table of strategies for the Missisquoi Bay Tactical Basin Plan

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
STRATEGIES TO ADDRESS RUNOFF FROM AGRICULTURAL LANDS[22]				
1. **Conduct soil health assessments; and assist farmers in identifying and implementing BMPs to improve soil health**	Rock River, Enosburgh Falls-Missisquoi, Headwaters Pike River (Lake Carmi), Black Creek, Fairfield River, Hungerford Brook; agric-impaired streams		UVM ext., NRCD, NRCS, AAFM	USDA AAFM AgCWIP, RCPP
2. Develop and distribute information to farmers about economic advantages of BMP implementation	Rock River, Enosburgh Falls-Missisquoi, Headwaters Pike River (Lake Carmi), Black Creek, Fairfield River, Hungerford Brook; agric-impaired streams		UVM ext., NRCD, NRCS, DEC, AAFM, FNLC	AAFM AgCWIP, VHCB, RCPP, USDA
3. Implement agricultural production-area BMP projects for preventing heavy use area, manure and feed runoff to surface waters	Basinwide focus on RAP compliance		AAFM, NRCS, VHCB, FNLC	AAFM, NRCS, VHCB
4. Increase adoption of cover cropping systems by supporting practices that will enhance performance, including reduced tillage practices (inter-seeding, manure injection, use of innovative equipment) and shorter day corn varieties, multi-species cover crops	Rock River, Enosburgh Falls-Missisquoi, Headwaters Pike River (Lake Carmi), Black Creek, Fairfield River, Hungerford Brook; agric-impaired streams		UVM ext, NRCS, VACD, NRCDs, USDA, FNLC	NRCS EQIP, AAFM FAP, RCPP

[21] Table 2 provides a list of towns associated with each subbasin

[22] Milestones associated with achieving RAP compliance and cumulatively working towards meeting 5-year phosphorus reduction targets for either production area or field/pastures identified in Table 9.

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
5. Increase pasture and hayland BMPs implementation and enhance performance by supporting appropriate harvest management (e.g., increased mower height), grassland injection, aeration, nutrient application timing, manure calibration, and soil health practices that in turn address compaction, erosion, and nutrient runoff	Rock River, Enosburgh Falls-Missisquoi, Headwaters Pike River (Lake Carmi), Black Creek, Fairfield River, Hungerford Brook; agric-impaired stream		UVM, NRCS, VACD, NRCDs, USDA, FNLC	AAFM FAP, NRCS EQIP (not aeration), RCPP
6. Support farms in nutrient management plan (NMP) implementation and maintenance	Basinwide		AAFM, NRCD, VACD, UVM Extension, USDA	AAFM AgCWIP; RCPP, NRCS EQIP
7. Support the distribution and use of AAFM critical source area (CSA) maps or similar to prioritize field erosion sites for regulatory field inspection and for identifying and developing opportunities for voluntary BMP adoption	Rock River and other areas identified on CSA map. Prioritize small tributaries		AAFM, DEC, NRCS, NRCDs, FNLC	AgCWIP, LCBP
8. Develop process to identify and prioritize areas where farm field and farm road stormwater enters road ditches and/or streams and address through field and road BMPs	Basinwide		DEC, NRCDs, AAFM, FNLC	AgCWIP, LCBP
9. Support collaborative efforts among agricultural partners to enhance service to the agricultural community.	Basinwide		NRCDs, NRCS, ANR, AAFM, UVM Sea Grant – Watershed Forestry Partnership, VAWQP, FNLC	AAFM, VAWQP, LCBP
10. Improve farming community's understanding of water quality response to land treatment through bracketed water quality sampling	Rock River, Mud Creek		DEC, LCBP, FNLC, OCNRCD, FCNRCD	LLP, LCBP, AgCWIP

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
above and below BMP and presentation of results				
11. Improve delivery and effectiveness of education to farmers in basin by identifying specific gaps in information made available to farmers	Basinwide		AAFM, NRCD, VACD, UVM Ext., VAWQP, FNLC	AAFM AgCWIP; RCPP,
STRATEGIES TO ADDRESS RUNOFF FROM DEVELOPED LANDS – STORMWATER				
12. Identity priority stormwater management projects through development of Stormwater Master Plans or similar in Priority Towns		Bakersfield, Lowell, Montgomery, Jay, and Troy	NRPC, FNLC, MRBA	DEC-CWF, LCBP
13. Implement priority stormwater projects	Giddings Brook	Towns with SWMP (Swanton, Sheldon, Highgate, Enosburgh Richford, Fairfield) Towns with CSO (Enosburgh)	FNLC, FCNRCD, NRPC	LCBP, DEC-CWF Green Schools Initiative
14. Support social marketing-based programs (e.g., Lake Wise and Stream Wise) to encourage residential communities to adopt BMPs	Lake Carmi, Fairfield Pond; villages and other areas of concentrated development		DEC, DFW, FNLC, FCNRCD, NRPC, UVM Sea Grant	LCBP

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
15. Improve functionality of existing stormwater infrastructure by developing training program for partners and municipalities to maintain, operate and assess	Village areas	All towns with DEC funded stormwater practices	DEC, NRPC, NVDA, FCNRCD, watershed groups, UVM Sea Grant	CWF
16. Assist municipalities and schools with obtaining Three-acre permit* coverage including supporting opportunities to address stormwater in partnership with private landowners	Basinwide	Enosburgh (Missisquoi Valley High School, Enosburg Falls Central School), Swanton Elementary School, Jay, Highgate, Richford,	FNLC, FCNRCD, NRPC	Public Private Partnership; Green Schools Initiative
STRATEGIES TO ADDRESS RUNOFF FROM DEVELOPED LANDS – Roads				
17. Facilitate collaborative solutions where private road or farmland drainage contributes to town road stormwater	Basinwide	Bakersfield	NRPC, Watershed groups, NRCD	DEC-CWF
18. Assist municipalities and private road owners in replacing culverts to achieve Aquatic Organism Passage (AOP)and geomorphic compatibility	Upper Missisquoi, Trout Tyler Branch	Montgomery, Richford, Enosburg, Bakersfield, and Orleans County towns	Northeast Kingdon Road and Rivers Group (ONRCD, NVDA); AOP group (NRPC, UMATR, USFWS, TNC), VTrans	TBP grant funding, federal hazard mitigation funds, Municipalities, USFWS, VTrans grants, USFWS SWG, Great Lakes Fisheries

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
				Trust, UMATR
19. Assist municipalities in inventorying and improving roads to meet the Municipal Roads General Permit: *	Very high and high priority ranked sections in REI, Giddings Brook	Bakersfield	DEC, NRPC, NVDA, NEK roads to river workgroup, Franklin County Road Round Table, ONRCD, VTrans	VTrans grant-in-aid, TBP partner funding,
20. Support towns in purchase or rental of equipment needed to comply with MRGP	Basinwide	]	NRPC, DEC, VTrans	VTrans Grant-in-Aid
21. Promote best winter management practices on public and private roads and parking lots	Lake Carmi, Fairfield Pond	Swanton, Enosburgh, Richford, Highgate, Sheldon, Fairfield	LC Sea Grant, NRPC,	LCBP, DEC-CWF
22. Assist landowners in managing stormwater off 8 private road segments to meet MRGP or Back Roads manual methods	Priority HUC12s based on loading for roads, Priority Lake Carmi road erosion inventory results		NRPC, FNLC, MRBA, FNCRD, ONRCD, LC Sea Grant, LCBP	LCBP
STRATEGIES TO ADDRESS WASTEWATER				

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
23. Ensure wastewater treatment facilities (WWTF) meet their TMDL allocations and optimize phosphorus reductions through facility operations and address CSOs by providing financial and technical assistance to municipalities *		Municipalities with WWTF, Enosburgh (CSO)	DEC	LCBP, ANR
24. Assist communities in addressing inadequate individual onsite wastewater treatment on small, challenging sites through the planning and development of solutions, including community wastewater systems or innovative/alternative onsite systems		Franklin, Fairfield, Highgate, Montgomery, and any other interested municipality	ANR Village Wastewater Committee, WID, NRPC, Municipalities	CWSRF, USDA Community Facilities Program, Northern Borders Grant, TBP Support Grant
STRATEGIES TO SUPPORT NATURAL RESOURCE PROTECTION AND RESTORATION – FORESTS				
25. Identify and prioritize forest road sections for BMP installations	Very high and high priority road segments identified in road erosion inventory		DFPR	DEC-CWF
26. Provide outreach and training on properly implementing the AMPs, including the use of the new AMP App.	Basinwide		DFPR	

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
27. Identify and properly close out inactive logging roads	Prioritize forest areas based on runoff potential for assessment and projects, BMP	Montgomery, Enosburg, Richford	DFPR County forester, conservation commissions, MRBA	CWF
28. Increase enrollment of forest acres in UVA through outreach to forestland owners	in HUC12 with low concentration of protected forest land (Hungerford, Lower Missisquoi Tributaries, Pike and Rock Rivers as identified in Figure 19), and sugaring operations		DFPR, UVM SG - WFP	
29. improve road placement and stream crossing to meet AMPs by providing technical and financial resources, include support for engineering costs	Sugaring operations, State Forest roads, high and very high priority on forest road erosion inventory		DFRP private lands staff, VLT, LEAP, Vermont Woodlands Association (VWA), Vermont Forests Products Association (VFPA).	RCPP
30. Assist interested towns in acquiring and maintaining forested parcels		Jay and other interested towns	DFPR County foresters, Trust for Public Lands	WISPr, CWSRF bridge funding, DWSRF, Conservation partners
STRATEGIES TO SUPPORT NATURAL RESOURCE PROTECTION AND RESTORATION – LAKES				
31. Conduct Lake Watershed Assessments and Lake Wise assessments and implement strategies	Fairfield Pond: Lake Carmi (Lake in Crisis Response Plan)		DEC, FNLC, FWC, NRPC, FNRCD, OCNRCD, UVM Sea Grant	DEC-CWF, LCBP

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
32. Implement bioengineered shoreland BMPs and add woody vegetation where shoreline erosion needs to be addressed	Basinwide		DEC, FCNRCD, FNLC, FWC	
33. Support community efforts to manage and control invasive species	Lake Carmi; Fairfield Pond		DEC, FNRCD, FWC, MRBA	DEC AIS grant-in-aid, LCBP
34. Provide education to homeowner to improve maintenance of on-site wastewater systems	Lake Carmi, Fairfield Pond		DEC, FWC, LCBP, LC Sea Grant, FCNRCD	LCBP
STRATEGIES TO SUPPORT NATURAL RESOURCE PROTECTION AND RESTORATION – RIVERS				
35. Conduct stream geomorphic assessments (SGA)	streams that are impaired by sediment or nutrients due to in part from channel erosion processes; agricultural drainage networks, Rock and Pike Rivers, see Appendix B		FCNRCD, OCNRCD, AAFM, DEC RIVER Program; UMATR, MRBA	DEC-CWF, LCBP
36. Enhance (beyond RAPs) riparian buffers through plantings of woody vegetation and controlling invasive species	Black Creek, Fairfield River and sites identified in SGA corridor plans (Appendix B) or by DEC River Program		USFWS, AAFM, UMATR, MRBA, VLT, ONRCD, FCNRCD, DEC, FWD	CREP, LCBP, DEC-CWIP: Riparian Planting Block Grant, CREP, LCBP (for larger buffers), CWIP-RCE, RCPP
37. Enhance floodplain connection through implementation of active restoration and protection through river corridor easements	Prioritize areas based on outcome of the Functioning Floodplain Initiative Program, flood-vulnerable property lists, and other SGA and Dam inventories		USFWS, DEC, FCNRCD, OCNRCD, FNLC, UMATR, MRBA	Project Development Block Grant, River Corridor Easement Block Grant, Hazard Mitigation Funding Programs

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
38. Encourage municipal adoption of river corridor protection or strengthened existing river protection by-laws, setbacks, and zoning by providing technical assistance	Basinwide	Interested municipalities	NRPC, NVDA, LRPC, DEC, UMATR, MRBA	TBP grant
STRATEGIES TO SUPPORT NATURAL RESOURCE PROTECTION AND RESTORATION – WETLANDS				
39. Restore degraded wetlands and protect through acquisition	DFW Wildlife Management Areas– Rock River (Wetland Packets #87, 88.), Fairfield Swamp. see the DEC RCPP Wetland Restoration Site Prioritization Map		DEC, NRCS, MRBA, USFWS, OCNRCD, FCNRCD, TNC, VLT	EPA thru DFW, WISPr, NRCS-Wetland Restoration Easement, DEC-CWF
40. Identify boundaries for a potential Class I designation in a portion of the Missisquoi National Refuge.	Missisquoi Delta, Maquam Bog		DEC, DFW, Missisquoi National Wildlife Refuge, Swanton	
41. Support community-led efforts towards recognition of wetlands as well as reclassification to Class I	Missisquoi Delta and Maquam Bog, Fletcher wetland below Metcalf Pond		DEC, conservation commissions	TBP grant
42. Identify state-significant wetland natural communities through ecological inventories and map	Open water Peatlands including: Shawville, Little Franklin, Adams, Proper and Fairfield SE Ponds identified by Lakes and Ponds, and others		Nongame Natural Heritage DFW; DEC-Lakes and Ponds and Wetlands Program	

Strategy Description	Priority Subbasin(s)	Priority Towns[21]	Partners (link to acronyms)	Funding
43. Collect quantitative data on restored wetlands to monitor health and use to inform wetland restoration practices	Rock River, VLT and NRCS WRE sites		DEC, VLT, NRCD	CWF

D. Monitoring Priorities

Based on the Missisquoi Basin's 5-year rotational planning process, WSMD's stream and wetland biomonitoring is scheduled for 2023. Both macroinvertebrates (bugs) and fish communities are the focus in stream biomonitoring assessments. In addition, other programs will feed monitoring data into the planning process on an ongoing basis. The Agency's Water Quality Monitoring Program Strategy describes the monitoring programs supported by both the Agency and its partners., which are also listed in Chapter 2. Common goals for monitoring efforts across programs include identifying water quality conditions as well as pollution sources. Prior to the monitoring year, the DEC Watershed Management Division coordinates a water quality summit for the basin to better integrate monitoring efforts across the division. During the summit, sites included in Tables 15 and 16 will be reviewed for inclusion in program sampling schedules as well as any efficiencies that could be achieved through program coordination.

Table 15. Monitoring and assessment opportunities for collecting data to identify reclassification candidates in the Missisquoi Basin, and for additional reasons. To be addressed by WSMD's Lakes and Ponds, and MAP (potential B1 reclassification candidates), DFW fisheries program and through the LaRosa Partnership Program (LPP).

Water body	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
Cutler Pond	Highgate	Confirm Best Lake status	Lack of invasives and intact shoreline	Water chemistry
Little Pond	Franklin	Confirm Best Lake status	Lack of invasives and intact shoreline	Water chemistry
McCallister Pond	Lowell	Confirm Best Lake status	Lack of invasives and good water quality conditions	Shoreline inventory
Metcalf Pond	Fletcher	Determine Trophic status	Lack of available data	Chemistry
***Jay Branch (2002) – RM 2.5 Revoir Flats Road –**	Jay	Explore as Class B(1) for fishing use	238 trout/mile, 21.7 lbs./acre	Additional trout density data
***Jay Branch (2002) – RM 5.3 Lucier Road –**	Jay	Explore as Class B(1) for fishing use	779 trout/mile, 34.1 lbs/acre	Additional trout density data
***Jay Branch (above RM 9.1.**	Jay	Explore as Class B(1) for fishing use	DFW Fisheries biologist Best Professional Judgement	DFW fish survey for additional trout density data
***Jay Branch Trib 10**	Jay	Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data supporting higher classification than Class B(2)	Updated fish and macroinvertebrate data
***Jay Branch Tributaries 12**	Jay	Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data supporting higher classification than Class B(2)	Updated fish and macroinvertebrate data

Water body	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
above Lower Access Road, Jay (above RM 0.2) and 13				
McGowan Brook (above RM 1.0)	Sheldon	Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data (2013) supporting higher classification than Class B(2).	Low gradient stream needs additional macroinvertebrate data
Upper Missisquoi (above RM 80.2)		Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data (2013) supporting higher classification than Class B(2)	Needs current macroinvertebrate and fish data
***Elm Brook (RM2.2)**		Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring 2018 excellent bugs at RM 2.2, look at agriculture	Needs additional biological data
***South Branch Trout River**		Investigate as Class B(1) for fishing		
***Upper Trout River to headwaters, including tributaries Black Falls Brook, Hannah Clark Brook, Wade Brook, Jay Brook, Tamarack Brook**		Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring data on Upper Trout River tributaries from 2013-2018 supports higher classification than Class B(2)	Needs additional and /or current biological data on mainstem and select tributaries
***Hannah Clark Brook**		Investigate as Class B(1) for fishing		DFW fish survey
***Wade Brook**		Investigate as potential Class B(1) for fishing		DFW fish survey
***Wade Brook Tributary**		Investigate as potential Class B(1) for fishing		DFW fish survey

Water body	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
***Loveland Brook**		Confirm as Class B(1) for aquatic biota and wildlife	Biomonitoring in 2018 supports higher classification than Class B(2)	Needs additional biological data, SGA
***Beetle Brook**		Confirm as Class B(1) or A(1) for aquatic biota and wildlife	Biomonitoring in 2013 supports higher classification than Class B(2) (excellent macroinvertebrates)	Needs additional biological data, SGA
Mill Brook (trib to Taft Brook) (RM 1.2)		Investigate as Class B(1) for aquatic biota and wildlife	Biomonitoring in 2018 supports higher classification than Class B(2)(Very Good macroinvertebrates)	Needs additional biological data
***Lucas Brook**	Richford	Investigate as Class B(1) for fishing or aquatic biota and wildlife	Unsampled, forested watershed	Visual assessment to consider for LPP (or also Biomonitoring) DFW fish survey
***Snider Brook**	Westfield	Investigate as Class B(1) for fishing or aquatic biota and wildlife	Unsampled, forested watershed	Visual assessment to consider for LLP. (or also Biomonitoring) Investigate for Class B(1) for fishing
Missisquoi trib in Shawville	Highgate	Investigate as Class B(1) for aquatic biota and wildlife	Unsampled, forested watershed	Visual assessment to consider for Larosa Partnership Program (LPP) or also Biomonitoring
***Mill Brook**		Investigate as Class B(1) for fishing		DFW fish survey
***Cold Hollow Brook**		Investigate as Class B(1) for fishing		DFW fish survey

Water body	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
***The Branch**		Investigate as potential Class B(1) for fishing		DFW fish survey
Black Creek Trib branches crossing at Egypt Road and Fairfield road		Assess current condition.	Unsampled watershed	Consider for LPP or for Biomonitoring
Black Creek up to headwaters	East Cambridge	Assess current condition.	2018 biomonitoring,	
Stanhope Brook (downstream of Richford water supply intake)	Richford	Assess extent of flow alteration and low flow conditions.	See flow alteration section.	Determine occurrences of low flow conditions; stream geomorphic assessment (SGA)

*see Figure 21, percent of stream's watershed that is forested.

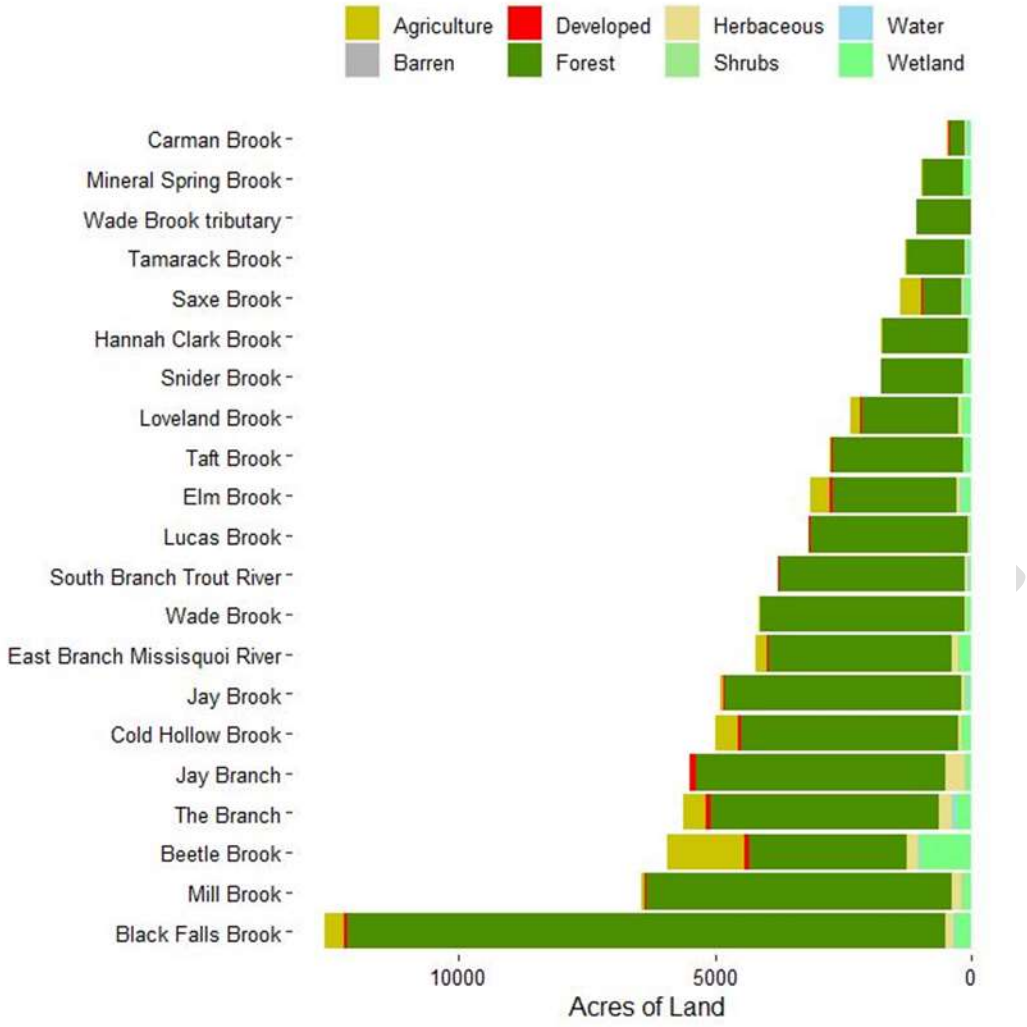


Figure 21. Streams with predominately forested watersheds identified in Table 15 recommended for additional assessment to confirm condition relative to classification.

Table 16. Biomonitoring priorities for reassessing impaired or stressed streams or where further assessment is needed to determine status.

Location	Station	Bug Date	Bug Assessment	Fish Date	Fish Assessment
Marsh Brook	1.2	09-Oct-13	**Excellent (Ex)**		
Groat Brook	3.9	09-Oct-13	**Very (V) good**		
Saxe Brook	0.4	30-Aug-16	**Fair**		
Kelly Brook	1.4	05-Oct-09	**Good**	05-Oct-09	**Unable to assess**
Hungerford Trib 4	0.1	23-Sep-19	**Fair**		
Black Creek	27.3	27-Sep-18	**Fair**		
Dead Creek	0.9	23-Sep-19	**Fair**		
Swamp School Brook	0.9	21-Sep-09	**Ex-Very good**	21-Sep-09	**Poor**
Fairfield River	1.9	10-Oct-18	**Good**	10-Oct-18	**Poor**
Chester Brook	1.4	16-Sep-13	**Ex**	16-Sep-13	**Poor**
Tyler Branch	2.2	04-Oct-91	**Ex-Vgood**	04-Oct-91	**Unable to assess**
Trout Brook	0.5	01-Oct-18	**Ex-Vgood**	01-Oct-18	**Poor**
Berry Brook	0.2	24-Sep-18	**Good (G)**	24-Sep-18	**Fair**
North Branch Berry Brook	0.1	10-Sep-09	**G-Fair**	10-Sep-09	**Poor**
Mud Creek	4.0	25-Sep-13	**G-Fair**	25-Sep-13	**Good**
Mud Creek Trib 10	0.2	25-Sep-18	**Fair**	25-Sep-18	**Poor**
Jay Branch	5.4	15-Oct-18	**Vgood-Good**	15-Oct-18	**Good**
Taft Brook	0.3	19-Sep-18	**Fair**		
Ace Brook	0.7	28-Sep-15	**Fair**	15-Sep-15	**Fair**
Burgess Branch	5.0	09-Sep-13	**Fair**	09-Sep-13	**Good**
Youngman Brook	1.5	25-Sep-18	**Unable to Sample**		

* High percentage of forested landcover in watershed (HUC12) (Fig. 20)

List of Acronyms

AAFM	Agency of Agriculture, Food, and Markets
AgCWIP	Agric. Clean Water Initiative Grant Program
Agric.	Agriculture
AIS	Aquatic Invasive Species
AMPs	Acceptable Management Practices
ANR	Agency of Natural Resources
AOP	Aquatic Organism Passage
BASS	DEC Biomonitoring&Aquatic Studies Section
BMP	Best Management Practices
CREP	Conservation Reserve Enhancement Program
CWF	Clean Water Funds
CWIP	Clean Water Initiative Program
CWSP	Clean Water Service Provider
CWSRF	Clean Water State Revolving Fund
DEC	Department of Environmental Conservation
DFPR	Department of Forests, Parks &Recreation
EQIP	Environmental Quality Incentive Program
ERAF	Emergency Relief and Assistance Fund
FAP	Farm Agronomic Practices
FEH	Fluvial Erosion Hazard
FNLC	Friends of Northern Lake Champlain
FOVLAP	Federation of Vermont Lakes and Ponds
FWD	Vermont Fish and Wildlife Department
GIS	Geographic Information System
IDDE	Illicit Discharge Detection & Elimination
LC	Lake Champlain
LFO	Large Farm Operation
LiDAR	Light Detection and Ranging
MFO	Medium Farm Operation
MNWR	Missisquoi National Wildlife Refuge
MRBA	Missisquoi River Basin Association
MPG	Municipal Planning Grant
MRGP	Municipal Roads General Permit
NFIP	National Flood Insurance Program
NMP	Nutrient Management Plan
NPDES	Nat'l Pollution Discharge Elimination System
NPS	Non-point source pollution
NRCD	Natural Resource Conservation District
NRCS	Natural Resources Conservation Service
ORW	Outstanding Resource Water
PCP	Phosphorus Control Plan
PDM	Pre-Disaster Mitigation
RAP	Required Agricultural Practices
RTE	Rare, Threatened and Endangered Species
RCP	River Corridor Plan
RCPP	Regional Conservation Partnership Program
RMP	River Management Program
RPC	Regional Planning Commission
SFO	Small Farm Operation
SGA	Stream Geomorphic Assessment
SWMP	Stormwater master plans
TBP	Tactical Basin Plan
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TS4	Transportation Separate Storm Sewer System General Permit
USDA	United States Department of Agriculture
USEPA	US Environmental Protection Agency

USFWS	United States Fish and Wildlife Service
USFS	United States Forest Service
USGS	United States Geological Survey
UVA	Use Value (Current Use) Appraisal program
UVM ext.	University of Vermont Extension
UVM SG	University of Vermont Sea Grant
VACD Districts	Vermont Association of Conservation
VAWQP partnership	Vermont Agricultural Water Quality
VDH	Vermont Department of Health
VHCB	Vermont Housing and Conservation Board
VIP	Vermont Invasive Patrollers
VLCT	Vermont League of Cities and Towns
VLT	Vermont Land Trust
VTrans	Vermont Agency of Transportation
VRC	Vermont River Conservancy
WISPr Program	Water Infrastructure Sponsorship

References

AAFM. (2016, May 13). *Required Agricultural Practices (RAPs).* Retrieved from Vermont.gov: http://agriculture.vermont.gov/water-quality/regulations/rap#Q16

ANR (2021). *Vermont Clean Water Initiative 2020 Performance Report.* Montpelier: VT Agency of Administration. Retrieved from https://dec.vermont.gov/sites/dec/files/2021-01-14_CleanWaterPerformanceReport_SFY2020 FINAL.pdf

Betts, A. K. (2011). *Climate Change in Vermont.* Climate Change Adaptation White Paper Series, Vermont Agency of Natural Resources. Retrieved from https://climatechange.vermont.gov/sites/climate/files/documents/Data/VTCCAdaptClimateChangeVTBetts.pdf

DEC. (2015). *Vermont Lake Champlain Phosphorus TMDL Phase 1 - Implementation Plan.* Montpelier: Vermont. Retrieved from https://www.epa.gov/sites/default/files/2015-09/documents/vt-lake-champlain-tmdl-phase1-ip.pdf

DEC. (2015). *Water Quality Monitoring Program Strategy Interim Update – May 2015.* Montpelier: VTDEC. Retrieved from https://dec.vermont.gov/sites/dec/files/documents/WSMD_MonitoringStrategy2015.pdf

DEC. (2016, August 5). *Vermont Surface Water Management Strategy.* Retrieved from DEC Website: http://dec.vermont.gov/watershed/map/strategy

DEC. (2017, January 15). *Vermont Water Quality Standards Environmental Protection Rule Chapter 29A.* VT: State of Vermont.

DEC. (2019). *Vermont Surface Water Assessment and Listing Methodology.* Montpelier, Vermont: Agency of Natural Resources.

DEC. (June 2019). *A Probabilistic Assessment of Vermont's Wadeable Streams.* Montpelier: Vermont Department of Environmental Conservation.

DEC. (2020). *State of Vermont 2016 Stressed Waters List.* Montpelier, VT: State of Vermont.

DEC. (2020). Part A. Impaired Surface Waters in Need of TMDL. *State of Vermont 2018 303(d) List of Impaired Waters - Draft.* Montpelier, VT: State of Vermont.

DEC. (2020). Part B. Impaired Surface Waters - No Total Maximum Daily Load Determination Required. *State of Vermont 2018 List of Priority Surface Waters.* Montpelier, VT: State of Vermont.

DEC. (2020). Part D. Impaired Surface Waters with Completed and Approved TMDLs. *State of Vermont List of Priority Surface Waters.* Montpelier, VT: State of Vermont.

DEC. (2020). Part E. Suface Waters Altered by Invasive Aquatic Species. *State of Vermont 2018 List of Priority Surface Waters*. Montpelier, VT: State of Vermont.

DEC. (2020). Part F. Surface Waters Altered by Flow Regulation. *State of Vermont 2018 List of Priority Surface Waters*. Vermont: State of Vermont.

Galford, G. A. (2014). *Considering Vermont's Future in a Changing Climate: The First Vermont Climate Assessment.* Gund Institute for Ecological Economics. Gund Institute for Ecological Economics.

Isles, P., Xu, Y., Stockwell, J., & Schroth, A. (2017). Climate-driven changes in energy and mass inputs systematically alter nutrient concentration and stoichiomentryin deep and shallow regions of Lake Champlain. *Biogeochemistry*.

Lake Champlain Basin Progran. (2021). *State of the Lake Report.* Grand Isle: Lake Champlain Basin Proram.

National Oceanic and Atmospheric Administration. (2013, May 28). *Climate Information*. Retrieved from National Centers for Environmental Information: https://www.ncdc.noaa.gov/climate-information

Pealer, S., & Dunnington, G. (2011, April). *Climate Change and Vermont's Waters.* Montpelier. Retrieved April 14, 2020, from Climate Change in Vermont: https://climatechange.vermont.gov/sites/climate/files/documents/Data/VTCCAdaptWaterResources.pdf

Stamp J, M. A. (2020). Effects of extreme high flow events on macroinvertebrate communities in Vermont Streams. *River Res Applic., 36*, 1891–1902.

State of Vermont. (2021, August 15). *Climate Change in Vermont*. Retrieved from Vermont Today: https://climatechange.vermont.gov/vermont-today

USEPA. (2016, June 17). *Phosphorus TMDLs for Vermont Segments of Lake Champlain*. Boston, MA, New England: USEPA.

USEPA. (2016). *National Lakes Assessment 2012: A Collaborative Survey of Lakes in the United States.* Washington DC: U.S. Environmental Protection Agency. Retrieved from https://nationallakesassessment.epa.gov/

Vermont Clean Water Act, VT No. 64 (H.35) (June 16, 2015).

Watson, K. B., Ricketts, T., Galford, G., Polasky, S., & O'Niel-Dunne, J. (2016). Quantifying flood mitigation services: The economic value of Otter Creek wetlands and floodplains to Middlebury, VT. *Ecological Economics, 130*, 16-24. doi:https://doi.org/10.1016/j.ecolecon.2016.05.015.

Weiskel, P. K. (2007). *The Charles River, Easter Massachusetts: Scientific Information in Support of Environmental Restoration.*

US Geological Survey. Retrieved from
https://pubs.usgs.gov/gip/2007/47/pdf/gip-47.pdf

Appendix A. Partners

Watershed Partners

Partners in the tactical planning process include multiple state and federal agencies. They can play multiple roles, including funder, technical resource (see the appendices in the Vermont Surface Water Management Strategy) or project manager as well as providing guidance during the planning process. In addition, the following list of non-government organizations partners are undertaking watershed monitoring, assessment, protection, restoration, and education and outreach projects in the Missisquoi Basin. Table 17 provides a description of the geographic range for groups that are involved in basin plan development as well as project development.

Table 17. Watershed partners in the North Lake Basin and their geographic range by Subbasin.

Group Name	*Association*	*Description*
Regional Planning Commissions (RPC): Northwest (NRPC). Northeastern Vermont Development Association (NVDA);	Regional	Statutory partners to the basin planning process, and help towns to complete road erosion inventories, stream geomorphic assessments, and stormwater master plans in addition to helping towns update their regulations to protect water quality. As part of the implementation of Act 64 (Sec. 43), DEC has contracted with RPCs to fulfill the specific roles and responsibilities around the development of tactical basin plans that should substantially enhance DEC's ability to reach municipalities and other relevant stakeholders. Further, the contracted activities are developing augmented capacity in RPCs to support water quality protection and restoration.
Natural Resource Conservation Districts (NRCD): Franklin County (FCNRCD). Orleans County (OCNRCD).		Statutory partners to the basin planning process, playing a critical role in implementing actions identified in basin plans. They also partner with Regional Planning Commissions on stormwater master planning, river corridor assessments, and road erosion assessments. NRCDs also work with the agricultural community to identify and assess natural resource concerns and implement farm BMPs to protect water quality.
Franklin Watershed Committee (http://www.franklinwatershedvt.org/index.php)	Non-profit	A community group focused on reducing phosphorus loads into the Pike (Lake Carmi) and Rock River watershed. The group works with farmers, campers, and other watershed landowners to carry out projects that improve the land's natural ability to utilize phosphorus and reduce the effect of erosion on land in the watershed. These projects range from efforts to improve septic systems on lakeshore properties, to cover crop incentive programs, to culvert and ditch repair

Group Name	*Association*	*Description*
Friends of Northern Lake Champlain (http://www.northernlakechamplain.org/)	Local non-profit	An organization dedicated to the rehabilitation and protection of northern Lake Champlain and all the waters that flow into it. The organization works collaboratively with local communities, farmers, government, lake associations, regional planning, and policy developers to reduce polluted land use runoff
Lake Carmi Campers Association (http://lakecarmi.mylaketown.com/)	Local non-profit	An association dedicated to conserving our unique natural resources, improving, and enhancing the quality of life and the environment, for all Lake Carmi residents and visitors. In cooperation with local and state authorities, the association shall provide educational, cultural, and recreational activities, as well as water quality management and safety education initiatives. Further, the association will provide a medium through which information and educational programs and materials may be distributed throughout the community
Lake Champlain Committee	Local non-profit	Abi-state organization that is solely dedicated to protecting Lake Champlain's health and accessibility. The committee uses science-based advocacy, education, and collaborative action to protect and restore water quality, safeguard natural habitats, and ensure recreational access. The program is also the home organization for the Lake Champlain Paddlers' Trail, providing a safe, recreational corridor for human-powered craft on the lake. The Lake Champlain Committee also leads citizen- based efforts to conduct blue-green algal surveillance and reporting for Lake Champlain and adjacent waterbodies. These efforts are coordinated with ANR and the VT Department of Health
Lake Champlain Basin Program	Non-profit	a congressionally designated initiative to restore and protect Lake Champlain and its surrounding watershed. The program works with partners in New York, Vermont, and Québec to coordinate and fund efforts to address challenges in the areas of phosphorus pollution, toxic substances, biodiversity, aquatic invasive species, and climate change. The LCBP also administers the Champlain Valley National Heritage Partnership, which builds appreciation and improves stewardship of the region's rich cultural resources by interpreting and promoting its history
Lake Champlain Sea Grant	University	develops and supports research, outreach, and education programs to empower communities, businesses, and other stakeholders in the Lake Champlain Basin to make informed decisions regarding the management, conservation, utilization and

Group Name	Association	Description
		restoration of their aquatic resources for long-term environmental health and sustainable economic development
Missisquoi River Basin Association (https://mrbavt.com/about-us/)	Non-profit	Dedicated to the restoration of the Missisquoi River, its tributaries, and the Missisquoi Bay, bringing together diverse interest groups within the community – teachers, farmers, summer residents, loggers, business owners, environmental experts, outdoor enthusiasts, municipal officers, woodland owners, and concerned citizens. Activities range from education and community outreach to tree planting and fieldwork. We work with landowners on stabilizing stream banks, we cost-share with farmers to implement conservation practices, and we manage a volunteer-led water-sampling program to monitor phosphorus, nitrogen, and turbidity throughout the watershed.
Better Roads (BR)	State	BR provides technical assistance, grant funding, and educational workshops related to transportation infrastructure and water quality. BR provides funding for municipalities through the Better Roads Grants. Grant funding can be used to undertake road erosion inventories and capital budgets and to implement transportation infrastructure best management practices (BMPs) that address road erosion and improve water quality and aquatic habitat.
USDA Natural Resources Conservation Service (NRCS)	Federal	NRCS provides cost-share, technical assistance, and targeted support of agricultural best management practices. Additionally, NRCS provides funding and technical assistance for forestry and wildlife habitat projects.
The Upper Missisquoi and Trout Rivers Wild and Scenic Committee (http://www.vtwsr.org/)	Non-profit	The committee was formed after the federal designation of the Upper Missisquoi and Trout Rivers as a Partnership Wild and Scenic River to develop and implement a management plan. The goal of this Partner approach is to maintain local governance and control of the rivers and their valleys. The Management Plan presents a series of recommendations that can be voluntarily implemented by area residents, riverfront landowners, local municipalities, and partnership state and federal agencies to help protect these river-related resources and maintain the quality and way of life valued by so many people.
Watershed Municipalities	Municipal	Nine Vermont towns completely in the watershed: Highgate, Franklin, Berkshire, Richford, Jay, Troy, Sheldon, Enosburg, and Westfield. Fourteen towns partially in the watershed: Newport, Lowell, Coventry, Irasburg, Lowell, Eden, Montgomery, Bakersfield, Fletcher, Cambridge, Fairfax, Fairfield, St. Albans, Swanton. Municipalities can protect water resources through town plan language and zoning

Group Name		Association	Description
			bylaws. Additionally, towns are responsible for managing large networks of roads, drainage ditches, and stream crossings.
VT Agency of Natural Resources (ANR) Internal Partners	Fish and Wildlife (FWD); Forests, Parks and Recreation (FPR); Environmental Conservation (DEC)	State	All Departments within ANR (Fish & Wildlife Department, Forest, Parks, and Recreation, and DEC) and Divisions within them, work collaboratively on several watershed assessment, restoration and protection projects. Additionally, FWD and FPR own and manage hundreds of acres of state-owned lands within the basin. Annual stewardship plans are prepared by District Stewardship Teams and includes staff from FWD, FPR, and DEC. Long Range Management Plans of state-owned properties include restoration and protection of water resources.
The Missisquoi National Wildlife Refuge		Government	The Missisquoi National Wildlife Refuge was established in 1943 to provide habitat for migratory birds. It consists of 6,729 acres, mostly wetland habitats, which support a variety of migratory birds and other wildlife. The 900-acre Maquam bog is designated as a Research Natural Area and the refuge was designated as an Important Bird Area in partnership with the Audubon Society. The Refuge in partnership with other publicly owned (State of Vermont) lands has been designated a Wetland of International Importance under the Ramsar Convention.
Northern Forest Canoe Trail (http://www.northernforestcanoetrail.org/)		Non-profit	the Northern Forest Canoe Trail (NFCT) is a 740-mile inland paddling trail tracing historic travel routes across New York, Vermont, Québec, New Hampshire, and Maine. The mission is to connect people to the Trail's natural environment, human heritage, and contemporary communities by stewarding, promoting, and providing access to canoe and kayak experiences along this route. NFCT delivers its mission and strategic goals through 3 program areas: Waterway Stewardship, Community Economic Development, and People and Place.
Clean Water Service Provider (CWSP)			Established under the Vermont Clean Water Delivery act (Act 76), CWSP's are part of the Clean Water service delivery framework to support Vermont's clean water goals. CWSPs are responsible for establishing and coordinating with Basin Water Quality Councils to identify, implement, operate, and maintain non-regulatory projects to meet non-regulatory pollution reduction targets for the Lake Champlain and Memphremagog TMDLs, and for other impaired waters in Vermont as pollution budgets are established. They anticipate being operational by November 2021

Appendix B. Stream and Lake Data

LIST of TABLES in Appendix B

Geomorphic Assessment Priorities for Missisquoi Bay Watershed

Identify projects through updated or new Phase 2 SGA on streams that are stressed or impaired by sediment or nutrients to determine if channel erosion processes involved

- Blue – 1st tier
- Yellow – 2nd tier
- White - Update or develop SGA for purposes of identifying projects
- Green - Preliminary evaluation through stream walk to infer initial condition and if further assessment needed

Table 18. Potential SGA assessments for streams in Basin 6

Stream	Town	Proposed assessment	Purpose
Loveland Brook		Update Phase 1 to Phase 2	ID high quality stream, and Development stressor at lower reach
Mountain Brook	Richford	Update Phase 1 to Phase 2	ID stressors that led to poor biomonitoring results although not on stressed list
Morrow Brook		Initiate	ID stressors to assist with ID of remediation projects to address agric impairment
Tyler Branch and the Branch		Update Phase 2	ID stressors to assist with ID of remediation projects to address stressed reaches

Stream	Town	Proposed assessment	Purpose
Samsonville Brook		Update Phase 1 to 2	ID stressors to assist with ID of remediation projects to address agric impairment
Godin Brook	Berkshire	Update Phase I to Phase 2	ID stressors to assist with ID of remediation projects to address agric impairment
Berry Brook	Richford	Update Phase 1 to Phase 2	ID stressors to assist with ID of remediation projects to address agric impairment
Wanzer Brook		Update Phase 2	ID projects to address channel erosion to remediate agric impairment
Ace Brook, lowest reach		Update Phase?	ID projects to remediate impairment from sediment discharge
Mud Creek, MO4		Update Phase 2	ID projects to address channel erosion to remediate agric impairment
East Branch, Missisquoi, R47		Update Phase 2	ID projects to address stressed condition due to sedimentation, and most likely temperature
Giddings Brook	Enosburg	Update Phase 1 to Phase 2	ID projects to address channel erosion to remediate stormwater? impairment
Fairfield River, 2 headwater tribs	Fairfield	Update Phase 2	Update corridor plan project list
Black Falls Brook (add Hanna and Wade Brook)	Montgomery	Update Phase 1 and 2 to Phase 2	Project ID to address development
Beetle Brook	Troy	Update Phase 1 to 2	ID projects to address road impacts
Taft Brook	Westfield	Update Phase I and 2 to Phase 2	ID projects to address potential land use impacts
Lucus Brook		Visual assessment/Initial scoping/stream walk	Assist in ID as B1
Stanhope Brook	Richford	Initial scoping/stream walk	Determine if evidence of low flows at town water intake; determine source of channel adjustment higher up in forested headwaters

Stream	Town	Proposed assessment	Purpose
Trout Brook	Enosburg	Initial scoping/stream walk to update Phase I	Need for Phase 2? Identify projects to address agric impaired section
Snyder Brook		Initial scoping/stream walk	Need for Phase 2?
McGowan Brook	Sheldon	Initial scoping/stream walk	Need for Phase 2?
Tamarack (upper Missisquoi)		Initial scoping/stream walk	Need for Phase 2?
Mineral Brook	Troy	Initial scoping/stream walk	Need for Phase 2?
Jay Branch	Jay	Initial scoping/stream walk	Identify projects (Lucifer Road down is stressed and has Phase 2 from 2008)
Prouty Brook	Franklin	Phase 2	Identify project
Dewing Brook and other Lake Carmi tribs	Franklin	Initial scoping	Identify project

Table 19. Stream Geomorphic Assessment completed in Basin 6

Date	***Stream Reach***	***Sub Watershed***	***Title*** [23]	***Priority Actions for TBP***
12/01/2005	Wanzer Brook	Black Creek Head	Wanzer Brook Watershed Phase 2	Protect, riparian buffer planting
4/01/2009	Black Creek	Black Creek Mouth	Black Creek Corridor Plan	Riparian buffer planting, protect floodplain access, reduce sediment input from upland sources (cropland)

[23] https://anrweb.vt.gov/DEC/SGA/finalReports.aspx

Date	Stream Reach	Sub Watershed	Title [23]	Priority Actions for TBP
4/01/2008	Hungerford Brook	Hungerford Brook	Hungerford Brook Corridor Plan	Restore hydrology: restore floodplain and wetlands
10/01/2006	Hungerford Brook	Hungerford Brook	Hungerford Brook Phase 2 Report	See above
3/01/2008	Missisquoi	Missisquoi - Canada to Trout	Missisquoi River Mainstem Phase 2	Riparian buffer protection, control urban stormwater
1/26/2007	Rock River	Rock River	Rock River Phase 2 Report	Restore floodplain and wetland, reduce sediment input from upland sources (cropland)
Expected 2023	Rock River (Canada)	Rock River	Rock River Phase 2 Update and Phase 2 report for Canada	
4/01/2007	Trout River Watershed Towns of Berkshire, Enosburg, Richford,Montgomery	Trout River Head	Trout River Watershed Phase 2	Increase woody riparian buffer, control sediment from upland sources (roads), protect river corridors
3/01/2007	Tyler Branch	Tyler Branch	Tyler Branch Corridor Plan	Increase woody riparian buffer, Protect, or increase areas for attenuation of sediment; control sediment from upland sources
6/02/2009	Tyler Branch	Tyler Branch	Tyler Branch Corridor Plan	See above
3/27/2008	Missisquoi Mainstem, Jay Branch, Mud Creek	Upper Missisquoi	Missisquoi Mainstem, Jay Branch, Mud Creek Phase 2	Reduce sediment and stormwater inputs from upland sources. Protect river corridor in upper Missisquoi.
9/30/2011	Upper Missisquoi	Upper Missisquoi	Upper Missisquoi River Corridor Plan	Allow channel to regain planform by protecting river corridor. Increase woody riparian buffer.

Date	***Stream Reach***	***Sub Watershed***	***Title*** [23]	***Priority Actions for TBP***
2020/2021	Marsh Brook	Pike River	Marsh Brook Stream walk – Phase 2 lite	Protection and crossing enhancement
Expected 2024	Pike River Main stem	Pike River	Pike River Phase 2 on US and Canadian side	

Basin Dam Inventory

Table 20. Vermont dam inventory with ecological priorities ranking by TNC as well as hazard class ranking by DEC

DamName	LatDecDeg	LongDecDeg	Town	Stream	OwnerType	DamStatus	YearBuilt	StateReg	DamHazClass	TNC	Action	Partners
Browns Pond	44.81215	-72.7905	Bakersfield	The Branch	Private	Breached (Partial)	1920	Department of Environmental Conservation	Low Hazard Potential	Medium	Feasability planned	Franklin NRCD, US FWS, Upper Misissquoi Working Group, VNRC,
Johnsons Mill	44.83163	-72.7556	Bakersfield	Bogue Branch	Private	Breached (Partial)	1928	None	Low Hazard Potential	High	Planned for 2021 removal	Franklin NRCD, US FWS, VNRC, DEC, VT FWD
Trout Brook Reservoir	44.93743	-72.7818	Berkshire	Trout Brook	Local Government	In Service		None	Low Hazard Potential	Medium	Candidate for Rem	
Fairfield Pond	44.85681	-72.9783	Fairfield	Dead Creek-TR	Local Government	In Service		Department of Environmental Conservation	Low Hazard Potential	High	Eval needed	

DamName	LatDecDeg	LongDecDeg	Town	Stream	OwnerType	DamStatus	YearBuilt	StateReg	DamHazClass	TNC	Action	Partners
Webster (Lower)	44.78662	-72.8626	Fairfield	Black Creek	Local Government	Breached (Partial)		None	Low Hazard Potential	Low	Eval needed	
Webster (Upper)	44.78396	-72.861	Fairfield	Black Creek	Local Government	Breached (Partial)		None	Low Hazard Potential	Low	Eval needed	
Sleeper Pond	44.95012	-72.3082	Newport Town	Mud Creek	Local Government	Breached (Partial)		Department of Environmental Conservation	Low Hazard Potential	Medium	Candidate for Rem	MRBA
Guilmettes Pond	44.9597	-72.674	Richford	Missisquoi River-TR	Private	Breached		None		Medium	Eval needed	
Richford Reservoir	44.9962	-72.6607	Richford	Missisquoi River-OS	Local Government	In Service		Department of Environmental Conservation	Low Hazard Potential	NA	Eval needed	
Fairfield Swamp Pond	44.82369	-72.9953	Swanton	Dead Creek	VT DFW	In Service	1967	Department of Environmental Conservation	Low Hazard Potential		Eval of drawdown schedule needed	

DamName	LatDecDeg	LongDecDeg	Town	Stream	OwnerType	DamStatus	YearBuilt	StateReg	DamHazClass	TNC	Action	Partners
Swanton	44.92059	-73.1279	Swanton	Missisquoi River	Local Government	In Service	1920	Department of Environmental Conservation	Low Hazard Potential		Candidate for Rem	
Coburn Brook Reservoir	44.91138	-72.4324	Westfield	Coburn Brook	Local Government	In Service		None	Low Hazard Potential		Eval needed	

Hydroelectric Dams

Table 21. Basin 6 Hydroelectric dams and their relicensing status

Dam Name	Stream	Comments
Enosburg Falls	Missisquoi River	Enosburg has proposed to change operations to run-of-river and increase conservation flow in the bypassed reach. Enosburg filed its final License Application with FERC in April 2021
Highgate Falls	Missisquoi River	Swanton has proposed to maintain peaking operations for the next license. Swanton will begin its second year of study in 2021.
Sheldon Spring	Missisquoi River	Central Rivers has proposed to change operations at the project to run-of-river. Central River will begin the second year of study in 2021.
Bakers Falls	Missisquoi River	operating under a FERC exemption and 401[24] issued in 2011
North Troy Hydroelectric Project	Missisquoi River	operating under a FERC exemption and 401 issued in 1987
Alder Brook Project	Missisquoi River	active FERC exemption and was issued 401 in March 2010. Project was constructed and is operating. .

Flow alterations

Table 22. Updates on certain surface waters listed as altered for flows. See Table 4 for additional waters altered for flows.

Surface water	Flow alterations

Missisquoi River – below Enosburg Falls dam	The Enosburg hydroelectric project current operation results in flow alterations that impact aquatic habitat below the dam. The Federal Energy Regulatory Commission license for the project expires in 2023 with the relicensing process beginning in approximately 2018. As part of the relicensing the project will require a Section 401 water quality certification from the State. As part of the Agency review of the project, flows needed to support aquatic habitat below the dam will be evaluated.
Jay Branch	Jay Peak currently operates a water withdrawal on the Jay Branch for snowmaking at the resort. The conservation flow below the intake does not meet current requirements under the Agency's Snowmaking Rules. Jay Peak is evaluating alternative sources for snowmaking, including the construction of a new intake on the Missisquoi River in Troy.
Stanhope Brook	The town of Richford withdraws water from Stanhope Brook for its water supply. The Richford System continuously flows raw water from Stanhope Brook through a 3.5-mile transmission main to the treatment plant. Normal operation is for the water to enter directly onto the filters, but depending on the demand, water is diverted to an open-air raw water reservoir at the treatment plant which continuously overflows into the streams around the treatment plant. The meter numbers provided to DEC does not account for the flow into the open-air reservoir, only the amount of water passing through the treatment plant (Email correspondence with M. Caldwell, DEC DWGWP 5/19/21). No report exists noting leaks of the transmission main or any distribution main. DEC will inspect stream flows summer 2022. Any needed upgrade to the system could be supported in part through the Drinking Water State Revolving funds.

Lakes and Ponds assessment data

Table 23. Lakes and ponds assessment data 2020: Red – poor; Yellow – Fair; Blue - good

Lake ID	Lake Area (acres)	Town	Water Quality Status	Water Quality Trend	Aquatic Invasive Species	Mercury	Shoreland Human Disturbance	Watershed Human Disturbance
LITTLE (FRANLN)	22.2	Franklin						
SHAWVILLE;	15.9	Highgate						
SOUTH RICHFORD;	11.9	Richford						
GUILLMETTES	11.7	Richford						
CUTLER	23.6	Highgate						
ADAMS (ENOSBG)	12	Enosburg						
WARNER;	10.4	Jay						
METCALF	84.5	Fletcher						
FAIRFIELD SWAMP	132.2	Swanton						

BEAVER MEADOW BRK-L;	27.7	Enosburg						
BEAVER MEADOW BRK-U;	21.6	Enosburg						
OXBOW;	17.2	Swanton						
FAIRFIELD-SE;	14.7	Fairfield						
COREZ	12.1	Lowell						
CARMI	1415.2	Franklin						
FAIRFIELD	463.3	Fairfield						
BULLIS;	12.8	Franklin						
PROPER	19.5	Highgate						
MCALLISTER	25.6	Lowell						

Appendix C. Responsiveness Summary

Vermont Department of Environmental Conservation
Agency of Natural Resources

Responsiveness Summary to Public Comments Regarding

Missisquoi Bay (Basin 6) Tactical Basin Plan

On October 13, 2021, the Vermont Agency of Natural Resources (ANR), Department of Environmental Conservation (DEC) notified the public about the public-comment period for the draft Missisquoi Bay Tactical Basin Plan (TBP). A summary of the public comments that were received through the public-comment period ending October X for this TBP are included in the following section.

Date, time, and place to participate were posted on the Basin 6 website and included in a press release. The public meetings were held on the following dates:

The DEC prepared this responsiveness summary to address specific comments and questions submitted during the comment period and to indicate how the plans have been modified in response to those comments. The comments received from

Some comments have been edited for brevity and clarity. The full text of the comments provided for each plan is available for review by contacting the Department of Environmental Conservation

Please note that page numbers referenced in comments refer to the DRAFT Plan rather than the final version.