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Vermont Agency of Natural Resources

Watershed Management Division

Winooski River

TACTICAL BASIN PLAN

The North Branch

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION

Vermont Surface Water Management Strategy

The Winooski Basin Water Quality Management Plan (Basin 8) was prepared in accordance with 10 VSA § 1253(d), the Vermont Water Quality Standards, the federal Clean Water Act and 40 CFR 130.6, and the Vermont Surface Water Management Strategy.

Approved:

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Emily Boedecker, Commissioner Date

Department of Environmental Conservation

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Agency of Natural Resources

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Executive Summary

The Winooski River (Basin 8) Tactical Basin Plan is a water quality management plan to protect, maintain, enhance and restore the quality of the basin's surface waters. The goal is for surface waters to meet or exceed Vermont Water Quality Standards. DEC Basin 8 Water Quality Assessment Report provides background to support the Plan's actions including assessments of wetlands, lakes and rivers.

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. The Agency of Natural Resources is assisted in the implementation of the plans through a combination of State and federal funding sources, partner support (Appendix A) and the public rulemaking process for certain protection efforts.

The Plan also includes the Phase II content (Chapter 3) for the Lake Champlain Phosphorus Total Maximum Daily Load (TMDL), including setting targets for phosphorus loading from the Winooski River to Lake Champlain. The Phase II content includes high-resolution phosphorus load modeling and projected phosphorus reductions for smaller sub-watershed as well as by types of sources (wastewater treatment plant, developed lands stormwater, roads, forestry and agricultural). The TMDL as well as the associated Phase I Implementation Plan both point to issuance of these plans as components of the accountability framework.

The surface waters in Basin 8 provide recreational and aesthetic opportunities, drinking water, agricultural irrigation and habitat for plant and animal communities. Pollutants degrading these uses include phosphorus, sediment, pathogens and toxins as well as aquatic invasive species.

The main sources of the top three pollutants, elevated phosphorus, sediment and pathogens, include agricultural, urban and road runoff, and eroding river channels. Many actions taken to address these stressors will also achieve required reductions in phosphorus loading to Lake Champlain (Phase II content in Chapter 3).

In Chapter 4, the plan describes management goals for Basin 8 surface waters and includes new classifications or candidates for reclassification (see Summary of Classification Opportunities below).

The heart of this plan is Chapter 5 and the Watershed Projects Database, which includes geographically explicit actions to protect or restore surface waters in the Basin. The actions are supported by the following top objectives and strategies for priority watershed (and associated municipalities):

Top Objectives and Strategies

Protect river corridors and floodplains to increase flood resilience and allow rivers to reach equilibrium with conservation easements and municipal adoption of appropriate bylaws. Focus will be placed on implementing VDEC river corridor plans as well as assisting municipalities with adoption of river corridor protection.

Increase knowledge of water quality conditions in the Basin, including the identification of high quality lakes and streams through the establishment and/or continuation of short-term intensive and long-term monitoring programs.

Implement agricultural Best Management Practices (BMPs) in areas that are a significant source of phosphorus.

Resolve E. coli impairments in the Winooski River between Plainfield and Cabot, as well as in the Huntington and Mad Rivers and Allen Brook by addressing discernable bacteria sources from agriculture and residential sources to meet bacterial TMDL.

Manage stormwater from developed areas through the development and implementation of stormwater master plans and Flow Restoration and Phosphorus Reduction Plans (see Appendix B).

Improve littoral zone habitat of ponds and lakes in the Kingsbury Branch watershed through direct outreach with landowners to encourage participation in the Lake Wise Program that promotes implementation of lakeshore BMPs.

Inventory and prioritize municipal road erosion features that discharge into surface waters and implement high priority actions in existing road erosion inventoried sites

Provide technical and, as available, financial assistance to wastewater treatment facilities to meet Lake Champlain Phosphorus TMDL goals.

Prioritize wetland and floodplain restoration projects for phosphorus retention and sediment attenuation.

Prioritize remediation of forest roads and log landings with high erosion risks, including sugaring operations and areas of high phosphorus loading.

Assist municipalities in identifying areas of landslide hazards for protection of future development including Jericho, Williston, Essex, Duxbury, Plainfield, Marshfield, and Barre Town.

Summary of Classification and Designation Opportunities

Waters proposed for reclassification to Class A(1)

Subbasin	River	Town	Latitude	Latitude
Mad River	**Bear Wallow Brook (.2 miles located 100 meters above Forest Service Road crossing)**	**Granville**	**44.06027**	**-72.85457**

Waters proposed for reclassification to Class B(1) for aquatic biota use

River	Town	***Latitude***	***Longitude***
Dowsville Brook	**Duxbury**	**44.267639**	**-72.818512**
Dog River – rm 14.8	**Northfield**	**44.111159**	**-72.69204**
Guernsey Brook	**Marshfield**	**44.305**	**-72.4077**
Nasmith Brook	**Marshfield**	**44.277599**	**-72.377281**
Gold Brook	**Stowe/Worchester**	**44.44772**	**-72.657722**
Nelson Brook	**Barre Town**	**44.181599**	**-72.389236**

Waters proposed for reclassification to Class B(1) for fishing use

Subbasin	River	Town	***Latitude***	***Latitude***
Upper Main Stem	**Winooski River (Above Lower Cabot)**	**Peacham**	**44.40153**	**-72.3137**
	Molly's Brook (Above Marshfield Dam)	**Peacham**	**44.3705**	**-72.27**
	Kidders (aka. Hooker) Brook	**Cabot**	**44.37392**	**-72.261**
	Nasmith Brook	**Plainfield**	**44.29974**	**-72.3876**
	Great Brook	**Middlesex**	**44.23199**	**-72.4063**
	Jones Brook	**Middlesex**	**44.24897**	**-72.6548**

Subbasin	River	Town	*Latitude*	*Latitude*
	Crossett Brook	**Waterbury**	**44.32805**	**-72.747**
	Thatcher Brook	**Waterbury**	**44.3409**	**-72.7514**
	Dugar Brook	**Calais**	**44.39334**	**-72.4678**
Stevens Branch	**Jail Branch**	**Barre City**	**44.10577**	**-72.4303**
	Gunners Brook	**Barre City**	**44.20545**	**-72.5062**
	Stevens Branch	**Barre City**	**44.13294**	**-72.5333**
North Branch				
	Martins Brook	**Middlesex**	**44.35313**	**-72.6067**
	Herrick Brook	**Middlesex**	**44.34628**	**-72.6092**
Dog River				
	Dog River Mainstem	**multiple**	**44.24616**	**-72.5991**
	Felchner Brook	**Roxbury**	**44.12513**	**-72.7158**
	Stony Brook	**Northfield**	**44.11922**	**-72.6817**
	Bull Run	**Northfield**	**44.11714**	**-72.673**
	Sunny Brook	**Northfield**	**44.12088**	**-72.6583**
	Robinson Brook	**Northfield**	**44.11606**	**-72.643**
	Union Brook	**Northfield**	**44.15772**	**-72.677**
	Chase Brook		**44.20673**	**-72.6366**
Little River	**Little River - West Branch**	**Stowe**	**44.52389**	**-72.7747**
	Ranch Brook	**Stowe**	**44.5021**	**-72.7587**
	Bakers Brook		**44.23333**	**-72.9633**
Mid Winooski Main Stem	**Duck Brook**	**Bolton**	**44.38365**	**-72.9253**
	Joiner Brook	**Bolton**	**44.37373**	**-72.8783**
	Mill Brook	**Jericho**	**44.45666**	**-73.0141**
	Preston Brook	**Richmond**	**44.37259**	**-72.9063**

Subbasin	River	Town	*Latitude*	*Latitude*
	Ridley Brook	**Duxbury**	**44.35719**	**-72.8279**
Mad River				
	Mad River (Above Warren Village)	**Warren**	**44.175722**	**-72.661631**
	Bradley Brook	**Warren**	**44.11949**	**-72.85795**
	Clay Brook*	**Waitsfield**	**44.13515**	**-72.895369**
	Rice Brook	**Waitsfield**	**44.138231**	**-72.891653**
	Mill Brook	**Fayston**	**44.194164**	**-72.889842**
	Chase Brook	**Fayston**	**44.178856**	**-72.884308**
	Slide Brook	**Warren**	**44.167197**	**-72.887525**
	Shepard Brook	**Fayston**	**44.236758**	**-72.821114**
	Dowsville Brook	**Duxbury**	**44.273039**	**-72.824189**

Wetland candidates for Class I:

- Derway Island, Burlington.

Candidates for Outstanding Resource Waters

- The Huntington River from the Gorge to the confluence with the Winooski (Richmond)
- North Branch of the Winooski River from Worcester Middlesex town line upstream to headwaters

In addition to the actions supported by priority objectives and the classification opportunities, the Basin Plan also includes actions for addressing stressed and impaired waters listed in Table 4 and actions relating to monitoring and assessment in Table 11.

The Vermont Agency of Natural Resources has prepared an online mapping tool, the ANR Natural Resources Atlas, that allows the reader to identify the locations of many basin features.

Chapter 1 – Planning Process and Watershed Description

The Tactical Basin Planning Process

The Vermont Department of Environmental Conservation's (VDEC) tactical basin planning process identifies actions that will protect, maintain, enhance and restore surface waters. This will be achieved by managing activities that cause known stressor(s) and address the resulting pollutants. The DEC Basin 8 Water Quality Assessment Report provides background to support the Plan's actions including descriptions of wetlands, lakes and rivers water and their health.

Using integrated watershed modeling (Appendix B), water quality monitoring, sector-specific pollution source assessments, and stakeholder input, actions are strategically targeted to subbasins (see Tables 4, 12 and 37). Specific waters have been identified where implementation would achieve the greatest benefit to water quality and aquatic habitat while being cost-effective.

For the purposes of assessing and reporting water quality information, the state is divided into 15 major drainage basins. Each basin includes one or more major river watersheds[1]. The VDEC is responsible for preparing Tactical Basin Plans, a water quality management plan, for each of the basins and updating them every five years. The resulting plans meets the three goals of the Vermont Surface Water Management Strategy (VSWMS):

1. to protect, maintain, enhance and restore the biological, chemical, and physical integrity of Vermont's surface waters,
2. to support public use and enjoyment of Vermont's water resources, and
3. to protect public health and safety.

The tactical planning process is outlined in Chapter 4 of the VSWMS.

The VDEC collaborates with State, federal and municipal organizations, local conservation groups, businesses, landowners and interested citizens to develop and implement the Tactical Basin Plan (see Appendix A). Partners play multiple roles, including funder, technical resource (see resources in the VSWMS) or project manager as well as providing guidance during the planning process. The Tactical Basin Plan

[1] A watershed is a distinct land area that drains into a particular waterbody through either channelized flow or surface runoff. Preparing a plan at a watershed level allows for the consideration of all contributing sources of runoff to the surface waters.

builds upon the Agency's previous Winooski River Tactical Basin Plan, signed in 2012 (VDEC 2012). The 2012 plan contains strategies that addressed river corridor protection, stormwater management, drinking water protection, aquatic invasive species management, and installation of agricultural Best Management Practices. Through efforts of the Agency and its watershed partners, many of these have been implemented or are in progress. This plan builds upon those original plan recommendations by providing additional geographically explicit actions in areas of the basin identified for intervention based on monitoring and assessment data, and high-resolution phosphorus modeling.

The Tactical Basin Plan actions are described in Chapter 5's implementation table summary and the Watershed Projects Database and will be addressed over the five-year life of the Winooski River Tactical Basin Plan. The plan will not be a static document. It is expected that the Agency and its partners will have to develop adaptive management techniques as new natural and anthropogenic events present themselves.

Successes and challenges in implementing actions will be reviewed in biannual meetings with watershed partners. In addition, the implementation table will be modified accordingly to best address newly emerging information, unanticipated events, and new requirements such as those anticipated by the Lake Champlain Phosphorus TMDL (see Chapter 3 for additional information on the TMDL).

Regulatory Guidance

The Tactical Basin Plan spells out clear attainable objectives and targeted strategies to achieve goals laid out in Act 64, the Lake Champlain Phosphorus TMDL and EPA's requirements for watershed planning. The WSMD's Watershed Projects Database is a tool by which progress can be tracked with regard to measurable indicators of each major goal. The data will be used in WSMD tracking and reporting 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).

In addition, the database will be revisited periodically and modified accordingly to best address newly emerging information, unanticipated events, and new requirements such as those anticipated by legislative acts, including Acts 110[2]and 64.

In 2015, the passage of Act 64, the Vermont Clean Water Act, strengthened multiple statutes related to water quality in Vermont. Act 64 was passed specifically to set in place statewide requirements necessary to achieve the phosphorus reduction targets in USEPA's Lake Champlain Phosphorus Total Maximum Daily Load (TMDL), and to establish the regulatory authorities necessary to implement the associated Phase I Implementation Plan. This Tactical Basin Plan is the tool for establishing five-year goals and actions related to the implementation of Act 64 directives.

Act 64 addresses agricultural water quality on small, medium and large farms through the Agency of Agriculture, Food and Markets. It establishes water quality requirements for stormwater discharges from new and existing development, industrial and municipal stormwater discharges, and runoff from municipal roads through the VDEC. In addition, through the Department of Forests, Parks and Recreation, the Act addresses stormwater runoff from silvicultural activities.

Act 64 also establishes the requirement that all water quality improvement actions undertaken by the State be integrated by means of Tactical Basin Plans (TBP), and establishes partnerships with Regional Planning Commissions, Natural Resource Conservation Districts, and other organizations to support this work. Lastly, Act 64 establishes a cleanup fund to dedicate resources towards the highest priority water quality remediation actions.

Regarding work with the Regional Planning Commissions, the Agency of Natural Resources (Agency) will work with the applicable regional planning commissions to develop an analysis and formal recommendation on conformance with the goals and objectives of applicable regional plans, see 10 V.S.A 1253(d)(2)(G). The overall role of the TBPs is not to determine where development should happen. This Tactical Basin Plan encourages communities to take protective measures that will restore, maintain and enhance water quality in all areas that in turn protect human health, ecological integrity, and water-based recreational uses. The TBP does not preclude any

[2] Act 110 directed the Secretary of Natural Resources to establish a river corridor management program and a shoreland management program, effective February 1, 2011, to provide municipalities with maps of designated river corridors and develop recommended best management practices for the management of river corridors, shorelands, and buffers.

development that is consistent with municipal bylaws, regional and municipal plans and with applicable State and federal regulations.

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

Contributing Planning Processes

Complementary planning processes in the watershed also direct resources towards surface water protection and remediation strategies. The strategies, associated resources and partnerships identified in these plans contributed to the development and implementation of actions in Chapter 5. These planning processes can be further explored through the links provided below:

- *A Framework for Action on Stormwater – Ridge to River Phase I Final Report* for Ridge to River
- *2013 ECO Regional Plan*, Chittenden County Planning Commission
- *2016 Central Vermont Regional Plan*, Central Vermont Regional Planning Commission
- Lake Champlain Basin Program's 2017 **-** Opportunities for Action
- *2015 Lamoille County Reginal Plan* with 2017 amendment, Lamoille County Regional Planning Commission
- *2016-2020 Northern Vermont Economic Development District Comprehensive Economic Development Strategy*

The Winooski River Basin

The Winooski River begins in Cabot, a town in the northeast corner of Washington County, and then courses northwesterly for approximately 90 miles before flowing into Lake Champlain just north of Burlington. Its drainage area of about 1,080 square miles covers 11.9 percent of Vermont. The Basin occupies all of Washington County, a little less than half of Chittenden County and small parts of Lamoille and Orange Counties.

The Winooski River has seven main tributaries. Three of the tributaries enter from the north: The Little River joining below the village of Waterbury; the North Branch joining at the city of Montpelier; and Kingsbury Branch joining in East Montpelier. The four remaining tributaries flow from the south: the Huntington River coming in at the village of Jonesville; the Mad River, joining in Middlesex; the Dog River entering just west of the city of Montpelier and the Stevens Branch entering just east of Montpelier.

In addition, 46 lakes and ponds, 10 acres or larger are scattered throughout the Basin with a concentration in the municipalities of Calais, East Montpelier and Woodbury.

The health of a waterbody is dictated for the most part by the landuse or landcover in its watershed. A forested watershed provides the best protection as it absorbs or detains the precipitation that in a developed or agricultural landscape would pick up pollutants and carry it to waterbodies as stormwater runoff.

Almost three quarters of the watershed benefits from forest and wetland cover, most of it located in the higher elevations or upper half of the watershed (Figure 1 and Tables 1 and 2). The agricultural and urban (developed land and roads) land use comprise only 9.6% and 7.7% of the landscape respectively. Agriculture is predominantly concentrated along the wide flood plains of the main stem and narrower valleys of its tributaries. The developed or urban areas are concentrated in Chittenden County, but also include small cities and municipalities located adjacent to the main stem and tributaries. A small percentage of the developed land includes four ski areas and resorts on the slopes of the Green Mountains. The water quality problems identified in the Basin later in this chapter tend to be associated with decreasing amounts of natural landcover. See Vermont Surface Water Management Strategy (VSWMS) for a more in-depth explanation of pollution sources.

A more detailed description of the Basin along with its water-based resources is contained in VDEC's Basin 8 - Winooski River Watershed Water Quality and Aquatic Habitat Assessment Report, dated April 28, 2008[3] and Water Quality Assessment Maps.

[3] http://www.anr.state.vt.us/dec/waterq/mapp/docs/mp_basin8.assessment_report.pdf

Table 1. Land Use Data[4] for the Winooski River Watershed

Land Use	Acres	% of Total
Forested	522602.4	76.8
Agriculture	65374.0	9.6
Surface Water	6399.2	0.9
Developed Land	52321.2	7.7
Wetlands	16696.9	2.5
Barren Land (Rock/Sand/Clay)	1159.3	0.2
Shrub/Scrub	12787.2	1.9
Grassland/Herbaceous	3108.4	0.5
Total	680448.7	100.0

[4] Land Use Data from the 2011 National Land Cover Database.

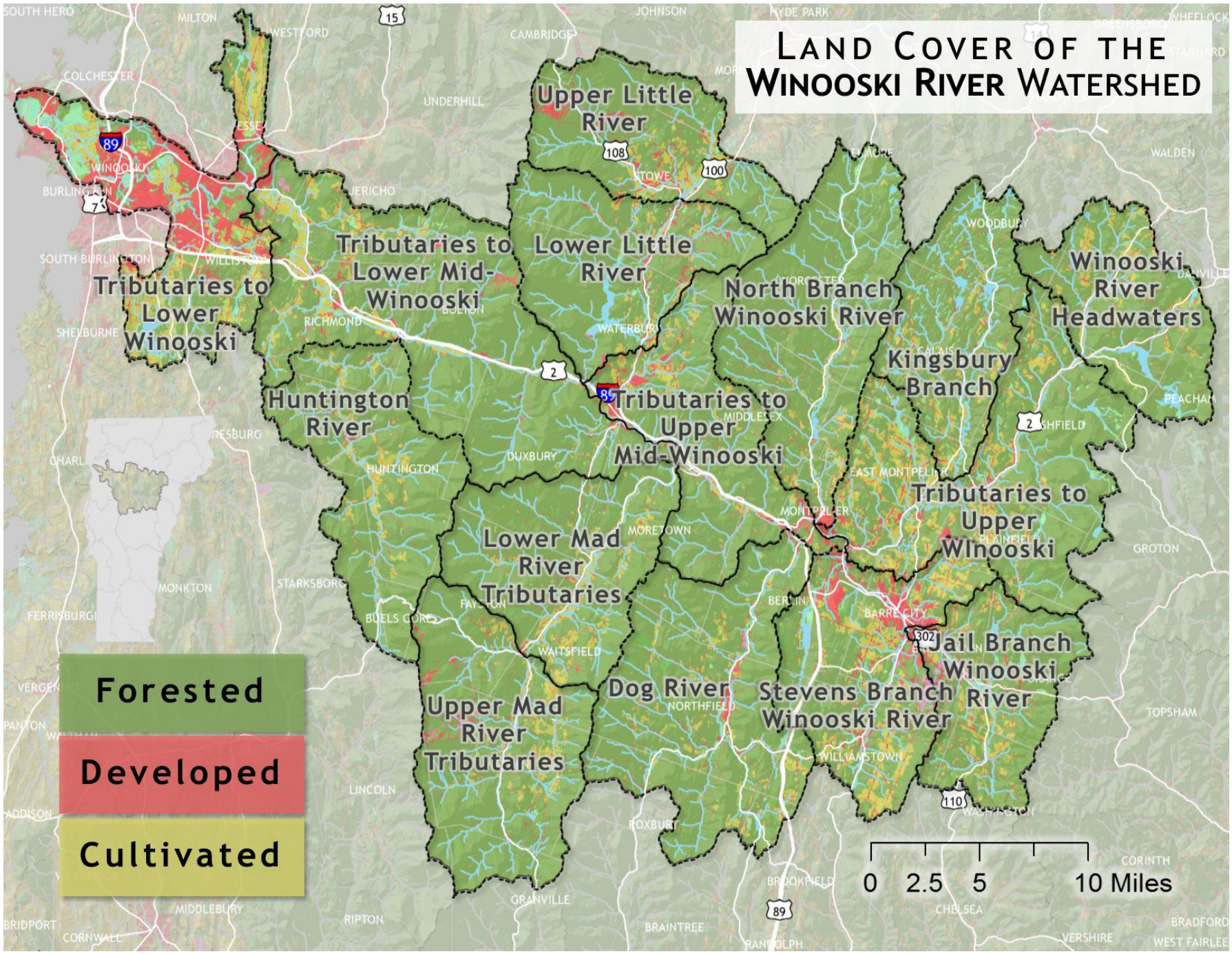


Figure 1. Winooski River Basin and sub basins with landuse and landcover identified (2011 National Land Cover Database.)

Table 2. Subbasins % land cover based on 2011 National Landcover Database.

Subbasins (Figure 1 provides location)	*Cultivated*	*Forested*	*Developed*
Tributaries to Lower Winooski	23.43	30.36	31.13
Tributaries to Lower Mid-Winooski	7.20	82.24	5.69
Tributaries to Upper Mid-Winooski	7.72	79.88	8.73
Tributaries to Upper Winooski	15.93	71.36	6.23
Winooski River Headwaters	9.60	77.01	4.19
Huntington River	7.30	88.21	2.51
Lower Little River	4.75	85.62	4.42
Upper Little River	7.51	79.55	8.18
North Branch Winooski River	3.85	88.36	3.38
Kingsbury Branch Winooski River	9.09	76.23	4.87
Jail Branch Winooski River	9.46	75.74	7.80
Stevens Branch Winooski River	18.07	58.36	16.17
Dog River	5.74	84.08	5.44
Lower Mad River tributaries	8.51	85.34	3.75
Upper Mad River tributaries	6.24	87.03	4.85

Subbasins

For tactical basin planning purposes, the Winooski River Basin is further divided into 15 subbasins, which include one or more of the tributaries or a section of the main branch (Table 2). The subbasins include a grouping of tributaries and/or sections of the main branch that encompass common characteristics associated with community, landscape, and/or physical features. A detailed description of these subwatersheds are contained in the DEC Basin 8 Water Quality Assessment Report and the Water Quality Assessment Maps . The subbasins that each of the towns fall into can also be identified on the above-mentioned maps as well as well as Figures 1-5.

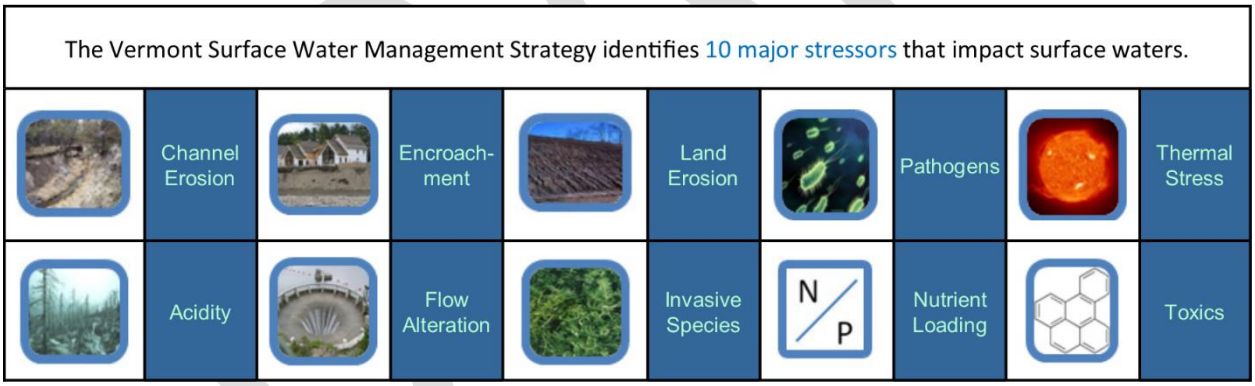
Chapter 2 - Water Resource Assessments

Assessment Methodology

The Agency's Watershed Management Division (WSMD) in the VDEC is responsible for assessing the health of Vermont's surface waters using biological, chemical and physical criteria. Most of this data can be accessed through the Vermont Integrated Watershed Information System, online data portal.

The results of the assessments are the basis for the biennial statewide 303(d) List of Impaired Waters and List of Priority Surface Waters Outside the Scope of 303(d) (Table 4). These priority waters lists also include preliminary information on responsible pollutants and/or physical alterations to aquatic and riparian habitat, the stressors and if known, the sources. VDEC Basin 8 Water Quality Assessment Report and Water Quality Assessment Maps provide additional information about these waters. The waterbodies identified on these lists are included as a focus for remediation efforts in this plan.

Table 3. Stressors relating to water resource degradation with links to in-depth information (Click on a stressor to learn more)



Stressors, Pollutants and Physical Alterations to Aquatic and Riparian Habitat

The Vermont Surface Water Management Strategy (VDEC 2012) (VSWMS) lays out the goals and objectives of VDEC's Watershed Management Division for addressing stressors and the resulting release of pollutants that can negatively affect the designated uses of Vermont surface waters. VDEC's tools includes the use of technical and financial assistance, as well as regulations.

A stressor (Table 3) is defined as a phenomenon with quantifiable damaging effects on surface waters resulting from the delivery of pollutants to a waterbody, or an increased threat to public health and safety. For the most part, stressors result from human activity on the landscape; however, when landscape activities are appropriately managed, stressors are reduced or eliminated.

Pollutants, the result of a stressor, enter surface waters either as a point source, a discrete source from a pipe, or as non-point source, carried in deposition or precipitation that runs off the landscape (i.e., stormwater runoff). Physical alterations, also associated with stressors, result from the inadvertent introduction of aquatic invasive species (AIS), or with a change in surface water levels because of dams or water withdrawal.

The tactical basin planning process develops geographically specific actions based on the VSWMS approaches for addressing stressors, pollutants and managing landuses.

Climate Change: increasing pollutant loads and impacts to waterbodies

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

Increased temperatures are also occurring, which increase thermal stress to waterbodies. In addition, warmer temperatures lead to the exclusion of cold water dependent species and allow invasive species to gain a competitive edge, requiring changes in management strategies to better protect native species. The Lake Champlain TMDL was developed with consideration of the effects of climate change, and the Lake Champlain Phase I Implementation Plan has a dedicated chapter as well.

Overview of Water Resources

The following is an overview of water resource health in Basin 8. Information on the condition of specific water bodies is included in Table 4.

Rivers

Sediment and nutrients are the most prevalent pollutants[5] in the streams and rivers of Basin 8. Dominant stressors include land erosion, channel erosion, and nutrient loading. Physical alterations in the watershed, range from habitat alteration to general stream channel and slope instability. In addition, development has encroached into the flood hazard zone (river corridors and floodplains) in many towns. The next most prevalent stressors are thermal modification and pathogens. More isolated stressors specific to particular reaches[6] include toxics from hazardous waste sites, chlorides from winter maintenance of roads and flow alteration associated with water withdrawals or hydroelectric dams.

The rivers in the Winooski Basin as well as Lake Champlain contain the highest diversity of fish species in Vermont, supporting popular recreational fisheries. Trout as one of those species, is naturally reproducing through the upper mainstem of the Winooski (above Bolton Dam) and as far downstream as Duxbury. Naturalized (wild) populations of rainbow and brown trout are found in much of the Winooski River's main stem and lower reaches of some tributaries. In the colder, higher elevation streams, wild populations of native brook trout flourish. Increasing temperatures in main stem and some tributaries limit wild trout distribution.

Landlocked Atlantic salmon is also present, with 100 to 200 returning from Lake Champlain in recent years. They spawn in the Winooski River with highest numbers counted adjacent to the town of Richmond's recreation fields (pers. Communications Nick Staats, USFWS). The salmon are able to access the Winooski River up to the base of Bolton dam by way of the Winooski One fish lift, operated annually through a joint effort between Vermont Fish & Wildlife, U.S. Fish & Wildlife Service, Burlington Electric Department and Green Mountain Power (condition of FERC license for the Winooski One Dam). The predominantly forested watershed of the tributaries to this

[5] See VSWMS for pollutant definitions.
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 2)

stretch of the main stem maintain the cooler water temperatures necessary for salmon habitat.

Barriers, thermal modification and lack of woody vegetation threaten fish habitat in the Winooski. Dams along the river and tributaries are partly responsible thermal modification and barriers to fish movement. However, dam owners are improving management during federal relicensing or by working with partners to remove dams.

Instream fish habitat was severely impacted in some areas following the removal of woody habitat and alteration of stream channels after tropical storm Irene. Within the Winooski watershed, it was estimated that major impact to instream habitat occurred along roughly 15,425 feet of stream following Tropical Storm Irene (Kirn 2012). Projects to restore fish habitat and protect water quality are currently ongoing and have occurred though various local, State, and federal partnerships. For additional information on the current status of the upper Winooski Watershed fishery see VFWD's document: Upper Winooski Watershed Fisheries Summary.

Excellent water quality in many of the tributaries along with striking, geologic formations result in popular swimming holes. Nasmith Brook, North Branch, Mad River and The Huntington Gorge are all good examples, and with community support, could be natural candidates for Outstanding Resource Water (see Chapter 4) based on their spectacular aesthetic value and swimming use. The North Branch is also popular for kayaking.

Lakes and ponds

The Basin includes 46 lakes and ponds, 10 acres or larger (see Appendix B). Encroachment, by way of shoreland development, is the greatest stressor to Vermont lakes, as recently reported in the National Lake Assessment survey (USEPA, 2012). In Basin 8, almost half the lakes are threatened by shoreland development. Other threats to aquatic habitat and water quality in the lakes include sedimentation and increased eutrophication due to nutrient loading-related stressors. While nutrient loading in other northwest lakes has resulted in regular algal blooms with intense cyanobacteria blooms (blue-green algae) becoming seasonal occurrences, the majority of lakes in the Winooski Basin still meet nutrient criteria and overall have good water quality (Table 40). A small group of lakes show poor to fair water quality trend based on nutrient concentrations, including Blueberry, North Montpelier, Peacham and Sabin.

Additional stressors include flow alterations (e.g., water level fluctuations) and the threat of Aquatic Invasive Species (AIS). Acidity is a stressor for 13 lakes and leads to impairment in 1 lake (see Tables 4 and 40).

All but one other lake in Vermont (and all Basin 8 lakes) are under a Vermont Department of Health Fish Consumption Advisory for exceeding the USEPA mercury limits in fish. Mercury is a chemical that becomes toxic to humans and other animals at high concentrations. As big fish eat smaller fish, the mercury concentrations increase in the fish tissues, and through this process of bioaccumulation, mercury levels become unsafe for human consumption of certain species of fish.

With excellent water quality, intact shoreline, high biodiversity, lack of invasive species and scenic features, the best lakes include Buck and Pigeon at top 5% of all Vermont lakes. Turtlehead is at the top 10%, Coits at the top 20% and Berlin making the top 25%.

Wetlands

The Winooski Basin contains a great diversity of wetlands, ranging from rich forested swamps to peat-accumulating fens, with Half Moon Cove, Richmond Flood plain forest and Chickering Fen as high quality examples. Potential Class I Wetland (see Chapter 4) candidates include: Shelburne Pond, Essex Alder Brook (Essex and Milton), Upper Gleason (Duxbury), Berlin Pond (Berlin), Kettle Pond south (Marshfield and Groton , Lanesboro Bog (Marshfield) and Mud Pond (Williston).

Wetlands are identified on the Vermont Wetlands Inventory Map, however, up to 40% of Vermont wetlands may not be mapped. More than 35% of the original wetlands in Vermont have already been lost. In recent years, residential, commercial and industrial development have been the primary causes of wetland loss.

The USEPA's National Wetland Condition Assessment (USEPA, 2012) included Vermont wetlands with assistance from the WSMD Wetlands Program. The assessment of Eastern Mountains wetlands, including Vermont's, estimated that 52% of the estimated wetland area is in good condition; 11% is in fair condition, and 37% is in poor condition.

Condition of Specific Water Resources

Impaired Waters and Priority Surface Waters

The VDEC uses monitoring and assessment data[7] to assess individual surface waters in relation to Vermont Water Quality Standards as outlined in the 2016 DEC Assessment and Listing Methodology. The four categories used to assess Vermont's surface water are **full support, stressed, altered** and **impaired**[8]. Waters that currently support designated and existing uses and meet water quality standards are placed into the full support or stressed categories. Waters that do not support uses and do not meet standards are placed into the altered or impaired category. Waters that exceed the standards are listed for protection priorities in Chapter 4 and mapped in Figure 27.

Table 4 lists the known stressed, impaired or altered waterbodies in Basin 8. These priority waters comprise the 303(d) List of Impaired Waters and List of Priority Surface Waters Outside the Scope of 303(d) (VDEC 2018a-e). The location of these waters is mapped in Figures 2, 3, 4 and 5. A more detailed description of monitoring results for each water is located in the Vermont Integrated Watershed Information System, online data portal.

The Tactical Basin Plan addresses the stressors (Table 3) and resulting pollutants degrading the listed waters in Table 4 through geographically specific actions. Chapter 5 includes a summary of actions that are included in the Watershed Projects Database. The types of actions prescribed stem from the stressor specific practices outlined in the Vermont Surface Water Management Strategy. Additional monitoring and assessment needs are outlined in Tables 4, 6 and 11.

[7] Appendix A of the Vermont DEC Water Quality Monitoring Strategy 2011-2020
[8] The 2016 DEC Assessment and Listing Methodology page 13 provides definitions for full support, stressed, altered and impaired waters.

Table 4. Basin 8 2018 Impaired, stressed and altered waters list (VDEC 2018a-e) and planned management interventions. See also Water Quality Assessment Maps .

Waterbody or River Segment and Town	*Status*	*Pollutant /Stressor*	*Source*	*Planned actions, see also actions associated with Stressors*[9]
VT08-01 Winooski River, mouth to Winooski dam	10.5 miles Impaired Part A List	E. coli/Pathogens	Burlington CSOs	See Vermont CSO Rule
VT08-02 Sunnyside Brook	Impaired Part A List	Chloride/Toxics	Runoff from impervious surfaces, winter management of roads and parking lots	Chloride TMDL in development
VT08-02 Muddy Brook Trib#4 & Trib to Trib#4	0.9 miles Impaired Part A List	Chloride/Toxics	From industrial and commercial land runoff	TMDL development planned. MS4 permit condition will require Chloride reduction plan
VT08-02L01 Shelburne Pond	Impaired Part A List	Phosphorus	Post development erosion and sedimentation, Crop production, managed pasture grazing	Development of TMDL planned
VT08-05 Upper Mid Winooski River above Montpelier WWTF discharge	2.0 miles Impaired Part A List	E. coli/Pathogens	Montpelier CSOs	See Vermont CSO Rule
VT08-07 Winooski River, Plainfield	0.7 miles Impaired Part A List	E. coli/Pathogens		Work with landowners to identify sources and continue to support water quality monitoring
VT08-07 Winooski River, Marshfield, rm 72.8 up to Mollys Brook	10.0 miles Impaired Part A List	E. coli/Pathogens		Work with landowners to identify sources and continue to support water quality monitoring
VT08-08 Blanchard Brook, Montpelier	0.3 miles Impaired Part A List	Unknown		BASS installed temperature and conductivity loggers in 2018
VT08-09 Winooski River, Cabot, Mollys Falls Brook up to rm 83.8	1.0 miles Impaired Part A List	E.coli/Pathogens		EPA approved TMDL March 8, 2001 - 2013 IDDE in Cabot found no source. Monitor for E. coli
VT08-12 Inn Brook, Stowe	0.3 miles Impaired Part A List	Iron/Toxics	Iron seeps from soils disturbed during development	Parent material is iron rich. Stream runs thru culvert under parking lot, nothing planned until redevelopment of area occurs

[9] The ANR's strategy for addressing each stressor is described in the Vermont Surface Water Management Strategies, at this link

Waterbody or River Segment and Town	*Status*	*Pollutant /Stressor*	*Source*	*Planned actions, see also actions associated with Stressors*[9]
VT08-13 Lower North Branch Winooski River, Montpelier	1.0 miles Impaired Part A List	E. coli/Pathogens	Montpelier WWTF collection system passes combined sewer overflows	See Vermont CSO Rule
VT08-16 Gunner Brook, below Farwell St. Dump, Barre	0.5 miles Impaired Part A List	Sediment, Toxicity	Farwell St. Landfill leachate, surface runoff from developed area and landslides	No additional site monitoring at the Farwell Dump since 2012.
VT08-17L01 Beaver Pond Roxbury	Impaired Part A List	Acidity	Atmospheric deposition	See actions associated with Stressor
VT08-20 Clay Brook, Waitsfield	0.5 miles Impaired Part A List	Pollutants in urban stormwater, iron/Land Erosion	Ski area development: stormwater runoff, erosion from construction activities & gravel parking lot; increased peak stormwater flows	Stream buried in culvert. Difficult remediation until redevelopment of area
VT08-02 Tributary to Winooski River, South Burlington	0.4 miles Impaired Part B List	Metals/Toxics	South Burlington landfill leachate	Active monitoring. VDEC ordered landfill facility closed and capped. Capping occurred in 1992. The facility's post-closure court order requires water quality monitoring and maintenance of the site. Water quality sampling is conducted semiannually to determine effectiveness of treatment. Water quality improvement is expected over time as water quality treatment & site management continues.
VT08-08 Muddy Brook in East Montpelier	0.1 miles Impaired Part B List	Iron/Toxics	Central Vermont landfill leachate	VDEC ordered landfill closed and capped in 1993. Due to the slumping of the capping soils in 2001, the original clay cap was removed, the landfill was re-graded, and a synthetic cap was installed along with a new toe drain and gas collection system. The landfill's post-closure court order requires water quality monitoring & maintenance of the site. Currently volume of water collected in the drains is

Waterbody or River Segment and Town	*Status*	*Pollutant /Stressor*	*Source*	*Planned actions, see also actions associated with Stressors[9]*
				significantly less than previously reported.
VT08-12 West Branch Little River, rm 7.5 to 8.0, Stowe	0.5 miles Impaired Part B List	sediment, stormwater runoff/Land Erosion	Ski area development, road	Stowe Mt. Resort WQRP
VT08-16 Trib #23 to Stevens Branch below Williamstown WWTF outfall	0.5 miles Impaired Part B List	Nutrients/Nutrient Loading	Williamstown WWTF discharge to small receiving water	Outfall to be moved to the Stevens Branch with WWTF refurbishment. Will monitor wq
VT08-01 Winooski River, mouth to Winooski Dam	10.5 miles Impaired Part D List	Mercury/Toxics	Atmospheric deposition	EPA approved regional mercury TMDL on 12/20/20, 2007. Vermont DOH advisory
VT08-02 Allen Brook, rm 2.4 to rm 5.0 Talcott Rd, Williston	2.6 miles Impaired Part D List	Stormwater/urbans stressors[10]	urban and suburban runoff	EPA approved TMDL in 8/2008, see Chapter 3.
VT08-02 Allen Brook, , Williston	2.6 miles Impaired Part D List	E. coli/Pathogens		EPA approved TMDL in 9/2011. See Chapter 3.
VT08-02 Sunderland Brook, rm 3.5 to rm 5.3, Colchester	1.8 miles Impaired Part D List	Stormwater/Urban stressors	urban and suburban runoff	EPA approved TMDL in 8/2008 - see Chapter 3 for work planned
VT08-02 Centennial Brook, mouth to rm 1.2, South Burlington	1.2 miles Impaired Part D List	Stormwater/Urban Stressors	urban and suburban runoff	EPA approved TMDL in 9/2007- see Chapter 3.
VT08-02 Morehouse Brook, mouth to rm 0.6, Winooski, Colchester	0.6 miles Impaired Part D List	Stormwater/Urban Stressors	urban and suburban runoff	EPA approved TMDL in 9/2007- see Chapter 3
VT08-09 Winooski River Cabot village	1.0 miles Impaired Part D List	E. coli /Pathogens	Residential direct discharges &/or failed septic systems.	EPA approved TMDL 3/8/2001. Straight pipes eliminated, but LaRosa program sampling suggests another NPS. See Chapter 3.
VT08-10 Huntington River, Huntington	0.5 miles Impaired Part D List	E. coli/Pathogens	Possible failing septic systems and other unknown sources;	EPA approved TMDL in 9/2011. see Chapter 3.
VT08-18 Mad River, mouth to Moretown	6.2 miles Impaired Part D List	E, coli/Pathogens	Possible failing septic systems and other unknown sources;	EPA approved TMDL in 9/2011. See Chapter 3.
VT08-02L01 Shelburne Pond	Altered Part E List	Aquatic Nuisance Species	Curley Leaf pond weed, Eurasian Water Milfoil, Myriophyllum	Provide assistance to community groups to control through AIS grant in aid program

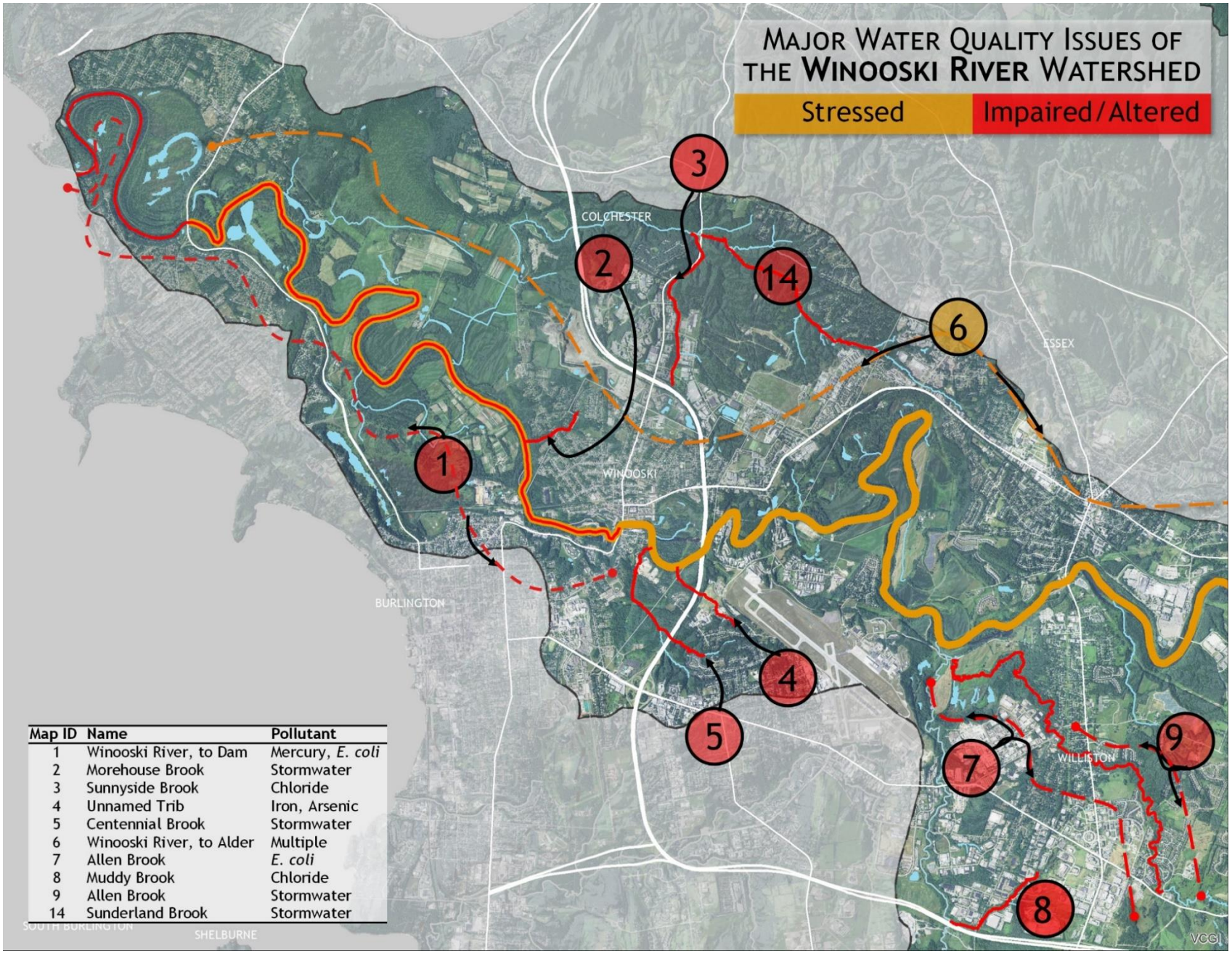
[10] Urban stressors that result in sedimentation, phosphorus or stormwater include: Land Erosion, Channel Erosion, Nutrient Loading

Waterbody or River Segment and Town	*Status*	*Pollutant /Stressor*	*Source*	*Planned actions, see also actions associated with Stressors*[9]
			Spicatum, non-native aquatic plants	
VT08-04 Joiner Brook, Bolton	2.9 miles Altered Part F List	Artificial and insufficient flow/Flow Alteration	Bolton Valley water withdrawal	Non-supp 2.9 mi (5.7 mi total length). All flow altered waters should be more closely reviewed and steps identified to ensure protection of resource.
VT08-05 Mid-Winooski River impoundment above Middlesex #2 hydro	2.0 miles Altered Part F List	De-watering of bypass, impound-ment, fluctuation causing stream-bank erosion/ Flow Alteration	Middlesex #2 hydro	Unlicensed facility
VT08-06 Tyler Brook, below Waterbury Village water withdrawal	0.1 miles Altered Part F List	Artificial and inadequate flow/ Flow Alteration	Waterbury water supply withdrawal	Unlicensed facility
VT08-06 Merriam Brook below Waterbury Village water withdrawal	0.1 miles Altered Part F List	Artificial and inadequate flow/ Flow Alteration	Waterbury water supply withdrawal	WSID #5284 - Waterbury village water
VT08-09 Mollys Brook, Cabot	2.0 miles Altered Part F List	Artificial flow condition, bypass waterfall, temp/ Flow Alteration and Thermal Stress.	Mollys Falls Hydro	Unlicensed facility; A Public Utilities Commission Certificate of Public Good review is underway, with VTANR input to address flow, water level, and water temperature issues.
VT08-09 Sucker Brook below Peacham Pond, Peacham	1.0 miles Altered Part F List		Mollys Falls Hydro	See above
VT08-09L03 Peacham Pond, Peacham	340 acres Altered Part F List	water level fluctuation by hydro-related dam may alter aquatic habitat	Mollys Falls Hydro	See above and unlicensed facility; owner filing application for certificate of public good to repair spillway at the Mollys falls dam
VT08-09L05 Mollys Falls Reservoir, Cabot	397 acres Altered Part F List	water level fluct'n by hydro alters aquatic habitat & recreation	Mollys Falls Hydro	See above. Vermont Lay Monitoring program will adopt as a site in 2018

Waterbody or River Segment and Town	*Status*	*Pollutant /Stressor*	*Source*	*Planned actions, see also actions associated with Stressors*[9]
VT08-11 Lower Little River segment below hydro dam, Waterbury	2.6 miles Altered Part F List	Artificial flow condition / Flow Alteration		Section 401 wq cert. Issued in 2014; FERC has yet to issue new license for the project which will delay construction until 2017
VT08-11L02 Waterbury Reservoir	839 acres Altered Part F List	winter drawdown alters all uses		See Flow Alteration section
VT08-16 Berlin Pond Brook (aka Benjamin Falls Brook), from Berlin Pond to mouth, Berlin	0.6 miles Altered Part F List	De-watering of brook/ Flow Alteration	Montpelier & Berlin water supply with-drawals	DEC permit for water supply: WSID #5272
VT08-20 Mill Brook, Fayston	2.1 miles Altered Part F List	Artificial and insufficient flow/ Flow Alteration	Mad River Glen snow-making water withdrawal	Partial support 2.1 mi (5.9 mi total length)
VT08-20 Slide Brook Warren	Altered Part F List	Artificial and insufficient flow/ Flow Alteration	Mt. Ellen snow-making water withdrawal	
VT08-01 Winooski River, mouth to Alder Brook	21.2 miles Stressed	Sediments, nutrients, temp., stormwater, toxic compounds/Urban stressors, Thermal stress, Toxics	Developed land runoff, agriculture, industry	See Lake Champlain P TMDL
VT08-04 Goose Pond Brook, mouth to head-waters. Bolton	1.5 miles Stressed	Acidity	Atmospheric deposition	2016 chemistry and 2017 biomonitoring data suggest acid stress. Collect data from one more monitoring event to confirm
VT08-05 Winooski River, below Middlesex dam & above Montpelier CSOs	11.0 miles Stressed	sediment, nutrients, storm-water runoff/ Urban Stressors	Developed land, transportation, channelization	See Lake Champlain P TMDL
VT08-06 Graves Brook, mouth upstream	0.3 miles Stressed	Sediment/Urban stressors, Encroachment	Residential, ag, riparian encroachment	See Lake Champlain P TMDL
VT08-06 Thatcher Brook, Waterbury	10.0 miles Stressed	Sediment/Channel Erosion	Morphological instability from past channelization, etc.	See Lake Champlain P TMDL River corridor easements planned and Mid Winooski Corridor Plan
VT08-07 Winooski River below Marshfield 6 hydro	10.0 miles Stressed	Low dissolved oxygen/Flow alteration.	Dissolved oxygen problems from hypolimnetic withdrawal of unlicensed hydro dam	See Flow Alteration section. Unlicensed facility; A Public Utilities Commission Certificate of Public Good review is

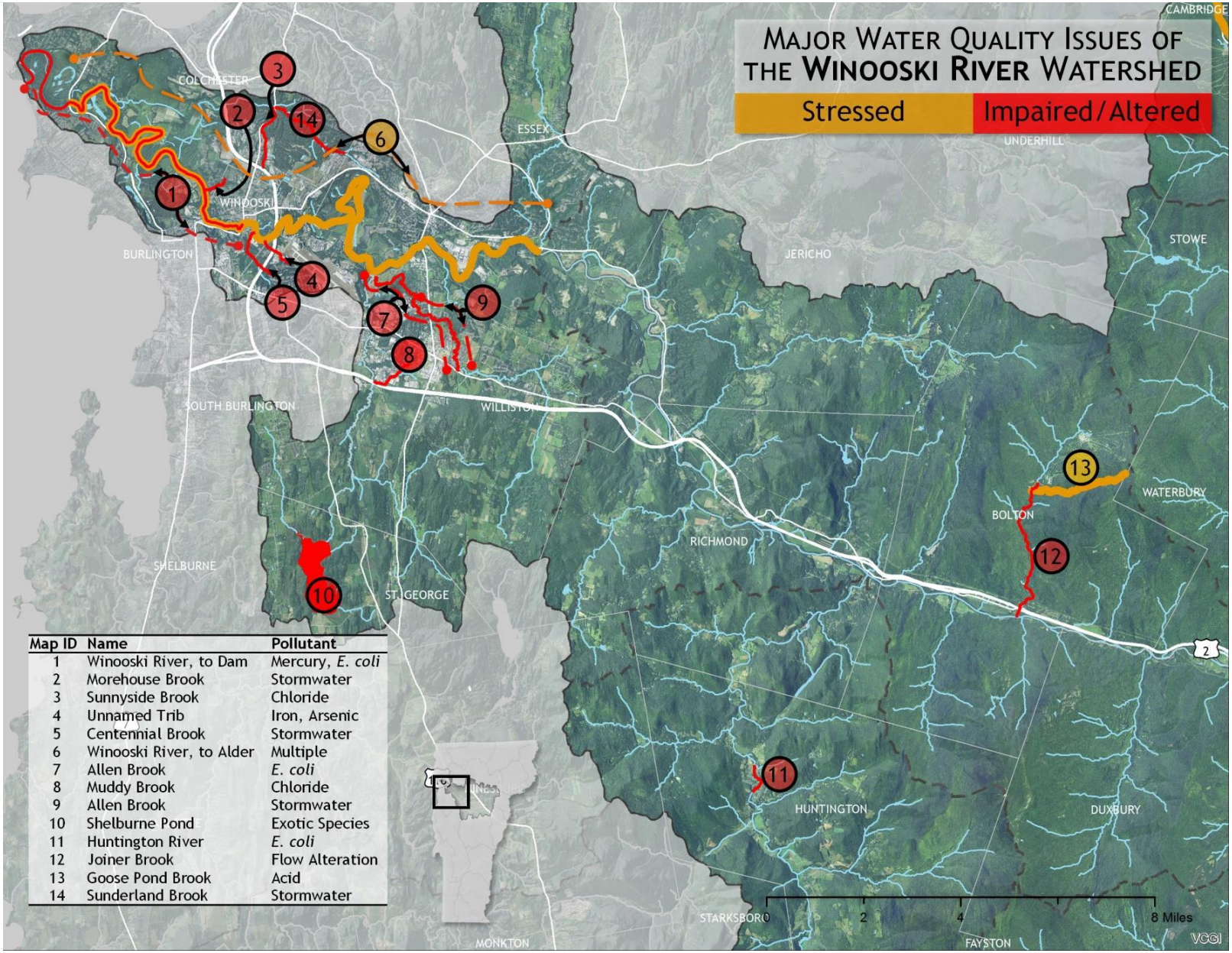
Waterbody or River Segment and Town	*Status*	*Pollutant /Stressor*	*Source*	*Planned actions, see also actions associated with Stressors*[9]
				underway, with VTANR input to address flow, water level, and water temperature issues.
VT08-07 Winooski River Stevens Branch up to Mollys Falls Brook	20.4 miles Stressed	sediment, turbidity, nutrients, physical alterations, E. coli/land erosion, channel erosion, thermal stress	Streambank erosion, road runoff, channel in-stability	See Lake Champlain P TMDL
VT08-09 Winooski River, from Mollys Falls Brook upstream	6.0 miles Stressed	Sediment/Channel erosion, Encroachment	Streambank erosion, lack of riparian vegetation, physical alterations	See Lake Champlain P TMDL
VT08-11 Gold Brook, mouth to headwaters, Stowe	5.0 miles Stressed	sediment, physical alterations/Land erosion, Channel erosion, Encroachment	Land development, roads, former mining	See Lake Champlain P TMDL
VT08-11 Little River, from West Branch down to Reservoir	5.5 miles Stressed	urban runoff, sediment/Urban Stressors	Channel instability, channel manipulation, urban/suburban development	See Lake Champlain P TMDL
VT08-12 Little River, upstream of the West Branch confluence	3.3 miles Stressed	sediments, nutrients, E. coli/Urban Stressors, Pathogens	Land development, agricultural runoff; morphological instability (west br upstream to sterling brook)	See Lake Champlain P TMDL
VT08-12 Little Spruce Brook, Stowe	0.1 miles Stressed	sediment, physical alteration/Urban Stressors	Ski area development	Stowe Mt. Resort WQRP
VT08-12 Long Trail Tributary, Stowe	0.1 miles Stressed	sediment, acidity/Urban stressors, y	development	Further assessment. pH shock in springtime
VT08-12 Sterling Brook, Morristown	7.0 miles Stressed	Acidity	Low alk conditions, moderately sensitive to acid rain	Sampling results from 1984. WSMD ABN will confirm or update status as resources permit
VT08-12 West Branch Little River, rm 7.0 to 7.5	0.5 miles Stressed	Sediment/Urban Stressors	Impacts may be related to past construction erosion	Continue monitoring and Stowe Mt. Resort WQRP benefits
VT08-12 West Branch Little River, rm 8.0 to headwaters	Stressed	sediment, acidity/Urban Development		need further assessment; pH shock in springtime. WSMD ABN will confirm

Waterbody or River Segment and Town	*Status*	*Pollutant /Stressor*	*Source*	*Planned actions, see also actions associated with Stressors*[9]
				or update status as resources permit
VT08-13 Hancock Brook, Worcester	4.0 miles Stressed	Acidity	Low alk conditions, moderately sensitive to acid rain	Biomonitoring planned. Bedrock geology controls to some degree
VT08-13 Minister Brook, Worcester	3.0 miles Stressed	Acidity	Low alk conditions, moderately sensitive to acid rain, gravel road runoff	Biomonitoring planned Bedrock geology controls to some degree
VT08-14 Kingsbury Branch, from outlet of North Montpelier Pond to mouth	3.5 miles Stressed	elevated temperatures/Flow Alteration	Warm water discharges from pond	Unlicensed. Project is operated under a FERC exemption.
VT08-15 Jail Branch, Barre City and below	1.5 miles Stressed	Sediment, nutrients, E. coli/Urban Stressors	Land development; erosion/sedimentation; urban runoff	Continue to support monitoring (Friends of Winooski River)
VT08-15 Jail Branch, Washington/Orange area	Stressed	E. coli/Pathogens	Elevated bacteria levels; source(s) unknown	Continue to support monitoring
VT08-16 Stevens Branch, Barre	5.8 miles Stressed	Sediment, nutrients, E. coli/Urban Stressors	Urban runoff including suspected floor drains from commercial buildings on river	See Lake Champlain P TMDL
VT08-17 Dog River, Riverton canoe access downstream ½ mile, Berline	0.5 miles Stressed	E.coli/Pathogens	Elevated e. Coli	Review with VAAFM
VT08-18 Mad River, Warren dam up to Route 100	0.5 miles Stressed	Sediment/Land Erosion, Channel Erosion	Morphological instability; contributions from nearby gravel/sand pit	Continue monitoring. Talk to someone about gravel/sand pit



Map ID	Name	Pollutant
1	Winooski River, to Dam	Mercury, *E. coli*
2	Morehouse Brook	Stormwater
3	Sunnyside Brook	Chloride
4	Unnamed Trib	Iron, Arsenic
5	Centennial Brook	Stormwater
6	Winooski River, to Alder	Multiple
7	Allen Brook	*E. coli*
8	Muddy Brook	Chloride
9	Allen Brook	Stormwater
14	Sunderland Brook	Stormwater

Figure 2. Stressed and impaired/altered surface waters on the 303d or state 2018 lists in Lower Winooski River Basin (see Table 4)



Map ID	Name	Pollutant
1	Winooski River, to Dam	Mercury, *E. coli*
2	Morehouse Brook	Stormwater
3	Sunnyside Brook	Chloride
4	Unnamed Trib	Iron, Arsenic
5	Centennial Brook	Stormwater
6	Winooski River, to Alder	Multiple
7	Allen Brook	*E. coli*
8	Muddy Brook	Chloride
9	Allen Brook	Stormwater
10	Shelburne Pond	Exotic Species
11	Huntington River	*E. coli*
12	Joiner Brook	Flow Alteration
13	Goose Pond Brook	Acid
14	Sunderland Brook	Stormwater

Figure 3. Stressed and impaired/altered surface waters on the 303d or state 2018 lists in Lower and Mid-Winooski River Basin (see Table 4)

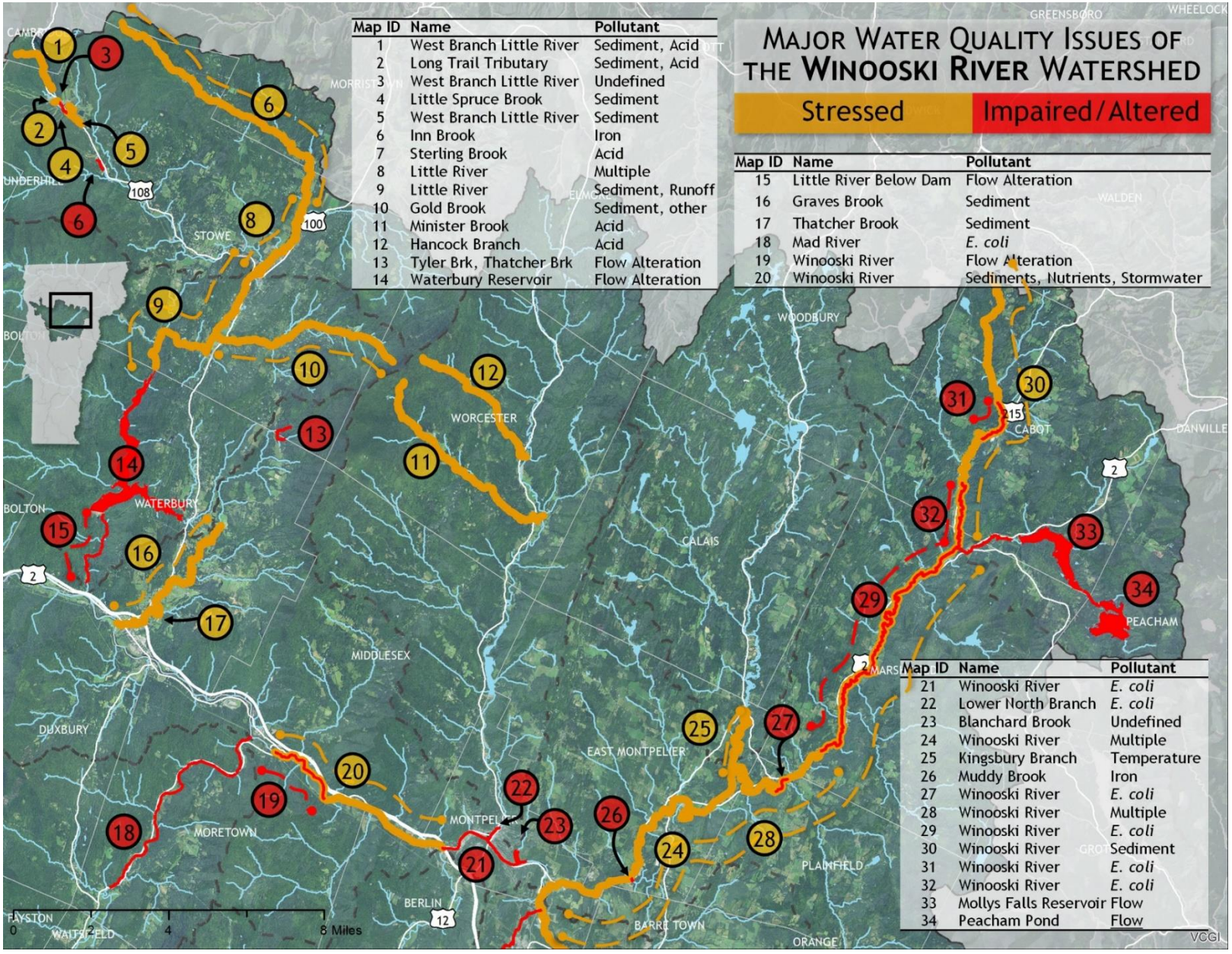


Figure 4. Stressed and impaired/altered surface waters on the 303d or state 2018 lists in Upper Winooski River Basin (see Table 4)

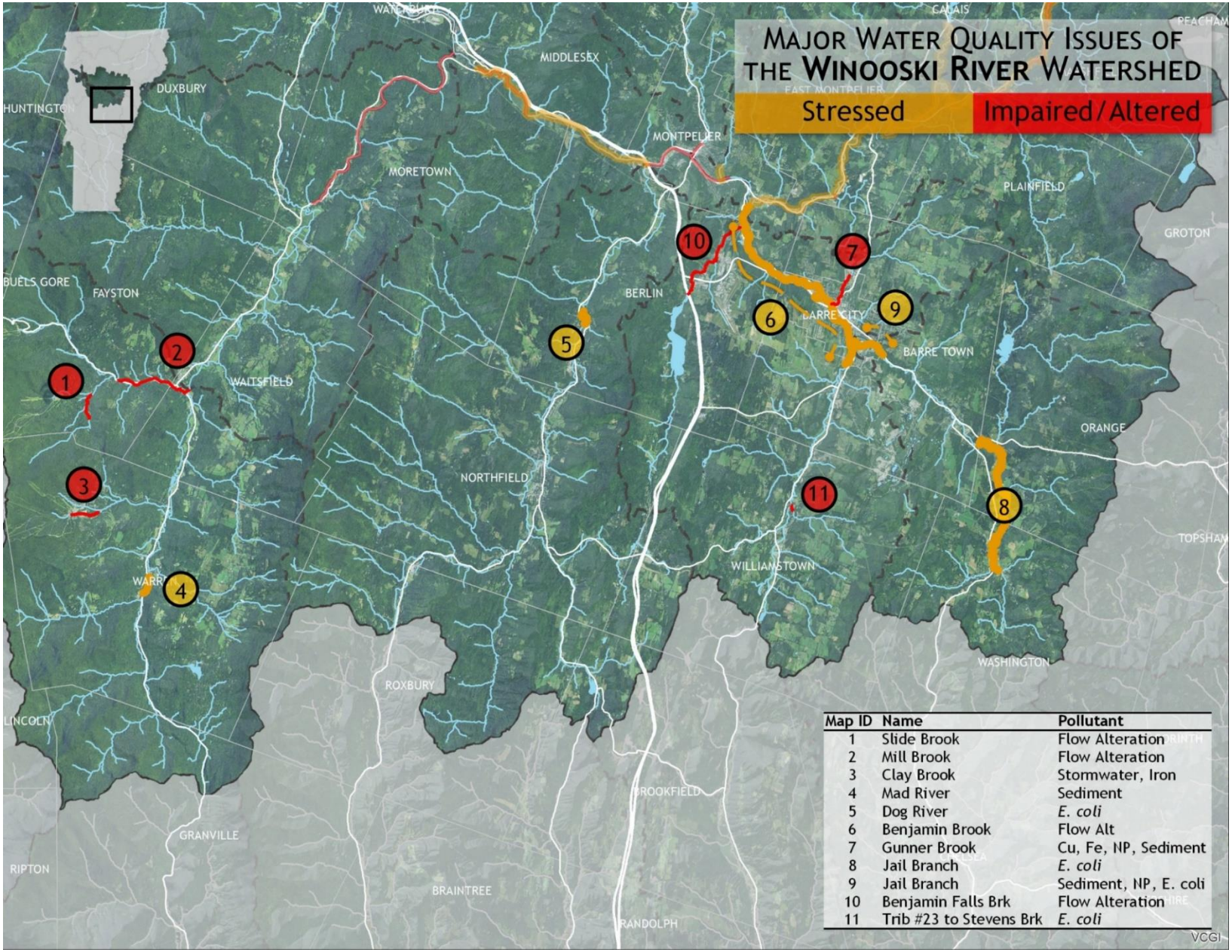


Figure 5. Stressed and impaired/altered surface waters on the 303d or state 2018 lists in Mad and Dog Rivers and Stevens Branch (see Table 4)

Additional Lake and Pond Assessment Results

In addition to the 303(d) List of Impaired Waters and List of Priority Surface Waters in Table 4 above, the Vermont Inland Lake Score Card summarizes the overall conditions of each lake in Vermont (Table 40).

The Vermont Inland Lake Score Card provides information about four key aspects of lake health: nutrients, aquatic invasive species, shoreland and lake habitat, and mercury pollution. Links embedded in the Score Card open deeper views into the underlying data.

Stressors, Pollutant and Project Identification

In addition to supporting surface water assessments to identify water quality degradation or reference conditions[11], VDEC and partners (Appendix A) support assessments that can lead to a better understanding of the stressor or pollutants and therefore initiate appropriate remediation efforts. The assessments described in this section cover most landuse activity in the basin as well as the physical condition of river corridors.

During the tactical basin planning process, assessments are considered along with modeling results (see end of Chapter for more explanation on modeling analyses) to prioritize geographic areas for project development and to identify priority projects for inclusion in the Tactical Basin Plan's Watershed Projects Database (Chapter 5). These projects can then be used to help meet regulatory requirements or support voluntary efforts. Specific assessment needs for each subwatershed are included in Tables 4 and Table 11.

Water Quality Monitoring by Citizen Groups

In addition to data collected by VDEC staff, data collected on streams and lakes by volunteer monitoring groups is assessed in the TBPs (see Figure 6). The groups as well as VDEC uses the results for identifying stressors and pollutant sources.

The VDEC supports volunteer water quality monitoring effort through the LaRosa Partnership Program, which provides chemical and bacterial analyses services to the volunteer groups through a grant program. The most common parameters requested include total and dissolved phosphorus, total nitrogen and total suspended solids. The

[11] Appendix A of the Vermont DEC Water Quality Monitoring Strategy 2011-2020

presence of pathogens is also tested for by a subset of this group. The list of groups follow:

- **Huntington River Conservation Partnership**
- **Friends of the Mad River**
- **Williston Conservation Commission**
- **Upper Winooski Joint Conservation Commissions**
- **Four Rivers Winooski Partnership**
- **Chittenden County Stream Team**

Once the samples are analyzed, the lab organizes all volunteer water quality monitoring data for easy downloaded to an excel file available to groups for use in their annual reports. Data and reports can be found at the LaRosa Volunteer Monitoring webpage.

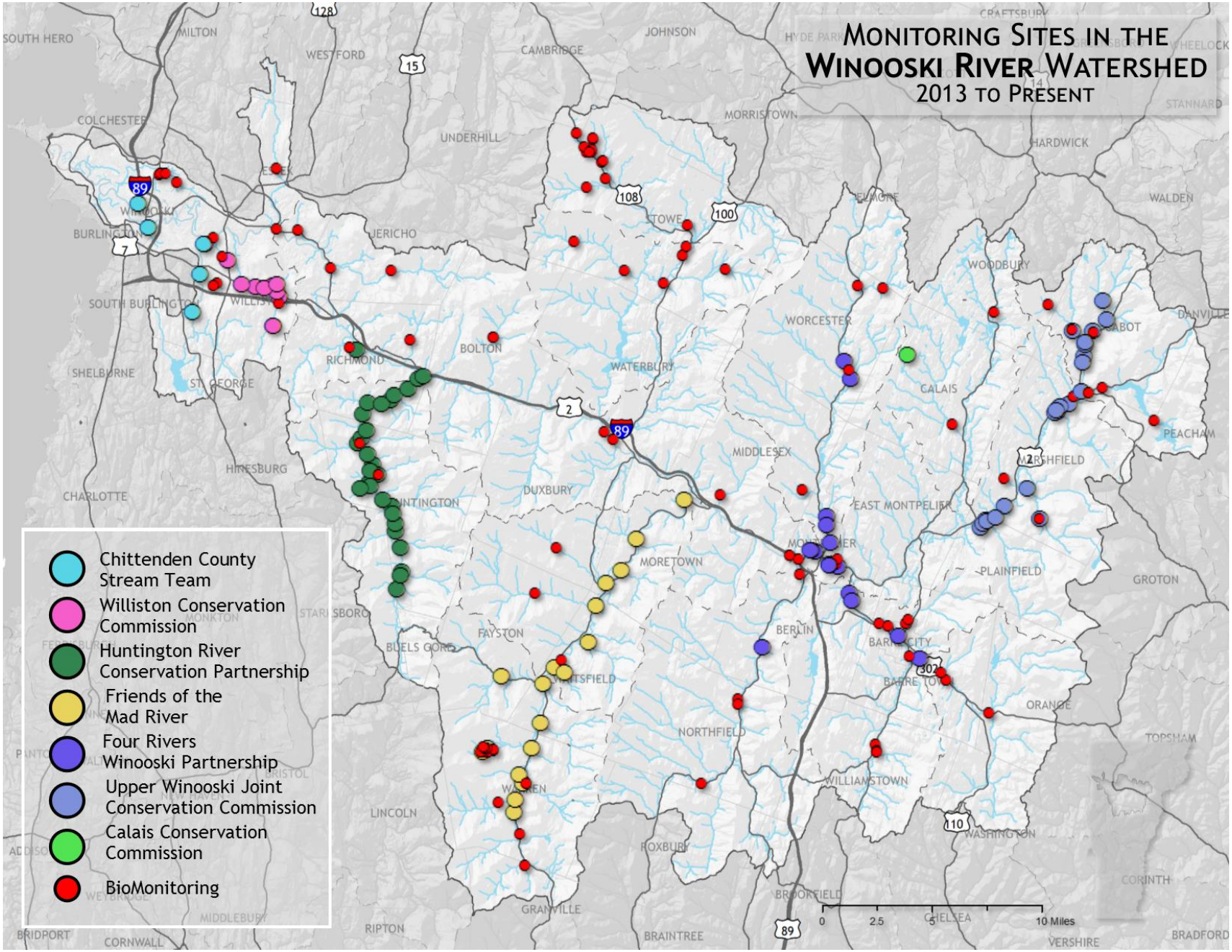


Figure 6. Winooski Basin biomonitoring sites sampled by VDEC and water quality monitoring sites sampled by watershed partners and the VDEC LaRosa Partnership Program

Stream Geomorphic Assessments

Geomorphic assessments measure and assess the physical dynamics of an entire watershed or collection of river reaches. See Vermont River Management Section - Geomorphic Assessment for more information.

The majority of the lower reaches of the assessed tributaries in Basin 8 (Table 5 and 39) are in disequilibrium evidenced by channel incision and subsequent ongoing planform adjustments. These adjustments result in a significant amount of legacy phosphorus and sediment loading to the basin's waterbodies from the eroded stream channels (Lake Champlain Basin Program, 2011). In the Basin, the most common causes of in-channel erosion are dams, diversions, culverts, and channelization practices, such as dredging, berming, and armoring. An additional source is the increased discharge of stormwater associated with increased development (impervious surfaces) within the watershed.

During the tactical basin planning process, projects from the Stream Geomorphic Assessments are reviewed and all priority river protection and restoration projects are included in the Watershed Projects Database (Chapter 5).

Restoration projects aim to restore lateral and longitudinal connectivity of rivers that will enhance floodwater storage in floodplain, reduce channel scour, and reduce sedimentation and phosphorus loadings to receiving lakes. See below for list of priorities in the basin:

Table 5. Priority action for streams with completed geomorphic assessments (Table 39)

Priority Streams	*Priority Actions*	*Rationale*
upper Winooski main stem, Pekin Brook, Upper Stevens Branch, Little, Mad and Huntington Rivers.	River Corridor protection	most at risk for movement (disequilibrium) based on high level of sensitivity and floodplain disconnection.
Little River	Floodplain restoration	the stressor, channel erosion, results in a loss of floodplain connection, sending fine sediment particles into the Winooski.
Allen Brook, Mad River, Upper Winooski, Dog River	Riparian Plantings	mature woody buffer can establish itself without

Priority Streams	*Priority Actions*	*Rationale*
		significant loss from channel erosion. High potential for overland runoff exists
Huntington River	Riparian Plantings with large setback to accommodate lateral instability	High potential for overland runoff exists and

Culvert and bridge replacement to conform with the geomorphic condition of streams will be mostly limited to deteriorating structures because of the significant cost to the towns. Towns will be assisted by the Chittenden County, Central Vermont and Lamoille Regional Planning Commission and the Northern Vermont Development Association in prioritizing and planning for expense.

Landslide Inventory

Landslides are the downslope movement of materials above bank full stream stage. In Vermont, slides have resulted in damage to infrastructure like roads and buildings located at either the top or the base of a slide. In addition, a slope failure can increase sediment and associated phosphorus loads to a receiving water.

The Washington County Phase 1 Hazard Map, 2017 and Report summarizes causes of landslides as well as identifying landslide sites (modern and ancient) and areas of steep slopes. Washington County represents a significant portion of the Winooski River Basin. The majority of the remainder of the basin is situated in Chittenden County. The expected completion date for a similar study in Chittenden County is 2018. The DEC Vermont Geological Survey with assistance from Norwich University supports these studies as part of the current State Hazard Mitigation Plan recommendation to map landslides gullies, and other slope instability hazards. (http://vem.vermont.gov/plans/SHMP).

The DEC Vermont Geologic Survey will continue to add to the inventory through input from the public. An online reporting form will be publicized by the program: http://dec.vermont.gov/geological-survey/hazards/landslides

Towns may also request a more detailed level of mapping to help inform the town planning and project review process from the Department of Public Safety.

The Washington County Phase 1 Hazard Report includes the following overview of landslide activity in the county:

1. Principle causes of landslides:
    a. Over steepen slopes that results in fluvial erosion of banks and stream beds during flash floods.
    b. Decreases in shear strength of soils due to increases in soil water pore pressures due to the heavy rainfall.
2. Gully instability initiated or at least exacerbated by stormwater discharges.

The report states that the detailed and periodic updates of (Phase 2) stream geomorphic data from the Vermont Rivers Program is critical to understanding the patterns of stream channel adjustment that are underway in the river corridors as it allows consideration of how the slopes had changed over time. The report recommends that Phase 2 data be made available for the streams in any areas where landslide mapping is to be undertaken.

Stormwater Master Plans and Mapping

Stormwater runoff from developed areas carries pollutants to streams, as well as increasing stream flows, which in turn erodes the stream channel. The VDEC has supported town stormwater mapping and stormwater master plans as well as illicit discharge detection to help both with regulatory requirements and voluntary efforts. The town reports can be found at the associated links above. Road runoff in each town will be addressed through the MRGP (see Chapter 4). Table 6 is an overview of assessment needs for identifying stormwater projects in Basin 8 towns.

Table 6 Inventory of stormwater master plans completed as well as proposed for towns in the Winooski River Basin.

Town	*Status*

Williamstown and village, Waterbury Village, and Stowe	Need Hybrid site & community retrofit Stormwater Master Plan with green stormwater infrastructure (GSI) stormwater management
See Appendix C	Stormwater Master Plans completed
Remaining towns (as well as all towns in watershed)	SMP not needed. Roads are the predominant source of stormwater, which will be addressed through the State general permit for discharges of regulated stormwater from municipal roads,

Lake Shoreland Protection and Restoration

The Vermont Lakes and Ponds Management and Protection Program (VLPP) evaluates all Vermont lakes for nutrients trends, aquatic invasive species, shoreland and lake habitat, mercury contamination and provides summaries using the Vermont Inland Lake Score Card[12]. Additional information about lakes collected by VLPP can be found here, including overall water quality, shoreline condition, biodiversity and unusual or scenic features. Table 7 lists lakes for the agency's focus based on the overall conditions of the lake as well as the actions that would be considered appropriate for addressing the identified condition.

Table 7 Priority actions for priority lakes and ponds based on VLPP evaluations (see Table 40)

Priority Lakes/Ponds	*Priority Action*	*Rationale*
Greenwood, Woodbury	Shoreline protection[13]	Shoreline and habitat ranked Poor, but not yet affecting water quality conditions and trends
See Table 40 for lakes with fair shoreline conditions	Shoreline protection	Existing shoreline condition is Fair

[12]Using Google Earth, viewers can select from more than 800 lakes in the state and learn about four key aspects of lake health: nutrients, aquatic invasive species, shoreland and lake habitat, and mercury pollution. Links embedded in the Score Card open deeper views into the underlying data

[13] Includes support of Lake Wise Program when shoreline owners express interest

Forest Pond, Calais; Blueberry, Warren, North Montpelier Pond, Peacham and Woodbury Pond	Watershed assessment and work to address sediment	Poor (Forest Pond) to Fair water quality trends
Buck and Pigeon, Turtlehead, and Berlin Pond	Protection	Ranked with top 25% of Best lakes in Vermont based on criteria for water quality, biodiversity and unusual or scenic features
Mansfield, Shelburne and Thurman W. Dix Reservoir	Protection	Lakes with unusual, scenic or natural features
All oligiotrophic lakes	Development of a Lake watershed assessment and implementation plan	Increasing nutrient trends in Vermont oligiotrophic lakes

Wetland Inventories for Restoration and Protection

The 2007 VT Agency of Natural Resources' Lake Champlain Basin Wetland Restoration Plan and 2016 updates includes the identification and prioritization of wetlands in the Vermont portion of the Lake Champlain Basin with the greatest potential for P removal through restoration.

The Vermont Wetlands Program also collects bioassessment data to assess 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, filling and draining.

Wetlands in remote areas and at high elevations tend to be in good condition, with the most threatened wetlands occurring in areas of high development pressure and exhibiting habitat loss.

The Bioassessment Program has conducted 218 detailed vegetation plots in wetlands throughout the state. The Winooski watershed includes 12 vegetation plots.

Surveys are primarily conducted on a rotating basis by watershed, and the Winooski River Basin will be surveyed in more detail with the next rotation in 2020.

In addition to detailed vegetation plots, the Wetlands program initiated rapid assessments of wetlands using the Vermont Rapid Assessment Method (VRAM) in 2017. A total of 24 VRAM assessments have been conducted thus far in Basin 8. Current pattern of conditions for this watershed mirrors much of the rest of the State: A clear pattern emerged in this watershed (and in the rest of Vermont) where high- elevation, small wetlands are often in excellent condition, but floodplain wetland complexes low in the watershed are often in poor condition and heavily impacted by human use (but also offer a great deal of restoration potential). Future VRAM analyses will also be completed by organizations and individuals.

Flow Alteration

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

The VDEC reviews hydroelectric generating dams as a flow alteration activity and issues a certification pursuant to Section 401 of the federal Clean Water Act (CWA) that the project as operated meets the Vermont Water Quality Standards. Table 8 includes a list of currently operating hydroelectric generating dams in the Basin. The surface

waters impounded by and downstream of these facilities are classified to maintain designated uses at a Class B(2)[14] level of quality.

Flow assessments

Managing water levels in a stream to meet human needs for property protection or a water source can compete with the need to protect aquatic habitat. Assessments have identified flow alterations that the VDEC addresses to ensure compliance with the Vermont Water Quality Standards as well the Vermont Surface Level Rules either through regulatory processes or as owner of a dam (see also Watershed Projects Database). A list of flow altered waters are included in Table 4.

Table 8. Hydroelectric generating dams in Basin 8. See below for additional information.

Dam	*River*	*Comments*	*Ownership*
Montpelier No. 4	Winooski River		Winooski Hydroelectric Co
Winooski One	Winooski River		Winooski One Partnership
Marshfield No. 6	Mollys Brook	FERC Unlicensed project. DEC reviewing application for Certificate of Public Good (CPG).	Green Mountain Power Corp
Bolton Falls No. 1	Winooski River	Entering 2nd year of FERC relicensing. Will conduct studies 2018 field season	Green Mountain Power Corp
North Montpelier Pond	Kingsbury Branch		Kingsbury Branch Hydroelectric Co.
Essex No. 19	Winooski River		Green Mountain Power Corp
Middlesex No. 2	Winooski River	Unlicensed facility. Fragments and degrades fisheries habitat	Green Mountain Power Corp
Moretown No. 8	Mad River	FERC relicensing process initiated recently	Ampersand Moretown Hydro, LLC
Northfield Mills	Dog River		Nantana Mill Partnership
Gorge No. 18	Winooski River	Unlicensed and ANR issued a Certificate of Public Good in 2012 after outstanding issues addressed during proceedings.	Green Mountain Power Corp
Ladds Mill	North Branch Winooski River		Worcester Hydro Co.
Peacham Pond	Sucker Brook	Unlicensed, Hydropower storage for Marshfield no. 6.	Green Mountain Power Corp
Wrightsville	North Branch Winooski River	also flood control. Project in the FERC relicensing process. Studies will likely begin summer 2018	State of Vermont – VDEC owns dam. Washington Electric Coop owns and operates the hydro.

[14] see Chapter 4 for discussion of surface water classification

Waterbury Reservoir	Little River	Section 401 wq certification appl'n under review by VDEC. Also flood control	State of Vermont – VDEC. Green Mountain Power Corp. owns and operates the hydro

Additional information about four of the above hydrodam facilities follows, including an assessment provided by the ANR Fish & Wildlife Department (2017 Upper Winooski Fisheries Assessment):

Marshfield 6 and Peacham Pond Dams

Molly's Brook enters the Winooski in Marshfield and flows from Peacham Pond and Molly's Falls Reservoir. These two ponds and Molly's Brook have been used as part of an unlicensed hydroelectric operation since 1927. Annual winter drawdowns in both Molly's Falls Reservoir and Peacham Pond impact littoral habitat (Ladago, 2017) and elevated water temperatures, decreased dissolved oxygen, and altered flows have been observed downstream of the impoundments as a result of these operations. The GMP hydro-electric generation results in extreme daily fluctuations in flow as well as rapid temperature changes of >5°F (Kirn 2017). GMP is currently seeking a Certificate of Public Good to repair the dam and will need to meet Vermont Water Quality Standards to move forward. The Vermont Fish and Wildlife Department (VFWD) and VDEC are working to improve facility operations to decrease impacts to water quality and aquatic populations.

Wrightsville

In Middlesex, the North Branch is impounded to create Wrightsville Reservoir. Elevated downstream temperatures due to a surface water releases are magnified by a loss of diurnal cooling within the reservoir. These factors likely limit the ability of the North Branch to sustain wild trout and other cold-water fish species below the reservoir (Kirn 2017). Poor recruitment of largemouth bass within the reservoir may reflect the impact of water level fluctuations during and following spawning and a lack of aquatic vegetation growth within the reservoir.

Waterbury

Downstream of Waterbury Dam, the river supports wild brown and rainbow trout. The populations are limited by regular and extreme flow and temperature fluctuations associated with the hydroelectric release. As part of a recently issued Section 401 water quality certificate and FERC license, flow and temperature below the dam is expected to improve by May 2018. Once the tainter gates and spillway of the dam are repaired, the winter drawdown will be eliminated, and year-around run-of-river operation will occur. Until this repair, the facility will operate in run-of-river mode from May 15 through

December 31 which should improve the overall health of the fishery and surrounding ecosystem.

Stage 2 of the 402 Water Quality Certification will begin this May. Green Mountain Power has replaced the turbine runner and constructed the bypass valves so that the project will operate in run-of-river between May 15 – December 31. Drawdown and limited peaking are allowed from January 1 – March 30; refill is allowed between April 1 – May 14. Stage 3 true run-of-river operations will begin year-round when tainter gates are replaced.

Other Dams

While some of the dams in the Basin provide power generation (Table 8) and recreational opportunities, and can be aesthetically or culturally important, others may be obsolete, providing little or no public benefit, or constituting a hazard. Removal of dams provides benefits to stream stability and run of stream opportunities for boating as well as aquatic organism passage. Removal is considered when dams no longer provide benefits and/or have become structurally unsafe. Table 9 includes a list of dams in the basin that may no longer be serving a useful purpose and have a significant ecological impact based on an analysis by The Nature Conservancy[15]. A few are in the process of being removed, but 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. These potential dam removal projects are also included in the Watershed Projects Database.

Table 9. Dams with high potential for removal based on landowner and community interest, expected resource improvement (TNC rank[16]) and dam hazard class.

[15] The Nature Conservancy (TNC) has developed a dam screening tool to prioritize removal based on ecological benefits:
: http://tnc.maps.arcgis.com/apps/webappviewer/index.html?id=414a9dc9540247ae92acd48f64f1290b

[16] The Nature Conservancy (TNC) has developed a dam screening tool to prioritize removal based on ecological benefits:
: http://tnc.maps.arcgis.com/apps/webappviewer/index.html?id=414a9dc9540247ae92acd48f64f1290b

State ID	Dam Name	Stream	TNC rank	Dam Hazard Class[17]	Comments
13.01	Brooklyn Street	Stevens Branch	high	3	
13.02	Habbep	Stevens Branch		3	
14.04	Jockey Hollow	Stevens Branch		3	
32.06	Wardner Pond	Sunny Brook			
39.04	Clarks Saw Mill	Winooski River		3	Active removal project
63.02	Duxbury Mill	Crossett Brook		3	
123.04	Laird Pond	Nasmith Brook	High		
131.01	Lane	North Branch Winooski River	High	3	
131.05	Trestle	North Branch Winooski River		3	Higher priority if Lane Removed
143.05	Cross Bros.	Dog River	high	3	VFWD involved in active removal project supported by the owner, Town of Northfield
143.09	Cooks Mill	Sunny Brook	high		

[17] Dam Hazard Class: The hazard class is based upon the potential of damage or loss of life if the dam were to fail and is not related to the condition of the dam, which could be an indication of the potential to fail. A hazard class of 3 indicates a low hazard to downstream uses were the dam to fail. For more detailed explanation, see DEC dam-safety inspection program.

State ID	Dam Name	Stream	TNC rank	Dam Hazard Class[17]	Comments
	Stony Brook	Stony Brook			VFWD involved
155.01	Old Batchelder Mill	Winooski River	high	3	Town residents are approaching the selectboard
199.04	Moscow Mills	Little River		3	ANR received informal inquiry about dam from Stowe Electrical Department to develop a hydroelectric project.
223.03	Warren Village	Mad River	high	3	
255.04	Chandler Sawmill	Minister Brook	high	3	Located at Natural falls/Partially Breached/ sediment barrier

Table 10. Dams in VDEC records that may not exist. Need to assess status.

State ID	Dam Name	Stream	TNC ranking	Dam Hazard Class	Comments
65.05	East Montpelier	Winooski River	medium		Appears to be gone
20.04	Montpelier Reservoir (Lower)	Benjamin Falls Brook			Intact/in use?
20.09	Montpelier Reservoir (Upper)	Benjamin Falls Brook			Intact/in use?
40.01	Nelson Pond	Mirror Lake-TR			Intact/in use?
40.02	Sabin Pond	Kingsbury Branch	high	3	Intact/in use?
40.16	Maple Corners	Curtis Pond Brook		3	Intact/ in use?

132.03	Eight Trout Club	Welder Brook	medium		Intact/in use?
255.06	Worcester-6	North Branch Winooski River	high		Appears to be gone

Hazardous Waste Sites and Landfills

Locations and additional information about hazardous waste sites and brownfields in the Basin 8 can be viewed on the ANR Natural Resources Atlas. Information for a specific site can be accessed through the ANR Environmental Tool Hazardous Site List. Detailed description of sites that may have the potential to contaminate surface waters are included in the DEC Basin 8 Water Quality Assessment Reports.

In Basin 8, leachate from three closed landfills, Farwell dump, the Central Vermont landfill, and South Burlington landfill are included as possible sources of impairment to three surface waters: Gunner Brook, Muddy Brook in East Montpelier and tributary to the Winooski (VT08-02) (see Table 4).

The potential for hazardous waste sites to leach will increase with inundation as well as proximity to surface waters. Large floods may result in adjustment of river channels that could increase potential for release of hazardous waste into surface waters. Towns may be interested in listing hazardous waste sites that sit within the river corridor in municipal hazard mitigation plans.

VDEC is continuing to monitor many of these sites thorough its biological monitoring program as well as groundwater and surface water monitoring for South Burlington and Central Vermont landfills.

Modeling Tools to Identify Remediation and Protection Efforts

The VDEC and its partners use modeling techniques to predict sources of pollutants, estimate pollutant loads and to identify where practices might be most effective at addressing the pollutant. Modeling tools play a significant role in the development of the Lake Champlain Phosphorus TMDL Phase II planning-level "sub-allocations." They are used to estimate phosphorus loads to lakes and rivers from specific geographic areas and landuse activities, as well as to determine effective practices (also known as a best management practices) for addressing load reductions from a specific landuse activity within a subbasin or even more specific geographic areas. The models and the results are included in Chapter 3's Lake Champlain Phosphorus Phase II section.

Modeling can never achieve a 100% accurate representation of actual conditions on the ground. For that reason, model estimates are always compared against observed values

to assess fit. The assessments and plans described at the beginning of Chapter 2 are based on the results of field work and therefore include those observed values. The results from observations, monitoring, assessments, and modeling are used in the development of the management actions in this plan (see Watershed Projects Database).

Modeling tools, complemented by site visits to verify conditions, can be used by technical staff in developing proposals for landowners or by programs to support planning, (e.g, estimate load reductions from BMPs, see below).

The following modeling or data analyses listed below have and will continue to be part of the process for identifying the efficacy of actions included in the Watershed Projects Database along with the assessments and plans described earlier in this chapter. The modeling tools are described in more detail in Chapter 3 or Appendix B and include information about how the information will be made available to any organization responsible for assisting in BMP implementation.

The following modeling tools and other assessments used to identify remediation and protection actions are described in greater detail in Chapter 3 or Appendix B:

- SWAT model
- HUC12 Tool
- EPA Scenario Tool
- Lake Champlain BMP Accounting and Tracking Tool (LC BATT)
- Clean Water Road Map Tool
- Floodplain restoration

Water Quality Monitoring and Assessment Needs

In addition to waters identified as needing further monitoring and assessment in Table 4, Table 11 includes additional monitoring and assessment needs based on conclusions from assessments previously described in this chapter or the results of the VDEC MAPP monitoring work[18] or the ANR Department of Fish and Wildlife. In large part, the locations listed below are identified for collecting information that would support reclassification of one or more designated use to a higher class of protection.

[18] The use of macroinvertebrate and fish communities to assess water quality and uses is described in the Vermont Water Quality Standards as well as the 2016 DEC Assessment and Listing Methodology

Table 11. Additional proposed monitoring and assessment needs to inform remediation or protection strategies.

Waterbody	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
Minister Brook	Worcester	Determine condition based on aquatic life support (ALS)	Stressed due to acid, low spring pH	Macroinvertebrate and fish[19]
Hancock Brook	Worcester	Determine condition based on aquatic life support	Stressed due to acid for ALS, low spring pH, 2005 macroinvertebrates and fish Good	Macroinvertebratea nd fish updated
Little River	Waterbury	Determine condition	stressed: so, instability still an issue.	Review geomorphic condition. Macroinvertebrate and fish data
Upper Winooski (btw Marshfield and Cabot Creamery)	Cabot	Determine condition	2015 and 2016 data above Cabot WWTF shows *Excellent* macroinvertebrates, but this area is currently listed as stressed	Macroinvertebrate and fish data
Upper Winooski – ¼ mile below Cabot WWTF	Cabot	Determine condition	macroinvertebrate – 2015 data = *Very Good*.) Recovered from spill	Macroinvertebrate and fish data
Upper Winooski – Molly Falls, brook – Upper area of brook	Cabot	Determine condition	Macroinvertebrate good in lower brook nearer to confluence (RM 0.1, RM 0.5); Indeterminate Fair/Good closer to Reservoir at RM 1.5. Fish fail at 1.5 and 0.5. VDFW data shows increased temp.	Macroinvertebrate and fish data
Main stem - Upper Winooski to Essex	Cabot to Essex	Determine condition	Macroinvertebrates are good or above, complete recovery after Cabot Creamery spill.	Macroinvertebrate data (river too wide to collect fish data).
Kingbury Branch	Calais, Woodbury	Determine condition		Nutrients and turbidity
Great Brook	Plainfield	Confirm that geomorphic issues are	Geomorphic assessment	Macroinvertebrates and fish data

[19] See footnote 20

Waterbody	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
		resulting in ALS degradation.		
Gunner Brook - RM 1.1 to mouth.	Barre City	Determine condition	Macroinvertebrates/fish results variable btw poor and good. Macroinvertebrates better than fish. The fish might be stressed due to invasive rainbow.	Macroinvertebrate and fish. Review Toxins data
Stevens Branch – Rm 4.9 and downstream	Barre City	Determine condition	Landscape suggests degraded conditions	Macroinvertebrate and fish data
Jail Branch above Barre City	Barre Town, Washington	Determine condition	Landscape suggests degraded conditions	Nutrients, turbidity
High Brook bridge, Welder Brook, and Folsom Brook	Waitsfield, Moretown	Determine condition	based on review of FMR volunteer data that has identified these as relatively high pollutant loads	Macroinvertebrate and fish data
Chase Brook	Fayston	Determine condition	upstream activity (Sugarbush North) 2006 data good.	Macroinvertebrate and fish data
Clay and Rice Brooks	Waitsfield	Determine condition	part of the Stormwater Master Plan for Sugarbush with consultant monitoring	Macroinvertebrate and fish data
Joiner Brook	Bolton	Determine condition	check impact of development	Macroinvertebrate and fish data
Cobb Brook	Huntington	Determine Condition	Huntington Conservation Commission requested assessment	Macroinvertebrate and fish data
Huntington River	Huntington	Determine condition	Texas Hill Road is steep and could contribute sediment. Macroinvertebrates very good to excellent and fish good condition.	Macroinvertebrate and fish data
Muddy Brook	Williston	Determine condition	Landuse suggests stressors beyond listed area	Macroinvertebrate and fish data
Blanchard Brook	South Burlington	Identify stressors	Will be listed for stormwater and temperature in 2018	Macroinvertebrate and fish data

Waterbody	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
Sand Hill Brook VT08-04	Essex	Confirm as Class B(1) for aquatic biota and wildlife	2015 macroinvertebrate =*Very Good*, fish=*Excellent*	Macroinvertebrate and fish data
Jug Brook VT08-09:	Cabot	Confirm as Class B(1) for aquatic biota and wildlife	Might meet B1 depending on whether final criteria allow two individual sample sites with only 1 sample to meet criteria (RM 1.4 & 3.0)	Macroinvertebrate and fish data
Pinnacle Brook VT08-12:	Stowe	Confirm as Class B(1) for aquatic biota and wildlife	Data from 2012-2016 shows very good or better macroinvertebrates Try to sample in 2018.	Fish data
Orange Brook VT08-15:	Orange	Confirm as Class B(1) for aquatic biota and wildlife	Low gradient, Very Good macroinvertebrates in 2013. an additional Very Good or better macroinvertebrate assessment.	Macroinvertebrate data
Upper Stevens Branch VT08-16:	Williams-town	Confirm as Class B(1) for aquatic biota and wildlife	RM 11.9 fish and macroinvertebrates were Very Good in 2015	Macroinvertebrate and fish data
Freeman Brook VT08-20:	Warren	Confirm as Class B(1) for aquatic biota and wildlife	Based on macroinvertebrate/fish data	Macroinvertebrate and fish data
Lincoln Brook VT08-20:	Warren	Confirm as Class B(1) for aquatic biota and wildlife	very good for macroinvertebrate/fish in 2015.	Macroinvertebrate and fish data
Gleason Brook	Duxbury	Explore for reclassification to A1	Landscape would support, part of Camels Hump State Park. Part of management plan's	Macroinvertebrate and fish data

Waterbody	Town	Assessment Goal	Existing data supporting goal	Monitoring needs
			Natural Area down to 900 ft.	
Trib to Woodbury Lake (across from DFW boat access)	Woodbury	Explore for Class B1 for aquatic biota and wildlife	Mouth of tributary provides habitat for X mussel	Macroinvertebrate and fish data
Mill Brook	Jericho	Explore for Class B1 for aquatic biota and wildlife	Based on macroinvertebrate/fish data	Macroinvertebrate and fish data

Remediation and Protection Strategies by Subbasins

The assessment results described throughout this Chapter as well as the EPA and State-listed waters (Table 4) provide a basis for identifying priority stressors in subbasins (Table 12) for remediation. In addition, the assessment results are also valuable for identifying high quality surface waters that could be protected (see Figure 27).

The priority subbasins have been identified as providing significant phosphorus and sediment loads to the watershed and/or need protection for purposes of flood resilience as well as maintaining high quality waters. The assessments also provide information to support identification of appropriate strategies and actions to address stressors, see Tables 36 and 37. The specific actions are located in the Watershed Projects Database.

Table 12. Strategies to address priority stressors and concerns in subbasins.

Subbasin Waterbody Name[20]	*Associated Tributaries to Winooski River*	*Priority Stressor/Concern*	*Priority Strategy*
Lower Winooski River mainstem		Urban development stressors and toxins[21] agriculture, chlorides	Support MS4 permit implementation, Education/Outreach to encourage

[20] To identify the towns encompassed by each of the subbasins, please see Water Quality Assessment Maps.

[21] Urban development stressors: land erosion, nutrient loading, channel erosion, pathogens, Thermal stress; encroachment
Agricultural stressors: land erosion, nutrient loading, channel erosion, pathogens, Thermal stress

			implementation of best practices by private landowners (E/O)
Tributaries to Lower Winooski	Centennial, Sunderland, Allen, Sucker, Alder and Muddy Brook	Urban development stressors, chlorides, agriculture	Support MS4 permit implementation, stormwater management to reduce landslide, E/O , protect/enhance river corridors
Lower Mid-Winooski River mainstem -the confluence of Alder Brook to the confluence of the Little River		Temperatures sustained from smaller streams despite Bolton and Waterbury dam, road stormwater, agriculture	Protect/enhance River corridor, manage stormwater, agric. BMP
Tributaries to Lower Mid-Winooski	Mill, Johnnie, Duck, Joiner, Pinneo, Preston, Gleason	Roads, landslide activity, these streams currently protect temp. of main stem. Trout/salmon spawning habitat	Driveway E/O and Road management, Protect/enhance River corridor
Huntington River	Cobb Brook, Hollow Brook	Pathogens, temperatures (limit spawning habitat), geomorphic instability, agric. runoff, septic. Protect swimming holes	Driveway E/0, support town floodplain protection, Protect/enhance river corridor. Manage stormwater and streams to reduce landslide/gully
Tributaries to Upper Mid-Winooski	Graves (Thatcher,) Jones Brook (Great),Herring Brooks.	Forested except for Thatcher (urban development). Private and town road runoff.	Waterbury village stormwater management; driveway E/0
Lower Little River		Geomorphic instability, Japanese Knotweed on river banks, temperature main stem, development in upper watersheds.	Protect River corridor: Protection of headwaters streams. and plantings
Upper Little River	West Branch, Ranch, Gold, Miller and Moss Glen Brooks	Geomorphic instability, temperature, development in upper watershed, agriculture in floodplain of main stem, some tribs support swimming holes and brook trout habitat	Stormwater management, protect/enhance river corridor, include berm removal. Transportation resilience plan, agric field BMPs

Upper Mid-Winooski River mainstem	from the confluence of the Little River to the confluence of Stevens Branch	Pathogens from CSO, stormwater runoff	Support permits, GSI in Montpelier
Mad River mainstem		Geomorphic instability, pathogens, road runoff, lack of riparian buffers, supports swimming holes	Agric field BMPs, flood resilience practices; protect/enhance river corridors
Lower Mad River tributaries		Steep slopes and erodible soils intensify erosion; high road density, geomorphic instability. Pathogens, Agriculture. Dowsville supports brook trout	Agriculture BMPs, silvicultural BMPs, private road E/Os, flood resilience practices; protect/enhance river corridors.
Upper Mad River tributaries		Steep slopes and erodible soils intensify erosion; high road density, geomorphic instability. above Warren supports brook trout	Manage developed land stormwater. Silvicultural BMPs, flood resilience practices; protect/enhance river corridors
Dog River		Pathogens, temperature, geomorphic instability. Upper tribs support brook trout	Stormwater management, protect/enhance river corridors, agricultural BMPs
North Branch Winooski River		Steep roads, including logging roads, lack of riparian buffer in agricultural and residential areas, dams increase temperature, supports swimming holes	Protect/enhance river corridor, private road E/O, remediate logging roads
Stevens Branch Winooski River	Jail Branch, Gunner Brook; Pond Brook (drains Berlin Pond)	Toxins, stormwater, temperature, geomorphic instability. Gunnar and Jail support brook trout	Stormwater management, flood resilience practices,
Upper Winooski River mainstem	from confluence of Stevens Branch to confluence of Mollys Bk	Geomorphic instability: cutting through old lake terraces, dams and lack of riparian buffer result in thermal modification. Pathogens from village centers; Increase flood resilience	Forest integrity E/O, grazing workshops, Protect/enhance river corridor, stormwater management including IDDE in villages

Tributaries to Upper Winooski	Great Brook (Plainfield), & Nasmith, Creamery, Mallory Bennett, Sodom Pond, Guernsey Brook	Geomorphic instability, landslides and gullies. Some brook trout habitat. Increase flood resilience	Forest integrity, river corridor easements, road and bridge work, Protect/enhance river corridor, manage stormwater and streams to reduce landslide/gully
Winooski River headwaters	from confluence of Molly's Brook to its headwaters and tributaries incl. Molly, Jugg and Sucker Brooks	Temperatures (dams), stormwater from villages, agriculture. pathogens protect flood resilience	Forest integrity E/O, agriculture BMP, including hay field management and woody riparian buffer

Chapter 3 –Addressing Stressors and Pollutants through TMDLs and Regulatory Programs

Regulatory programs play a significant role in addressing pollutants and stressors responsible for degraded water quality. An overview of all of the Agency of Natural Resources' (ANR) and the Agency of Agricultural, Food and Markets' regulatory programs associated with water resource protection is located in Appendix A of the Vermont Surface Water Management Strategy,. The objectives in Table 37 describe ANR's support to help the community meet regulations associated with the recently passed Act 64.

Recently Passed Acts: Vermont Clean Water and the Shoreline Protection Acts

The passage of Act 64 in 2015 resulted in the creation of the State's Clean Water Initiative Program (CWIP). The CWIP provides additional resources toward sediment and phosphorus reduction, based upon the assessments and integrated implementation table action (Watershed Projects Database) in this Tactical Basin Plan. The goals of the Initiative are to satisfy the State's legal obligations under both the Vermont Clean Water Act and the federal Clean Water Act. At the highest level, priorities include:

- Implementing Agriculture Best Management Practices
- Treating Stormwater Runoff and Erosion from Developed Lands
- Installing Pollution Controls on State and Municipal Roads
- Restoring and Protecting Natural Infrastructure (e.g., wetlands) for Flood Resiliency and Water Quality Improvements
- Increasing Investments in Municipal Wastewater Treatment Infrastructure

The regulatory processes that will support the priorities include the development of the following permits or regulations:

- Required Agricultural Practices
- Town road permit
- VTrans road permit
- Management of stormwater on under or un-treated 3-acre parcels

Another recent protection to water resources was enacted July 1, 2014. The Shoreline Protection Act addresses land use within 250 feet of a lake's mean water level where

any new development, redevelopment, or vegetation removal may require a permit. Shoreland Permits are issued under 10 V.S.A Chapter 49A, Subsections 1441–1449.

The new and existing regulations will be important tools that ensure Vermont Water Quality Standards are met. While the Watershed Projects Database (see Chapter 5) includes numerous actions that will be implemented on a voluntary basis, other actions will be required by permits. Partners as well as VDEC are supporting education and outreach efforts to facilitate regulatory compliance. As appropriate, Clean Water Initiative funding may provide municipalities and landowners with financial and technical assistance to develop and implement requirement management plans under the new permits.

Total Maximum Daily Load Implementation Plans

Total Maximum Daily Load (TMDL) Implementation Plans are also products of regulatory requirements. Some of the waterbodies in the Winooski River Basin do not currently meet Vermont Water Quality Standards for bacteria, mercury and/or phosphorus. In addition, the Winooski River flows into a phosphorus impaired section of Lake Champlain. Water Quality Standards assure that beneficial uses of the river and tributaries, such as swimming, fish consumption and fish habitat, are protected. When water quality standards are not met, the federal Clean Water Act requires states to establish a Total Maximum Daily Load (TMDL) for polluted waters.

A TMDL is the maximum amount of a pollutant a water body can receive without violating water quality standards. The plan specifies an acceptable level of pollutant in the water, identifies sources of that pollutant in the watershed, and set an allowable allocation for each of the pollutant's sources so that they cumulatively do not exceed the accepted level. When needed, Vermont develops implementation plans for each waterbody with a TMDL that provides reasonable assurance that the waterbody will meet target load reductions by a specific date. Basin 8 includes surface waters with TMDLs for mercury (in fish tissue), bacteria, and phosphorus (see Table 4 for specific waters and links to the TMDL).

The Mercury TMDL will be met through the region's efforts to reduce sources as well as EPA's efforts to control atmospheric emissions. The other TMDLs are addressed through implementation plans developed by ANR and approved by EPA. These TMDLs and associated implementation plans are explained in further detail below. The

bacteria TMDLs will be met in part by many of the regulations and actions that will be implemented to meet the Lake Champlain phosphorus TMDL.

Vermont TMDLs for Stormwater Impaired Waters and related regulations

Seventeen of Vermont's waters are listed as "impaired" due to stormwater runoff. These waters fail to meet the Vermont Water Quality Standards based primarily on biological monitoring data. Vermont's TMDLs use stormwater as it represents a combination of stressors. The use of this surrogate has the primary benefit of addressing the physical impacts to the stream channel caused by stormwater runoff such as sediment release from channel erosion and scour from increased flows. These physical alterations to the stream are substantial contributors to the aquatic life impairment. Also, reductions in stormwater runoff volume will help restore diminished base flow (increased groundwater recharge), another aquatic life stressor. For more information on the development of the stormwater TMDLs for these waters, see the Stormwater TMDL page.

Lowland "Urban" Watersheds

Remediation of the twelve (four in Winooski Basin) urban stormwater-impaired waters has commenced through a combination of permits issued pursuant to Vermont's federally delegated National Pollutant Discharge Elimination System (NPDES) permitting program. These permits include a reissued and enhanced NDPES permit for small municipal separate storm sewer systems (MS4s), which was issued on December 5, 2012. Under the reissued permit, each MS4 permittee has developed a Flow Restoration Plan for any stormwater impaired water to which they discharge.

In Basin 8, Centennial Brook, Allen Brook, Sunderland Brook, Morehouse Brook are urban stormwater-impaired waters. All MS4 permittees in the Winooski Basin have completed Flow Restoration Plans (FRP) with assistance from a computer-based best management practice decision support system (BMPDSS) and VDEC to identify the BMP options and associated costs.

The MS4s are currently planning for and implementing projects (see Appendix C). Projects that are competitive for DEC Ecosystem Restoration Program (ERP) grant funds based on phosphorus removal efficiencies and readiness for implementation are included in the Watershed Projects Database (WPD). The Winooski River Watershed

Summary, Vermont Clean Water Initiative 2017 Investment Report includes a summary of stormwater projects, including FRP projects, completed with ERP funding.

Mountain Watersheds

In Basin 8, sections of the Clay Brook, Warren (map) and West Branch of the Little River, Stowe along with five other mountain watersheds in Vermont are listed as impaired primarily due to stormwater runoff (see Table 4). The mountain watersheds differ substantially from the remaining urbanized "lowland" watersheds in terms of density of development, geographic position, hydrology, impairment source, and land ownership. Based on these factors, VDEC has concluded that use of the so-called "4b alternative," a non-TMDL based alternative pollution control strategy, is the best implementation strategy. The Department is working with responsible parties developing and implementing watershed-specific Water Quality Remediation Plans (WQRPs) for the impaired mountain watersheds.

Designated discharges not covered under MS4 Permit Coverage under General Permit 3-9030 is required for designated discharges to Centennial Brook that are not covered under the NPDES municipal separate storm sewer system (MS4), another NPDES permit covering stormwater discharges, or has been issued a State stormwater discharge permit resulting in no net contribution to the receiving water. For more information see Centennial Brook Residual Designated Authority permit

New and Existing Discharges

Currently, expired permits in Centennial Brook are not able to be renewed under a General Permit unless they have been residually designated (see above). Expired stormwater discharge permits will be required to renew under an anticipated new general permit and the requirements in place at that time. New discharges currently must apply under an individual discharge permit and may also be able apply for coverage in the future under a new general permit, once available.

Vermont Statewide TMDL for Bacteria-Impaired Waters

Twenty-one of Vermont's waters are impaired at least in part due to bacterial contamination; three of those are located in Basin 8 and include:

- 2.6-mile reach of Allen Brook,
- .5-mile reach of Huntington River
- 6.2-mile reach of Mad River
- 1.0-mile reach of the Winooski River in Cabot

A Vermont Statewide TMDL Report[22] was designed to support bacteria pollution reduction and watershed restoration throughout Vermont, including the first three river segments listed above. The TMDL, which established bacterial load 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 two of the four Basin 8 streams. The TMDL report supports the implementation of the following actions to allow the streams to meet their targeted bacterial loads. The actions, which are included in the Chapter 5 Implementation Table, include:

- Improve NMP and other land treatments that reduce runoff of animal waste into streams.
- convert grazing land in the riparian area into permanent livestock exclusion areas is recommended.
- Finally, the bacterial concentrations of each stream will need monitoring to show improvements.

EPA approved a TMDL for Cabot Village in 2001. Since then, several sewer straight pipes have been removed and a recent illicit discharge detection and elimination study (2013) did not identify any additional sources. Monitoring will be conducted to determine current condition of waters.

[22] http://wsmd.vt.gov/mapp/docs/mp_bacteriatmdl.pdf

The Lake Champlain Phosphorus TMDL Phase II: Winooski River Basin

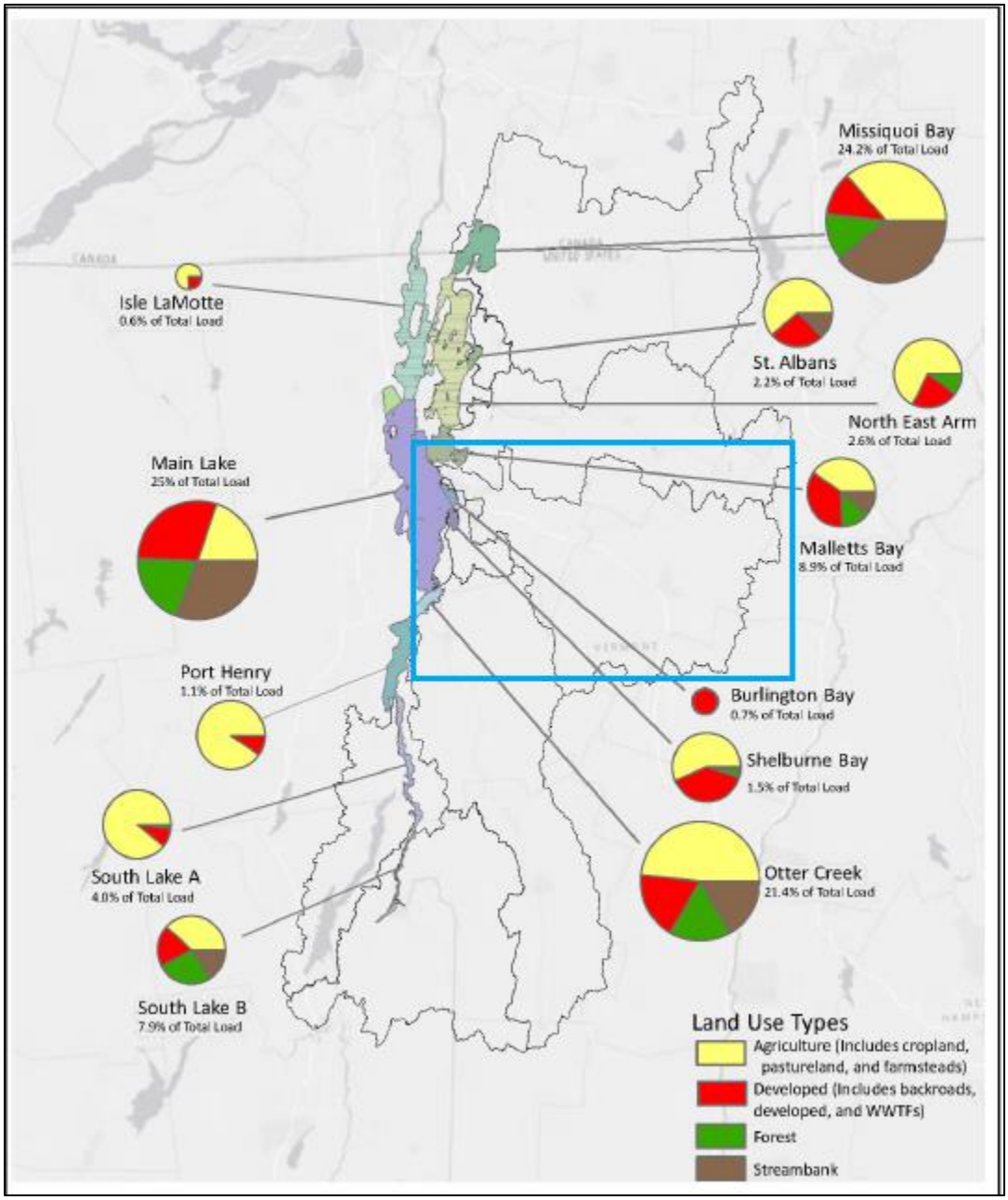
The Basics

A total maximum daily load or TMDL is the amount of a pollutant a waterbody can safely absorb and still meet water quality standards. The maximum pollutant load is divided among the various pollutant sources and locations. In the case of Lake Champlain, there are proposed TMDLs outlining the phosphorus reductions for each of the twelve lake segments required to restore the Lake and meet Vermont's Water Quality Standards. The Winooski Basin inputs drain wholly into the Main Lake Champlain segment. Phosphorus as a pollutant leads to increased algal blooms, including cyanobacteria blooms.

In 2002, the U.S. Environmental Protection Agency (EPA) approved a Lake Champlain Phosphorus TMDL that was prepared by the States of Vermont and New York. In 2011, the EPA concluded that two elements of the TMDL did not comply with EPA regulations and guidance, and thus their approval of the 2002 TMDL was withdrawn. The EPA approved a new TMDL and the Vermont Lake Champlain Phosphorus TMDL Phase 1 Implementation Plan in September 2016 and the State of Vermont is undertaking a new aggressive restoration plan for Lake Champlain and its tributaries. The approved plan addresses all major sources of phosphorus to Lake Champlain and involves new and increased efforts from nearly every sector of society, including state government, municipalities, farmers, developers, and homeowners.

Priority actions have been identified to address surface water stressors (and attendant sources and causes of pollutants) and have been incorporated into the Winooski River Basin Implementation Table (Table 37), see sources column to identify actions that meet the Phase I objectives. The specific projects to implement related actions are identified in VDEC's online Watershed Projects Database. In addition, a list of highest priority catchments (the area draining to a surface water with an average size of 5 square kilometers) has been identified through the downscaled Soil and Water Assessment Tool, or "SWAT" modeling analysis, which allows geographic targeting as the highest priority for project ("BMPs" or best management practices) implementation, and the prospective locations for practices in a general sense (see Figures 15, 16, 18 and 19). Specific BMPs will be identified through ongoing land use sector assessments to leverage funding and target project development in these highest priority catchments and will be the focus on ongoing coordination efforts with partners to maximize project implementation over the next 5 years, and in future iterations of Tactical Basin Plans, concurrent with VDEC's Accountability Framework.

Figure 7. Vermont sources of phosphorus loading to Lake Champlain segments, by land use; annual average of 2001-2010. **The Winooski Basin extent is highlighted in the blue box** (Source: US Environmental Protection Agency, 2016**).**

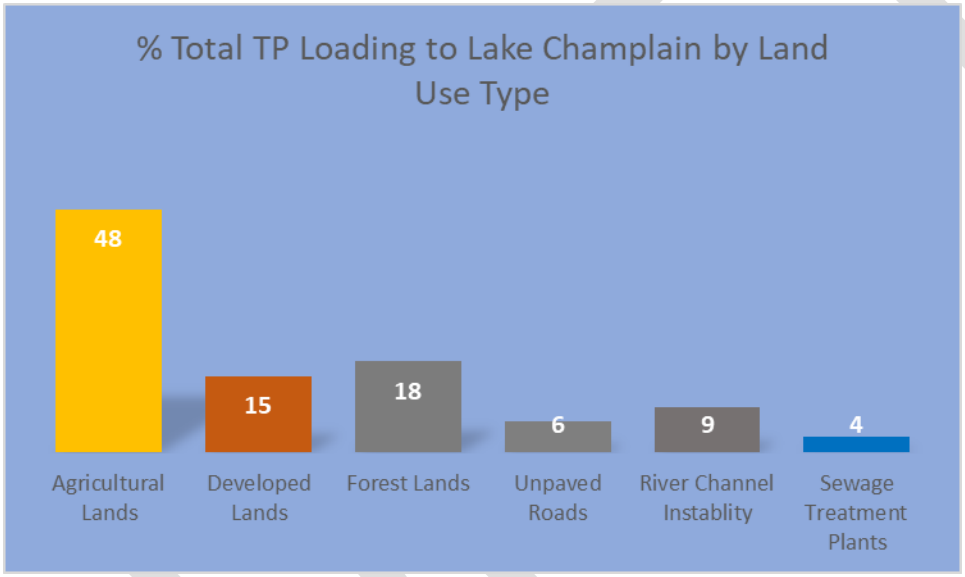


Phosphorus in the Lake comes primarily from nonpoint sources (Figure 7). Nonpoint sources deliver phosphorus from the land to our waterways by rain or snowmelt. Nonpoint sources of phosphorus come from roads, parking lots, lawns, agricultural and logging operations, and eroding stream channels. Point source discharges of

phosphorus include regulated stormwater discharges from agricultural production areas, sewage treatment plants and other concentrated points of discharge.

Measuring the phosphorus content of water that comes out of a pipe (point source) is less complicated than measuring phosphorus content of water flowing over land surfaces (non-point source). As a result, determining phosphorus loading of non-point sources utilizes environmental modeling based on long-term field measurements, land use information from satellite imagery and LiDAR data. The overall sources of phosphorus loading to Lake Champlain are given in Figure 8. More information on how phosphorus loading was projected in the Lake Champlain Basin can be found in Chapter 5 of the Phosphorus TMDLs for Vermont Segments of Lake Champlain.

Figure 8. Source of phosphorus loading to Lake Champlain by land use. (Source: Tetra Tech Inc., 2016)

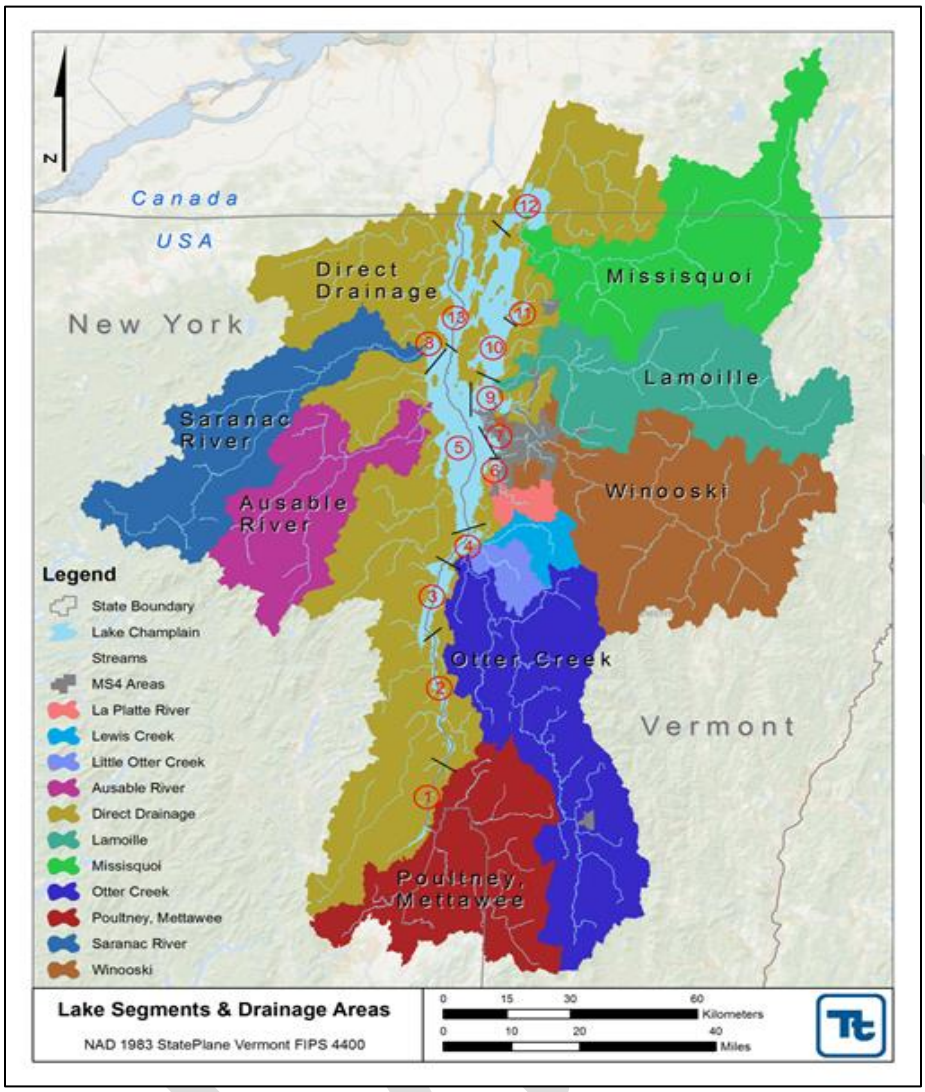


The Winooski Tactical Basin Plan will report actions to reduce phosphorus loading per land use type in sub-watersheds and catchments within the Basin. However, the reduction of phosphorus to fully restore Lake Champlain could take decades in some areas. Accomplishing all the necessary phosphorus reduction actions on the land that drains to the Lake will require many phases of action. Progress will be tracked incrementally through internal VDEC tracking systems and a portion of the progress will be tracked in the Watershed Projects Database, which is an electronic extension of the implementation tables included in ftactical basin plans.

The Winooski Basin and the Lake Champlain Phosphorus TMDL

The Lake Champlain Basin is divided into numerous drainage areas located in Vermont, New York State and Quebec, as depicted in Figure 9.

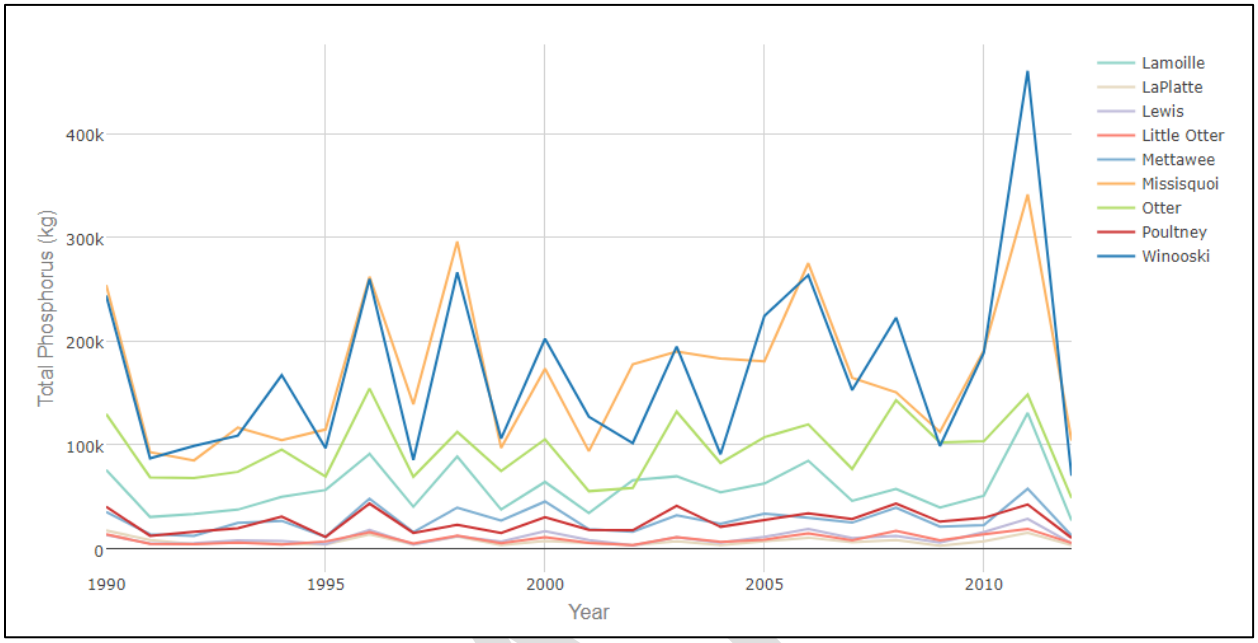
Figure 9. Lake segments and drainage areas of the Lake Champlain Basin. The Winooski Basin drains wholly to the Main Lake segment of Lake Champlain.



Vermont contributes about 69 percent (630.6 MT/yr.) of the total phosphorus load per year to Lake Champlain in comparison to Quebec at 9 percent (77 MT/yr.) and New York at 23 percent (213.8 MT/yr.).

Based on estimates provided in the 2016 Lake Champlain TMDL, nonpoint phosphorus sources from the Winooski Basin contribute approximately 72% of the average total delivered (non-point source and point source) from the Vermont portion of the Lake Champlain in a given year. However, total annual total phosphorus (TP) loading varies from year to year based on flow and on-going land use. Measured TP loading from the major river basins in the Lake Champlain Basin is shown in Figure 10.

Figure 10. Total phosphorus annual flux as measured at monitoring stations on the major tributaries of Lake Champlain



To meet the Lake Champlain Phosphorus TMDL expectations, total annual TP loading reductions from the Winooski Basin will be significant. The following sections will address how these requirements can be met across all sectors within the Winooski Basin including regulatory and non-regulatory actions.

Lake Champlain Phosphorus TMDL Phase II Plan

The Lake Champlain Phosphorus Total Maximum Daily Load (LC TMDL) establishes the allowable phosphorus loadings, or allocations, from the watershed for the lake water quality to meet established standards. These allocations represent phosphorus loading reductions that are apportioned both by land use sector (developed land, agriculture, etc.) and by lake watershed basin (South Lake, Otter Creek, etc.). Due to the large size of the Lake Champlain watershed in Vermont, the modeling techniques used to estimate loading were implemented at a coarse scale. For example, the modeled loading at the mouth of the major river basins is based on monitoring data and represents the collective inputs from the various land uses and physical features of the entire watershed. Overall, this is useful to estimate the necessary level of phosphorus-reducing Best Management Practices (BMPs) required to reduce overall load. However, when looking at smaller scale areas such as a municipality, a farm or a local road network, it's necessary to complete a detailed on-the-ground analysis to determine appropriate actions for the area.

As part of the LC TMDL development, EPA developed a Reasonable Assurance analysis at the major-basin scale to determine if it was theoretically possible to obtain the necessary phosphorus reductions. By using modeling results for the entire Champlain Basin, the TMDL showed that through a concerted effort across all phosphorus sources, it is possible to reach the lake loading targets with appropriate application of BMPs. However, because this exercise was conducted at the major-basin scale, specific direction was not provided about how individual BMPs should be applied. It is through the development of the Tactical Basin Plans that more precise opportunities for BMPs can be identified and prioritized for implementation at the catchment scale – but individualized assessments and on the ground field assessments are necessary to identify specific BMP's. Where such assessments have been completed and specific projects identified, these BMP's have been listed in the Watershed Projects Database.

Permit programs and site specific BMPs beyond the scope of specific programs will together form the backbone of the LC TMDL implementation process, many guided by the content of the Tactical Basin Plans. While many permit programs will be "self-implementing", in many instances BMP implementation will proceed in a two-step process of first knowing "where to look" for opportunities (assessment) followed secondly by "what to do" (BMP selection and installation). Many of the phosphorus reduction programs require an initial assessment phase to identify what BMPs may already exist on the landscape and where others need to be placed. In some instances,

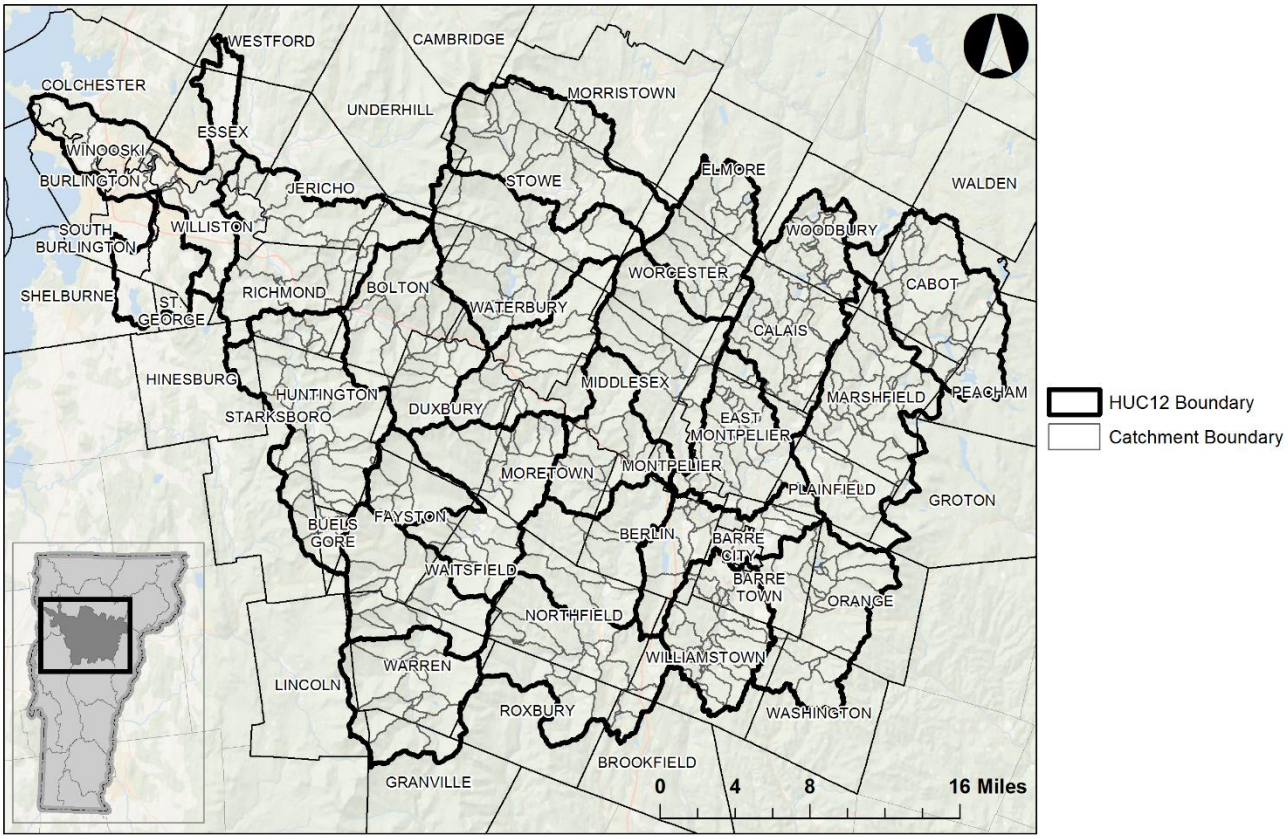
the Tactical Basin Plans can aid prioritization of where to look first, such as expected high phosphorus producing areas. After the assessment phase, BMP implementation can be prioritized and carried forward. Additionally, the Tactical Basin Plans can identify known beneficial projects, the "what to do", prioritize them for funding so that implementation can be expedited and tracked transparently.

The LC TMDL also incorporates an Accountability Framework that aims to ensure that phosphorus reduction actions are being implemented at a sufficient pace to see results in the lake. While a specific timeline for lake improvement is not specified by the TMDL, an updated evaluation of the phosphorus reduction needed to meet TMDL targets will be identified within each Tactical Basin Plan on a 5-year rotating basis. Estimating the potential phosphorus reductions expected from site specific actions is one way of determining if the level of effort is sufficient compared to the overall TMDL goals.

In conjunction with tactical basin planning is a project implementation tracking system that VDEC also developed. This system tracks implementation of projects across all sectors and applies an expected phosphorus reduction estimate to each. Over time, as projects are continually implemented, cumulative estimates of phosphorus reduced by **actual** actions can be reported rather than relying on estimates of **potential** actions.

Several useful modeling products were used to spatially represent where LC TMDL reductions will be most effectively targeted to implement the TMDL. The underlying data from which many of the following analyses originate is the EPA SWAT model (Soil and Water Assessment Tool). This model was developed to estimate phosphorus loading from the Lake Champlain watershed from various land use sectors for development of the TMDL. Discrete SWAT models were calibrated and validated for each of the Hydrologic Unit Code – level 8 (HUC8) watersheds as well as for direct drainages to the lake. Three additional tools were developed from the SWAT modeling results: the HUC – level 12 (HUC12) Tool, the BMP Scenario Tool, and the Clean Water Roadmap which downscales the SWAT modeling from the HUC12 scale to the catchment level. In the analyses that follow, varying geographic scales are used, depending on the source sector; Figure 11 displays the HUC12 and catchment scales.

Figure 11. Comparison of HUC12 and catchment watershed scales within the Winooski River Basin.



HUC12 Tool

The HUC12 Tool (Figure 12) is a Microsoft Excel spreadsheet that displays SWAT estimates of total phosphorus (TP) loading at a HUC12 scale for each lake segment. TP loading estimates (kg/yr.) in the HUC12 Tool are summarized by general land use category for each HUC12 in a lake segment basin (Table 13). In addition, detailed annual load (kg/yr.) and areal loading rate (kg/ha/yr.) estimates can be displayed by land use for each HUC12 watershed. This more detailed information includes the minimum, maximum, mean, median, 25th percentile, and 75th percentile loading rates per hectare for each land use category. In this way, TP loading magnitudes can be compared across all HUC12 watersheds in a lake segment basin as well as different land use categories within a HUC12.

Figure 12. Screenshot of HUC12 Tool display for Main lake segment. The Little River HUC12 is highlighted with resultant TP loading information.

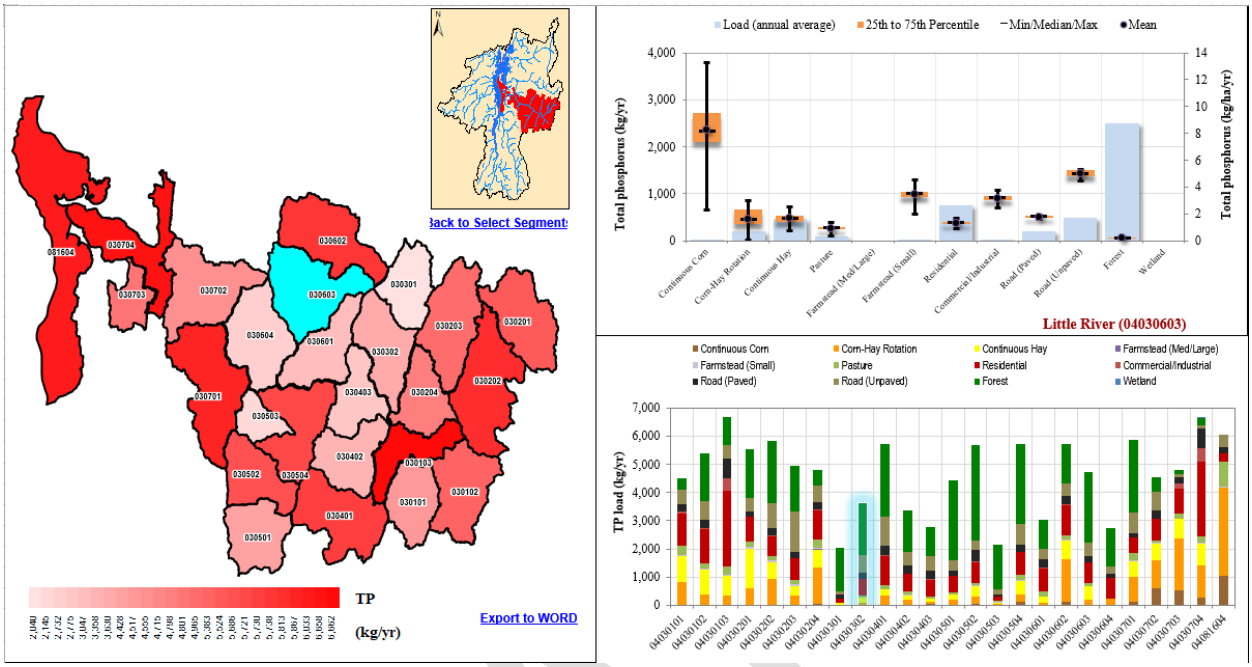


Table 13. General land use categories represented in the HUC12 Tool

HUC12 Tool Land Use Categories	
Continuous Corn	Residential
Corn-Hay Rotation	Commercial/Industrial
Continuous Hay	Road (Paved)
Farmstead (Med/Large)	Road (Unpaved)
Farmstead (Small)	Forest
Pasture	Wetland

BMP Scenario Tool

This Microsoft Excel based tool allows users to apply BMP scenarios at the lake segment basin scale to evaluate the phosphorus load reduction potential of various management actions. The Scenario Tool uses SWAT model results and estimates of BMP efficiencies to answer questions such as: "what is the expected phosphorus reduction if this BMP is

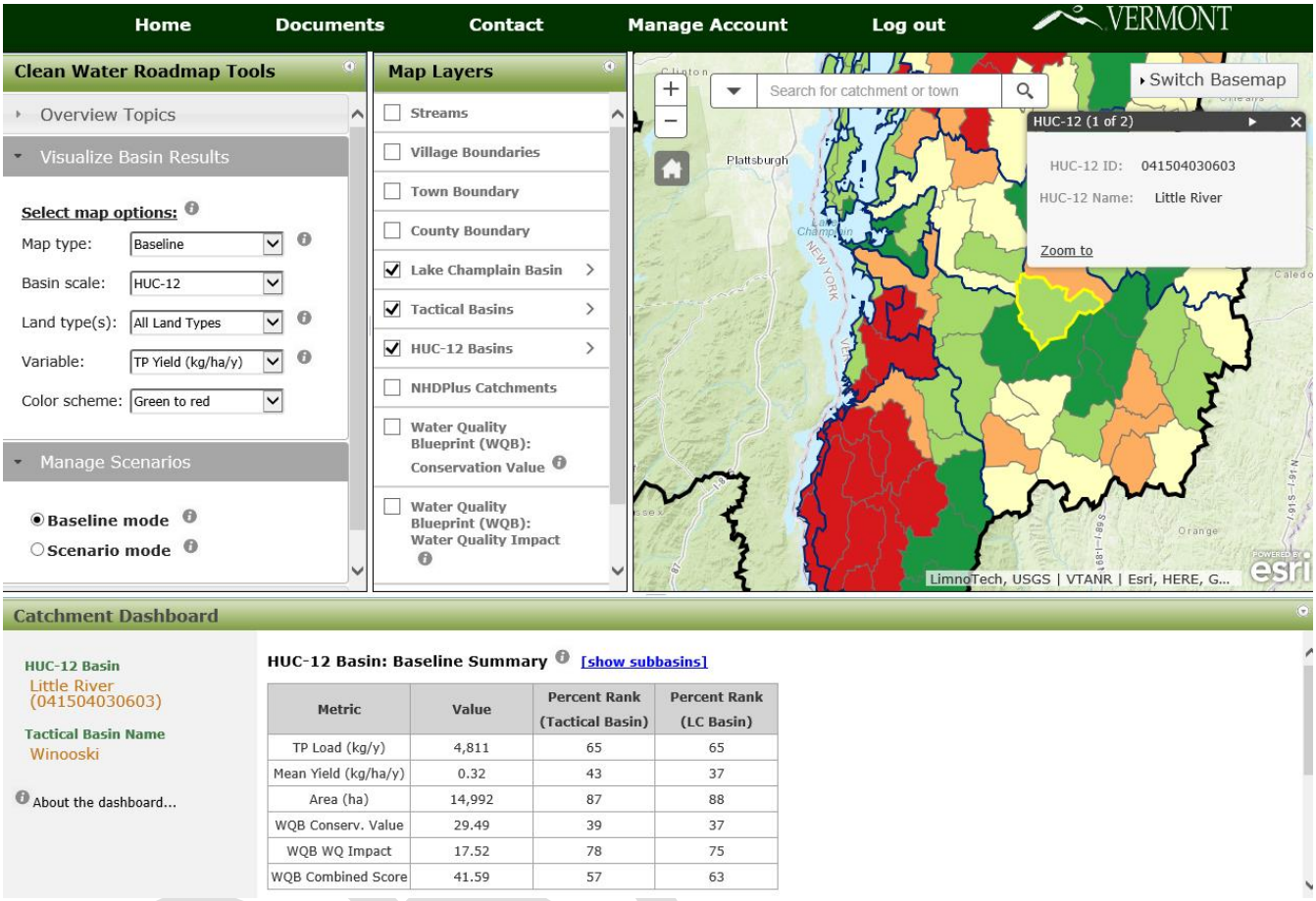
applied to 60% of the applicable area in a lake segment basin?" BMP suitability in a basin is based on SWAT model inputs such as land use, soil type, and slope. Multiple BMPs can be 'applied' in a basin, and BMP scenarios can be evaluated for a range of loading sources: developed lands, forests, agricultural lands, unpaved roads, and streambank erosion. This functionality allows users to evaluate whether a specific management plan has the potential to meet the TMDL loading targets for Lake Champlain. Stored scenarios can be compared with tabular and visual summaries. The tool also contains extensive summary tables and figures of TMDL targets and existing source loads.

Clean Water Roadmap Tool

The Clean Water Roadmap Tool (CWR) is a partnership between VDEC, Keurig-Green Mountain Coffee Roasters, the Nature Conservancy (TNC), and other stakeholders. The overall goal of the CWR is to map the results of the Lake Champlain SWAT model and associated follow-on products, especially EPA's BMP Scenario Tool, along with management actions contained in VDEC's Tactical Basin Plan implementation tables and tracking systems. The CWR provides a description of one way the LC TMDL phosphorus reductions can be achieved, largely based on EPA's reasonable assurance scenario.

The CWR is a map-based application that allows users to click on a specified watershed and receive a summary report of relevant best management practices (BMPs). BMP suitability is assessed using the landscape criteria in SWAT and EPA's Scenario Tool, while implementation table activity locations can be based on data in VDEC's BMP tracking database. The summary data also includes estimated phosphorus loadings based on SWAT modeling (Figure 13). Additional relevant spatial information, such as township boundaries, partner data (TNC's Conservation Blueprint for Water Quality), hydrologically connected backroads, etc., has also be included. The CWR can be used by regional planners, the public, and VDEC staff to identify priority areas and actions for Lake Champlain phosphorus reductions.

Figure 13. Screen shot of the Clean Water Roadmap highlighting TP loading from the Little River HUC12 watershed.



Metric	Value	Percent Rank (Tactical Basin)	Percent Rank (LC Basin)
TP Load (kg/y)	4,811	65	65
Mean Yield (kg/ha/y)	0.32	43	37
Area (ha)	14,992	87	88
WQB Conserv. Value	29.49	39	37
WQB WQ Impact	17.52	78	75
WQB Combined Score	41.59	57	63

What follows below - through a series of discussions, tables, and graphics - is an expression of the TMDL reductions required in a site-specific manner as currently possible. Many of these expressions rely on modeled information that are limited by certain spatial extents even though some sector analyses may be more developed based on the currently available data. Because of this, the summing of loading results across different sectors may not "add up" to overall basin loading estimates but are sufficient for planning-level analyses. In some instances, this information will aid the "where to look" aspect of planning while other instances provide the "what to do". Over time, additional assessment information will more accurately inform the identification of BMP opportunities and it is the goal of the Tactical Basin Plans to present the most up-to-date information available to facilitate implementing the LC TMDL.

Table 14 below provides the final phosphorus allocations and the resulting reductions required for the Main Lake segments of Lake Champlain. These values are taken directly from the final LC TMDL and the Phase I Implementation Plan (2016). Table 14

also indicates how the major land use phosphorus sources are broken down into more specific categories that are addressed using specific approaches as well as how each source is allocated under the TMDL.

Table 14. Percent reductions needed to meet TMDL allocations for the Main Lake segment from the Winooski River Basin (adapted from 2016 Phosphorus TMDLs for Vermont Segments of Lake Champlain, Tables 7 & 8)

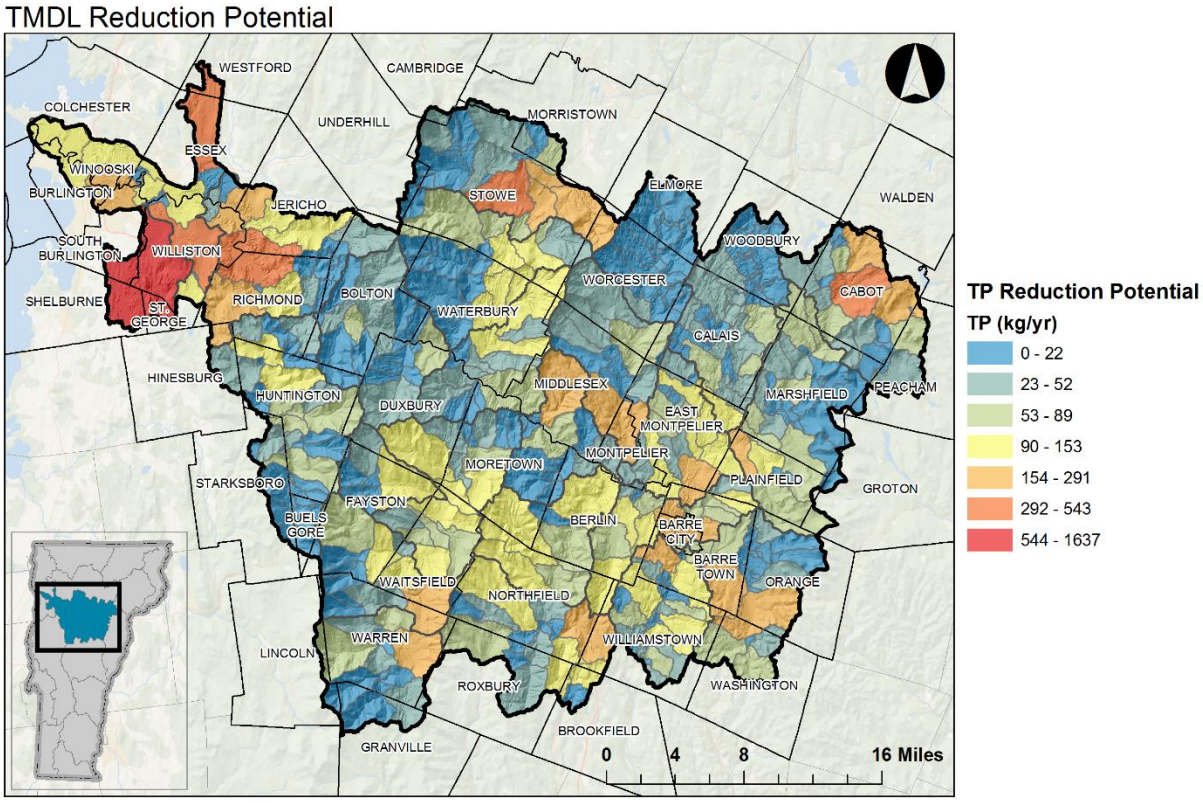
Source	Category	Allocation category	Total allocation for basin (MT/yr.)	Percent reduction required for basin
Forest	All lands	Load	30.90	5.0%
Stream Channels	All streams	Load	35.66	28.9%
Agriculture	Fields/pastures	Load	16.22	46.9%
	Production Areas	Wasteload	0.43	80.0%
Developed Land[2]	Summary		28.02	20.2%
	VTrans owned roads and developed lands	Wasteload		
	Roads MRGP	Wasteload		
	MS4	Wasteload		
	Larger unregulated parcels	Wasteload		
Wastewater[1]	WWTF discharges	Wasteload	9.85	61.1%
	CSO discharges	Wasteload	NA	NA

[1]Percent change from pre-TMDL permitted loads
[2]Includes reductions needed to offset future growth

Figure 14 below illustrates the required level of TP reductions identified in Table 14 at the catchment-scale. The transition from blue to red indicates a greater level of TP reduction across all catchments, as prescribed for all land use sectors across the Basin. For example, for any given catchment, the TMDL reduction percentage is applied to each appropriate land use sector, based on the TMDL reductions required for that

sector (Table 14). Then, all reductions are summed for the catchment and displayed on a relative loading scale.

Figure 14. Estimated total TMDL reductions from land uses in the Winooski Basin at the catchment scale



Within the Basin, the top 20 catchments with the greatest overall identified TP reductions are identified in Table 15. The catchments are located by the primary town they occur in and primary waterbody they discharge to. The total TMDL reduction is broken down by each land use sector. If the total required LC TMDL reductions were applied to these top 20 catchments, which make up ~4% of the total number of catchments, then 32% of the overall needed basin reduction would be realized. For context, there are 480 total individual catchments in the Winooski River Basin.

Table 15. Catchments with the greatest overall TP reductions as identified in the TMDL.

Catchment ID	Town name	Ag lands reduction (kg/yr.)	Developed lands reduction (kg/yr.)	Farmstead reduction (kg/yr.)	Forest reduction (kg/yr.)	Potential TP reduction
4578814	Williston	1375.0	234.8	21.6	5.8	1637.3
4577340	Stowe	439.4	89.7	3.9	9.7	542.7

Catchment ID	Town name	Ag lands reduction (kg/yr.)	Developed lands reduction (kg/yr.)	Farmstead reduction (kg/yr.)	Forest reduction (kg/yr.)	Potential TP reduction
4576908	Essex	440.8	73.7	10.6	3.5	528.7
4578812	Williston	367.8	139.9	6.2	2.7	516.6
4577416	Cabot	275.7	52.1	14.4	14.0	356.3
4578848	Richmond	238.7	86.0	12.2	4.8	341.7
4578846	Jericho	259.8	22.7	5.2	3.3	291.1
4577986	Orange	175.7	63.9	7.3	12.5	259.3
4577342	Stowe	191.9	43.7	1.0	4.9	241.5
4577996	Waitsfield	169.2	32.7	15.2	23.2	240.3
4577774	Warren	148.2	44.3	8.7	18.6	219.8
4577934	East Montpelier	149.8	48.4	3.9	2.4	204.5
4578832	South Burlington	22.0	176.9	0.0	0.3	199.2
4577822	Stowe	139.3	30.4	3.0	17.8	190.5
4578766	Richmond	131.5	43.1	7.1	5.5	187.3
4577690	Barre Town	153.0	25.3	6.0	2.6	187.0
4577974	Barre Town	85.0	75.5	6.6	7.9	175.0
4577388	Cabot	134.7	26.0	6.7	7.4	174.8
4577916	Middlesex	60.2	97.3	3.4	12.3	173.3
4577680	Barre Town	30.4	137.2	2.6	1.7	171.9
Percent of total TP reduction if all sector allocations are applied to these catchments						**31.5%**

Limiting Phosphorus Losses from Managed Forest

Vermont adopted rules in 1987 for Acceptable Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont. The AMPs are intended and

designed to prevent any mud, petroleum products and woody debris (logging slash) from entering the waters of the State and to otherwise minimize the risks to water quality. The AMPs are scientifically proven methods for loggers and landowners to follow for maintaining water quality and minimizing erosion.

The Vermont Department of Forests, Parks, and Recreation (FPR) updated the AMPs effective as of October 22, 2016. Subsequent updates have occurred spring of 2018 (expected approval in May or June 2018) to include standards for permanent crossing on intermittent streams. Key modifications include:

- Require compliance with standards set forth in the VDEC Stream Alteration General Permit for actions including the installation and sizing of permanent stream crossing structures on perennial streams.
- Require compliance with standards set forth in the AMP rules' Table 2a or 2b when installations require replacement or new installations. Culvert may also be sized to accommodate the active channel as observed at the crossing site on intermittent streams.
- Strengthen standards pertaining to temporary stream crossing practices on logging operations. The standards include:
    - Better management of ditch water on approaches to stream crossings. The proposal is to prohibit drainage ditches along truck roads from terminating directly into streams and to specify a minimum distance for installing turn-outs. Drainage ditches approaching stream crossings must be turned out into the buffer strip a minimum of 25 feet away from the stream channel, as measured from the top of the bank.
    - Better management of surface water runoff from skid trails, truck roads and temporary stream crossings on logging operations. The proposal is to prevent surface runoff from entering the stream at stream crossings from skid trails and truck roads and to specify a minimum distance for installing surface water diversion practices, such as drainage dips. Surface runoff is to be diverted into the buffer strip at a minimum distance of 25 feet from the stream channel, as measured from the top of the bank.
    - Better management of stream crossings after logging. The proposal is to prevent erosion and to specify a minimum distance from the stream for diverting runoff. Upon removal of the temporary stream crossing structures, the site is to contain water bars 25 feet from the stream channel on downhill approaches to the stream crossing to divert runoff into the

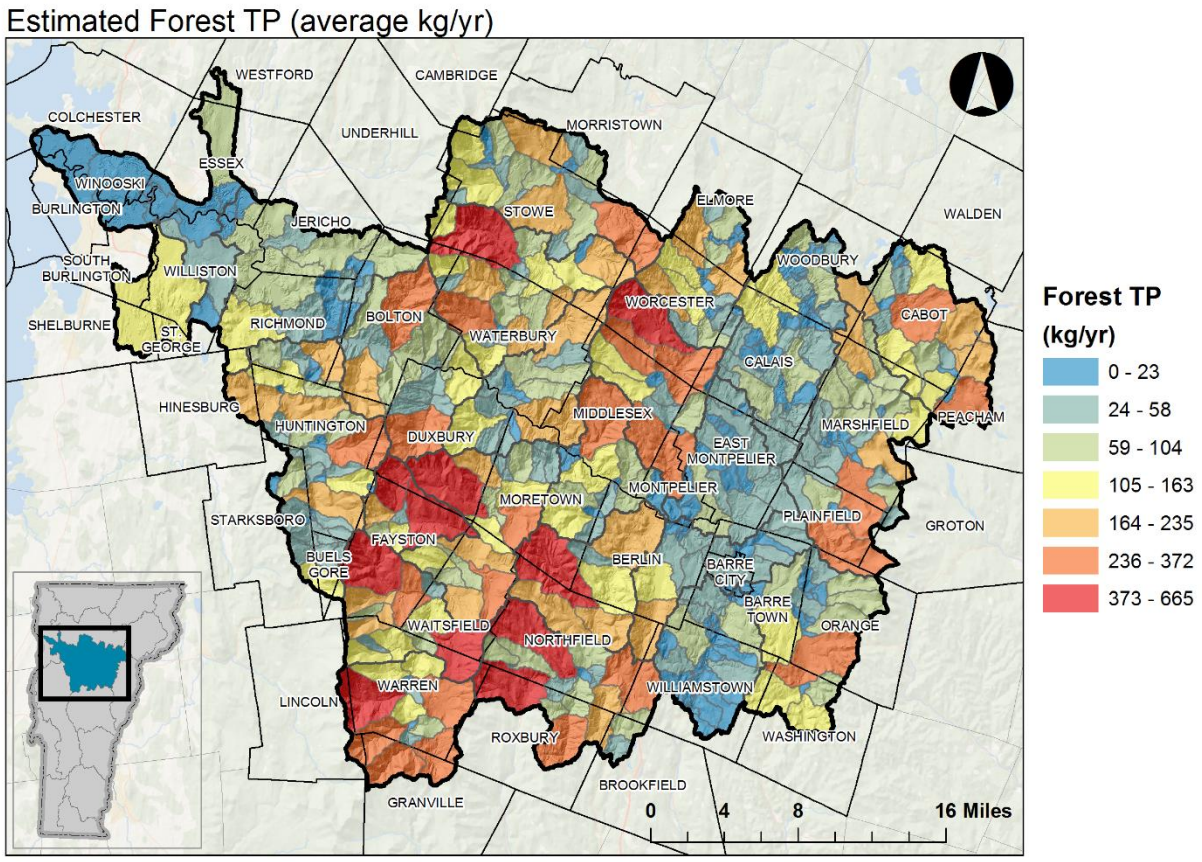
buffer to capture sediment before entering the stream. Additionally, all exposed soil, at a minimum of 50 feet on each side of the crossing, must be stabilized with seed and mulch according to application rates specified in the AMPs.

- Include a new AMP to address the management of petroleum products and other hazardous materials on logging operations. Such materials must be stored in leak-proof containers, place outside of buffer strips, and must be removed when logging is completed.
- Enhanced stream buffer guidance in the AMPs and established metrics for minimum residual stand density, stand structure and crown cover.
- Enhanced options and guidance with metrics provided for soil stabilization to establish temporary and permanent ground cover.
- Better clarification provided for selection and spacing of water diversions on skid trails and truck roads both during and immediately after logging.
- Increased seeding/mulching of exposed soil adjacent to streams and other bodies of water from 25 feet to 50 feet

For Winooski Basin, an overall TP reduction target of 5% has been allocated to all forest lands. Based on documentation that the primary sources of phosphorus from forested areas are forest roads and harvest areas, and that AMPs have been revised (effective October 22, 2016) to address better management of road erosion and harvest areas to avoid water quality impacts, EPA suggests the 5% reduction called for in the Reasonable Assurance scenario is easily supported.

Based on watershed modeling in support of the TMDL, the catchments are displayed in Figure 15 in order of increasing TP export – from blue to red. While TP loading rates are generally low in forested areas, there are situations which could exacerbate loading. Gleaned from the modeling input data, areas of steep slopes and thin soils could be most problematic for forest road building and harvest activity. It is these areas that could receive the most activity oversight to control erosion.

Figure 15. Estimated forest TP loading for the Winooski River at the catchment scale



The mapped catchment TP export is also shown in Table 16 which identifies the highest-loading catchments from Figure 15 by town and lists the forest load as well as the potential phosphorus load reduction if the respective lake segment reduction targets were applied. If allocated reductions were completely applied to these top catchments, approximately 60% of the necessary reductions from forest land could be realized.

Table 16. The top 11 modeled catchments for forest load export (correspond to red catchments in Figure 15)

Catchment ID	Town Name	Forest TP (kg/yr.)	Potential TP Reduction (kg/yr.)
4577964	Fayston	665.5	33.3
4577932	Duxbury	604.0	30.2
4578008	Warren	554.8	27.7
4577646	Fayston	514.2	25.7
4577700	Moretown	491.3	24.6
4577996	Waitsfield	463.2	23.2
4577828	Stowe	448.8	22.4
4577992	Northfield	408.6	20.4
4577850	Worcester	405.2	20.3
4577940	Fayston	398.6	19.9
4578004	Roxbury	389.2	19.5
Percent of total Forest TP reduction if sector allocations are applied to these catchments			**15.3%**

Reducing Phosphorus Attributable to Unstable Stream Channels

The Lake Champlain Phase I Implementation Plan recognizes that we will never achieve the load reduction targets for unstable streams if we focus entirely on restoration activities. If the river corridors along our incised and straightened stream channels are not protected from encroachment, they will be developed, and the potential for cost-effective restoration would be lost forever. River corridor and floodplain protection ensure that the desired channel evolution, stream equilibrium, and natural floodplain function can take place whether it be from restoration activities or through the natural channel forming processes that occur during floods. Further, the estimation of precise subwatershed phosphorus loadings from stream channels would be a scientifically tenuous proposition at any scale smaller than that established by the

TMDL. As such, this Tactical Basin Plan relies on the identification of high-priority subwatersheds where Stream Geomorphic Assessments indicate the highest likelihood for phosphorus reductions thru the pursuit of dynamic stream equilibrium.

Progress to Date

The highest priority stream segments in the Winooski River Basin have been assessed and will be revisited as needed. The stream geomorphic assessments completed for the Basin are identified in Table 39, Appendix B. The resulting project priorities are summarized in Table 7 and listed in the online Watershed Projects Database. The increased number of completed priority projects, including protection as well as remediation, reflect an increasing interest in partners over the last 10 years to become involved in project planning and implementation (see Clean Water Board Reports.)

Interest within communities to support river corridor protection or remediation projects has been cultivated based on multiple benefits, including: flood resilience, outdoor recreational opportunities, and habitat function as well as nutrients and sediment reduction. The interest has led to municipally supported projects over the last several years in three Winooski Basin towns: Barre City, Northfield and Stowe, where flood resilience was a primary focus. The ANR contributed to the necessary technical assistance and funding required to enhance flood resilience through the restoration of floodplain.

The interest in the basin to protect the river for the benefit of aquatic biota including salmonids as well as enhanced aesthetics and swimming opportunity has also led to increased community participation in project implementation. As examples, the Huntington Conservation Commission is actively looking for projects to protect a favorite swimming hole and the USFWS is supporting practices that reduce sedimentation to protect Salmonid habitat. Examples of projects to support these interests will include woody riparian plantings, culvert upgrades and corridor protection, which will lead to enhanced equilibrium in a stream's condition.

In addition, the basin has seen an increase in the number of land trusts interested in assisting with river corridor easements, with the Vermont Land Trust (VLT) entering most recently. The ability of the VLT to work with owners of large land holdings may work to accelerate the reforestation of riparian buffers. Over the last ten years, roughly, 22,000 linear feet of stream have been protected with a river corridor easement in the Winooski River Basin.

The most significant work to protect river corridors from encroachment of the built environment has been through the municipal adoption of river corridor protection. ANR continues to provide technical assistance to encourage towns to protect river corridors through municipal zoning, over lays, and conservation. Twenty-three out of the 35 towns that are mostly encompassed by the basin have already protected river corridors. See Flood Resilience Efforts section for additional information.

Measuring Phosphorus Reductions

VDEC has developed a methodology to document long-term achievement of the TMDL allocation for stream channels. Approved by EPA, the methodology still needs to be piloted and database developed to support it.

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

Reach Deficit Score Data							
Phase 2 Incision ratio	Phase 2 Entrenchment	Floodprone to Belt Width Ratio	Phase 2 Channel Evolution Stage	Overall Segment Depature Score	Seqment Equilibrium Deficit Score	Segment Protection Deficit Score	Total Deficit Score
1.5	2.5	0.46	IV	90	50	20	70.0
1.5	5.9	0.93	III	110	70	20	90.0
1.5	2.1	0.41	III	125	75	30	105.0
1.6	4.5	0.64	III	120	80	20	100.0
1.6	5.5	1.26	II	130	90	20	110.0
1.6	10.2	1.50	III	120	80	20	100.0
1.7	4.3	0.68	III	125	85	20	105.0
1.7	1.7	0.31	II	150	110	20	130.0
2.1	1.1	0.15	II	185	135	30	165.0
2.4	1.3	0.27	II	200	160	20	180.0
2.6	1.6	0.24	II	200	160	20	180.0
2.6	1.2	0.27	II	200	160	20	180.0
2.9	1.5	0.34	III	200	160	20	180.0
				Total Watershed Deficit			3117

Parameters used for developing Reach Deficit Score:

- **Incision Ratio** – looking at how connected reach is to the floodplain
- **Confinement** – Entrenchment and Flood-prone to Belt-width ratio – determining how much floodplain is available compared to what should be available
- **Channel Evolution Stage** – Determine how far from equilibrium the reach is
- **Protection** – Consideration for ability of stream to obtain/maintain equilibrium over time

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

Controlling Phosphorus from Agriculture

Load Allocation

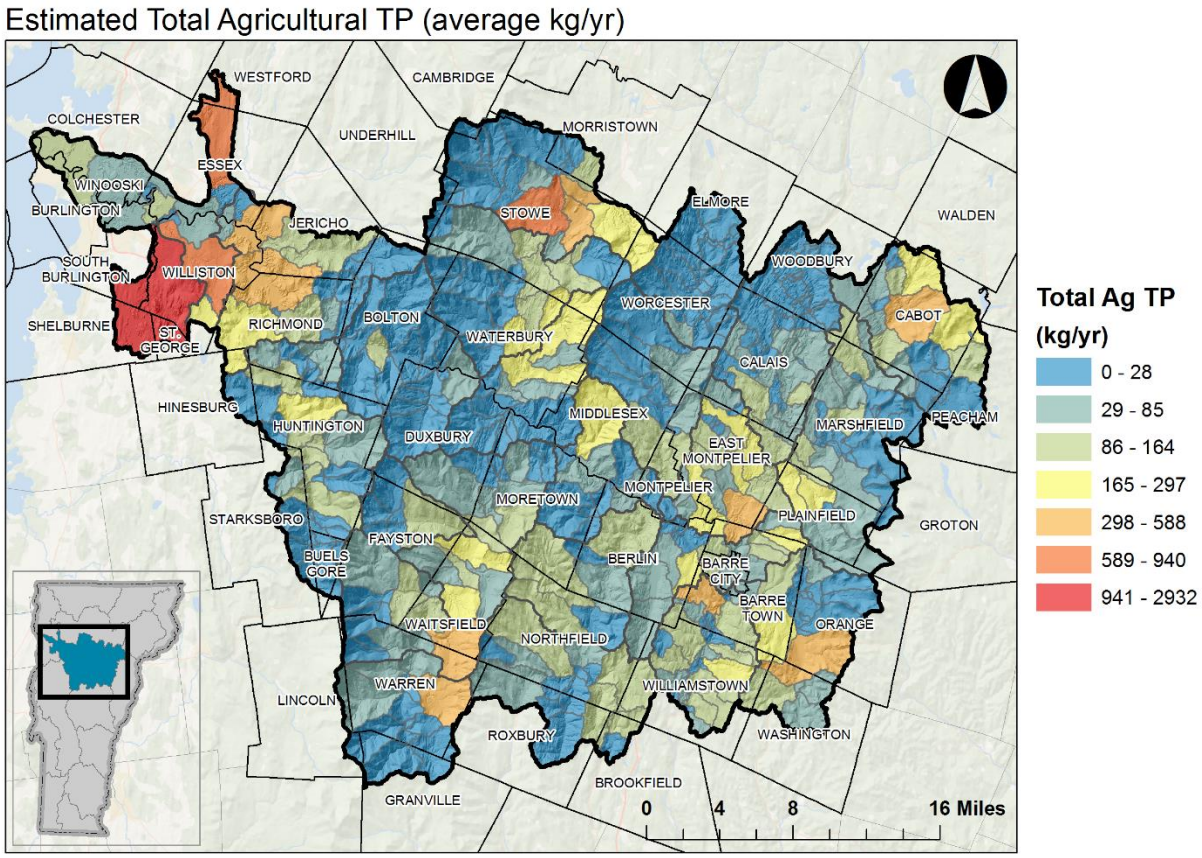
In the Lake Champlain TMDLs, all permissible nonpoint source agricultural land phosphorus loads are considered part of the load allocation. As such, this section describes the estimated phosphorus loading areas in the Basin, potential reductions based on the Reasonable Assurance Scenario, as well as the regulatory programs or provisions that are part of the load allocation for agricultural lands. The latter includes

the Required Agricultural Practices for regulated Small Farms; Large and Medium Farm Permits; and lessons learned from the North Lake (Champlain) Farm Survey. Additionally, other, non-regulatory activities that are aimed at reducing phosphorus loading from the agriculture sector will be discussed in this section as well.

Estimated Phosphorus Loading

Estimated modeled phosphorus loading from agricultural land uses is given in Figure 16 at both the catchment and HUC-12 scales.

Figure 16. Estimated agricultural TP export by catchment.



Another representation of the modeled TP export map is given in Table 17 below. The top TP export catchments are listed and are associated with the town in which they occur. The TP reduction amount is calculated by applying the appropriate agricultural nonpoint reduction allocation according to the lake segment in which the catchment resides. This ranking provides the general reduction opportunities as they exist across

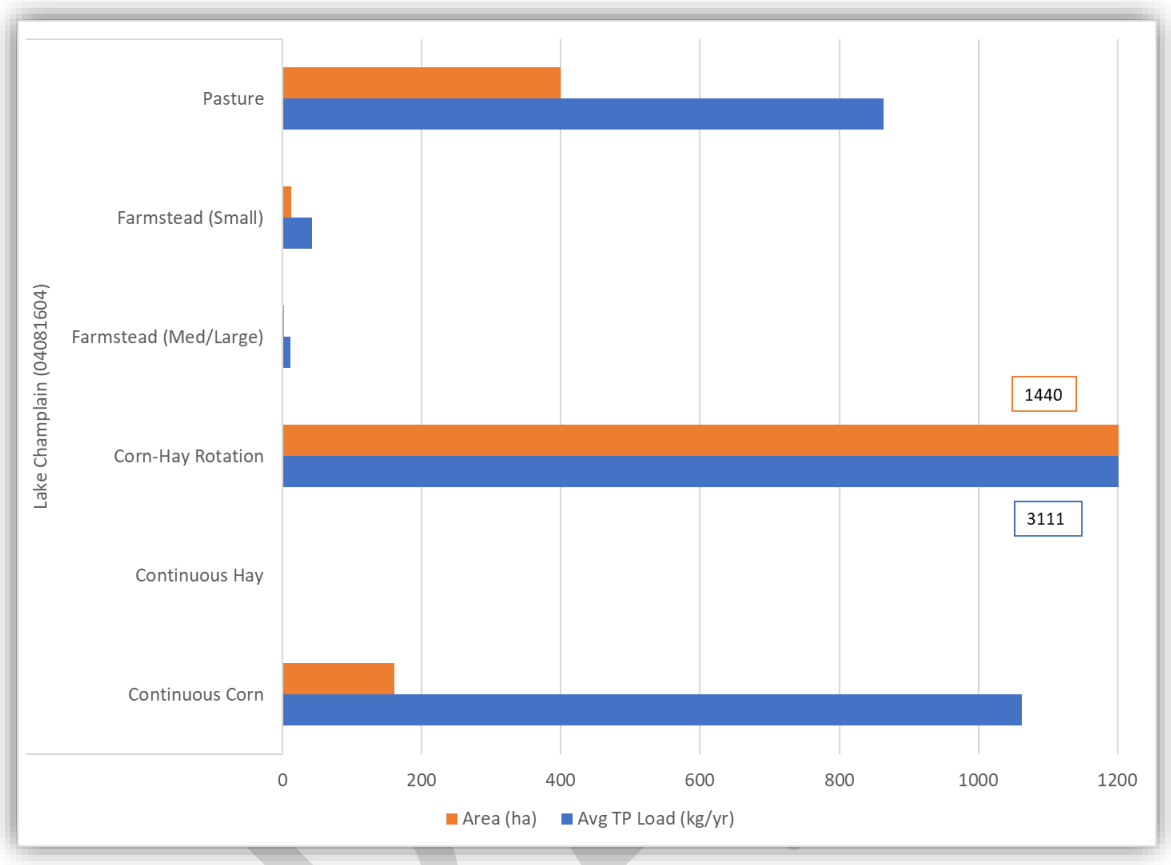
the landscape, but actual practice implementation will vary across catchments as practical assessment information is obtained.

Table 17. Catchments with the highest estimated TP export from agricultural land uses (non-farmstead). These catchments correspond to the red and orange catchments mapped in Figure 16 above.

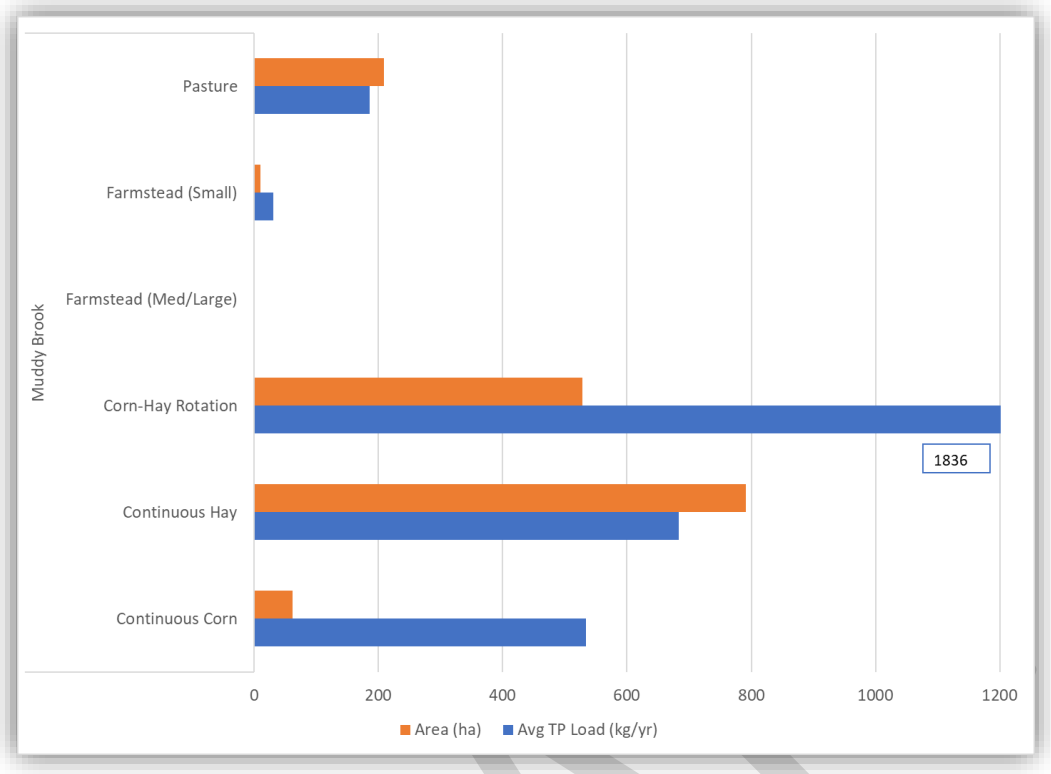
Catchment ID	Town Name	Ag TP (kg/yr.)	Potential TP Reduction (kg/yr.)
4578814	Williston	2931.8	1375.0
4576908	Essex	940.0	440.8
4577340	Stowe	936.9	439.4
4578812	Williston	784.2	367.8
4577416	Cabot	587.9	275.7
4578846	Jericho	554.0	259.8
4578848	Richmond	509.0	238.7
4577342	Stowe	409.3	191.9
4577986	Orange	374.6	175.7
4577996	Waitsfield	360.8	169.2
4577690	Barre Town	326.2	153.0
4577934	East Montpelier	319.5	149.8
4577774	Warren	315.9	148.2
4577334	Stowe	315.5	148.0
Percent of total Ag TP reduction if sector allocations are applied to these catchments			**35%**

Figure 17 (parts A-J) presents the total phosphorus load from various agricultural land uses relative to the area of each land use within a given HUC12 watershed. This identifies land use and location combinations that may be more likely to export more TP per unit area than others.

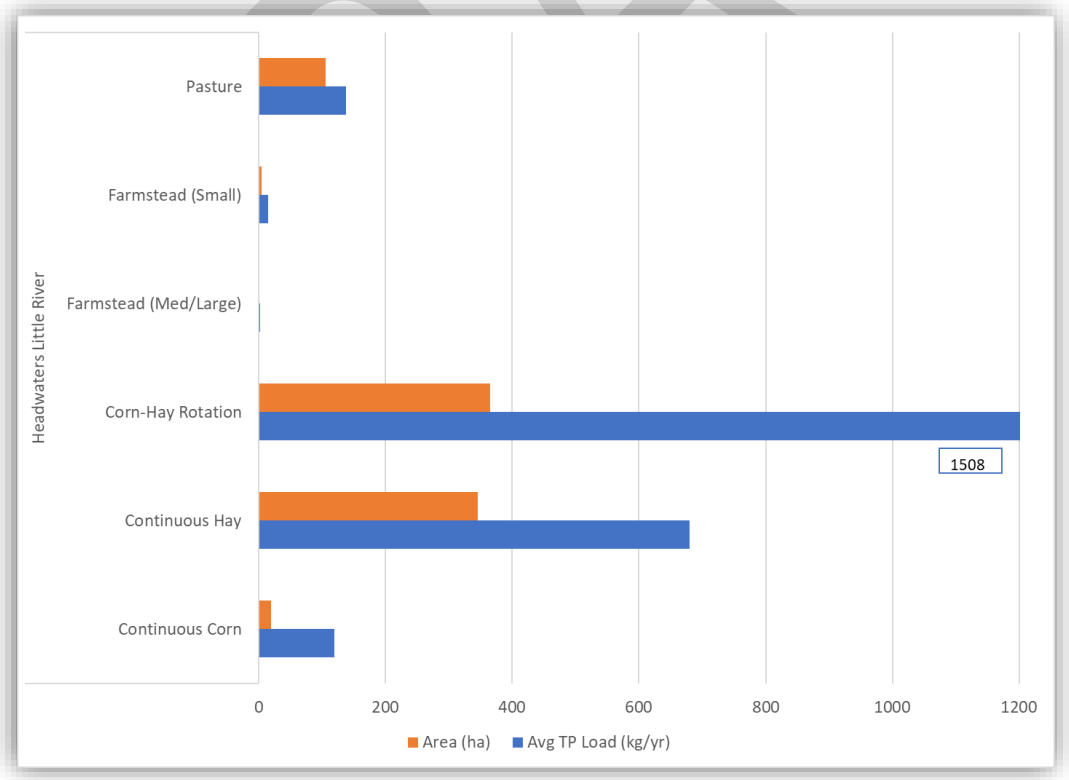
Figure 17(A – J). SWAT loading estimates and corresponding agricultural land areas in the top loading HUC12s (highest to lowest) in the Winooski River Basin.



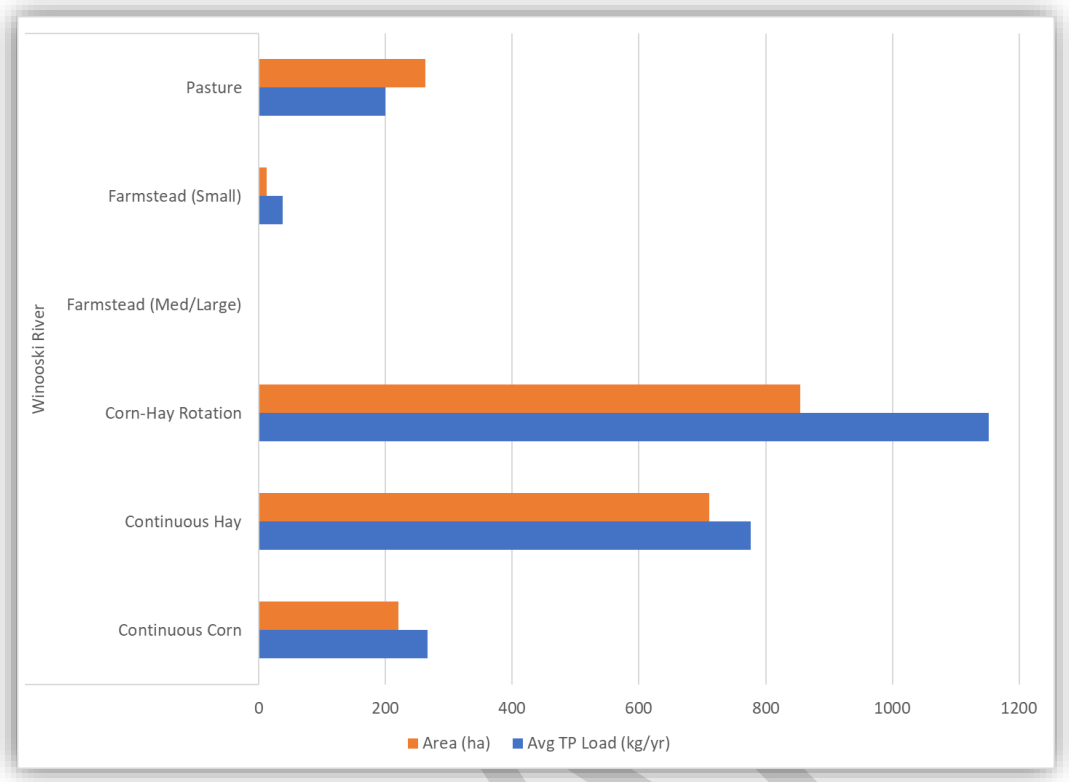
A


Muddy Brook
Pasture
Farmstead (Small)
Farmstead (Med/Large)
Corn-Hay Rotation
Continuous Hay
Continuous Corn
1836
0
200
400
600
800
1000
1200
Area (ha)
Avg TP Load (kg/yr)

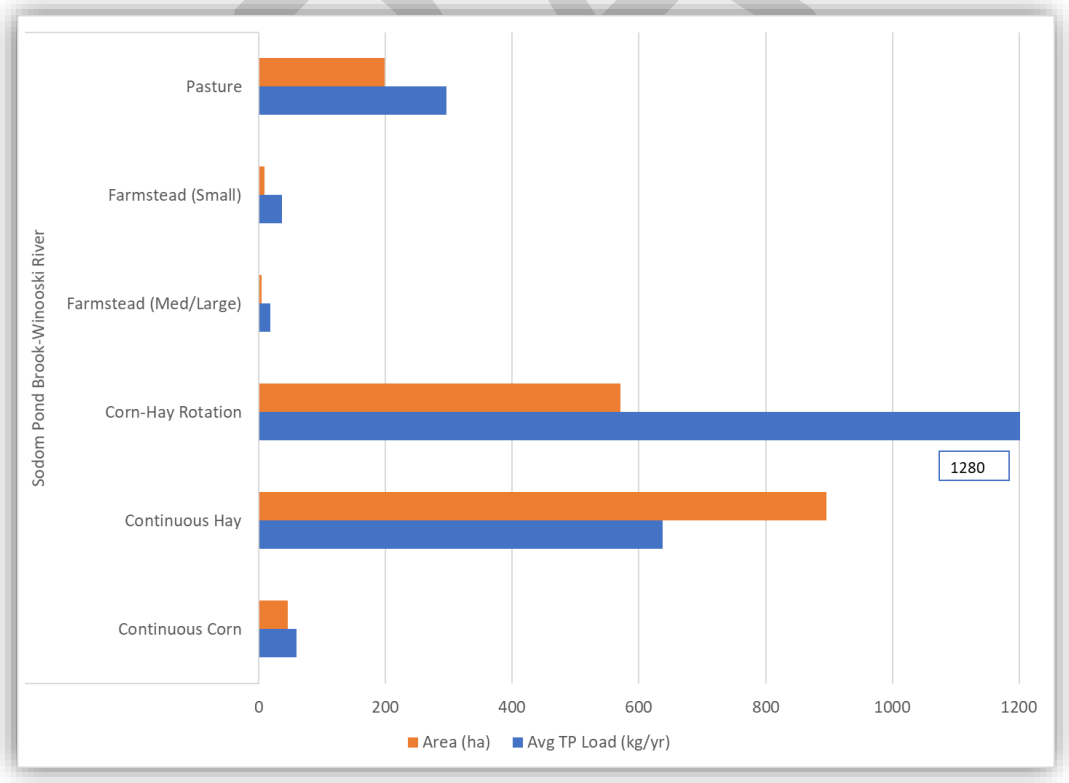
B


Headwaters Little River
Pasture
Farmstead (Small)
Farmstead (Med/Large)
Corn-Hay Rotation
Continuous Hay
Continuous Corn
1508
0
200
400
600
800
1000
1200
Area (ha)
Avg TP Load (kg/yr)

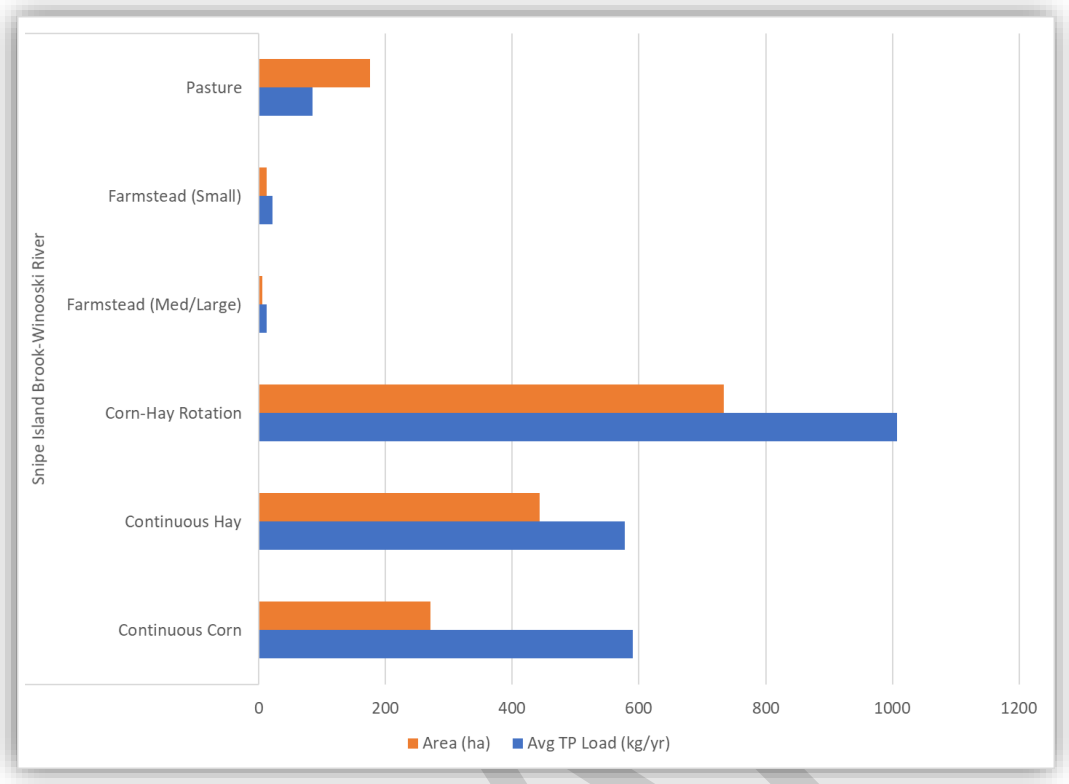
C


Winooski River
Pasture
Farmstead (Small)
Farmstead (Med/Large)
Corn-Hay Rotation
Continuous Hay
Continuous Corn
0
200
400
600
800
1000
1200
Area (ha)
Avg TP Load (kg/yr)

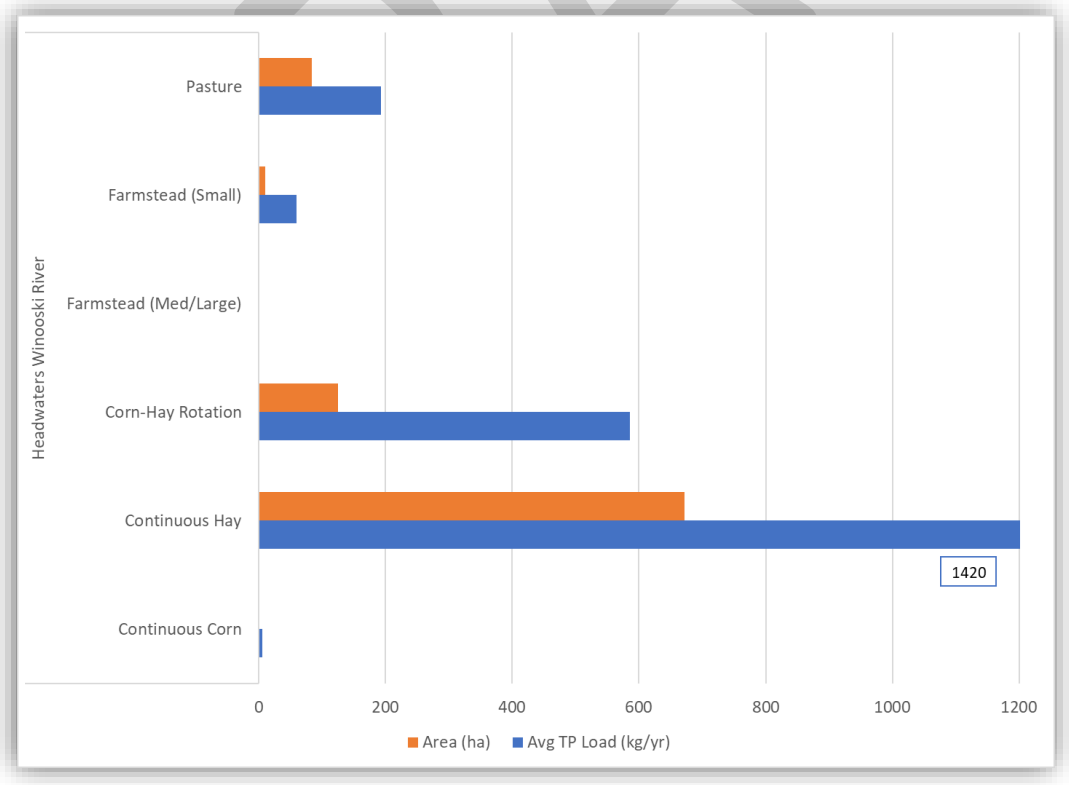
D


Sodom Pond Brook-Winooski River
Pasture
Farmstead (Small)
Farmstead (Med/Large)
Corn-Hay Rotation
1280
Continuous Hay
Continuous Corn
0
200
400
600
800
1000
1200
Area (ha)
Avg TP Load (kg/yr)

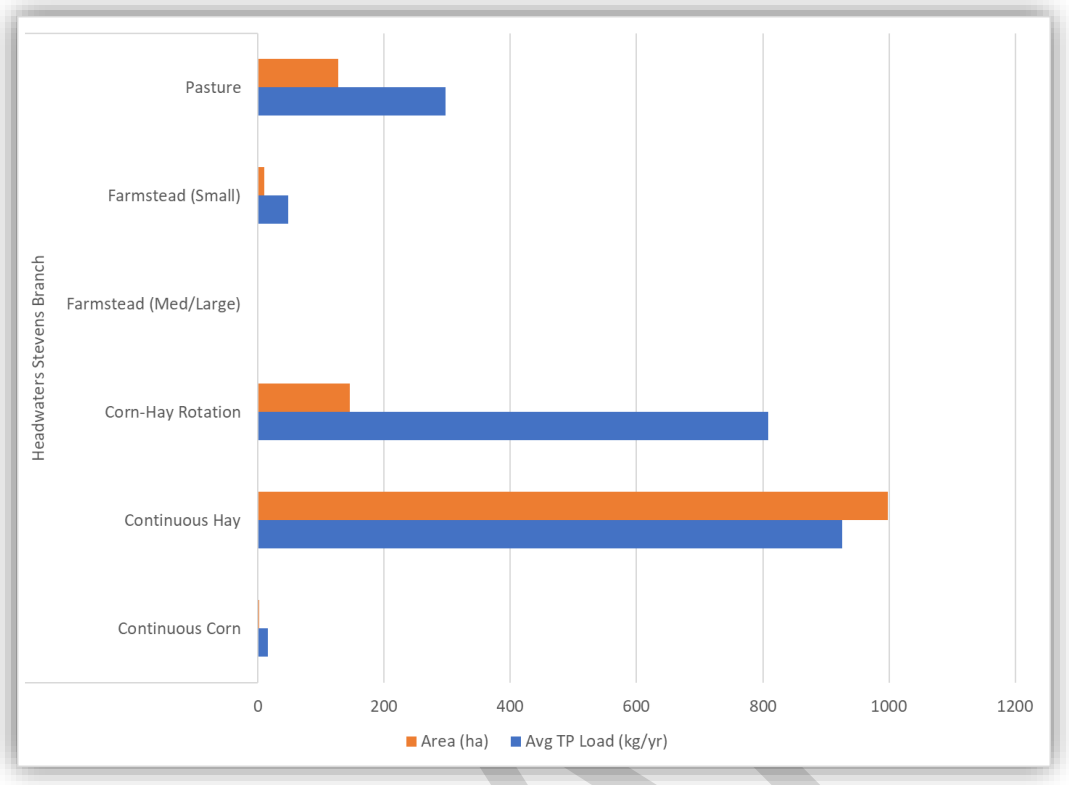
E


Snipe Island Brook-Winooski River
Pasture
Farmstead (Small)
Farmstead (Med/Large)
Corn-Hay Rotation
Continuous Hay
Continuous Corn
0
200
400
600
800
1000
1200
Area (ha)
Avg TP Load (kg/yr)

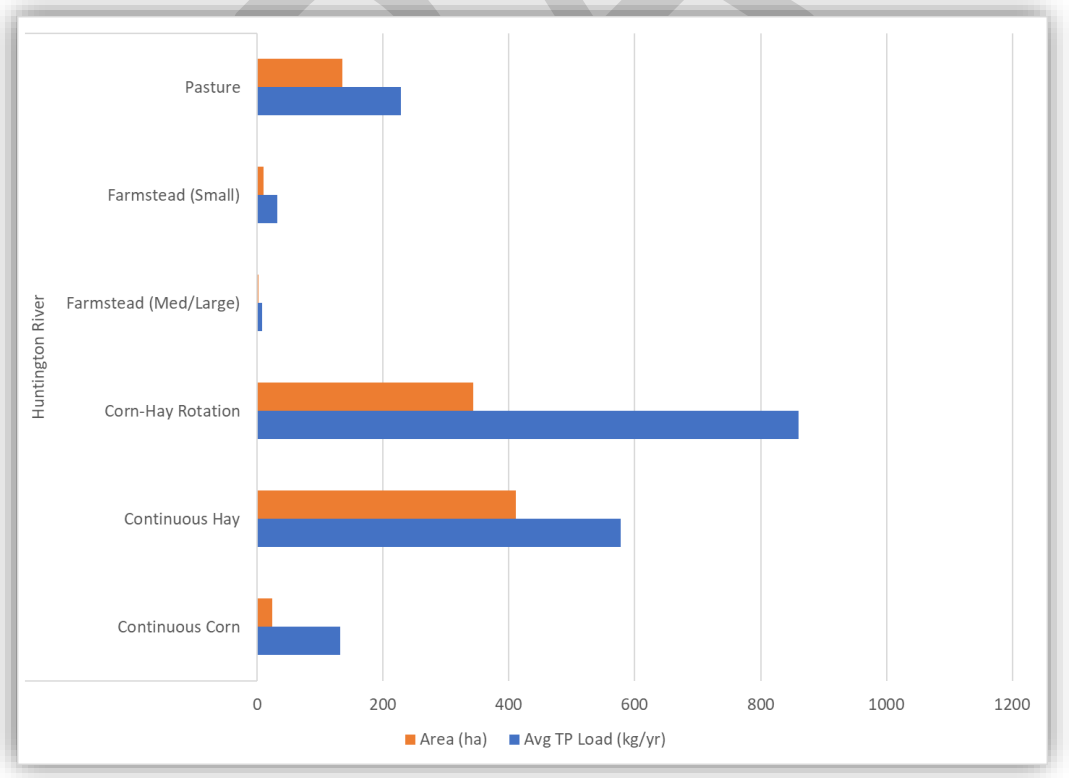
F


Headwaters Winooski River
Pasture
Farmstead (Small)
Farmstead (Med/Large)
Corn-Hay Rotation
Continuous Hay
Continuous Corn
1420
0
200
400
600
800
1000
1200
Area (ha)
Avg TP Load (kg/yr)

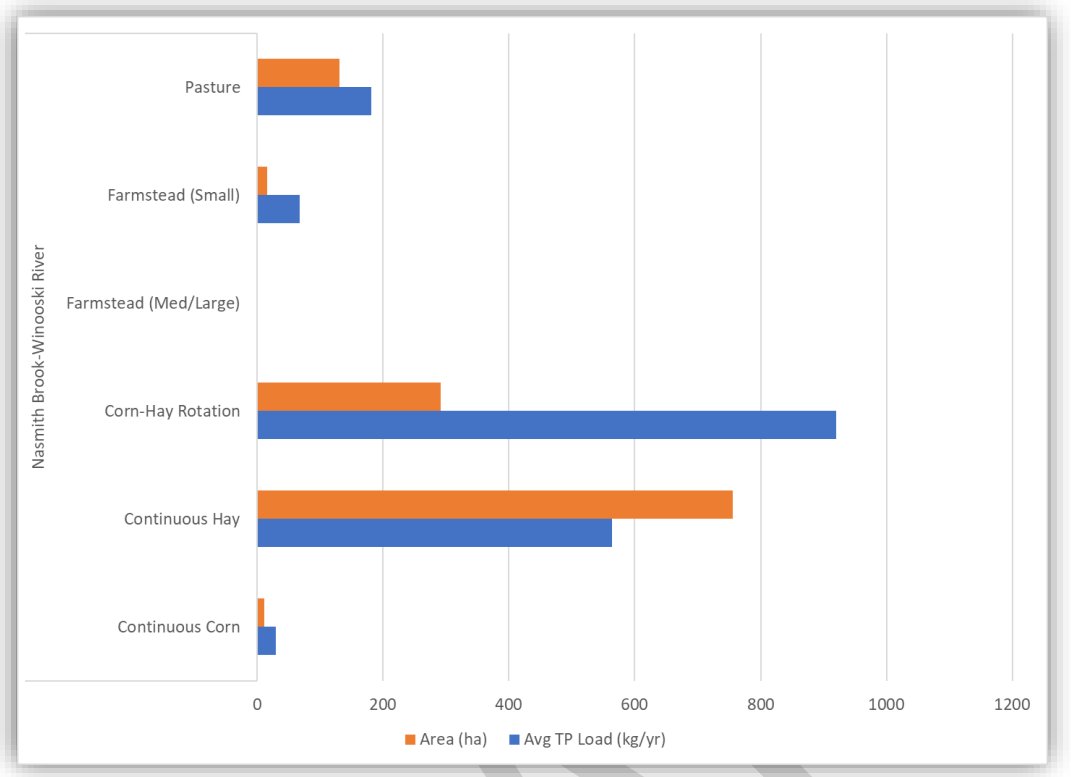
G


Headwaters Stevens Branch
Pasture
Farmstead (Small)
Farmstead (Med/Large)
Corn-Hay Rotation
Continuous Hay
Continuous Corn
0
200
400
600
800
1000
1200
Area (ha)
Avg TP Load (kg/yr)

H


Huntington River
Pasture
Farmstead (Small)
Farmstead (Med/Large)
Corn-Hay Rotation
Continuous Hay
Continuous Corn
0
200
400
600
800
1000
1200
Area (ha)
Avg TP Load (kg/yr)

I



J

Table 18 provides information regarding agricultural practice efficiencies that were used to estimate the necessary TMDL reductions as presented in the Scenario Tool.

Table 18. TP reduction efficiencies associated with BMPs as represented in the SWAT-based Scenario Tool

BMP Type	Minimum % Efficiency	Maximum % Efficiency	Average % Efficiency	Efficiency Source
Barnyard Management *	80.00	80.00	80.00	Literature
Change in crop rotation	19.49	28.11	25.26	SWAT
Conservation tillage	10.00	50.00	27.50	SWAT
Cover crop	25.00	30.00	28.33	SWAT
Crop to Hay	0.00	80.00	64.17	SWAT
Ditch buffer	51.00	51.00	51.00	Literature

Fencing/livestock exclusion without riparian buffer	55.00	55.00	55.00	SWAT
Fencing/livestock exclusion with riparian buffer	73.45	73.45	73.45	SWAT
Grassed Waterways	20.00	68.20	38.95	SWAT
Reduced P manure	0.30	17.79	4.95	SWAT
Riparian buffer	41.00	41.00	41.00	SWAT

* Barnyard management addresses runoff considered part of the Wasteload Allocation, but its efficiencies are listed here with the remaining BMPs that address runoff related to the Load Allocation.

Required Agricultural Practices and Permit Programs

The Required Agricultural Practices (RAPs) and existing Medium and Large farm permit programs set baseline farm management practices to ensure environmental protection. Medium and Large farm permits have been in place for nearly 10 years, but the RAPs (formally the Accepted Agricultural Practices) have been in place as the current regulatory standard since 2006 and were revised on December 5th, 2016. This revision is expected to result in a significant increase in conservation practice implementation over the next few years. The changes to the RAPs that are expected to result in the greatest impact include:

- Nutrient Management Planning and Implementation on All Farms (New Requirement for Small Farms)
- Creation of Small Farm Certification Program
- Stabilization of Ephemeral Gullies
- 10 ft. grassed filter strips on all field ditches
- Increase in grassed filter strip and manure spreading setback width from 10ft to 25ft on surface waters for small farms (already 25ft requirement for Medium and Large Farms)
- Establishment of cover crops on fields containing frequently flooded soils
- Increased manure spreading ban duration on fields containing frequently flooded soils

- Increase in grassed filter strip and manure spreading setback from 25ft to 100ft on surface waters adjacent to fields with a slope greater than 10%
- Reduction in maximum soil erosion rates by ½ on small farms
- Increased setbacks for construction of waste storage facilities from surface water (50' to 200')
- Increase setbacks for unimproved stacking of ag wastes from surface water (100' to 200')
- Livestock exclusion from surface waters in production areas
- Partial livestock exclusion in pastures

It is impossible for us to estimate the exact impact that these rules will have, because doing so would require a detailed understanding of the current management on all farms. However, we are confident that because of this rule we will see a dramatic increase in the implementation of Nutrient Management Plans, Cover Crops, Grassed Waterways, and Grassed Filter Strips and Riparian Buffers. Any of these practices that are implemented as part of the many existing financial assistance programs will be tracked and reported on in the next planning cycle. Finally, through the creation of the Small Farm Certification program, inspections will be conducted on every small farm that meets the certification thresholds over the next seven years at minimum.

Adoption of Best Management Practices

In addition to work completed to meet regulatory requirements, farm operators have begun and will continue to voluntarily adopt BMPs based on the increased availability of technical and financial assistance throughout the Lake Champlain Basin. As early adopters of new practices experience success, others have begun to follow. Specifically, for the Winooski River Basin, the rate of adoption of cover crops has increased in the Basin with substantial increases in year 2016 and 2017.

Based on the last eight years of NRCS contracts[23], a total of 5,583 acres were cover cropped for at least a one-year period. The rate of adoption has increased with contracts accounting for 1,457 acres in 2016 and 1,825 acres in 2017. Combined, the last two years make up over half of the total area that has been cover cropped under NRCS

[23] Reed Sims, NRCS, personal communications to Emily Bird, ANR WSMD, July 20, 2018

contracts over the last 8 years. UVM extension staff believe adoption is at least partially based on farmers' satisfaction with economic return[24]

The areas managed with cover crops and any of the other practices that are supported by agricultural partners will be tracked and reported on in the next planning cycle.

Farm Certification Program

Through the creation of the Small Farm Certification program, inspections will be conducted on every small farm that meets the certification thresholds over the next seven years at minimum. Certified Small Farm Operation inspections are prioritized by the Agency of Agriculture, Food and Markets (VAAFM) to fulfill the goals of the Tactical Basin Plans (TBP) for the various watersheds. As part of this process, the first step throughout the Lake Champlain Basin is to prioritize visits based on any agriculturally impaired subwatersheds. The second step is prioritization of catchments identified in the TBP as potentially high phosphorus loading. Prioritization is to be determined by DEC Basin Plans using the most up to date plan. If the plan is older, the staff are to contact the Basin Planner directly for that area and ask for direction on which sub watersheds DEC has identified as the highest priorities in terms of agricultural impairments. The VAAFM is aiming for 25 farms inspected/surveyed per year per inspector.

The inspection cycle on medium farms has been reduced from 5 to 3 years (Act 64), and with the additional staffing the Agency received has allowed the Agency to perform more comprehensive inspections on medium and large farm facilities. The Agency will continue to perform annual inspections on large farm operations and the regulatory inspections on small and medium farms, all of which will result in a significant increase in compliance with the management practices set forth in the permit programs and the RAPs.

Lessons Learned from the North Lake Farm Survey

A North Lake Farm Survey (NLFS) was conducted in 2015 and 2016 in the Missisquoi and St. Alban's Bay watersheds. An analysis using this data from the Missisquoi Bay watershed revealed the types of compliance challenges many farms are facing. While the Agency has not conducted a full assessment of all farms in the North Lake Basin, we

[24] Kirsten Workman, UVM Extension, pers communication, July 23, 2018.

expect that the larger trends found NLFS would apply to farms in the Winooski River Basin. Therefore, we imagine that roughly 45% of the farms in the Winooski River Basin will need at least one production area fix, while 41% will have at least one land management issue.

Vermont Environmental Stewardship Program

Starting in 2017, the Agency of Agriculture will pilot a Vermont Environmental Stewardship Program that will recognize and certify farmers who achieve high standards pertaining to sediment and nutrient management, pasture condition, and soil health. This program is designed to increase the recognition of farms that manage their lands in a way that provides environmental benefits, with the goal of fostering a shift toward more ecologically based farm management in the agricultural community. The pilot is expected to launch in in 2017 with 10-12 farms, with the full program starting in 2019.

Ag Clean Water Initiative Program

A new grant program was started in 2016 as a result of Vermont's clean water act. This grant program makes funds available for farmers and technical service organizations to help with education and outreach, project scoping and implementation, and enhancing organizational capacity. The goal of this program is to both increase compliance with the RAPs, as well as to implement projects that go above and beyond these baseline regulations.

Wasteload Allocation

In this section, a description of the applicable agricultural phosphorus runoff control regulations will be provided. In this instance, the only separable-applicable regulatory program is the NPDES Confined Animal Feeding Operation permit. As this program at present does not provide coverage for any Vermont facilities, the tabular representation will provide information regarding the numbers of LFO and MFO permitted farms. As mentioned earlier, a small farm certification program has been created that will bring many farms into a permitted program, but the exact number of farms for each watershed has not been estimated at this point. Table 19 shows the number of LFO and MFO permitted facilities in the Winooski River Basin by HUC12.

Table 19. Total number of facilities associated with permitted LFOs and MFOs in the Winooski Basin by HUC12.

HUC12 Number	HUC12 Name	MFOs	LFOs
04030204	Sodom Pond Brook-Winooski River	1	3
04030403	Great Brook-Winooski River	1	-
04030502	Mill Brook-Mad River	2	-
04030602	Headwaters Little River	7	-
04030701	Huntington River	3	-
04030702	Snipe Island Brook-Winooski River	3	-
04030501	Headwaters Mad River	1	-
04030203	Kingsbury Branch	3	-
	Total:	21	3

Table 20 shows the estimated TP farmstead export for each HUC12. It is important to note that the farms counted are the primary facilities, and that other facilities are often associated with the primary facilities but are captured under the same permit.

Table 20. SWAT estimated farmstead loading for the Winooski Basin (kg/yr.)

HUC12 name	HUC12 number	P Loading from Farmsteads (kg/yr)	The 80% reduction in P loading (previous column) required to meet TMDL (kg/yr)
Headwaters Winooski River	041504030201	49	39
Snipe Island Brook-Winooski River	041504030702	45	36
Nasmith Brook-Winooski River	041504030202	44	36
Mad River	041504030504	39	32
Kingsbury Branch	041504030203	39	31
Sodom Pond Brook-Winooski River	041504030204	38	31
Headwaters Stevens Branch	041504030101	38	30
Huntington River	041504030701	34	28
Mill Brook-Mad River	041504030502	30	24
Winooski River	041504030704	30	24
Jail Branch	041504030102	27	22
Muddy Brook	041504030703	27	22
Stevens Branch	041504030103	21	17
Headwaters Little River	041504030602	19	15
Headwaters Dog River	041504030401	15	12
Dog River	041504030402	12	10
North Branch Winooski River	041504030302	12	9
Headwaters Mad River	041504030501	11	9
Great Brook-Winooski River	041504030403	10	8

HUC12 name	HUC12 number	P Loading from Farmsteads (kg/yr)	The 80% reduction in P loading (previous column) required to meet TMDL (kg/yr)
Little River	041504030603	8	6
Graves Brook-Winooski River	041504030601	6	4
Joiner Brook-Winooski River	041504030604	5	4
Shepard Brook	041504030503	3	3
Headwaters North Branch Winooski River	041504030301	2	2
	Totals	**564**	**452**

Controlling Phosphorus from Developed Lands

In the LC TMDLs, all permissible developed land phosphorus loads are considered part of the wasteload allocation. As such, this section describes the four regulatory programs identified to address phosphorus and other impairment pollutant discharges from developed lands. They are the: Transportation Separate Storm Sewer System Permit (TS4); Municipal Roads General Permit; Municipal Separate Storm Sewer Permit; and, the Operational Three-acre Impervious Surface Permit.

As a generalized summary, Table 21 indicates which regulatory program applies to which jurisdiction and the estimated modeled load for that jurisdiction where it is able to be determined.

Table 21. Total Load and the Regulatory Programs applicable in each jurisdiction

Jurisdiction	Load reduction target (%)	Applicable Regulatory Program to address Phosphorus			
		TS4	MRGP	MS4	Three-acre designation
VTrans/State highways	Variable by lake segment. See Table 14 for specifics	✓			
MS4 municipalities				✓	✓
All other non-MS4 municipalities			✓		✓

Prior to discussing the permitting regulatory authorities and their specific areas of application, modeled loading across the entire Basin can be visualized in Figure 18. This map represents estimated annual phosphorus loading at the catchment scale with municipal boundaries overlain. This estimate includes loading from all areas of developed lands including roads and low and high-density development. These areas are further described in Table 22, whereby the highest TP loading catchments are presented. The last column shows the amount of TP reduced if the 20.2% reduction allocation (Table 14) were applied to each of these catchments. Summarized at the bottom is the percentage, 42%, of total TP reduction from developed lands identified in the TMDL that could be realized if the sector TMDL reduction allocations were applied.

Figure 18. Estimated TP export from developed land uses excluding roads (paved and unpaved)

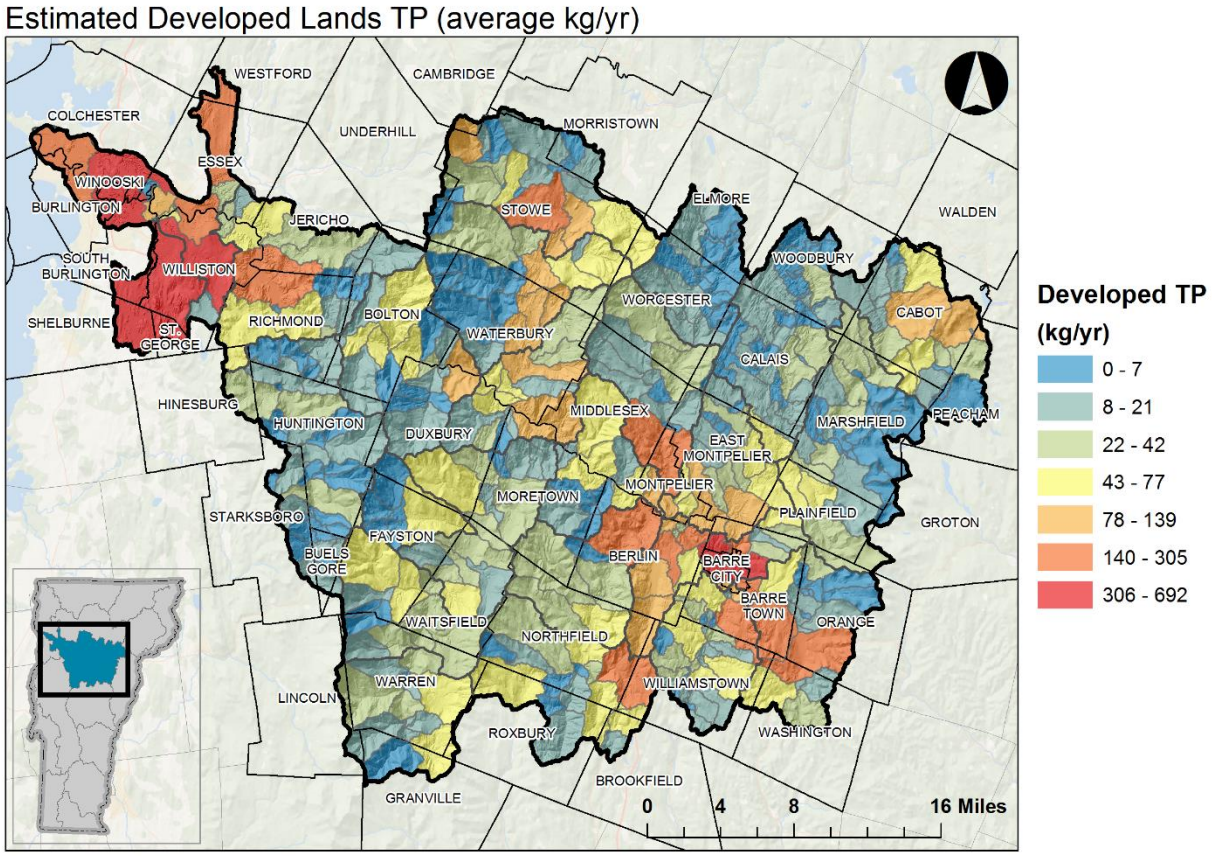


Table 22. Catchments with the highest estimated TP developed lands export, excluding roads. Catchments are associated with individual towns if most of the area of that catchment occurs within a given town boundary. These listed catchments align with the top two highest exporting catchment categories (red and orange) identified in Figure 18 above.

Town name	Catchment ID	Developed lands TP load (kg/yr.)	Developed lands TP reduction (kg/yr.)
Williston	4578814	692	140
South Burlington	4578832	644	130
Barre Town	4577680	492	99
Williston	4578812	455	92
Colchester	4576910	394	80
Barre City	4577664	373	75
Williston	4578834	305	62

Town name	Catchment ID	Developed lands TP load (kg/yr.)	Developed lands TP reduction (kg/yr.)
Berlin	4577660	303	61
Stowe	4577340	234	47
Barre Town	4577974	224	45
Colchester	4576956	217	44
Middlesex	4577916	214	43
Barre Town	4577710	201	41
Richmond	4578848	201	41
Essex	4576908	196	40
Berlin	4577650	193	39
Williamstown	4578002	190	38
Barre Town	4577958	186	38
Berlin	4577952	174	35
Barre Town	4577950	163	33
Orange	4577986	161	32
Percent of total Developed TP reduction if sector allocations are applied to these catchments			**42%**

Phosphorus Loading from Roads

Currently, TP loading estimates for roads only exist from the SWAT model, which distinguishes only between paved and unpaved roads. Two of the primary phosphorus reduction regulatory programs related to roads, the MRGP and the TS4, are defined by more narrow parameters than just paved and unpaved. For example, the MRGP will apply to municipally managed roads, and require applicable practices to be applied to all roads that are hydrologically connected to waterbodies, including lakeshores, while the TS4 permit will only apply to state-managed roads.

Derived directly from the SWAT loading estimates, Figure 19 identifies the range of catchment TP loading from roads, both paved and unpaved, across the Winooski River

Basin. A further breakdown of loading estimates is presented in Tables 23 and 24 whereby the top twenty highest roads loading catchments, paved and unpaved, regardless of hydrological connectivity, are shown respectively. Also shown are the overall percent reductions achievable if the 20.2% reduction allocation is realized. However, for each catchment or municipality, these are not actual allocations but rather opportunities. Actual reductions will be accounted for as the essential roads permits are implemented.

Figure 19. Estimated SWAT loading from all paved and unpaved roads in the Winooski Basin at the catchment scale.

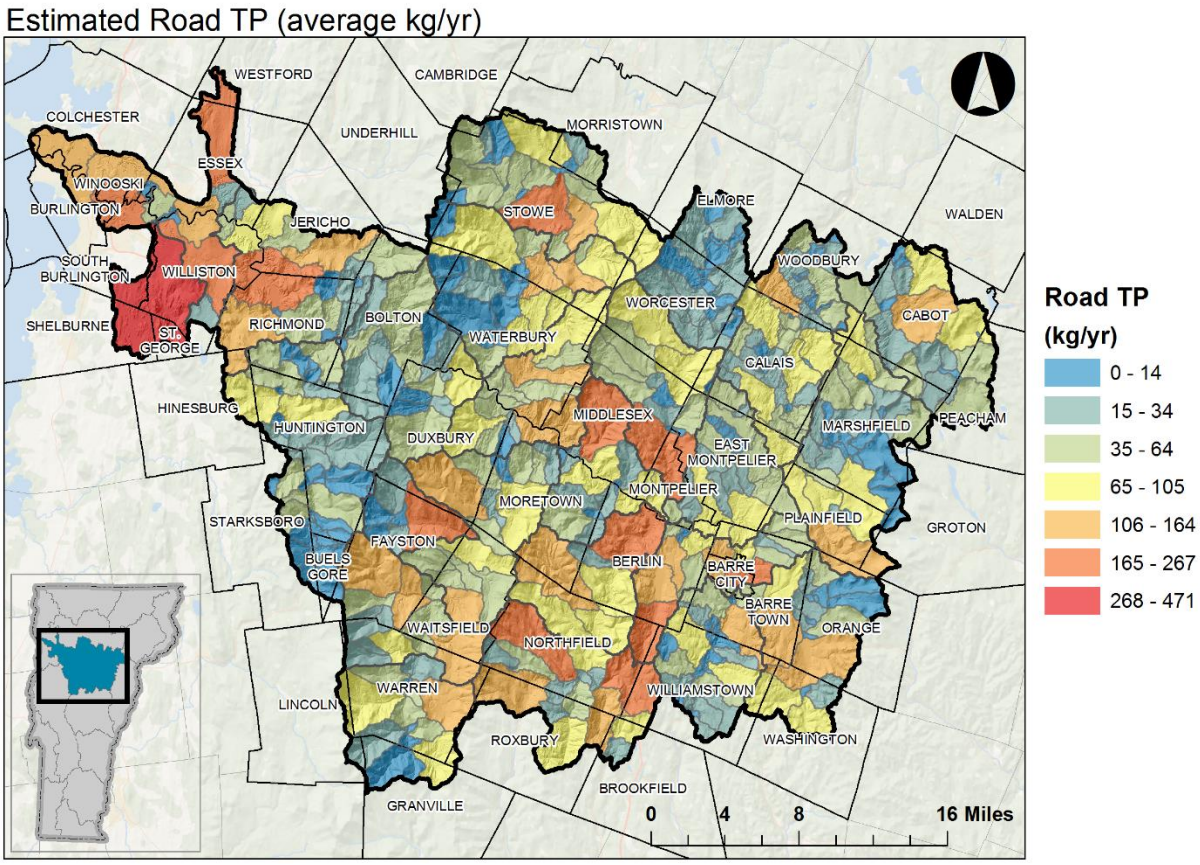


Table 23. Catchments with the highest estimated TP export from paved roads.

Town name	Catchment ID	Paved roads TP load (kg/yr.)	Paved roads TP reduction (kg/yr.)
Williston	4578814	234	47

Town name	Catchment ID	Paved roads TP load (kg/yr.)	Paved roads TP reduction (kg/yr.)
Williston	4578812	167	34
Barre Town	4577680	156	32
Middlesex	4577916	153	31
South Burlington	4578832	137	28
Richmond	4578848	129	26
Williamstown	4578002	129	26
Berlin	4577952	116	23
Stowe	4577340	107	22
Barre City	4577664	103	21
Northfield	4577730	101	20
Middlesex	4577558	100	20
Colchester	4576956	92	19
Middlesex	4578132	91	18
Barre Town	4577974	88	18
Essex	4576908	88	18
Northfield	4577992	87	18
Berlin	4577660	87	17
Orange	4577986	86	17
Fayston	4577646	82	17
Percent of total paved roads TP reduction if sector allocations are applied to these catchments			**23%**

Table 24. Catchments with the highest estimated TP export from unpaved roads.

Town name	Catchment ID	Unpaved roads TP load (kg/yr.)	Unpaved roads TP reduction (kg/yr.)
Middlesex	4577916	54	11
Northfield	4577992	49	10
Middlesex	4577558	47	9
Northfield	4577730	45	9
Woodbury	4578202	40	8
Fayston	4577646	40	8
Plainfield	4577656	39	8
Orange	4577986	37	7
Richmond	4578848	37	7
Hinesburg	4578772	36	7
Jericho	4577830	35	7
Duxbury	4577932	34	7
Stowe	4577370	33	7
Plainfield	4577920	33	7
Calais	4577468	32	6
Richmond	4578766	31	6
Barre Town	4577974	30	6
Moretown	4577700	30	6
Middlesex	4578132	29	6
Calais	4577432	29	6
Percent of total unpaved roads TP reduction if sector allocations are applied to these catchments			**22%**

To derive more detailed loading source estimates than those given above, it was necessary to apply a secondary analysis to the initial SWAT loading estimates. To further break down the SWAT loading data for paved and unpaved roads, the extent of VTrans-managed and municipal-managed paved roads was derived from a more detailed GIS analysis than that used in the model. Through this analysis, the estimated load was apportioned at a somewhat finer level. Although, when combining the separate data sources to estimate loads, there are unavoidable inconsistencies that become apparent. For example, there is not an exact fit between the input roads data for the two methods and therefore results don't necessarily align. Currently with the tools available, these issues are inherent in the analysis. However, it's believed that they provide good planning level information when considered across the entire Basin.

State Managed Roads (Transportation Separate Storm Sewer System General Permit – TS4)

The TS4 is a new stormwater permit for all VTrans owned or controlled infrastructure. As part of the permit, VTrans will develop comprehensive Phosphorus Control Plans (PCPs) for their developed land in each lake segment. This includes state roads, garages, park and rides, welcome centers, airports and sand and gravel operations. The plans will require inventories of all regulated surfaces, establishment of baseline phosphorus loading per lake segment, and a prioritized schedule for implementation of BMPs to achieve the lake segment percent phosphorus reductions.

To begin this assessment, VDEC estimated the miles of state roads per HUC12 in the Winooski Basin, given in Figure 20, and which is also reflected in Table 25. To provide some estimate of the overall basin loading at the bottom of the table, the hybrid analysis mentioned above was utilized with all the inherent inconsistencies. The noted load provides a reasonable planning level loading estimate. VTrans will address state roads under the 2017 TS4 General Permit. The permit requires VTrans to develop a Phosphorus Control Plan (PCP) for its stormwater discharges in the Lake Champlain Basin and requires VTrans to reduce the discharge of pollutants from the TS4 to the maximum extent practicable (MEP) through compliance with the six minimum control measure requirements throughout the entire State.

Figure 20. Estimated mileage of State-managed roads summarized by HUC12 in Basin 8

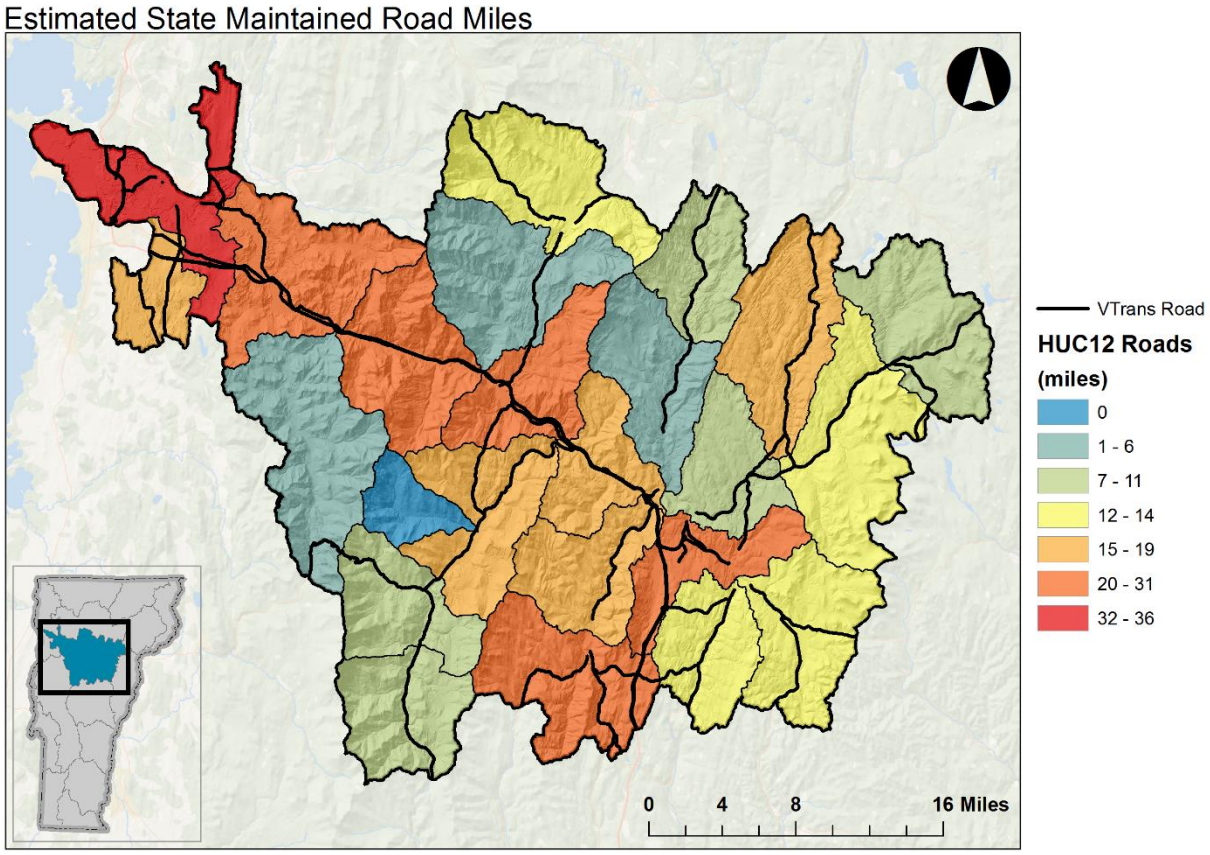


Table 25. Estimated miles for State-managed highways, does not include other VTrans owned and controlled infrastructure

HUC12 watershed name	State-managed road miles
Winooski River	36.0
Stevens Branch	30.6
Snipe Island Brook-Winooski River	29.0
Headwaters Dog River	27.1
Graves Brook-Winooski River	26.7
Joiner Brook-Winooski River	25.0
Great Brook-Winooski River	19.1

HUC12 watershed name	State-managed road miles
Muddy Brook	16.6
Kingsbury Branch	15.1
Dog River	15.1
Mad River	15.0
Headwaters Stevens Branch	13.6
Headwaters Little River	12.8
Jail Branch	12.7
Nasmith Brook-Winooski River	12.0
Sodom Pond Brook-Winooski River	10.9
Mill Brook-Mad River	10.7
Headwaters Winooski River	10.5
Headwaters North Branch Winooski River	9.5
Headwaters Mad River	8.2
Little River	5.6
North Branch Winooski River	5.6
Huntington River	4.3
Shepard Brook	0.2
Estimated State-managed roads TP loading (kg/yr.)	372

Municipal Managed Roads (Municipal Roads General Permit)

The Municipal Roads General Permit is a new stormwater permit for all non-MS4 Vermont cities and towns that is intended to achieve significant reductions in stormwater-related erosion from municipal roads, both paved and unpaved. The permit requires each municipality to develop a road stormwater management plan to bring road drainage systems up to basic maintenance standards to stabilize conveyances and reduce erosion by December 2020. The plan will require an inventory of municipal roads and current conditions, an identification of potential road best management practices (BMPs), and a prioritized implementation schedule to achieve the road standards.

The Agency is providing both technical and financial assistance to municipalities to support their work towards meeting the MRGP permit requirements by 2020. In response, the majority of municipalities have been able to complete road erosion inventories in the last two years and are also in the process of remediating eroding sections of roads.

VTrans Back Roads and the Agency's Grants-in-Aid programs, both supported by the Clean Water Fund, have together supported the development of municipal hydrologically connected road erosion inventories (REI) and project implementation. In addition to completing REI, the majority of towns in the basin have taken advantage of these grant programs in addition to State technical assistance to address erosion along hydrologically connected roads (Table 42). Specifically, of the 30 municipalities that are mostly or entirely located in the basin, in SFY 2018, 24 enrolled in Grants-in-Aid (80%) and in SFY 2019, 25 enrolled in Grants-in-Aid (83%) to receive financial support for addressing hydrologically connected roads.

Once all municipalities begin submitting annual tracking reports, the Agency can begin to estimate load reductions that will be achieved through this permit. In the meantime, road improvements funded through the Clean Water Fund will be summarized for the Winooski River Basin in the Vermont Clean Water Initiative Annual Investment Report .

The following maps and tables were developed to further assist municipalities in setting priorities through the road management planning process. To break some of the basin roads loading data down to a town scale, the sum of loading from the catchments within that town needs to be calculated. Figure 21 shows the primary watershed catchments within each town. For these calculations, a given catchment is associated to any given town if most of that catchment falls within that town. While not a perfect fit,

it does provide a reasonable estimate of the modeled TP load for any given municipality. Based on this association of catchments related to towns, VDEC estimated the TP load coming from both paved and unpaved roads in each of the towns, shown in Table 26. As towns implement road management plans and stabilize road networks, VDEC will be able to use this data to estimate the reductions in TP loading and confirm progress in meeting the LC TMDL.

Figure 21. Association of catchments to towns in the Winooski River Basin

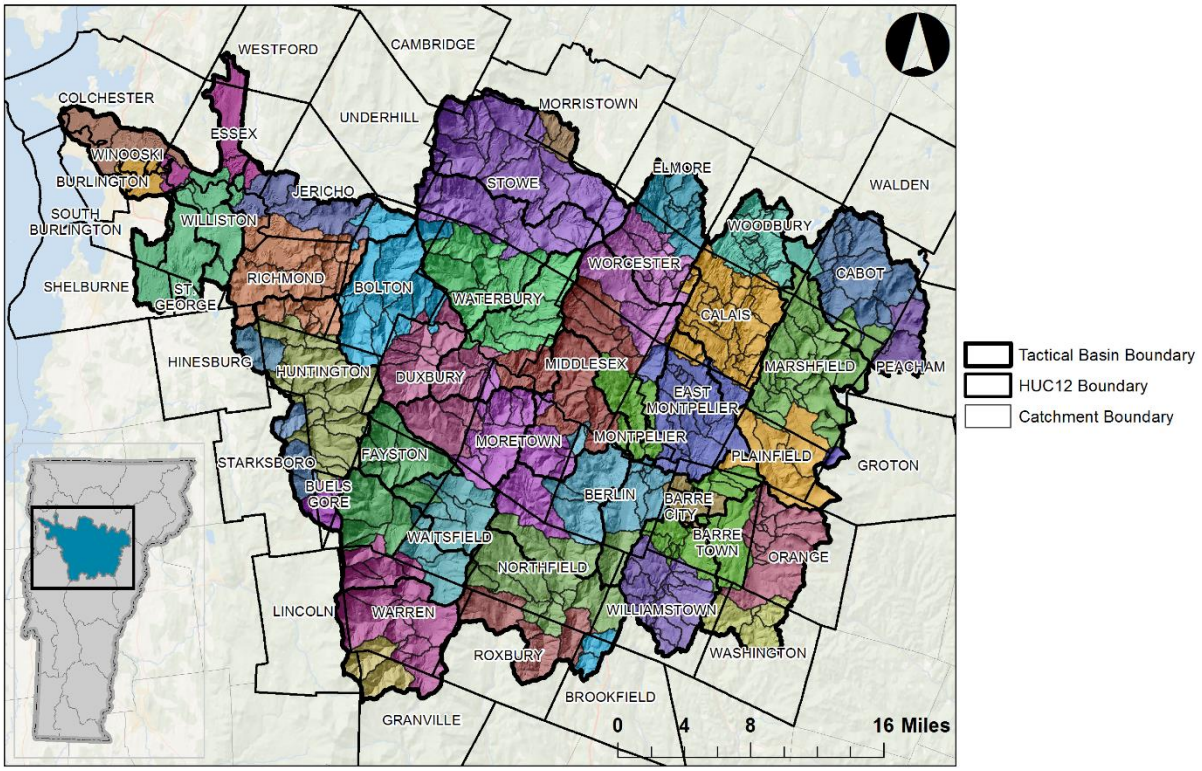


Table 26. Estimated loading for all non-VTrans managed roads occurring in each non_MS4 municipality

Town	Estimated TP loading (kg/yr.)	Town	Estimated TP loading (kg/yr.)
Barre City	79.5	Moretown	89.1
Barre Town	526.5	Morristown	13.1
Berlin	129.5	Northfield	253.5

Town	Estimated TP loading (kg/yr.)	Town	Estimated TP loading (kg/yr.)
Bolton	76.7	Orange	86.3
Brookfield	0.0	Peacham	0.0
Buels Gore	3.4	Plainfield	108.4
Cabot	155.4	Richmond	180.0
Calais	72.0	Roxbury	41.1
Duxbury	36.0	Starksboro	9.2
East Montpelier	141.5	Stowe	399.7
Elmore	0.0	Waitsfield	164.4
Fayston	140.0	Warren	283.1
Hinesburg	40.3	Washington	0.0
Huntington	146.0	Waterbury	230.3
Jericho	118.3	Williamstown	169.6
Marshfield	77.8	Woodbury	9.2
Middlesex	257.6	Worcester	55.3
Montpelier	116.0		

VDEC developed remote sensing information for municipalities to initially identify hydrologically connected road segments that have the potential to be at risk of erosion and may be a source of sediment and phosphorus pollution to surface waters (Figure 21). This estimated mileage, along with more detailed town maps, will help municipalities establish initial town road inventories and prioritize improvements. Results of this analysis are given in Table 27. It should be noted that mileages are given for the entirety of each town, whether or not the whole town or just a part of it is in the

Winooski Basin. Figure 22 breaks down the percent of hydrologic road connectivity by the type of receiving water.

Figure 22. Estimated percentage of hydrologically connected roads by catchment.

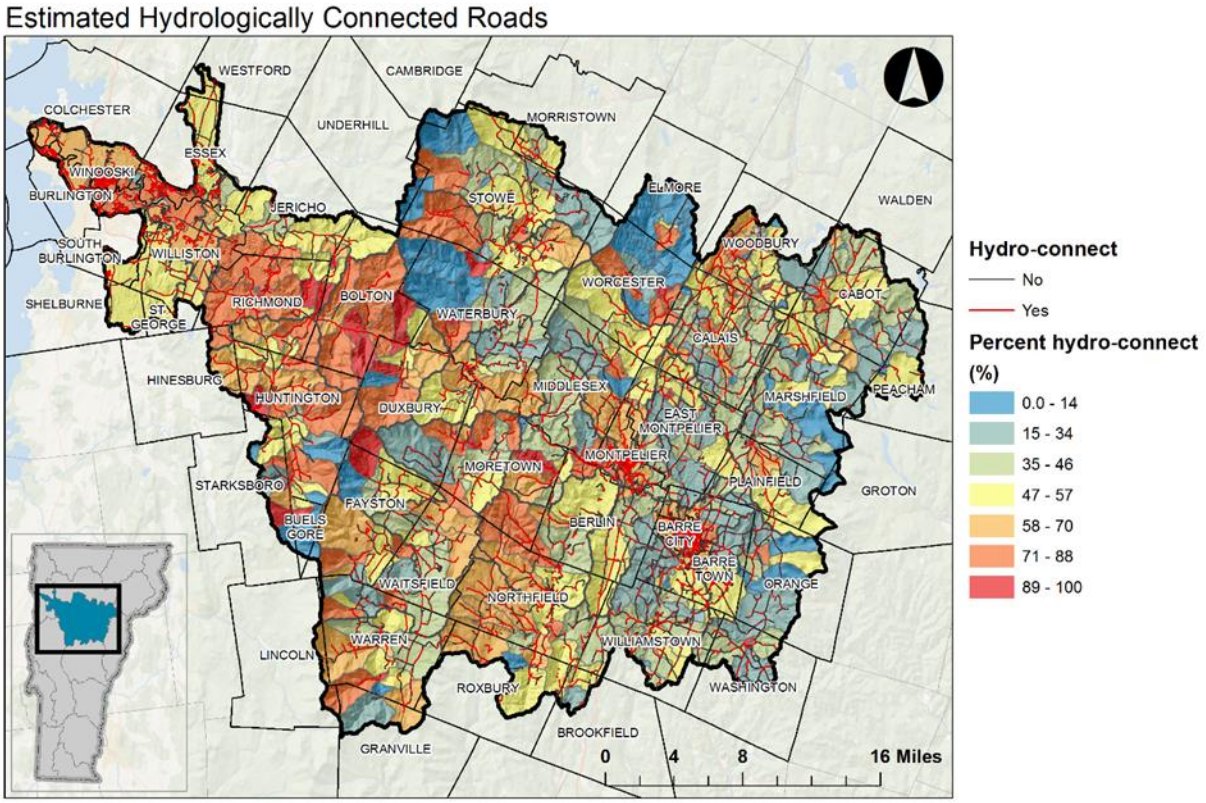
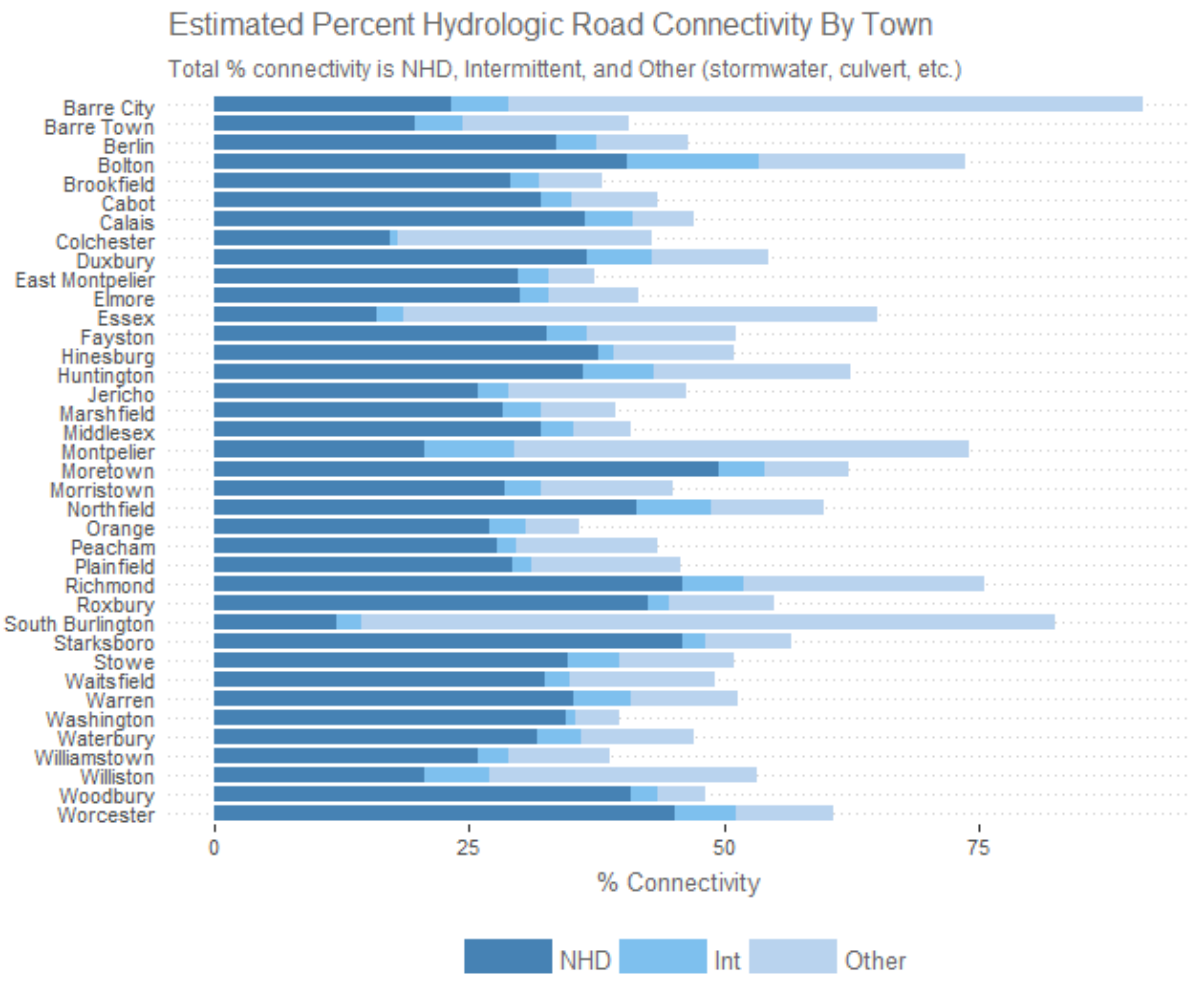


Table 27. Estimated mileage of hydrologically connected municipal road miles by town. These do not include state managed or private roads.

Town	Hydrologically connected municipal road miles	Town	Hydrologically connected municipal road miles
Barre City	49.3	Moretown	31.1
Barre Town	43.7	Morristown	48.4
Berlin	27.9	Northfield	51.6
Bolton	15.8	Orange	13.9
Brookfield	29.5	Peacham	30.6

Town	Hydrologically connected municipal road miles	Town	Hydrologically connected municipal road miles
Cabot	28.8	Plainfield	19.8
Calais	40.5	Richmond	39.5
Colchester	42.6	Roxbury	25.2
Duxbury	17.5	South Burlington	74.4
East Montpelier	24.7	Starksboro	27.5
Elmore	16.3	Stowe	50.1
Essex	80.8	Waitsfield	18.1
Fayston	20.9	Warren	27.5
Hinesburg	30.9	Washington	33.8
Huntington	29.6	Waterbury	27.9
Jericho	31.0	Williamstown	32.7
Marshfield	21.3	Williston	42.8
Middlesex	23.9	Woodbury	30.9
Montpelier	43.6	Worcester	15.0

Figure 23. Estimated percent hydrologic road connectivity by Town (NHD = National Hydrography Dataset = mapped perennial streams).



Municipal Separate Storm Sewer Systems (MS4)

The Municipal Separate Storm Sewer System permit is a permit for municipalities with census designated urbanized areas and stormwater impaired watersheds and was issued in July 2018. MS4 communities will need to apply for coverage by January 2019. Under the MS4 permit, those designated municipalities will be required to develop a comprehensive phosphorus control plans (PCP) to achieve the percent phosphorus reduction for their respective lake segment, on all municipally owned or controlled developed land within the municipality. Completed PCPs are due by April 2021. These municipalities will not need separate permit coverage under the Municipal Roads General Permit or the "3-acre designation," (see below) as these requirements will be incorporated into the phosphorus control planning within the municipality. The PCPs will include requirements to inventory all municipally owned or controlled developed

land within the municipality, estimate phosphorus loading from the owned or controlled developed land, and identify BMPs and an implementation schedule to achieve the required reductions. VDEC has developed initial estimated TP loads from all developed lands within each MS4 municipality, as shown below in Table 28.

Table 28. Estimated loading from developed land categories for MS4 communities. Loading only represents portions of the municipality that drain to the Winooski River Basin.

MS4 Municipality	Paved road (excluding VTrans managed roads) (kg/yr.)	Unpaved roads (kg/yr.)	Other developed lands (kg/yr.)
Colchester	141.5	8.9	635.0
Essex	136.5	23.0	335.8
South Burlington	102.5	2.3	646.9
Williston	356.8	34.2	1535.5
Total	737.3	68.4	3153.2

Operational three-acre impervious surface permit program

The Stormwater Program will issue a general permit in 2019 that will include a schedule by which owners of three or more acres of impervious surface will need to obtain permit coverage. Following issuance of the general permit, the Program will identify and notify affected owners. An impervious surface will require coverage under the three-acre permit if it is not covered under a permit that incorporates the requirements of the 2002 Vermont Stormwater Management Manual (VSMM).

It is anticipated that the "three-acre impervious surface" program will address the developed lands phosphorus reductions necessary to achieve the TMDL that are not addressed by other developed lands programs. Once the program is implemented, this projection will be verified by tracking phosphorus reductions achieved through implementation. If additional reductions in phosphorus are required to implement the TMDL, developed lands permitting requirements may be adjusted accordingly, including requiring projects with less than three acres of impervious surface to obtain permit coverage.

An initial estimate of parcels containing three or more acres of impervious was completed by TetraTech, Inc. with funding from EPA (Table 29).

Table 29. Estimated three-acre parcels and associated impervious cover for Winooski River Basin towns.

Town	Estimated # of 3+ acre parcels	Impervious acres
Barre City	12	74.3
Barre Town	14	98.1
Berlin	15	140.5
Bolton	5	33.6
Burlington	11	51.0
Cabot	1	11.8
Cambridge	2	2.6
Colchester	28	220.1
Duxbury	2	12.4
East Montpelier	3	25.8
Essex	39	286.2
Fayston	3	27.2
Jericho	2	32.1
Marshfield	1	5.2
Middlesex	5	21.7
Montpelier	11	56.1
Moretown	2	12.9
Northfield	2	34.9
Plainfield	2	10.1

Town	Estimated # of 3+ acre parcels	Impervious acres
Richmond	4	22.6
Roxbury	1	4.2
Saint George	1	0.3
South Burlington	20	245.8
Stowe	21	152.0
Waitsfield	3	16.0
Warren	6	31.2
Waterbury	11	72.7
Williamstown	3	14.6
Williston	45	326.6
Winooski	4	21.0
Worcester	2	9.6
Total	281	2072.9

The initial estimate of the three-acre parcel coverage will require additional screening by VDEC prior to notification of the affected parties. The analysis does not yet identify which impervious surfaces have permit coverage that incorporates the requirements of the 2017 VSMM. VDEC will also identify eligible impervious surfaces from existing permits that were not identified in the TetraTech analysis because the impervious surface is located on more than one parcel.

Controlling Phosphorus from Wastewater Treatment Facilities and Other Industrial Discharges

This section of the Phase II statement in each tactical basin plan is intended to provide additional information regarding wastewater treatment facilities in the Lake Champlain Basin.

As of the issuance of this Plan, all but two facilities are presently operating under administrative continuance of existing permits, which were issued in conformance with the allocations in place under the remanded 2002 LC TMDL. Montpelier and Williamstown have recently been issued new permits. Additionally, Montpelier has also submitted the required phosphorus optimization plan and has been issued a 1272 Order requiring development of the required CSO long term control plan. The 2016 LC TMDL altered the allowable phosphorus discharge loads from several WWTFs that discharge to the Main Lake segment and loads are outlined in Table 30.

As part of a necessary refinement of the facility-specific phosphorus wasteload allocations, WSMD, with assistance from certain municipalities, is conducting an extensive sampling effort to document the current loading conditions for phosphorus and determine the "reasonable potential" that WWTP's have to cause or contribute to downstream water quality impairment. In addition, the approved 2016 LC TMDL presents a wasteload allocation for phosphorus loads, to which each facility in the Basin will adhere (Table 30).

Table 30. Summary of permit requirements for the wastewater treatment facilities in the Winooski River Basin

Facility (permit ID)	Permit expiration date	Planned permit re-issuance year	Design flow MGD	IWC* 7Q10 /LMM	Current permitted load (mt/yr. P)	TMDL Allocated Wasteload (mt/yr. P)	Current Percent of Design Flow (YEAR)	Treatment type	Number of CSOs	Receiving water
Barre 3-1272	9/30/2011	2020	4.000	0.32/0.14	3.314	1.105	0.68	Extended aeration	0	Steven's Branch
Burlington – North 3-1245	9/30/2009	2020	2.000	0.02/0.01	1.657	0.552	0.79	Activated sludge	1 – Gazo St	Winooski River
Burlington – Riverside 3-1247	9/30/2009	2020	1.200	0.01/<0.01	0.994	0.331	0.45	Activated sludge	0	Winooski River
Cabot 3-1440	12/31/2009	2020	0.050	0.04/0.01	0.041	0.041	0.43	Activated sludge	0	Winooski River
Essex Junction 3-1254	6/30/2009	2020	3.300	0.03/0.01	2.569	0.911	1.71	Activated sludge	0	Winooski River
Global Foundries 3-1295	9/30/2008	2019	8.000	0.07/0.02	5.531	2.210	0.39	Sequential batch reactor, industrial treatment	0	Winooski River
Marshfield 3-1195	9/30/2010	2020	0.045	0.01/<0.01	0.311	0.311	0.42	Aerated lagoon	0	Winooski River

Facility (permit ID)	Permit expiration date	Planned permit re-issuance year	Design flow MGD	IWC* 7Q10 /LMM	Current permitted load (mt/yr. P)	TMDL Allocated Wasteload (mt/yr. P)	Current Percent of Design Flow (YEAR)	Treatment type	Number of CSOs	Receiving water
Montpelier 3-1207	9/30/2022	2022	3.970	0.08/0.03	3.290	1.097	0.49	Activated sludge	6	Winooski River
Northfield 3-1158	6/30/2010	2020	1.000	0.20/0.08	0.829	0.276	0.52	Sequential batch reactor	1	Dog River
Plainfield 3-0381	6/30/2011	2020	0.125	0.01/<0.01	0.691	0.138	0.46	Sequential batch reactor	0	Winooski River
Richmond 3-1173	9/30/2010		0.222	<0.01/<0.01	0.184	0.061	0.062	Extended aeration	0	Winooski River
So. Burlington – APPW 3-1278	3/31/2013	2019	3.300	0.03/0.01	1.906	0.911	0.54	Activated sludge	0	Winooski River
Stowe 3-1232	12/31/2013	2020	1.000	0.17/0.07	0.282	0.276	0.331	Sequential batch reactor	0	Little River
Waterbury 3-1160	12/31/2009	2020	0.510	0.01/<0.01	0.563	0.141	0.76	Aerated lagoon	0	Winooski River
Williamstown 3-1176	12/31/2022	2022	0.150	0.14/0.04	1.036	0.166	0.61	Aerated lagoon	0	Steven's Branch
Winooski 3-1248	12/31/2009		1.400	0.01/<0.01	1.160	0.387	0.59	Activated sludge	0	Winooski River

* *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.*

Facility –specific information

Barre

There have been no recent upgrades to the WWTF. Much of the infrastructure has exceeded 20 years in operation and the WWTF is currently in the process of conducting a 20-Year Engineering Evaluation. They are also planning to upgrade some of the digester covers, waste gas burner, and boiler system.

Burlington North

The City of Burlington operates this activated sludge facility and disinfects with chlorine. The operators have been doing trials for to improve phosphorous removal and were planning to start two-point injection in January 2018.

Burlington – Riverside

The City of Burlington operates this activated sludge facility and disinfects with chlorine. No major upgrades have occurred at the WWTF in the past 5 years.

Cabot

No major upgrades have occurred at the Cabot WWTF in the past 5 years. P removal is achieved largely through the addition of sodium aluminate.

Essex Junction

The WWTF had a major refurbishment in 2012 – 2013. Anaerobic and anoxic tanks were added to the aeration tank for improved phosphorous removal. The sand filter was also replaced with cloth disc filters for improved particulate and phosphorous removal.

Global Foundries

The WWTF is complex and includes three main processes: Chemical metal polishing pretreatment, biological wastewater treatment, and industrial wastewater treatment. The biological wastewater treatment process includes three Sequential Batch Reactors (SBRs) that achieve complete nitrification and biological phosphorus removal.

Marshfield

No major upgrades have occurred at the WWTF in the past 5 years. There is no specific treatment technology used for phosphorus removal.

Montpelier

The WWTF is currently in the planning phase of an upgrade/refurbishment to existing infrastructure, including the digesters, clarifiers, & UV channel. With this upgrade, they are exploring the feasibility of co-generation at the WWTF from recovered digester gas. TP removal is achieved through two-point injection of polyaluminum chloride.

Northfield

The WWTF is currently in the planning phase of a combined-sewer separation project in the downtown area.

Plainfield

The WWTF is currently in the process of installing a supervisory control and data acquisition system. This will give them greater control over aeration in their sequencing batch reactor, which will be used to optimize biological phosphorus removal.

Richmond

No major upgrades have occurred at the WWTF in the past 5 years.

So. Burlington – Airport Parkway (APPW)

The WWTF completed a major $28 M upgrade in 2011 that included a biological nutrient removal system for the activated sludge process and 10-micron filtration for the effluent. Alum is used for chemical phosphorus removal.

Stowe

Stowe uses both biological removal and chemical precipitation for phosphorus removal. No changes have been made to the facility in the last five years.

Waterbury

In 2013, Waterbury installed the Evoqua CoMag tertiary treatment system to consistently achieve 0.2 mg/L TP removal.

Williamstown

Williamstown moved their outfall pipe from a small tributary to the Stevens Branch to the mainstem of the Stevens Branch. They also and upgraded the facility in 2017 to include chemical addition for phosphorus removal.

Winooski

No major upgrades have occurred at the WWTF in the past 5 years.

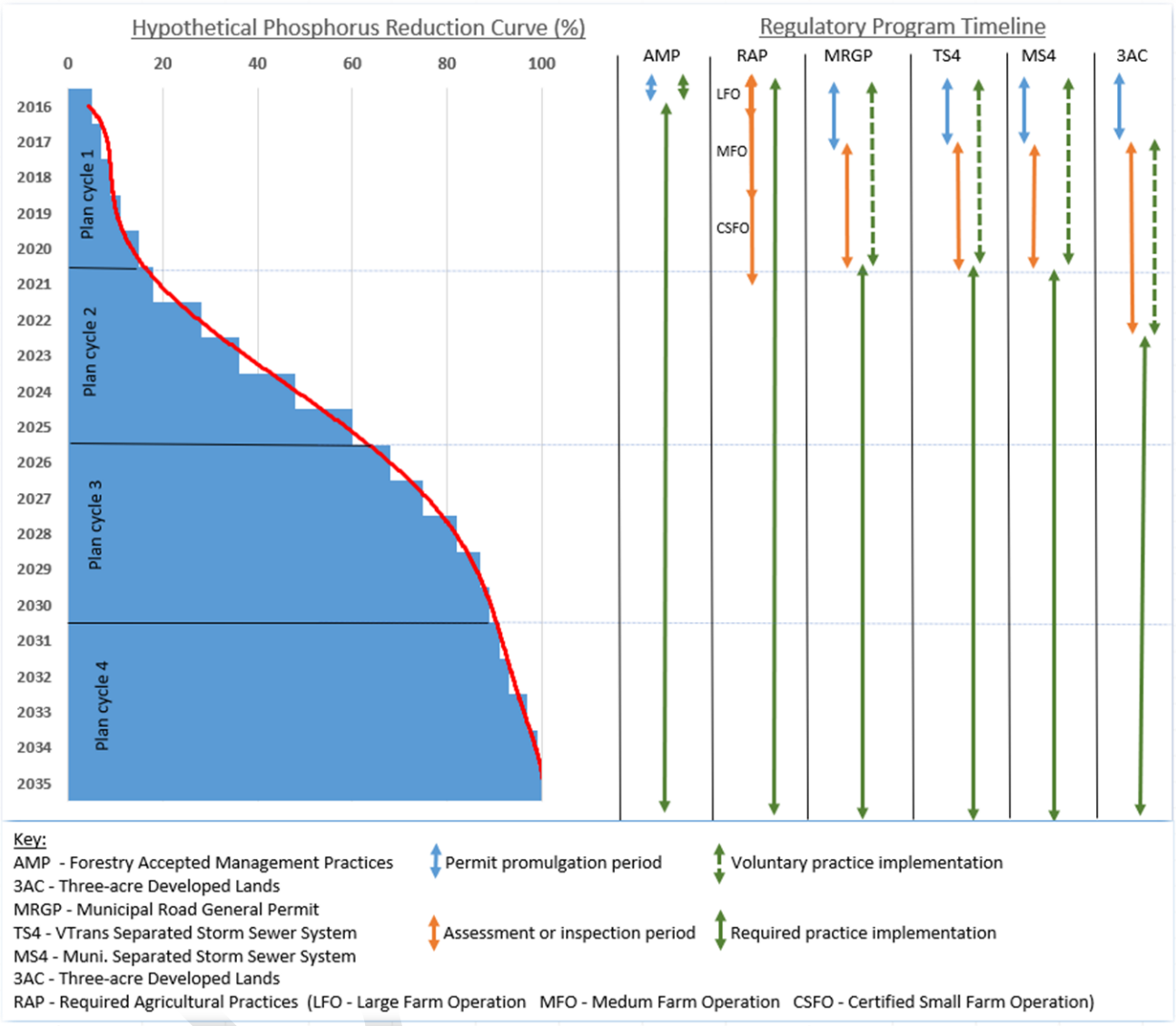
Summary

The information provided in the foregoing provides the best-available information regarding the locations of the Winooski Basin where phosphorus loading is modeled to be greatest. This information is provided by source sector and tied to the regulatory programs that are highlighted by Act 64 to compel phosphorus pollution reductions for each sector. An important consideration in the development of this modeling analysis is the pace at which the expected reductions may be achieved from any given sector. Generally, the Lake Champlain TMDL is envisioned to be implemented over a 20-year timeframe. Figure 24 provides a hypothetical representation of the pace at which nutrient reductions may be achieved, informed by the timelines during which each regulatory program is being put into place.

The capability for the State to compel reductions in the first five-year iteration of this tactical plan cycle is limited by the timelines set forth by Act 64 for the establishment and promulgation of the permit programs. and the availability of funding. In the first instance, the State cannot compel, for example, the reduction of phosphorus from specific municipal road segments, until: 1) that permit program has been established; 2) the municipality has applied for coverage under that program; and, 3) the municipality has completed their road assessment, and staged a plan for implementation based on the most effective phosphorus reduction efforts. Further, in order for those plans to be implemented, there needs to exist funding to support implementation of the specific projects. Figure 24 provides the timelines for permit promulgation, permit application and assessment/inspection, and implementation. These timelines do not, however, preclude any particular landowner or municipality from acting sooner on specific projects, and many owners or municipalities have done so. The following link provides access to the database resources discussed in this Plan:

VTDEC Watershed Projects Database and Tracking System

Figure 24. Theoretical phosphorus reduction, relative to the load and wasteload reductions required by the LC TMDL. The timelines for regulatory programs are also shown.



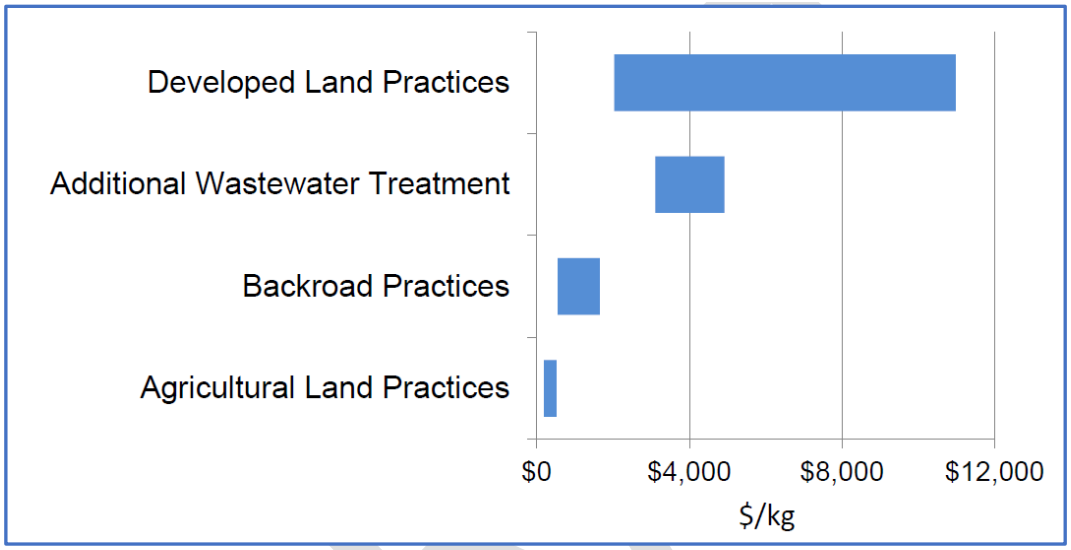
Regarding funding, this current Tactical Basin Plan cannot yet articulate a precise estimation of the total cost of implementation to achieve the full completion of TMDL activities. However, the following information provides a cost perspective based on a statewide view of clean water funding needs,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

The Vermont State Treasurer's report (2017) describes the full costs of implementing Act 64 to achieve clean water for the entire State of Vermont. The total new 20-year total clean water compliance costs are projected to be $2.3 billion. It recommends significant capital investment by the State over the next two years of $50 million or more.

From the perspective of sector-specific costs, Figure 25, adapted from the Phase I Plan, presents useful practice-level cost estimates. These latter estimates indicate a gradient of cost efficiency, with highest efficiencies associated with agricultural practices, followed by roads, developed lands, and wastewater infrastructure.

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

Figure 25. General costs of practices, by land use sector, expressed by kilogram of phosphorus reduced.



A robust phosphorus reduction tracking approach is being put into place to document implementation of on-the-ground practices and projects. The tracking system will be used to track the implementation of projects and will calculate estimated phosphorus reductions achieved by those projects. Pollutant reductions achieved by State-funded projects will be reported publicly in the Vermont Clean Water Initiative Annual Investment Report, as required by Act 64 of 2015 (see the 2017 report). General progress implementing the Lake Champlain TMDL will be reported to the U.S. EPA on a five-year rotating basis, as required by the Lake Champlain TMDL Accountability Framework. TMDL progress will be measured based on estimated phosphorus reduced by projects, increase magnitude of clean water project outputs, and changes in monitored phosphorus loads to Lake Champlain. Project tracking will primarily focus on projects implemented through state and federal programs and through water quality regulatory programs. Additional projects will be tracked on a voluntary basis where data are available.

As of this writing, the modeling and projected phosphorus reductions shown by this Chapter are the best information available to Vermonters but remain a starting point. Future iterations of the Winooski River Tactical Basin Plan will provide augmented specificity in regard to phosphorus reductions achieved, reductions planned, costs, and as appropriate, success stories documenting incremental water quality improvement.

Flood Resilience Efforts

As part of its effort to address climate change, the Agency is working with communities to enhance their flood resilience. Working towards resilience means both proactively reducing vulnerabilities to flooding and flood damage and improving response and recovery efforts when flood events do occur, so that communities bounce back quickly from natural resource, social and economic impacts. Reducing vulnerabilities includes efforts to diffuse stormwater flows from buildings, over roads, especially in areas with slope and erodible material.

The importance of flood resilience was highlighted in the aftermath of tropical storm Irene and other recent flooding events across Vermont. Act 16, effective July 2014, requires municipal and regional plans to incorporate a "flood resilience" component.

Flood Hazard Regulations

VDEC's efforts to help towns improving flood resilience has included mapping local flood hazard areas, identifying flood attenuation zones (including floodplains, river corridors, forests and wetlands) and recommending specific actions and policies to towns that will help protect these areas and reduce the risks facing existing development. All available information is located on VDEC's Flood Ready website, including River Corridor Protections Summary Report and Expanded Community Reports.

Figure 26 identifies the towns in the Basin that have adopted municipal river corridor and floodplain protection bylaws to date. Appendix D provides additional information on municipal level flood resilience and water resource protection.

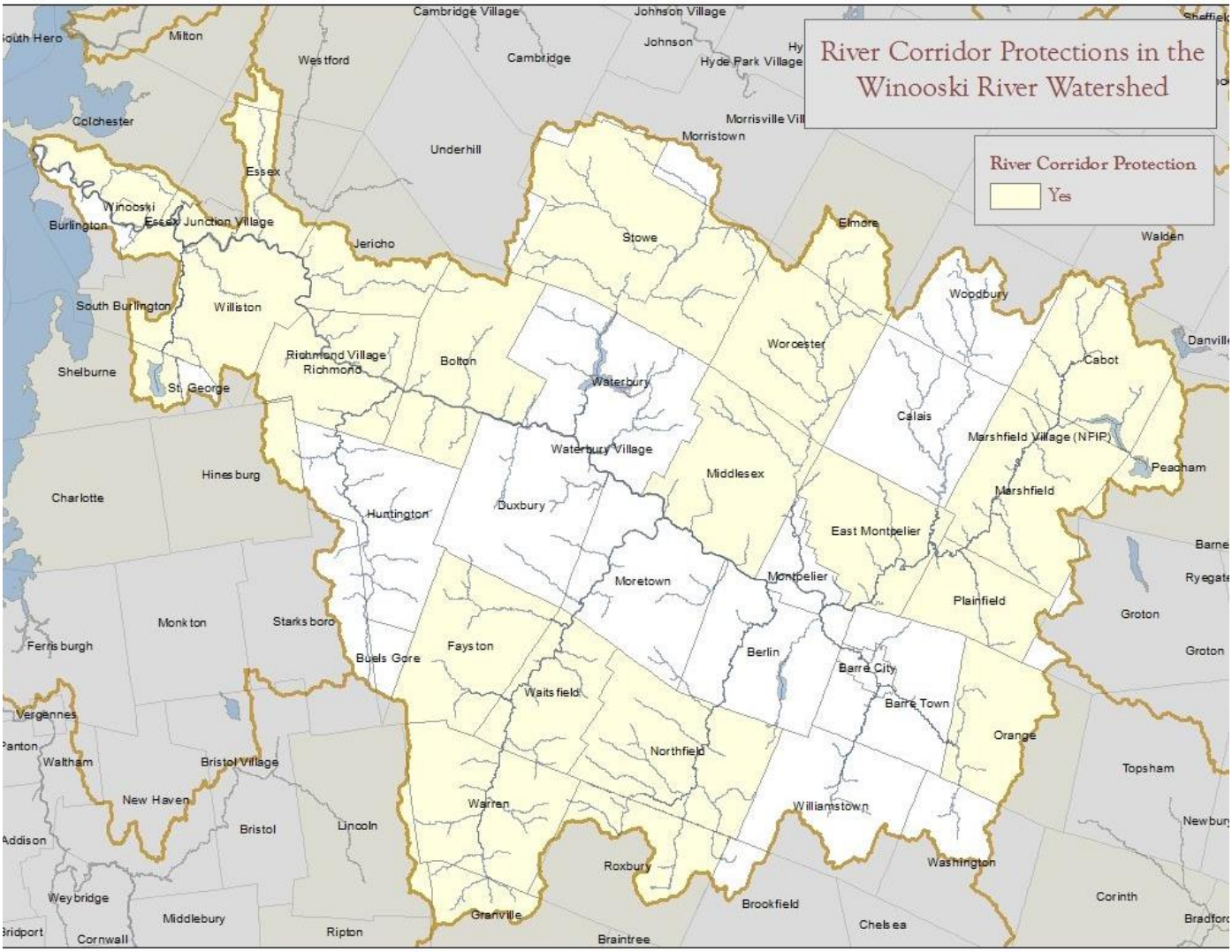
All communities in Basin 8 have bylaws in place that allow them to participate in the National Flood Insurance Program. X communities – have adopted standards to protect Special Flood Hazard Areas from new encroachments in river corridors.

Because these communities 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 the towns shown in Figure 26 as having adopted the bylaws to date, except Elmore and East Montpelier, are recognized as proving river corridor protection on an "interim" basis. The VDEC and RPCs will work with these towns, to assist them in meeting qualifications for permanent status, allowing them to receive enhanced cost share under the Emergency Relief and Assistance Fund. Elmore and East Montpelier have met qualifications for permanent status.

Hazard Mitigation Plan

The Regional Planning Commissions may also help towns increase flood resilience through development of a Hazard Mitigation Plan. This may include adding in locations of hazardous waste sites within a river corridor. In addition, the locations of landslide prone areas, provide an understanding of potential landslide activities, which may also be used to plan to reduce infrastructure damage with proactive placement of new development. Hazard Mitigation Plan projects that also protect water resources are included in the Watershed Projects Database.



Communities with River Corridor Protections have adopted bylaws that specifically protect River Corridors. Except for Elmore and East Montpelier, all of these communities have only Interim Protections, which indicates that they acted before 2015 to protect Special Flood Hazard Areas and/or a limited Fluvial Erosion Hazard Area where River Corridor maps were not available yet.

Figure 26. Status of river corridor and floodplain protection bylaws in Winooski River Basin municipalities.

Vermont Economic Resiliency Initiative (VERI)

The VERI Project Report aims to help municipalities take steps to reduce and better manage their flood risks. Barre city and town were included in the study as they were

identified as one of Vermont's top 32 communities where economic activity and associated infrastructure are at high risk of flooding.

The VERI report for Barre City and Town includes 5 projects that also provide for water resource and water quality protections and are therefore included in the watershed projects database. Implementation is under way with the city managing the federal buy out of at-risk housing along the Gunner's Brook and floodplain restoration.

The project was led by the Agency of Commerce and Community Development, working with the Agencies of Natural Resources and Transportation, Regional Planning Commissions, and consulting river scientists. The report was prepared by the Vermont Agency of Commerce and Community Development in partnership with the Two Rivers-Ottauquechee Regional Commission using Federal funds under award 01-79-14251 from the Economic Development Administration, U.S. Department of Commerce.

Chapter 4 - Management Goals for Surface Waters

The Vermont Water Quality Standards establish water quality classes and associated management objectives. The protection or improvement of water quality and water-related uses can be promoted by establishing specific management goals for particular bodies or stretches of water. The management goals describe the values and uses of the surface water that are to be protected or achieved through appropriate management. In Chapter 2 of this plan, a number of waters were identified as being notably high quality, and these, as well as other unique areas, may be candidates for establishing alternate management goals or augmented protections through one of the processes that are further described below.

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

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

Public involvement is an essential component to restoring and protecting river and lake ecology. The Vermont Water Quality Standards state that *"Public participation shall be sought to identify and inventory problems, solutions, high quality waters, existing uses and significant resources of high public interest."* Emphasis on the identification of values and expectations for future water quality conditions can only be achieved through public contributions to the planning process. Additional information relating to management goals for surface waters is in Chapter 4 of the Vermont Surface Water Management Strategy (VSWMS).

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

Table 31. A list of designated uses that can be individually classified into each of the water classes in the Vermont Water Quality Standards

Classification (2016)	*Applicable Uses*
Class A(1)	One or more of Aquatic Biota and Wildlife, Aquatic Habitat, Aesthetics, Fishing, Boating, or Swimming may be classified to Class A(1) if the Secretary finds that it is in the public interest, pursuant to 10VSA1253d.
Class A(2)	Public Water Source
Class B(1)	One or more of Aquatic Biota and Wildlife, Aquatic Habitat, Aesthetics, Fishing, or Boating may be classified to Class B(1) when that use is demonstrably and consistently attained.
Class B(2)	Aquatic Biota and Wildlife, Aquatic Habitat, Aesthetics, Fishing, Boating, Swimming, and Irrigation are all to be supported at Class B(2) for all waters in the State not presently classified to a higher class.[25]

Classification, and Recent Revisions to the Vermont Water Quality Standards

Since the 1960s, Vermont has had a classification system for surface waters that establishes management goals and supporting criteria for each use in each class of water (see Table 31). These goals describe the class-specific uses of surface waters that

[25] Class B(2) management objectives and supporting criteria are the same as with the former Class B.

are to be protected or restored through appropriate management practices. The Agency works to implement activities that restore, maintain or protect the management goals.

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

Through the tactical planning process, surface waters where one or more uses is of consistently and demonstrably higher quality than Class B(2) are to be identified and proposed for reclassification to Class B(1) for the use(s) in question. Basin plans may also identify surface waters that merit reclassification to Class A(1).

The Vermont Water Quality Standards have been amended to account for this change. The new Standards feature four classes: A(1), A(2), B(1) and B(2), and have been restructured to clarify which the quality criteria pertaining to each designated use, by class.

With the exception of the waters listed below, all waters in Basin 8 are currently classified as B(2) for all designated uses.

- Waters above 2,500 feet in elevation, are classified A(1) by Vermont statute.

- The surface waters in Table 32 are currently used as water supplies and are currently classified as A(2) and are managed to be suitable for use as a public water source with disinfection, and filtration when necessary.

- The A(2) waters in Table 33 remain classified as public water supplies but are abandoned and no longer used as such.

Table 32. Surface waters classified as A(2) that are managed as public drinking water supplies

Surface Water	*Location*	*Water Supply user*	*Water supply owner(if different from user)*	*Use Status*
Thatcher Brook and tributaries	Waterbury	Village of Waterbury		**Active**
Unnamed tributary to the West Branch	Stowe	Village of Stowe		**Emergency use only**
Thurman Dix, Lower Reservoir and tributaries	Barre Town & Orange	City of Barre		**Active**
Consolidated quarries[26] : Barclay #1 and capital quarries	Barre Town	Websterville	**Fire District #3**	**Active**
Berlin Pond	Berlin, Northfield, Williamstown	City of Montpelier		**Active**
Pecks Pond	**Barre Town**	**Barre City**	**Barre City**	**Emergency Use via dry fire hydrant**

Table 33. Basin 8 waters no longer used as a water supply

Surface Water	*Location (Town)*	*Former Water Supply Owner*	*Former Water Supply User(s)*	*Comment*
Unnamed tributary to Alder Brook	Essex	**Essex Town Water System**	**Winooski, Essex Center, Essex Jct., and Pinewood manor**	**No longer used**

[26] In 2016 Vermont Water Quality Standards, referenced as "**Standard & consolidated quarries". The Old grant quarry, also referenced, is actually "Standard quarry" and this one quarry is proposed to be reclassified to B(2), while the Consolidated quarries remain as A(2).**

Surface Water	*Location (Town)*	*Former Water Supply Owner*	*Former Water Supply User(s)*	*Comment*
Martin Brook, Reservoir & Tributaries	Williamstown	**Barre City Water System**	**City of Barre**	**No longer used and not owned by city. Thurman Dix reservoir is water supply with Jail branch as an emergency source.**
Bolster reservoir and tributaries, excluding Pecks Pond	Barre Town (South Barre)	**Barre City Water System**	**City of Barre**	**See above. No longer used and not owned by city**
Unnamed brook and tributary	Barre Town	**East Barre Fire District #1**	**Barre Town**	**Use of Reservoir with dam is not feasible. Town uses wells.**
Little John and Milne quarries	Barre Town (southwest of East Barre Village)	**East Barre Fire District #1**	**Barre Town**	**Water was piped from quarries to above unnamed tributary. See above**
Old Granite Quarry (Standard Quarry)	Barre Town (south of Websterville)	**Graniteville Fire District #4**	**Barre Town and Williamstown (Foxville section)**	**Water was piped from quarries to above unnamed tributary. See above**

Class A(2) to Class B

VDEC would support the reclassification of surface water supplies that are no longer used or intended for use as an emergency supply (see Table 33) from A(2) to another appropriate classification.

Class B(2) to A(1)

The management objective for A(1) waters is to maintain their natural condition. Through biological monitoring VDEC has documented that a 0.2-mile section of Bear Wallow Brook has the water quality sufficient to be proposed for designation as Class A(1) waters.

Subbasin	River	Town	Latitude	Latitude
Mad River	**Bear Wallow Brook (.2 miles located 100 meters above Forest Service Road crossing)**	**Granville**	**44.06027**	**-72.85457**

Class B(1)

The following list represents waters in which one or more uses are of demonstrably and consistently higher quality than Class B(2) waters, meeting criteria for reclassification to Class B(1).

Class B(1) for Fishing

The VT Fish & Wildlife Department (VFWD) assesses wild trout populations and important nursery areas to document very high quality recreational fisheries, which are typically found in surface waters that which support diverse and complex physical habitats and cool water temperatures.

Waters with abundant wild self-sustaining salmonid populations supporting multiple age classes are identified below as "very good" or class B(1) waters for recreational fishing. These waters support multiple age classes of trout totaling a minimum of 1,000 per mile (all species/ages/sizes), and/or 200 per mile > 6 inches (total length).

It should be recognized that wild trout populations vary widely from year to year and therefore an individual population may sometimes go below or greatly exceed these values (1,000 per mile, and/or 200 per mile > 6 inches (total length)) in any given year. The upstream and downstream extent of the stream classification should be based upon consistent or improving water quality, physical habitat quality and land use conditions, as per VDEC language for class A(1) waters: "The length of river or stream reach to be recommended for reclassification shall be delineated by analyzing the extent of biological, chemical, physical habitat, and land use information available for the watershed. The decision to include tributaries to the river or stream under consideration will follow the same process." The reach should include all upstream habitats which are deemed essential to sustain water quality and physical habitat requirements necessary to support wild salmonid populations at a very good level.

Other waters that have not been surveyed may also support similar wild trout densities and may be identified in the future. Certain noteworthy streams are also important to support spawning and nursery habitat and are noted below. Location data is provided for either the survey location or the downstream extent of the proposed reach.

Based upon fish population surveys conducted by VFWD, very good fisheries exist in the following waters (Table 34) within the Winooski Basin, see also Figure 27.

Table 34. Basin 8 streams meeting criteria for very good fisheries

Subbasin	River	Town	*Latitude*	*Latitude*
Upper Main Stem	**Winooski River (Above Lower Cabot)**	**Peacham**	**44.40153**	**-72.3137**
	Molly's Brook (Above Marshfield Dam)	**Peacham**	**44.3705**	**-72.27**
	Kidders (aka. Hooker) Brook	**Cabot**	**44.37392**	**-72.261**
	Nasmith Brook	**Plainfield**	**44.29974**	**-72.3876**
	Great Brook	**Middlesex**	**44.23199**	**-72.4063**
	Jones Brook	**Middlesex**	**44.24897**	**-72.6548**
	Crossett Brook	**Waterbury**	**44.32805**	**-72.747**
	Thatcher Brook	**Waterbury**	**44.3409**	**-72.7514**
	Dugar Brook	**Calais**	**44.39334**	**-72.4678**
Stevens Branch	**Jail Branch**	**Barre City**	**44.10577**	**-72.4303**
	Gunners Brook	**Barre City**	**44.20545**	**-72.5062**
	Stevens Branch	**Barre City**	**44.13294**	**-72.5333**
North Branch				
	Martins Brook	**Middlesex**	**44.35313**	**-72.6067**
	Herrick Brook	**Middlesex**	**44.34628**	**-72.6092**
Dog River				
	Dog River Mainstem	**multiple**	**44.24616**	**-72.5991**
	Felchner Brook	**Roxbury**	**44.12513**	**-72.7158**
	Stony Brook	**Northfield**	**44.11922**	**-72.6817**

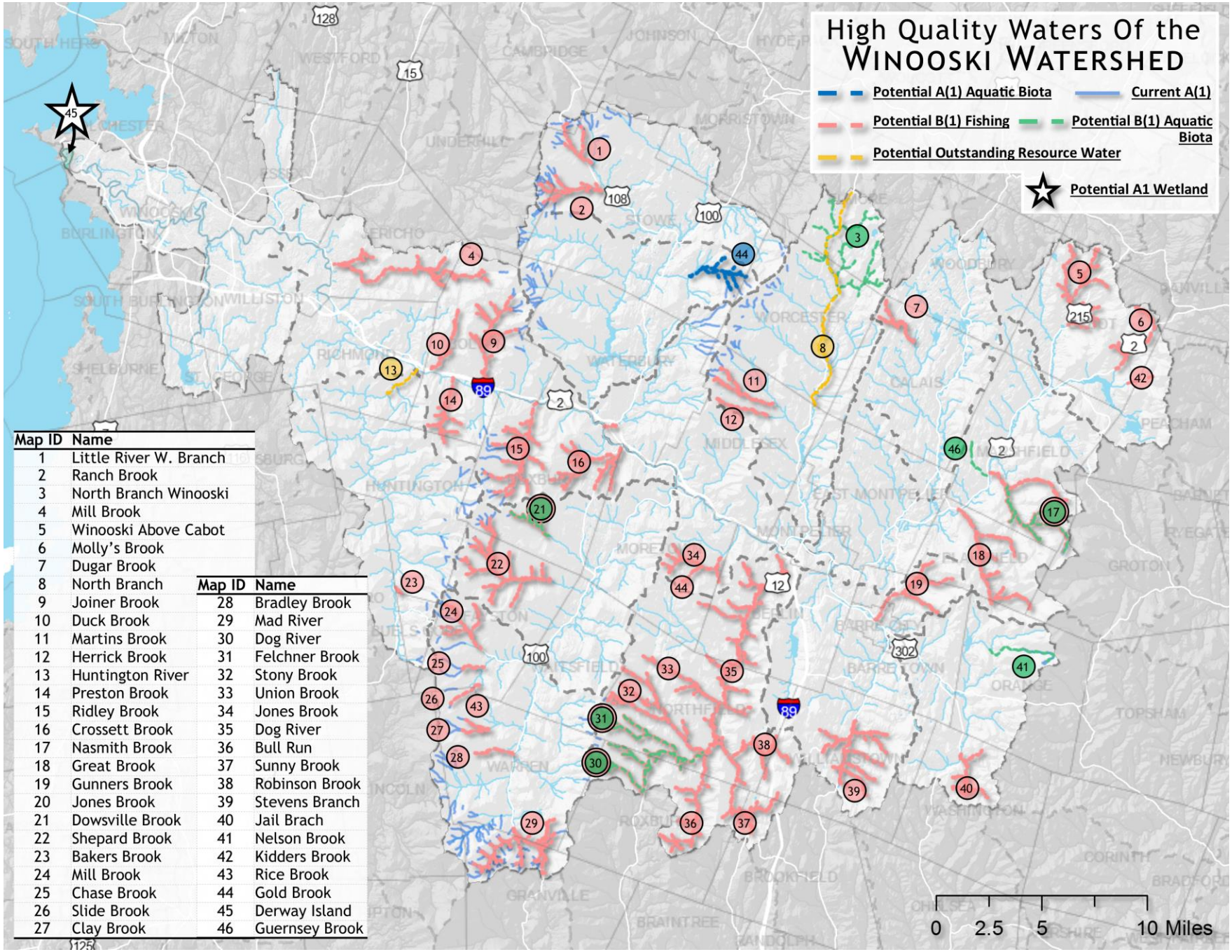
Subbasin	River	Town	*Latitude*	*Latitude*
	Bull Run	**Northfield**	**44.11714**	**-72.673**
	Sunny Brook	**Northfield**	**44.12088**	**-72.6583**
	Robinson Brook	**Northfield**	**44.11606**	**-72.643**
	Union Brook	**Northfield**	**44.15772**	**-72.677**
	Chase Brook		**44.20673**	**-72.6366**
Little River	**Little River - West Branch**	**Stowe**	**44.52389**	**-72.7747**
	Ranch Brook	**Stowe**	**44.5021**	**-72.7587**
Mid Winooski Main Stem	**Bakers Brook**		**44.23333**	**-72.9633**
	Duck Brook	**Bolton**	**44.38365**	**-72.9253**
	Joiner Brook	**Bolton**	**44.37373**	**-72.8783**
	Mill Brook	**Jericho**	**44.45666**	**-73.0141**
	Preston Brook	**Richmond**	**44.37259**	**-72.9063**
	Ridley Brook	**Duxbury**	**44.35719**	**-72.8279**
Mad River				
	Mad River (Above Warren Village)	**Warren**	**44.175722**	**-72.661631**
	Bradley Brook	**Warren**	**44.11949**	**-72.85795**
	Clay Brook*	**Waitsfield**	**44.13515**	**-72.895369**
	Rice Brook	**Waitsfield**	**44.138231**	**-72.891653**
	Mill Brook	**Fayston**	**44.194164**	**-72.889842**
	Chase Brook	**Fayston**	**44.178856**	**-72.884308**
	Slide Brook	**Warren**	**44.167197**	**-72.887525**
	Shepard Brook	**Fayston**	**44.236758**	**-72.821114**
	Dowsville Brook	**Duxbury**	**44.273039**	**-72.824189**

Class B(1) for Aquatic Biota

Based upon biomonitoring assessments conducted by the VDEC WSMD, the following surface water consistently and demonstrably attain a higher level of quality than Class B(2), meeting Class B(1) criteria for aquatic biota. See also Figure 27.

Table 35. Surface waters that currently meet water quality criteria for Class B(1)for aquatic biota use

River	Town	*Latitude*	*Longitude*
Dowsville Brook	**Duxbury**	**44.267639**	**-72.818512**
Dog River – rm 14.8	**Northfield**	**44.111159**	**-72.69204**
Guernsey Brook	**Marshfield**	**44.305**	**-72.4077**
Nasmith Brook	**Marshfield**	**44.277599**	**-72.377281**
Gold Brook	**Stowe/Worchester**	**44.44772**	**-72.657722**
Nelson Brook	**Barre Town**	**44.181599**	**-72.389236**



Map ID	Name
1	Little River W. Branch
2	Ranch Brook
3	North Branch Winooski
4	Mill Brook
5	Winooski Above Cabot
6	Molly's Brook
7	Dugar Brook
8	North Branch
9	Joiner Brook
10	Duck Brook
11	Martins Brook
12	Herrick Brook
13	Huntington River
14	Preston Brook
15	Ridley Brook
16	Crossett Brook
17	Nasmith Brook
18	Great Brook
19	Gunners Brook
20	Jones Brook
21	Dowsville Brook
22	Shepard Brook
23	Bakers Brook
24	Mill Brook
25	Chase Brook
26	Slide Brook
27	Clay Brook

Map ID	Name
28	Bradley Brook
29	Mad River
30	Dog River
31	Felchner Brook
32	Stony Brook
33	Union Brook
34	Jones Brook
35	Dog River
36	Bull Run
37	Sunny Brook
38	Robinson Brook
39	Stevens Branch
40	Jail Brach
41	Nelson Brook
42	Kidders Brook
43	Rice Brook
44	Gold Brook
45	Derway Island
46	Guernsey Brook

Figure 27. High quality waters of the Winooski River Basin

Existing Uses

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

The degree of protection afforded to these uses is based on the water's class as described in Table 31. In addition, under the anti-degradation policy of the Vermont Water Quality Standards, if the Agency of Natural Resources identifies in a waterbody, a use, the existing condition of which exceeds its classification criteria, then that use shall be protected to maintain that higher level of quality. The Agency may identify existing conditions, known as existing uses, of particular waters during the tactical basin planning process or on a case-by-case basis during application reviews for State or federal permits. Consistent with the federal Clean Water Act, the Vermont Water Quality Standards have always stipulated that existing uses may be documented in any surface water location where that use has occurred since November 28, 1975. Pursuant to the definition of the new Class B(1) in Act 79, the Agency will identify an existing use at Class B(1) levels when that use is demonstrably and consistently attained.

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

Based on the above paragraph, the existing uses identified by VDEC for the Winooski Basin to date should therefore be viewed as only a partial accounting of known existing uses based upon limited criteria. The list does not change protection under the Clean Water Act or Vermont Water Quality Standards for waters not listed. Appendix F presents the current list of Existing Uses determined for the Winooski Basin, while Table 11 identifies those surface waters where additional data will be obtained to demonstrate the consistent attainment of Class B(1) criteria for aquatic life and wildlife.

Outstanding Resource Waters

In 1987, the Vermont Legislature passed Act 67, "An Act Relating to Establishing a Comprehensive State Rivers Policy." A part of Act 67 provides protection to rivers and streams that have "exceptional natural, cultural, recreational or scenic values" through the designation of Outstanding Resource Waters (ORW). Depending on the values for which designation is sought, ORW designation may protect exceptional waters through permits for stream alteration, dams, wastewater discharges, aquatic nuisance controls, solid waste disposal, Act 250 projects and other activities.

There are currently no ORW designated waters in Basin 8. Based on data collected by the Watershed Management Division, the VANR would support a community-led effort to petition the following waters as ORW:

- The Huntington River from the Gorge to the confluence with the Winooski (Richmond) due to outstanding recreational, aesthetic and cultural reasons. The Huntington Gorge and the river above and below serve as a major swimming destination for Chittenden County. The steep gorge, the waterfalls, and the forested riverbanks create a gorgeous setting. Culturally the gorge is a former mill site, with foundations remaining nearby.

- North Branch of the Winooski River from Worcester Middlesex town line upstream to headwaters based on the river's exceptional natural, scenic and recreational values. Numerous swimming holes, many surrounded by waterfalls, dot the river.

As part of the implementation of this Tactical Basin Plan, the Department will evaluate the values of the Huntington Gorges and the North Branch for consistency with the features and values identified in prior ORW determinations. Surface waters that satisfy criteria for designation as ORW will be proposed for such designation through rulemaking.

Class I Wetland Designation

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

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

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

Class III: Neither a Class I or Class II wetland

As part of the development of this Tactical Basin Plan, several wetlands have been identified as prospective candidates for Class I, which are presented below. These wetlands have passed a cursory review by the Vermont Wetlands Program Ecologists. In addition, there are at least three wetlands that warrant study for Class I potential. These wetlands are listed below. As part of the implementation of this Tactical Basin Plan, the Department will develop and implement procedures and documents to enable submission, evaluation, and implementation of petitions to classify wetlands as Class I. Those wetlands that satisfy criteria for designation may be proposed for such designation through Departmental rulemaking authority, and as consistent with the Vermont Wetland Rules.

Prospective candidates in Basin 8 for reclassification to Class I status include:

- Derway Island, Burlington. Owned by the Winooski Valley Park District, the 120-acre floodplain forest sits just south of the Winooski River just above the river's mouth. The wetland is listed in the *Wetlands of Outstanding Ecological Significance in Chittenden County.* Prepared by the Vermont Department of Fish and Wildlife, March 1992.

Wetlands in Basin 8 that warrant further study for Class I potential**:** Shelburne Pond, Essex Alder Brook (Essex and Milton), Upper Gleason (Duxbury), Berlin Pond (Berlin), Kettle Pond south (Marshfield and Groton, Lanesboro Bog (Marshfield) and Mud Pond (Williston).

Warm and Cold-Water Fish Habitat designations

To provide for the protection and management of fisheries, waters are designated in Appendix A of the 2016 Vermont Water Quality Standards as being either a cold or a warm water fish habitat. Where appropriate, such designations may be seasonal. The list can be found on page 38 for the Winooski Basin. No changes to warm water fish or cold-water habitat designations are proposed by this plan.

Chapter 5- Implementation: Protection and Remediation Actions

The Tactical Basin Plan addresses all impaired, stressed and altered waters (Table 4) in the Basin as well as protection needs for high quality waters; however, the focus of the plan is the identification of specific priority actions to reduce nutrient and sediment loading in priority subbasins as part of the effort to meet the Lake Champlain Phosphorus TMDL goals. The list of actions covers future assessment and monitoring needs (Table 11), as well as implementation projects that protect or remediate waters and related education and outreach.

Action items are supported by the objectives in the Lake Champlain Phosphorus TMDL Phase I Implementation Plan as well as the Statewide Surface Water Management Strategy. The actions are located in the Watershed Projects Database and summarized in Table 37 (Phase I associated actions are referenced in the sources column in Table 37 as "TMDL Phase I").

The objectives and strategies specific to the plan are identified in Table 36. A summary (Table 37) of the Watershed Projects Database is intended to present a broad view of the project entries in the database. VDEC and its partners (Appendix A) will proceed to make progress in all areas of the summary table.

The process for identifying priority actions includes a comprehensive compilation and review of both internal ANR monitoring and assessment data and reports (see Chapter 2), and those of our watershed partner organizations (see Appendix A). Modeling of high phosphorus loading areas by sector (see Chapter 3) 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, the Summary of the Implementation Actions (Table 37), along with Appendix A are resources to Winooski River Basin stakeholders in their efforts to pursue and secure technical and financial support for implementation of high priority projects. Together, these resources include location information, project description, the source of the project if an 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 VDEC identifies them

with the assistance of partners. It is envisioned that the action items currently in the database as of the signing of the plan will be accomplished within the next five years as resources allow.

Table 36. Winooski River Tactical Basin Plan objectives, focus areas and strategies

Plan Objectives	Focus Areas (not to exclude work in other areas)	Strategies
Implement agricultural BMPs	Winooski Main stem, Little River, Mad, Dog and Huntington rivers	Complete surveys of farm needs; provide modeling analysis to identify most effective BMP, support BMP implementation
Manage Stormwater	MS4 entities, towns with stormwater master plans and road erosion inventories,	Identify projects through Stormwater Master Plan Assessments, Road Erosion Inventories (REI); provide technical assistance to towns. Support MS4 municipalities and non-municipal MS4s in their work to develop and implement Flow Restoration Plans and Phosphorus Control Plans as well as projects identified by REI.
Protect and remediate river corridors	Upper Winooski Main Stem, West Branch, Great Brook (Middlesex), Thatcher Brook, North Branch, Mad and Dog Rivers	Corridor protection Riparian buffer/ Floodplain restoration, dam removal, and review of permits to ensure adequate flows
Remediate logging roads and landings	Kingsbury Branch, Upper Winooski, North Branch, Mid Winooski tributaries	Promote programs that protect riparian forests, identify old logging roads and landings for remediation with high erosion potential.
Restore wetland	Great Brook (Plainfield), Winooski Main stem	Work with TNC and USFWS to identify and restore candidates
Identify and protect high quality lakes	Kingsbury Branch	Continue to collect monitoring data to confirm as high-quality lakes.
Protect and remediate lake shorelands	Kingsbury Branch	Shoreland protection, education and outreach about shoreland restoration practices, contractor certification through

Plan Objectives	Focus Areas (not to exclude work in other areas)	Strategies
		the Natural Shoreland Erosion Control Certification program
Reduce the spread of Aquatic Invasive Species	Kingsbury Branch	Provide education and outreach to boaters to reduce spread; provide technical and financial resources to assist with spread prevention
Increase knowledge of water quality conditions in the Basin	See Table 11	Support watershed groups, NRCDs, Regional Planning Commissions and MS4 permitees
Address Toxics	Stevens Branch, Winooski Main stem	Encourage winter maintenance plans that reduce chloride use, encourage management and reduction in use of toxins
Identify streams for reclassification	Entire watershed	Continue to collect macroinvertebrate and fish data to support reclassification efforts

VDEC will track progress through both implementation progress and monitoring results. Lake Champlain BMP Accounting and Tracking Tool (BATT) will be used to track implementation of projects across all sectors and apply an expected phosphorus reduction estimate to each. Annually, VDEC will summarize the progress in each basin, including the Winooski. The report will include projects implemented and total of phosphorus reduced. The 2017 report is currently available here as part of the Vermont Clean Waters Initiative Annual Investment Report.

Over time, as projects are continually implemented, a more precise estimate of cumulative phosphorus reductions can be reported rather than relying on estimates from potential actions. Chapter 2 includes a description of monitoring programs available to VDEC.

In the instance that the pollution reductions are inadequate, based on the monitoring data, but the implementation progress is adequate, based on project tracking and modeling (Appendix B), adaptive management will be required by the Vermont Clean Water Act.

With regard to education and outreach efforts, workshops and participants at events supported through the Act 64, will be tracked and reported in the Vermont Clean Water Initiative Program annual report to the Legislature.

It is VDEC's goal to prioritize staff time and direct internal and external grant funding opportunities towards the recommended actions. These actions include work on types of waterbodies within the Basin and all the spectrums of land use that could potentially impact water quality and aquatic habitat. It is our hope that these tables outline priorities that are realistic to implement over a five-year period, noting that there are many unforeseen variables, like landowner willingness and funding availability.

Table 37. Summary of Implementation Actions (Watershed Projects Database). The objectives (yellow)and strategies supporting priority actions in Basin 8. The on-going detailed list of actions can be viewed via Watershed Projects Database)

Priority Subbasin	And/or	Priority Towns/catchments[27]	Strategies	Source [28]	Stressor addressed	Partners[29]	Funding (see also VSWMS Appendix D)
AGRICULTURE: Implement BMPs							
		Phase II priority catchments for agricultural land Table 17	**Expand small farm NMP development courses** and workshops, trainings for farmers, manure applicators and technical service providers	TMDL Phase I	Nutrients, pathogen	VACD, UVM extension, WNRCD	
		Phase II priority catchments for agricultural land Table 17	**Target inspections in priority catchments/watersheds**: target implementation based upon the results	TMDL Phase I	Land erosion, nutrients, pathogens	VAAFM,	
		Phase II priority catchments for agricultural land Table 17	**Increase implementation in priority catchments/watersheds**: 1.Provide farms with access to case managers to increase conservation practice implementation through participation in State and federal financial and technical assistance programs; 2 provide modeling analyses as needed to identify most effective BMPs	TMDL Phase I	Land erosion, nutrients, pathogens	VAAFM, VDEC,	RCPP, USDA
		Phase II priority catchments for agricultural land Table 17	**Increase technical assistance in priority catchments/ watersheds**: work with farms, including vegetable farms, to meet RAP and adopt BMPs	TMDL Phase I	Land erosion, nutrients, pathogens	WNRCD, VACD	RCPP, USDA
		Phase II priority catchments for agricultural land Table 17	**Pilot the Environmental Stewardship Program** to incentivize additional practice adoption	TMDL Phase I	Land erosion, nutrients, pathogens	VAAFM	RCPP, USDA
		Phase II priority catchments for agricultural land Table 17	**Create grassed waterways program** Target funding to critical source areas in coordination with partners	TMDL Phase I	Land erosion, nutrients, pathogens	UVM extension	RCPP, USDA
		Phase II priority catchments for agricultural land Table 17, Huntington River	**Provide outreach to support implementation of prescribed pasture practices**. Provide financial support for livestock exclusion	TMDL Phase	Land erosion, nutrients, pathogens	UVM extension, WNRCD, WNRCS, VAAFM	USDA, ERP, ACAP, VAAFM BMP
Huntington, Mad and Dog Rivers		Phase II priority catchments for agricultural land Table 17,	**Increase the availability of equipment** for rental or through custom operators to allow farmers to follow NMPs, including equipment to measure crop yields, manure application rates and to take soil samples. In addition, increase availability of equipment to implement BMPs, including crop and grassland no till drills, Crop and grassland manure injectors, and tine weeder air seeders.	TMDL Phase I, E. coli TMDL	Land erosion, nutrients, pathogens	UVM extension, WNRCD, WNRCS, VAAFM	NRCS CSP, ACAP, VHCB

[27] High priority catchments identified in Phase II content which provides the highest phosphorus loading for a particular sector.
[28] Pertain only to strategies that are included in other documents. If no source specified, then strategy identified during tactical basin planning meetings with partners.
[29] See Appendix A for additional description of partners

Priority Subbasin	And/or	Priority Towns/catchments[27]	Strategies	Source [28]	Stressor addressed	Partners[29]	Funding (see also VSWMS Appendix D)
Mad River			**Develop and provide support for equine specific programing** including support for installing horse manure compost bins and making pasture improvements		Land erosion, nutrients, pathogens	UVM extension, WNRCD,	ACAP, EQIP, VAAFM BMP
Upper Winooski		Phase II priority catchments for agricultural land Table 17	**Provide technical and financial resources to farms that aren't large enough to meet VAAFM Small Farm Operation definitions**		Land erosion, nutrients, pathogens	WNRCD, watershed groups	
		Phase II priority catchments for agricultural land Table 17	**Complete targeted water quality sampling on 3 farms** to help identify source areas and evaluate nutrient reductions achieved through BMP implementation.		Land erosion, nutrients, pathogens	Watershed groups, WNRCD, VDEC	VDEC LaRosa Partnership
STORMWATER: Reduce pollutants and volume							
Lower Winooski		MS4 entities	**Support the development and implementation of Phosphorus Control Plans and implementation of the Flow Restoration Plans.**	TMDL Phase I	Land erosion, nutrients, pathogens	VDEC, CCRPC	CWIP
Stevens Branch, West Branch		Williamstown, Stowe	**Provide technical assistance** to identify and prioritize stormwater management projects. Use stormwater plan template developed by VDEC	TMDL Phase I	Land Erosion, Channel erosion, pathogens	VDEC, CVRPC,	CWIP
Multiple		See Appendix C	**Support implementation of high priority projects in stormwater master Plans**	TMDL Phase I	Land Erosion, Channel erosion, pathogens	VDEC, CCRPC, CVRPC, LCPC	CWIP
Basin wide		See top 10 prioritized road projects in town road erosion inventories as well as Phase II priority catchments for roads (Tables 23 and 24)	**Help municipalities control runoff from gravel and paved roads to meet the Municipal Roads General Permit:** implement road assessment protocol to assist with prioritization; provide technical and financial resources to assist with implementation, including projects within 250 feet of lakes.	TMDL Phase I	Land Erosion	CCRPC, CVRPC, LCPC. NVDA, VTrans, WNRCD, VDEC, Municipalities	CWIP
All		Phase II priority catchments for developed land, Table 22	**Support municipal stormwater ordinance adoption,** include incorporation of LID and GSI practices; Implement "Three-acre" permit, including the green schools initiative to help schools meet the three-acre permit	TMDL Phase I	Land erosion, nutrients, Channel erosion, pathogens	Municipality, CCRPC, CVRPC, LCPCLCPC, NVDA, VDEC,	CWIP
Basin wide			**Implement six minimum control measures required in the State TS4 permit**	TMDL Phase I	land erosion, channel erosion,	VTrans	VTrans
Basin wide			**Develop and begin implementation of a phosphorus control plan early in the next TS4 permit cycle**	TMDL Phase I	land erosion, channel erosion,	VTrans	VTrans

Priority Subbasin	And/or	Priority Towns/catchments[27]	Strategies	Source [28]	Stressor addressed	Partners[29]	Funding (see also VSWMS Appendix D)
		Phase II priority catchments for paved roads (Table 23)	**Intercept and treat runoff from agricultural and silvicultural land before it reaches VTrans right of way**		Land Erosion, Channel erosion, pathogens	VAAFM, NRCS, WNRCD,	USDA, ERP
Basin-wide		Phase II priority catchments for develop land, Table 22.	**Support brownfields restoration efforts that mitigate surface water pollution generated from these sites.**	VDEC	Toxics, Land Erosion, Channel erosion, pathogens	CCRPC, CVRPC, LCPC, towns	VDEC, EPA
Stevens Branch, Sunny Brook, Lower Winooski tributaries		Barre city, Montpelier, MS4 entities	**Provide education on winter maintenance strategies to businesses and towns to reduce use of Chlorides.**		Toxics	CCRPC, CVRPC, LCPC, UVM Sea Grant, WNRCD, towns	LCBP
		Phase II priority catchments for develop land, Table 22.	**Support stormwater management education for private landowners, including private drive ways (http://dec.vermont.gov/sites/dec/files/wsm/erp/docs/VT_Guide_to_Stormwater_for_Homeowners_DRAFT.pdf and Lake Wise reports**	VDEC	Land erosion, channel erosion	UVM Sea Grant, WNRCD	LCBP
RIVER CORRIDOR: Reach stream equilibrium and flood resilience							
Basin wide		See River Corridor plans Table 39	**Implement high priority projects identified in river corridor plans**	TMDL Phase I	Channel erosion, flood resilience, thermal modification	VDEC, FWR, FMR, WNRCD, municipalities	CWIP
Mid and Upper Winooski tributaries		Potential B(1) for fishing watersheds (Table 34)	**Replace geomorphologically and aquatic organism passage (AOP) incompatible culvert and bridges:** RPCs work with municipalities to identify, add to capital budget, seek additional funding sources	DEC	Channel erosion, flood resilience	CCRPC, CVRPC, LCPC, municipalities VTrans,	federal hazard mitigation funds, Municipalities, VTrans
Basin wide		See River Corridor Plans Table 39	**Increase River Conservation Easements**: support projects which incorporate channel management and riparian buffer and provisions in areas where protection does not otherwise exist.	TMDL Phase I	Channel erosion, flood resilience, thermal modification	VDEC, VRC, VLT, WNRCD	CWIP
Basin wide		Towns with interim ERAF status	**Enhance the Flood Resilient Communities Program** with funding and technical assistance incentives for municipalities. Encourage municipalities with provisional ERAF status to meet current standards	TMDL Phase I	Channel erosion, flood resilience	VDEC, CCRPC, CVRPC, LCPC, UVM Sea Grant	State of Vermont
Basin wide		See Table 9	**Support studies to investigate benefits of removal of dams listed in Table 9 and where landowner interest exists**	VDEC	Channel erosion, encroachment, thermal modification	Friends of Winooski River, TU, VDEC, VNRC	CWIP, LCBP, Watershed Grant

Priority Subbasin	And/or	Priority Towns/catchments[27]	Strategies	Source[28]	Stressor addressed	Partners[29]	Funding (see also VSWMS Appendix D)
See Landslide Inventory Map, 2017		Middlesex, Plainfield, Calais, Warren, Jericho, Bolton,	**Assist towns in accessing and understanding use of the Vermont Geological Survey's landslide inventory to benefit Hazard Mitigation Plan** as well as preventing landslides through protection	VDEC	Land Erosion, encroachment	CCRPC, CVRPC, LCPC, Vermont Gas	FEMA (for Hazard Mitigation)
Basin-wide			**Support gully stabilization and remediation by addressing stormwater inputs and/or through natural channel design where possible to prevent further migration of gullies**		Land erosion	CVRPC	ERP
FISHERIES HABITAT: Restore complexity and diversity (see also above for addressing AOP and Thermal Modification)							
Mad and Dog River			**Remediate habitat** in highly degraded areas and/or areas where extensive channel management occurred by adding woody debris	VDFW	Channel erosion	VFWD, TU, VTrans,	
Mid Winooski tributaries, Winooski headwaters, Mad River, Dog River, Huntington		See high quality waters map for potential B1 for fisheries watershed (Fig. 27)	**Protect water quality and riparian characteristics in subwatersheds that protect salmon and brook trout habitat** (see Ladago 2017, page 17 for recommended strategies). Use community interest in salmon and/or brook trout to engage community in watershed protection actions	VDFW		TU, USFW, FWD	USFWS
FOREST MANAGEMENT: Abate soil erosion							
		Phase II priority catchments for forested land (Table 16)	**Identify and remediate eroding, abandoned and retired forest roads, skid trails and log landings**	TMDL Phase I	Land erosion	DFPR	RCPP
		Phase II priority catchments for forested land (Table 16)	**Provide technical and financial assistance to forest landowners**. Prioritize assistance based on contribution of erosion features on logging roads to water quality impairment, use of roads to manage a sugarbush.	TMDL Phase I	Land erosion	State foresters, DFPR	RCPP
Basin-wide			**Provide loggers with access to bridges** to reduce floodplain encroachment and improve AOP, including renting portable skidder bridges or promote building and ownership of bridges by logging as part of their general practices. In addition, DFPR will continue renting larger temporary bridges, which provide a larger opening than the skidder bridge and can handle logging trucks.	DFPR	Land erosion, Channel erosion	Fontaine Lumber, DFPR, WNRCD, VACD	CWIP
Basin-wide		All	**Enhance forest** cover to improve watershed health by promoting the use of Ecologically Sensitive Treatment Areas for managed forest in current-use.	TMDL Phase I	Land erosion, Channel erosion	DFPR	
Winooski headwaters, North Branch, Kingsbury Branch,		Berlin, Middlesex	**Protect forestland** through support of the working landscape as well as conservation to protect community valued ecosystem services. Use Vermont Cover to identify priority forest areas for protection, encourage municipalities to protect forested area in watershed of water supplies, direct outreach to landowners of large forested tracks under or eligible for current use	ANR, CVRPC	Land Erosion, Protection	CVRPC, FWR, VLT,	ACCD -VHCB programs; High Meadows (2017 grant)
WETLANDS: Protect and restore							
			Determine following wetlands potential as Class I wetland through collection of additional information: Shelburne Pond, Essex Alder Brook (Essex and Milton), Upper Gleason (Duxbury), Berlin Pond (Berlin), Kettle Pond south (Marshfield and Groton) , Lanesboro Bog (Marshfield) and Mud Pond (Williston) to	TMDL Phase I	Protection	VDEC,	

Priority Subbasin	And/or	Priority Towns/catchments[27]	Strategies	Source [28]	Stressor addressed	Partners[29]	Funding (see also VSWMS Appendix D)
		Contact WSMD Wetlands Program for priority areas	**Prioritize restoration of wetland and floodplains on agricultural lands with highest potential for phosphorus retention and sediment attenuation.**	TMDL Phase I, VDEC	pathogens, land erosion, nutrients, channel erosion	VDEC, USFWS,	USDA, RCPP, CWIP
			Prioritize restoration and protection of wetlands, as well as floodplain forests, and river corridors based on potential to filter out pollution. See Water Quality Blueprint for specific areas: https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/vermont/freshwater/nature-based-solutions-for-clean-water.xml	VDEC, TNC	land erosion, nutrients, channel erosion	VDEC, TNC,	ERP, ACCD-VHCB
LAKE and SHORELINE: Protect and restore							
Kingsbury Branch		Calais, East Montpelier, Woodbury, including Greenwood Lake	**Promote the Lake Wise Program's online resources** to encourage lake-friendly shoreline property maintenance	TMDL Phase I	Shoreline encroachment, land erosion	UVM Sea Grant, VDEC	LCBP, Watershed Grants, CWIP
		Greenwood Lake	**Promote contractor and partner participation on the Natural Shoreland Erosion Control Certification Program**			UVM Sea Grant, VDEC	
Kingsbury Branch		Calais, East Montpelier, Woodbury	**Incorporate materials specific to spiny water flea into signs, greeter program. Place spiny water flea spread prevention information at all lake accesses**	VDEC	Aquatic invasive species	VDEC, lake associations	LCBP
See Table 4 for lakes altered by Eurasian watermilfoil			**Support community's efforts to control Eurasian watermilfoil** and other invasives	VDEC,	Aquatic invasive species	VDEC	AIS grant-in-aid program
Kingsbury Branch		Curtis Pond, Calais	**Grow the access greeter program at Curtis Pond to include other local lakes**	VDEC,	Aquatic invasive species	VDEC	
			Assist development of a cyanobacteria (blue-green algae) volunteer monitoring program and response plan	VDEC	Land erosion, channel erosion, nutrient loading	LCBP, LCC, municipalities, VDEC, VDH,	VDEC, VDH staff time
Kingsbury Branch		Buck, Pidgeon, Coits, Turtlehead	**Recruit lay monitors for collecting water quality data on high priority lakes**	VDEC		VDEC Lay monitoring program, residents	VDEC
Basin-wide		All	**Support community efforts to protect lake shoreland**		Encroachment, land erosion	Watershed groups, NGOs, FOLAP	

Priority Subbasin	And/or	Priority Towns/catchments[27]	Strategies	Source [28]	Stressor addressed	Partners[29]	Funding (see also VSWMS Appendix D)
Other							
Entire Basin		See Table 30	**Issue permits to WWTF that meet new phosphorus limits. Support municipalities pursuing phosphorus optimization, expansion projects and upgrades**	TMDL Phase I	Pathogens, nutrients	VDEC, municipalities	USDA-Rural Development, Clean Water State Revolving Funds
		All	**Document the current loading conditions for phosphorus, and determine the "reasonable potential" that WWTF's have to cause or contribute to downstream water quality impairment**	VDEC	Nutrients	VDEC, municipalities	VDEC
Kingsbury Branch, Jail Branch, Muddy Brook		See Table 11	**Monitor and assess surface waters** to gain better understanding of condition and potential pollution sources, including internal phosphorus loading in lakes. In addition, monitor for pathogens at swimming areas and report to community.	VDEC	Pathogens, land erosion, channel erosion	VDEC, watershed groups,	VDEC including LaRosa Partnership Program, Lay Monitoring Program
Huntington River, Kingsbury Branch, Jail Branch		Curtis Pond	**Provide septic system maintenance education to homeowners**	Partners	Pathogen	UVM Sea Grant, WNRCD, VDEC	
		See Table 11	**Conduct biomonitoring and/or water quality monitoring on streams** that have met "very good" or "excellent" criteria to identify candidates for reclassification	VDEC	Protection	VDEC	VDEC
Basin-wide			**Assist land managers in managing or reducing use of toxins** that adversely impact aquatic biota		Toxins	LCBP	

List of Acronyms

604(b) -Federal Clean Water Act, Section 604b
ANR -Vermont Agency of Natural Resources
AMP -Acceptable Management Practice
AIS -Aquatic invasive species
AOP -Aquatic Organism Passage
BR - Backroads grant
BMP -Best Management Practice
CCRPC-Chittenden County Regional Planning Commission
CVRPC-Central Vermont Regional Planning Commission
CWSRF -Clean Water State Revolving Fund
CREP -Conservation Reserve Enhancement Program
CWI – Clean Water Initiative
DWSRF -Drinking Water State Revolving Fund
ERP – Ecosystem Restoration Program
EQIP -Environmental Quality Incentive Program
E/O – Education & Outreach
FEH -Fluvial Erosion Hazard
FERC -Federal Energy Regulatory Commission
FOVLAP – Federation of Vermont Lakes and Ponds
GSI- Green Stormwater Infrastructure
IDDE – Illicit Discharge Detection and Elimination
LCPC-Lamoille County Planning Commission
LID -Low Impact Development
MAPP -Monitoring, Assessment and Planning Program
MS4-Municipal Separate Storm Sewer System
NPDES -National Pollution Discharge Elimination System
NPS -Non-point source pollution
NRCD -Natural Resource Conservation District
NRCS -Natural Resources Conservation Service
ORW -Outstanding Resource Water
PDM -Pre-Disaster Mitigation
RAP – Required Agricultural Practices
RCPP – NRCS Regional Conservation Partnership Program
RMP -Vermont WSMD River Management Program
RPC -Regional Planning Commission
SGA -Stream Geomorphic Assessment
TNC-The Nature Conservancy
TU-Trout Unlimited
TBP – Tactical Basin Plan
TMDL -Total Maximum Daily Load
USDA -United States Department of Agriculture
USEPA -United States Environmental Protection Agency
USFWS -United States Fish and Wildlife Service
UVM -University of Vermont
VAAFM -Vermont Agency of Agriculture, Food and Markets
VDEC - Vermont Department of Environmental Conservation
VDFPR -Vermont Department of Forests, Parks and Recreation
VFWD – Vermont Fish and Wildlife Department
VTrans -Vermont Agency of Transportation
VDH -Vermont Department of Health
VGS - Vermont Geological Survey
VIP -Vermont Invasive Patrollers
VLCT -Vermont League of Cities and Towns
VLT -Vermont Land Trust
VRC-Vermont River Conservancy
WSMD – VDEC Watershed Management Division

References:

AMC. 2002. AMC River Guide – VT and NH (3rd Edition). Appalachian Mountain Club, Boston, MA

FB Environmental Association 2011, *Vermont statewide TMDL for Bacteria-impaired Waters*. Vermont Department of Environmental Conservation, Water Quality Division, Waterbury, VT.

Jenkins J. and P. Zika, 1992. The Whitewater Rivers of Vermont: *The Biology, Geography and Recreational Use*. Agency of Natural Resources, Waterbury, VT.

Jenkins, J. and P. Zika, 1985. *The Waterfalls, Cascades, and Gorges of Vermont*. VT Agency of Environmental Conservation, Waterbury, VT.

Kirn, R. 2012. *Impacts to Stream Habitat and Wild Trout Populations in Vermont Following Tropical Storm Irene.* The Vermont Fish and Wildlife Department. Federal Aid in Fish Restoration, F-36-R14. Montpelier

Ladago, B. 2017. *2017 Upper Winooski Fisheries Assessment.* VT Department of Fish and Wildlife, Montpelier, VT. http://dec.vermont.gov/sites/dec/files/wsm/mapp/docs/mp_UpperWinooskiWatershedFisheriesSummary_2017-12-15.pdf

Tetra Tech. 2015a. *Lake Champlain BATHTUB Model Calibration Report*. Prepared for: U.S. EPA Region 1 – New England Boston MA. https://www.epa.gov/sites/production/files/2015-09/documents/lc-bathtub-model-calibration-report.pdf

Tetra Tech. 2015b. *Lake Champlain Basin SWAT Model Configuration, Calibration and Validation*. Prepared for: U.S. EPA Region 1 – New England Boston MA. https://www.epa.gov/sites/production/files/2015-09/documents/swat-model-configuration-calibration-validation.pdf

Tetra Tech. 2015c. *Lake Champlain BMP Scenario tool requirements and design*. Prepared for: U.S. EPA Region 1 – New England. Boston MA. http://www.epa.gov/tmdl/lake-champlain-bmp-scenario-tool-report

US. Environmental Protection Agency, 2012. *National Lakes Assessment. Washington, D.C. http://water.epa.gov/type/lakes/lakessurvey_index.cfm*

VAAFM(Agency of Agriculture Food & Markets). (2016, May 13). Required Agricultural Practices (RAPs). Retrieved from Vermont.gov: http://agriculture.vermont.gov/water-quality/regulations/rap#Q16

VAAFM, 2008. http://www.vermontagriculture.com/ARMES/awq/presentations.html

VT Association of Conservation Districts. (2015, May). Regional Conservation Partnership Program. Retrieved from USDA Natural Resource Conservation Service Vermont: http://www.nrcs.usda.gov/wps/portal/nrcs/main/vt/programs/farmbill/rcpp/

VDEC, (2016 March). Vermont Surface Water Assessment and Listing Methodology. Montpelier, Vermont: Agency of Natural Resources.

VDEC, (2018). State of Vermont 2018 Stressed Waters List - DRAFT. Montpelier, VT: State of Vermont.

VDEC, (2017). Vermont Water Quality Standards: Environmental Protection Rule Chapter 29A. Montpelier, VT: State of Vermont.

VDEC, (2018a). 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.

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

VDEC, (2018c). Part D. Impaired Surface Waters with Completed and Approved TMDLs. State of Vermont List of Priority Surface Waters - DRAFT. Montpelier, VT: State of Vermont.

VDEC, (2018d). Part E. Surface Waters Altered by Invasive Aquatic Species . State of Vermont 2018 List of Priority Surface Waters - DRAFT. Montpelier, VT: State of Vermont.

VDEC, (2018e). Part F. Surface Waters Altered by Flow Regulation. State of Vermont 2018 List of Priority Surface Waters - DRAFT . Montpelier, VT: State of Vermont.

VDEC. 2013. Gauging the Health of Vermont Lakes: Results of the 2007 National Lake Assessment. Vermont Agency of Natural Resources. Vermont Department of Environmental Conservation, Watershed Management Division.

VDEC. 2012d. Vermont Surface Water Management Strategy. Vermont Department of Environmental Conservation, Watershed Management Division

VANR and VAAFM. (2015, August). Vermont Lake Champlain Phosphorus TMDL Phase 1 Implementation Plan. Montpelier, VT: State of Vermont.

VDFW. 2008. *2008 Vermont Guide to Hunting, Fishing and Trapping*. VT Dept. of Fish and Wildlife, Waterbury, VT.

VDFW. 2018. 2018 Proposed Stocking Schedule https://anrweb.vt.gov/FWD/FW/FishStockingSchedule.aspx

VT Department of Health. 2016. Blue-*Green Algae in Lake Champlain*. Available at http://healthvermont.gov/enviro/bg_algae/bgalgae.aspx

Wilson, A. 1992. AMC Quiet Water Canoe Guide. Appalachian Mountain Club, Boston, MA.

Glossary

Please see http://dec.vermont.gov/sites/dec/files/documents/WSMD_swms_Glossary.pdf

Winooski Tactical Basin Plan Appendices

Appendix A – Partners

All of the following organizations and agencies contributed to the development of the Winooski Tactical Basin Plan and/or will assist in the plan's implementation

Group Name	Association	Description
Regional Planning Commissions (RPC): Chittenden County (CCRPC); Central Vermont (CVRPC); Lamoille (LCPC); Northeastern Vermont Development Association (NVDA);	Regional	Statutory partners to the basin planning process, and help municipalities to complete road erosion inventories, stream geomorphic assessments, and stormwater master plans in addition to helping municipalities update their regulations to protect water quality. As part of the implementation of Act 64 (Sec. 43), VDEC has contracted with RPCs to fulfill the specific roles and responsibilities around the development of tactical basin plans that should substantially enhance VDEC'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 (FNRCD); Winooski(WNRCD); Lamoille (LCCD)		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.
Friends of the Huntington River and the Huntington Conservation Commission	Non-profit	A community group focused on reducing bacterial loads in the Huntington River. They support water
Friends of the Mad River	Local non-profit	A private, non-profit organization committed to protecting, improving and enhancing the ecological, recreational, and community values of the Mad River and its watershed
Friends of the Winooski River	Local non-profit	Their mission is to safeguard and enhance the natural resources of the Winooski River watershed in order to create a healthy balance with its human communities. The Friends support restoration projects, monitoring, partnerships, education and outreach.
Lake Champlain Committee	Local non-profit	A bi-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 restoration of their aquatic resources for long-term environmental health and sustainable economic development
Rethink Runoff		Regional	Partnership of twelve MS4 permitees in Chittenden County administered by Chittenden County RPC to implement regional effort to meet permitees' obligation under Minimum Measure #1 (Public Education & Outreach) and Minimum Measure #2 (Public Participation/Involvement). See www.rethinkrunoff.org
Vermont Youth Conservation Corps (VYCC)		Statewide non-profit	The VYCC works on Class IV road projects by assessing and implementing BMPs in high risk areas. The role of the VYCC in helping to implement actions in the basin plan continues to evolve as funding and needs change.
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.
Watershed Municipalities		Municipal	46 Vermont municipalities are located entirely or partially in the watershed: Municipalities can protect water resources through town plan language and zoning bylaws. Additionally, municipalities are responsible for managing large networks of roads, drainage ditches, and stream crossings.
VT Agency of Natural Resources (ANR) Internal Partners	Fish and Wildlife (VFWD); Forests, Parks and Recreation (VFPR); Environmental Conservation (VDEC)	State	All Departments within ANR (Fish & Wildlife Department, Forest, Parks, and Recreation, and VDEC) and Divisions within them, work collaboratively on a number of watershed assessment, restoration and protection projects. Additionally, FWD and FPR own and manage hundreds of acres of state-owned lands within the basin. Annual stewardship plans are prepared by District Stewardship Teams and includes staff from FWD, FPR, and VDEC. Long Range Management Plans of state-owned properties include restoration and protection of water resources.

Appendix B - Modeling Tools and Assessments for Identifying Remediation and Protection Efforts

Table 38. Modeling Tools

Tool	*Description and Use*	*User*	*Info available in following format*	*Use/ BMP[30]*
SWAT model	Model used to estimate phosphorus (P) loading in the Lake Champlain watershed. Discrete SWAT models were calibrated/validated for each HUC8 watershed and direct drainage. P estimates based on land use, soil type, slope, climate, and other variables. Used in development of the TMDL.	ANR, NRCS	Tables, figures, maps	Prioritize areas of high P loading; identify potential BMPs at watershed scale.
HUC12 Tool	Summary of SWAT P estimates by general land use sector. Reported at HUC12 (subbasin) scale for each lake segment basin.	ANR	Tables, figures	Compare loading estimates across land use sectors at HUC12 scale.
EPA Scenario Tool	Used to evaluate scenarios for P reduction in the Lake Champlain watershed based on SWAT estimates of P loading and BMP efficiencies. Identifies potential load reductions based on the type and coverage of specified BMPs.	ANR – (LC P TMDL[31])	Tables, figures, maps	Evaluate impact of various BMP implementation scenarios.
Clean Water Roadmap Tool	A partnership between VT DEC, Keurig-Green Mountain Coffee Roasters, the Nature Conservancy (TNC), and other stakeholders. The overall goal is to 'map' the results of the Lake Champlain SWAT model and associated follow-on products, especially EPA's BMP Scenario Tool, along with management actions contained in DEC's Tactical Basin Plan implementation	by regional planners, the public, and VDEC staff	A map-based application that allows users to click on a specified watershed and receive a summary report	The CWR will provide a description of one way the Lake Champlain TMDL phosphorus reductions can be achieved, largely based on EPA's reasonable assurance scenario.

[30] Best Management Practice
[31] Lake Champlain Phosphorus TMDL

	tables and tracking systems. The CWR can be used to identify priority areas and actions for Lake Champlain phosphorus reductions.		of relevant best management practices (BMPs)	
Lake Champlain BMP Accounting and Tracking Tool (LC BATT)	The Watershed Projects Database tracks project implementation and the LC BATT calculates P loading reductions for implemented BMPs.	ANR (LC P TMDL)	Report	Track implemented BMP reductions relative to TMDL goals.
Prioritizing agricultural fields for BMP	Process that uses SWAT and associated tools to develop a list of priority P loading sectors at NHD+ catchment (sub-HUC12) scale. Identify potential BMPs and/or other management actions.	case managers; NRCS, NRCD; UVM extension	Maps	Identify priority areas and potential BMP implementation.
Prioritizing Riparian Buffer Enhancement	Combines NRCS estimates of buffer gaps with stream and watershed characteristics to prioritize riparian planting efforts.	NRCS, Partners that plant trees,	NRCS has developed for Rock and Pike River. Develop for other priority basins based on partner interest and data availability	Identify areas for riparian plantings
Field gully identification	Model framework that uses high-resolution elevation data to predict gully locations. Predicted gullies can be checked against aerial imagery and/or land use data to identify locations in agricultural lands. Under RAPs/AAPs, farmers are responsible for addressing field gullies. Restorations of edge of field gullies may also be eligible for funding.	VAAFM, case managers, NRCS	Maps	Develop for priority areas. Dependent on availability of LiDAR.

Floodplain restoration	Projects are identified using stream geomorphic assessment data (see table 38) as well as site visits to confirm conditions. Priority sites include high incision rate in stream channel, but small watersheds to limit amount of land needed to restore flood plain, which would be more amendable to agricultural landowners.	ANR	Develop for priority areas where hydrology significantly altered by ditching/tile drains; dependent on landowner interest	Flood plain restoration; two-tiered ditch
Wetland restoration	In 2007, Agency of Natural Resources (ANR) released the Lake Champlain Wetland Restoration Plan, which identified opportunities to restore wetlands and the benefits they provide. These sites are now being targeted by the NRCS Wetland Reserve Program. VDEC will create site profiles for high ranking wetland restoration sites. In addition, The Nature Conservancy will also provide resources for ecological restoration, including wetlands.	ANR, NRCS, USFWS	Maps	Wetland restoration

Hydrologically Connected Roads Layer	A data layer on the ANR atlas which identifies road segments by erosion risk to surface waters as well as potential hydrologic connectivity. Road projects may be further prioritized by finding documented points of stormwater input to rivers using Stream Geomorphic Assessments. High priority road remediation sites will likely include hydrologically connected segments on steep slopes, where significant road-related erosion is present, and/or where road BMPs are currently lacking or insufficient.	ANR, municipalities, VTrans	Data layer on ANR Atlas; list of priority road segments	Road BMPs include: grass and stone-lined drainage ditches, the installation of properly sized drainage culverts, culvert header and outlet stabilization, road crowning, regular catch basin clean outs and street sweeping, and addressing erosion from municipal sand piles. The Interim Guidance for completing municipal road erosion inventories and capital budgets 2016-2018 (June 2, 2016, VDEC Municipal Roads Program) outlines the steps for developing the list of priority road segments for remediation.
Culvert replacement and prioritization	Prioritization of municipal culvert replacement using VTrans culvert database. Criteria include structural integrity, conformance with geomorphology, and aquatic organism passage. The NRPC and NVDA both assist municipalities with prioritizing as well as financial budgeting through use of a capital budget. The VTrans culvert database will be provided to municipalities as a resource	Municipalities with help from RPC	List of culverts by town; prioritization based on aquatic organism passage	VTrans culvert database will be provided to municipalities as a planning resource.

Table 39. Stream Geomorphic Assessments and River Corridor Plans for Basin 8. Except where noted, all streams are moving towards planform stability with channel erosion and encroachment as the primary stressors.

Stream or River	Report date	Report Link	Summary of Findings/project priorities
Alder Brook	12/01/2006	Alder Brook Phase 1 and 2 SGA	Landslide prone below Rte. 15: manage stormwater and protect corridor (upper) where not protected through wetland rules
Allen Brook	4/11/2008	Allen Brook Watershed Departure Analysis and Project Identification Summary	address encroachments and stormwater: River corridor protection[32], Riparian plantings, stormwater management
Dog River	3/01/2009	Dog River Corridor Plan	Thermal stress from lack of buffer and widened stream: Riparian plantings and focus river corridor easements outside of bedrock-controlled areas
Huntington River	9/14/2009	Huntington River Watershed Corridor Plan	Riparian plantings, river corridor protection
Huntington River	12/01/2005	Huntington River Watershed Phase 1 SGA	See above
Huntington River	1/01/2006	Phase 2 SGA Huntington River Watershed	See above
Kingsbury Branch	10/01/2008	Kingsbury Branch of the Winooski River Watershed River Corridor Plan	Geomorphic condition protection by bedrock and VT wetland Rules. Limited actions needed
Pekin Brook	6/02/2010	Pekin Brook Corridor Plan, Calais, VT	River corridor protection,
Little River	6/28/2010	Little River Corridor Plan	River corridor protection, relocate or upgrade infrastructure in river corridor
Mad River	1/01/2008	Mad River Headwaters Phase 2 SGA	See below
Mad River	3/01/2008	Mad River Phase 1 and 2 SGA	See below
Mad River	4/20/2018	Moretown, Vermont Phase 2 Geomorphic Assessment & River Corridor Plan	Livestock exclusion, floodplain/stream restoration, river corridor protection and buffer plantings

[32] River corridor protection can include river corridor easements, adequate sizing of culverts as well as municipal regulations for flood resilience.

Stream or River	Report date	Report Link	Summary of Findings/project priorities
Mad River	1/01/2008	Upper Mad River Corridor Plan	River corridor protection and riparian buffer plantings
Morehouse			Stormwater management. consider gully restoration and culvert replacement
Muddy Brook	2/01/2008	Muddy Brook Phase 1 and 2	River corridor protection in upper watershed (existing wetlands). Upper area protected by wetland, relocate or upgrade infrastructure in lower river corridor: Stormwater management, riparian plantings,
North Branch Winooski	3/01/2009	North Branch Winooski Corridor Plan	Bed rock gorges protects geomorphic condition. Protect depositional areas between bedrock-controlled areas.
North Branch Winooski	5/01/2007	North Branch Winooski Phase 1 SGA	See above
North Branch Winooski	3/01/2007	Upper Winooski Watershed, North Branch and Lower Stevens Branch Phase 1 SGA	See above
Richmond tribs	9/01/2007	Winooski River tributaries in Richmond Phase 1 SGA	Encroachment: upgrade culverts, riparian plantings
Stevens Branch	3/01/2009	Stevens Branch and Jail Branches of the Winooski River Corridor Plan	Jail Branch: Landslide prone - manage stormwater at top of bank, and new development Stevens Branch – River corridor protection
Stevens Branch	4/01/2004	Stevens Branch in Williamstown and Barre City Phase 2 SGA	See above
Sucker Brook	10/01/2007	Sucker Brook Phase 1 and 2 SGA	River corridor protection (not high priority) where not already confined by ravines, riparian plantings, address stormwater
Sunderland Brook		Find Phase 2 report	River corridor protection and floodplain restoration in agricultural areas, address stormwater
Little River Main Stem	6/28/2010	Little River Corridor Plan	River Corridor Protection and riparian planting
West Branch Little River	10/12/2010	Upper West Branch Little River Corridor Plan, Stowe, VT	Stormwater management and Encroachment: work with landowners to reduce infrastructure conflicts

Stream or River	Report date	Report Link	Summary of Findings/project priorities
West Branch Little River	5/01/2007	West Branch Little River in Stowe Corridor Plan	Encroachment: work with landowners to reduce infrastructure conflicts
West Branch Little River	11/01/2005	West Branch Little River Phase 2 SGA	See above
Winooski - Cabot	3/30/2006	Phase 2 SGA, Winooski River Watershed, Town of Cabot, VT	See below
Winooski - Cabot	6/01/2006	Winooski River in Cabot Corridor Plan	Temperature: plant and protect riparian buffers
Winooski - Cabot	11/01/2004	Winooski River in Cabot Phase 1 SGA	See above
Winooski - Cabot	12/01/2006	Winooski River in Cabot Phase 2 SGA	See above
Winooski - Montpelier to Cabot	3/19/2014	Great Brook River Corridor Plan	Encroachment: address infrastructure conflict, increase wetland in headwaters,
Winooski - Montpelier to Cabot	1/01/2008	Upper Winooski Corridor Plan	Temperature: riparian plantings and river corridor protection
Winooski - Montpelier to Cabot	4/01/2007	Upper Winooski Phase 2 SGA	See above
Winooski - Montpelier to Cabot	3/31/2010	Upper Winooski River: Plainfield to Montpelier, River Corridor Plan	Temperature: riparian plantings and river corridor protection
Winooski Mid, Alder to Montp	2/01/2009	Joiner Brook, Bolton River Corridor Plan	Geomorphic condition is good to fair with good riparian buffers. Snowmaking weir causing sediment accumulation upstream. Stormwater management
Winooski Mid, Alder to Montpelier	6/01/2007	Mid-Winooski Watershed Chittenden, Washington, and Lamoille Phase 1 SGA	See below
Winooski Mid, Alder to Montp	12/15/2015	Middle Winooski River Corridor Plan	River corridor protection, riparian planting
Winooski, Mouth to Alder Brook	8/01/2006	Lower Winooski Phase 1 and 2 SGA	Bedrock controlled with large wetland within river corridor: restore and protect wetlands

Table 40. Inland Lake Score Card information for 51 Basin 8 lakes

The water quality condition is represented by different colors: Blue = Good Conditions; Yellow = Fair/Stressed Conditions: Red = Poor/Impaired/Altered Conditions; Blank = assessment needed.

Water Quality Status key: pH = acid sensitive (low alkalinity), TP = total phosphorus, Flow = water level manipulation, DO = dissolved oxygen, Cl = chloride

Aquatic Invasive Species key: EWM = Eurasian water milfoil, CLP = curly leaf pondweed, EF = European frog bit, BN = brittle naiad.

Lake ID	Lake Area (acres)	Town	Water Quality Trend	Water Quality Status	Aquatic Invasive Species	Mercury in Fish Tissue	Shoreland & Habitat	Waters' Disturbed
BAILEY	17	Marshfield						
BAKER (BRKFLD)	35	Brookfield						
BANCROFT	14	Plainfield						
BEAVER (ROXBRY)	10	Roxbury		pH				
BERLIN	293	Berlin			EWM			
BLISS	46	Calais		TP				
BLUE	6	Calais						
BLUEBERRY	48	Warren						
BOLSTER	5	Barre Town						
BUCK	39	Woodbury						
CHAPELS	2	East Montpelier						
COITS	40	Cabot						
CRANBERRY MEADOW	28	Woodbury						
CURTIS	72	Calais		TP				
CUTTER	16	Williamstown						
DOBSON	9	Woodbury						
DRY	2	Northfield						
EAST CALAIS MILL;	6	Calais						
FELCHNER;	12	Northfield						
FOREST (CALAIS)	133	Calais						
GILLETT	30	Richmond		Sed, pH				
GOODALL	7	Woodbury						
GOOSE	2	Bolton						
GOSLANT	5	Peacham						
GREENWOOD	96	Woodbury						
HALFMOON COVE	14	Colchester		TP				
HARDWOOD	49	Elmore		pH				
HAWKINS	9	Calais						
HORN OF THE MOON	10	East Montpelier						
KNOB HILL	16	Marshfield						

Lake ID	Lake Area (acres)	Town	Water Quality Trend	Water Quality Status	Aquatic Invasive Species	Mercury in Fish Tissue	Shoreland & Habitat	Waters' Disturbed
LAIRD	12	Marshfield						
LEECH	4	Woodbury						
LIGHT TROUT CLUB	7	Moretown						
LILY PAD	2	Colchester						
LIMEHURST	13	Williamstown						
LITTLE (CALAIS)	7	Calais						
LITTLE (ELMORE)	14	Elmore		pH				
LITTLE MUD (WOODBY)	10	Woodbury						
LONG MEADOW;	7	Calais						
LOWER ORANGE	8	Orange						
LOWER WINOOSKI;	4	Winooski		TP, Cl				
LOWER WORCESTER	35	Worcester		pH				
MANSFIELD	38	Stowe		pH				
MARTIN;	28	Williamstown						
MIDDLE WOODBURY;	9	Woodbury						
MIRROR	85	Calais						
MOLLYS	38	Cabot						
MOLLYS FALLS	397	Cabot		Flow				
MUD (WOODBY)-SE	18	Woodbury						
NELSON (EMONTP)	10	East Montpelier						
NORTH KING	3	Woodbury						
NORTH MONTPELIER	72	East Montpelier		TP, Sed	EWM			
OAK HILL;	8	Williston						
ORANGE;		Orange						
PAINE;		Northfield						
PEACHAM	340	Peacham		Flow				
PECKS	16	Barre Town						
PIGEON	69	Groton		pH				
PRESTON	9	Bolton						
RICHARDS;	14	Marshfield						
RICHMOND	24	Richmond		pH				
ROBINSON;	7	Northfield						
ROSS;		Morristown						
ROULEAU	1	Williamstown						
RUSS	7	Elmore		pH				
SABIN	142	Calais		DO, Sed				
SCHWARTZ;		Morristown						
SHELBURNE	452	Shelburne		TP, DO	CLP, EWM, EF			

Lake ID	Lake Area (acres)	Town	Water Quality Trend	Water Quality Status	Aquatic Invasive Species	Mercury in Fish Tissue	Shoreland & Habitat	Waters' Disturbed
SMITH (WOODBY)	4	Woodbury						
SODOM	21	East Montpelier						
SOUTH KING	4	Woodbury						
SOUTH WOODBURY;	6	Woodbury						
STERLING	8	Cambridge		pH				
TABER;		Stowe						
TABOR	5	Calais						
THURMAN W. DIX	123	Orange						
TURTLEHEAD	69	Marshfield		pH				
UNION;		Northfield						
UPPER WINOOSKI;	10	Winooski		TP, Cl				
UPPER WORCESTER	11	Worcester						
VALLEY	88	Woodbury		TP, DO				
WALTON	13	Woodbury						
WATERBURY	839	Waterbury		Flow, sed. pH	BN			
WATSON	11	Calais						
WEST HILL	46	Cabot		Flow				
WHEELER (WOODBY)	4	Woodbury						
WHEELOCK	4	Calais						
WHITCOMB	1	Williamstown						
WILLIAMSTOWN-NE;	7	Williamstown						
WOODBURY;		Woodbury						
WRIGHTSVILLE	190	East Montpelier		Flow, pH				

Appendix C Winooski Basin Towns with Stormwater Master Plans, FRP, Road Erosion Inventories

Table 41. Winooski Basin towns with Stormwater Master Plans or Flow Restoration Plans

Chittenden County				Central Vermont Counties			
Town	**SWMP / FRP †**	**Year filed**	**Projects Identified***	**Town**	**SWMP Completed**	**Year**	**# of High Priority Projects Identified**
Burlington	Centennial Brook FRP	2016	3	**Barre City**	Y	2017	5
				Barre Town	Y	2017	5
Burlington	Englesby Brook FRP	2016	29	**Berlin**	Y	2017	5
				Cabot	N		
Burlington	Potash Brook FRP	2016	1	**Calais**	In progress	2018	
Colchester	Morehouse Brook FRP	2016	2	**Duxbury**	In progress	2018	
Colchester	Sunderland Brook FRP	2016	1	**East Montpelier**	In progress	2018	
Essex	Sunderland Brook FRP	2016	4	**Fayston**	In progress	2018	
Essex/UVM	Sunderland Brook FRP	2016	1	**Marshfield**	N		
Essex Junction	Sunderland Brook FRP	2016	1	**Middlesex**	N		
Colchester/VAOT	Sunderland Brook FRP	2016	1	**Montpelier**	Y		
Essex Junction	Indian Brook FRP	2016	7	**Moretown**	In progress	2018	
Essex	Indian Brook FRP	2016	4	**Northfield**	Y	2011	4
VAOT	Indian Brook FRP	2016	1	**Orange**	N		
Essex/EJ/VAOT	Indian Brook FRP	2016	2	**Plainfield**	Y	2017	5
Jericho	Town-wide SWMP	2017	21	**Roxbury**	N		
Richmond	Town-wide SWMP	2018	21	**Waitsfield**	In progress	2018	
Shelburne	Munroe Brook FRP	2016	33	**Warren**	In progress	2018	
VAOT	Munroe Brook FRP	2016	2	**Washington**	N		
South Burlington	Bartlett Brook FRP	2016	15	**Waterbury**	N		
				Williamstown	N		
VAOT/private	Bartlett Brook FRP	2016	1	**Woodbury**	In progress	2018	
South Burlington	Centennial Brook FRP	2016	5	**Worcester**	N		
So.Burl / BTV	Centennial Brook FRP	2016	8				
So.Burl / VAOT	Centennial Brook FRP	2016	3				
So.Burl/Burl./UVM	Centennial Brook FRP	2016	1				
South Burlington	Englesby Brook FRP	2016	3				
South Burlington	Potash Brook FRP	2016	97				
UVM	Potash Brook FRP	2016	3				
BTV Airport	Potash Brook FRP	2016	1				
VAOT	Potash Brook FRP	2016	6				
Underhill	Town-wide SWMP	2018	20				
Williston	Allen Brook FRP	2016	30				
Winooski	Morehouse Brook FRP	2016	8				

** town-wide SWMP projects could include more than 1 watershed*
† Flow Restoration Plan (FRP) projects identified refer to locations; may need more than one "project" at location.

Table 42. Winooski Basin towns with Road Erosion Inventories per the Municipal Road General Permit

Central Vermont Counties			Central Vermont Counties			Lamoille County		
Town	**Year REI Completed**	**# high priority Projects Identified/ completed**	**Town**	**Year REI Completed**	**# high priority Projects Identified/ completed ***	**Town**	**Year REI Completed**	**# high priority Projects Identified/completed**
Bolton	2016		**Barre City**			**Elmore**	2017	
Buels Gore	2016		**Barre Town**	In progress		**Morristown**	**n/a**	
Burlington	2017		**Berlin**	2014		**Stowe**	**2017**	
Colchester	2017		**Cabot**	In progress				
Essex	2017		**Calais**	In progres				
Essex Junction	2017		**Duxbury**	2016				
Jericho	2016		**East Montpelier**	In progress				
Richmond	2016		**Fayston**	In progress				
Saint George	2016		**Marshfield**	2013				
Shelburne	2017		**Middlesex**	2016				
South Burlington	2017		**Montpelier**	2017				
Underhill	2016		**Moretown**	2016				
Westford	2017		**Northfield**	In progress				
Williston	2017		**Orange**	In progress				
Winooski	2017		**Plainfield**	2013				
			Roxbury	**2017**				
			Waitsfield	**2016**				
			Warren	**2017**				
			Washington	**In progress**				
			Waterbury					
			Williamstown	**In progress**				
			Woodbury	**In progress**				
			Worcester	**In progress**				

Appendix D –Status of flood resilience and water quality protection at municipal level

Chittenden County							
Green = muni proofread data	Status	**Bolton**	**Buels Gore**	**Burlington**	**Colchester**	**Essex**	**Essex Jnctn**
National Flood Insurance Program (NFIP)	**Enrolled?**	Y	Not required	Y	Y	Y	Y
Road and Bridge Standards	**Adopted?**	N	Y	Y	Y	Y	Y
Hazard Mitigation Plan (LHMP)	**Adopted?**	Y	Y	Y	Y	Y	Y
River Corridor Protection	**Adopted?**	Early Adopter	N	N	Early Adopter	Early Adopter	Early Adopter
Comments on River Corridor Protection		reluctant to adopt VTRANS Muni Road & Bridge stand'ds = cost	no floodplain, minimal RC, no incentive to adopt		Also designated CRS community		
ERAF	**Percent**	7.5	12.5	12.5	17.5	17.5	17.5
Flood Hazard By-law	**Adopted?**	Y	N	Y	Y	Y	Y
	Comment	Y	No (see row 7)	Y	Y	y	Y
Flood Resilience in Town Plan	**Completed?**	Yes	In process	Yes	Yes	Yes	Yes
	Comment		Plan expired in 2012; CCRPC staff are drafting a new one.				
Municipal By-law or Zoning District for Water Resource Setback	**River/Stream**	Y		Y	Y	Y	Y
	Comment	Winooski River has a 150 ft setback. Named Stream/brook has a 100 ft setback. or streams has a 50 ft setback.		Named Streams has a 100 ft setback. minor streams have a 50 ft setback. Winooski River has a 250 ft setback.	River = 250 ft setback. Streams = 85 ft setback. NOTE: 250 ft back from mean water mark on Winooski & Lamoille River creates no-build buffer 100 ft fr mean water mark.	Streams has a 50 ft setback.	Streams has a 50 ft setback.
	Wetland	Y		Y	Y	Y	
	Comment	50 ft		Wetland has a 100 ft setback.	50 ft setback.	Class II wetlands has a 50 ft setback.	
	Lake/Pond	Y		Y	Y	Y	
	Comment	Named Pond = 200 ft setback. or pond = 50 ft setback.		Lake Champlain = 250 ft setback. minor lake/pond = 50 ft setback.	Lake, Pond = h 250 ft setback.	Lakes/Ponds/Reservoirs over .5 ac = 150 ft setback.	

Chittenden County					
Green = muni proofread data	**Hinesburg**	**Huntington**	**Jericho**	**Richmond**	**St. George**
National Flood Insurance Program (NFIP)	Y	Y	Y	Y	N
Road and Bridge Standards	Y	Y	Y	Y	Y
Hazard Mitigation Plan (LHMP)	Y	Y	Y	Y	Y
River Corridor Protection	Early Adopter	N	Early Adopter	Early Adopter	N
Comments on River Corridor Protection	has some FEH (Not RC) overlay already	RC provisions in proposed 2018 revisions to bylaws	FEH areas included in town's River District		Working with VDEC and FEMA towards NFIP and RCP in 2018
ERAF	17.5	12.5	17.5	17.5	7.5
Flood Hazard By-law	Y	Y	Y	Y	N
	Y	Yes, updating zoning bylaws in 2018	Y	Y	Working with VDEC and FEMA towards NFIP and RCP in 2018
Flood Resilience in Town Plan	Yes	Yes	Yes	In process	In process
				re was a flood resilience element in 2012 plan, which is now expired. town is in process of updating its plan and CCRPC staff have assisted with flood resilience sections.	Plan expired in 2012; CCRPC staff are working with town on flood resilience updates to meet statutory requirements and reflect its pursuit of NFIP participation
Municipal By-law or Zoning District for Water Resource Setback	Y	Y	Y	Y	Y
	Outside Village District, streams have 75 ft setback for new structures, but vegetation mgt. is not addressed. Village District: has stream buffer provisions combined with stream setbacks in village growth area. In se areas stream buffers have greater protection re how vegetation is managed.- LaPlatte River and Patrick Brook – 100' on each side. Village District - Streams in developed areas – 25' on each side (see map), unless waived by DRB, see below.	Huntington River has a 100 ft setback. Named Streams has a 50 ft setback.	35-ft 1st order, 50-ft 2nd order, 100-ft 3rd order	Winooski, Huntington Rivers 50 ft. setback. or rivers, brooks & ponds has a 50 ft setback.	Streams has a 50 ft setback.
	Y	Y	Y	Y	Y

Chittenden County					
	Wetlands & assoc. buffer areas (per State of VT) protected in 2 large rural districts (AG and RR2 – 80% of town) from certain types of development – i.e., subdivisions and projects requiring site plan review. See §5.26 of Zoning & §6.12 of Subdiv. Regs.	Class II wetlands has a 50 ft setback.	25-ft Class III, 50-ft Class II, 100-ft Class I	Class II wetlands has a 50 ft setback.	class II wetlands have a 50 ft setback.
	Y		N	Y	
	Lake/Pond has a 75 ft setback. Outside of Village District			Gillette Pond & Lake Iroquois = 50 ft setback. or rivers, brooks & ponds = 50 ft setback.	

Chittenden County						
Green = muni proofread data	**Shelburne**	**So. Burlington**	**Underhill**	**Westford**	**Williston**	**Winooski**
National Flood Insurance Program (NFIP)	Y	Y	Y	Y	Y	Y
Road and Bridge Standards	Y	Y	Y	Y	Y	Y
Hazard Mitigation Plan (LHMP)	Y	Y	Y	Y	Y	Y
River Corridor Protection	Early Adopter	Early Adopter	N	Early Adopter	Early Adopter	Early Adopter
Comments on River Corridor Protection(RCP)		considering RC or RCPA in 2018	considering RC or RCP in 2018	working on combined RC and RCPA overlay district	considering RC or RCPA	considering RC or RCPA over next few years
ERAF	17.5	17.5	12.5	17.5	17.5	17.5
Flood Hazard By-law	Y	Y	Y	Y	Y	Y
	Y	Y	Y	Y	Y	Y
Flood Resilience in Town Plan	Y	Yes	Yes	Yes	Yes	Yes
	Town staff are aware of need to strengthen Fluvial Erosion discussion in next draft of plan, which will be adopted 2019					Plan drafting beginning. 2014 Plan-City staff & PC aware of need to increase discussion of fluvial erosion. In flood resilience section
Municipal By-law or Zoning District for Water Resource Setback	Y	Y	Y	Y	Y	
	LaPlatte, McCabe's and south branch Munroe has a 100 ft setback. North branch Monroe & tribs has a 50 ft setback.	Muddy and Potash Brook has a 100 ft setback. Minor streams have a 50 ft setback.	25-ft for all rivers and 50-ft from TOB or 100-ft from TOS for Selected Rivers: Beaver Brook, Settlement Brook, Crane Brook, Roaring Brook, Seymour River, Harvey Brook, Stevensville Brook, Mill Brook, Clay Brook, and Brown's river	Water Resource Overlay District =50 ft for 1st order stream & 100 ft.for all or streams, rivers, class 2 wetlands, etc. Ponds= same buffer as associated waterway	Named Rivers and Brooks has a 150 ft setback. unnamed streams have a 50 ft setback.	
	Y	Y	Y	Y	Y	
	Wetlands has a 500 ft setback.	wetlands have a 50 ft setback.	25-ft Class III, 50-ft Class II, 100-ft Class I	Yes, 100 ft. per WRO	Class II wetlands has a 50 ft setback.	

Chittenden County						
	Y	Y	N	Yes, 100 ft. per WRO	Y	
	Shelburne Pond =s a 500 ft setback. Lake Champlain = a 100 ft setback.	Lake Champlain has a 150 ft setback.			Lake Iroquois has a 250 ft setback.	

Lamoille County				
	Status	**Elmore**	**Morristown**	**Stowe**
Town Plan rewrite timeframe		2017-2018, have started update process	Last Plan update August 2016. Next Plan update 2023-2024	Last updated June,2015, next update 2019-2020
New Zoning adoption scheduled		Adopted revised subdivision regulations and River Corridor Bylaws in January 2017. Town is applying for an FY 18 Municipal Planning Grant to re-format/ further update zoning bylaws and subdivision regulations with an emphasis on forest fragmentation.	Zoning and Subdivision Bylaws last updated June, 2017	Zoning Regulations last updated June 2017. Subdivision Regulations last updated June 2012.
National Flood Insurance Program (NFIP)	Enrolled?	Y	Y	Y
Adopted new Road and Bridge Standards (2013)	Adopted?	Y	N. LCPC has conducted outreach through TAC and directly to Town staff, Road Foreman, Town officials, but adopting these standards are too cost prohibitive for the Town. LCPC continues to outreach and work with Road Foreman/public works on providing guidance to implementing MRGP standards.	N. LCPC has conducted outreach through TAC and directly to Town staff, Road Foreman, Town officials, but adopting these standards are too cost prohibitive for the Town. LCPC continues to outreach and work with Road Foreman/public works on providing guidance to implementing MRGP standards.
Hazard Mitigation Plan (LHMP)	Adopted?	Y	Y (Valid through October 2017) Town was approached regarding assistance for 2017 update but did not show interest. LCPC brought this issue up to the Town again fall of 2017 and noted PDM funding opportunities. LCPC put Town contacts in touch with the State Hazard Mitigation Planner. Town expressed interest in being part of the 2017 State PDM grant to update the Morristown Hazard Mitigation Plan.	Y (re-adopted and approved in 2017)
River Corridor Protection	Adopted?	Y	N	Y
Comments		50-ft or more setback for streams	Stream setback varies by district, generally 50-ft	Adopted Fluvial Erosion Hazard Overlay District. Bylaws last updated in 2017.
ERAF	Percent	17.5	7.5	7.5
Flood Hazard By-law	Adopted?	Y	Y	Y
	Comment	Updated Flood Hazard Regulations to include River Corridor Overlay language. River Corridor Bylaws adopted in January 2017.	Zoning Bylaws last updated June, 2017	Flood Hazard Bylaws updated during 2017 Zoning Regulations update.
Flood Resilience in Town Plan	Completed?	N	Y	Y
	Comment	Part of 2017-2018 Town Plan update. LCPC will be assisting the Elmore Planning Commission with meeting Flood Resilience Element requirements.	Included in 2016 Town Plan update	Flood Resilience Plan included in 2015 Town Plan update.

Lamoille County				
	Status	**Elmore**	**Morristown**	**Stowe**
Municipal By-law or Zoning District for Water Resource Setback (provide needs assessment for outreach and technical assistance along with appropriate partner)	River/ Stream buffer	Y	Y	Y
	Comment	50 feet. Larger setback for steep slopes (additional 2ft buffer for every 1% increase in slope above 15% when within 500ft of river/stream/wetland)	varies by district, generally 50 ft	50 feet setback from watercourses.
	Wetland	Y	Y	Y
	Comment	50 feet. Larger setback for steep slopes (additional 2ft buffer for every 1% increase in slope above 15% when within 500ft of river/stream/wetland	50 feet	50 feet setback from watercourses
	Lake/ Pond	Y	Y	Y
	Comment	Local delegation for VT shoreline protection act. Regulates activities within 250 feet of the mean water level of lakes greater than 10 acres in size (Lake Elmore).Vegetative cover within 100 feet of the mean water level must be managed according to the Vegetation Protective Standards. The Remote Area Overlay District is located east of Route 12, in the southeast section of town. Within the District development is restricted in areas a substantial distance from existing public roads and public services. Permitted uses in the RAO District are forestry, agriculture and passive recreation.	varies by district, generally 50 ft	Shoreland District:no development within two hundred (200') feet of the mean water mark of Lake Mansfield and any form of development within five hundred (500') feet of the mean water mark must be reviewed by the DRB for approval of a conditional use permit in addition to the existing zoning.

Central VT counties	Status	**Barre City**	**Barre Town**	**Berlin**	**Cabot**	**Calais**	**Duxbury**	**E. Montpelier**	**Fayston**
Town Plan rewrite timeframe (expiration date)		**Jun-19**	**May-19**	**expired**	**Aug-25**	**Feb-24**	**Oct-19**	**expired**	**Oct-19**
New Zoning adoption scheduled				draft zoning dated May 20, 2016 includes increased protections for all riparian areas	draft zoning regulations dated August 2014 include flood hazard and increased protections				
National Flood Insurance	Enrolled?	Y	Y	Y	Y	Y	Y	Y	Y

Central VT counties Program (NFIP)	Status	Barre City	Barre Town	Berlin	Cabot	Calais	Duxbury	E. Montpelier	Fayston
Road and Bridge Standards	Adopted?	N	Y	Y	Y	Y	Y	Y	Y
Hazard Mitigation Plan (LHMP)	Adopted?	Y	Y	Y	Y	Y	Y	Y	Y
River Corridor Protection	Adopted?	N	N	N	N	N	N	N	N
Comments									
ERAF	Percent	7.5	12.5	12.5	17.5	12.5	12.5	12.5	17.5
Flood Hazard By-law	Adopted?	Y	Y	Y	Y	Y	Y	Y	Y
	Comment	Standalone Flood Hazard Area Regulations	Section 5.8 Flood Hazard Area Development. Regulations buried within the development review section of the zoning regulations.		Flood Hazard regulations not included in current zoning and not posted on town website - status?	Table 2.7 Flood Hazard Overlay	Section 7 Flood Hazard Overlay District	Article 9 Flood Hazard Regulations	Table 2.7 Flood Hazard Overlay District
Flood Resilience in Town Plan	Completed?	N	N	Y	Y	Y	Y	N	Y
	Comment	in progress						in progress	
Municipal By-law or Zoning District for Water Resource Setback (provide needs assessment for outreach and technical assistance along with	River/Stream buffer	N	Y	Y	N	Y	N	Y	Y
	Comment		Section 3.11 - 50 ft buffer on streams, ponds and wetlands (class I and II)	75 FT		Section 3.14 - Surface Water Protection - on all lakes, ponds, streams, rivers and wetlands. Buffers of 50 ft - 20 ft (on un named streams)		Section 3.12 Protection of Water resources applies to surface waters and wetlands as identified on towns water resource map. 25 ft - 50 ft dependent on development type.	Section 3.13 Streams and Wetlands section. 50 ft. Plus Table 2.2 Soil and Water Conservation District purpose to protect water resources.
	Wetland	N	Y	Y	N	Y	N	Y	Y

Central VT counties **appropriate partner)**	Status	**Barre City**	**Barre Town**	**Berlin**	**Cabot**	**Calais**	**Duxbury**	**E. Montpelier**	**Fayston**
						Section 3.14 - Surface Water Protection - on all lakes, ponds, streams, rivers and wetlands. Buffers of 50 ft - 20 ft (on un named streams)			
	Comment		Section 3.11 - 50 ft buffer on streams, ponds and wetlands (class I and II)	50 FT				Table 2.6 Conservation Overlay Districts include Wetland Overlay District. 50 ft.	Section 3.13 Streams and Wetlands section. 50 ft
	Lake/Pond	N	Y	Y	Y	Y	N	Y	N
				Highland Conservation District plus the Rural Res District's purpose statements include references to protecting wetlands and surface waters. Also see Section 3.14 Stream Protection	Section 4.4 Shoreland District includes 75 ft, 50 ft or 25 ft setback from pond dependent on use or development type.	Section 3.14 - Surface Water Protection - on all lakes, ponds, streams, rivers and wetlands. Buffers of 50 ft - 20 ft (on un named streams). ALSO, Table 2.4 Shoreland District - purpose to protect surface waters.		Section 3.12 Protection of Water resources applies to surface waters and wetlands as identified on towns water resource map. 25 ft - 50 ft dependent on development type.	
	Comment		Section 3.11 - 50 ft buffer on streams, ponds and wetlands (class I and II)						

Central VT Counties	Status	**Marshfield**	**Middlesex**	**Montpelier**	**Moretown**	**Northfield**	**Orange**	**Plainfield**	**Roxbury**
Town Plan rewrite timeframe (expiration date)		**expired**	**Mar-18**	**Dec-25**	**Jan-24**	**Sep-19**	**May-18**	**Feb-19**	**Jun-19**

Central VT Counties	Status	Marshfield	Middlesex	Montpelier	Moretown	Northfield	Orange	Plainfield	Roxbury
New Zoning adoption scheduled				proposed regulations in hearing process - may include increased protections?				draft revised zoning regulations incorporate river corridor into flood hazard overlay district.	
National Flood Insurance Program (NFIP)	Enrolled?	Y	Y	Y	Y	Y	Y	Y	Y
Road and Bridge Standards	Adopted?	Y	Y	Y	Y	Y	Y	Y	Y
Hazard Mitigation Plan (LHMP)	Adopted?	Y	Y	Y	Y	Y	Y	Y	Y
River Corridor Protection	Adopted?	N	N	N	N	Y	Y	Y	Y
Comments						Included within Article V Floodplain Zoning Regulations			
ERAF	Percent	7.5	17.5	12.5	12.5	17.5	17.5	17.5	17.5
Flood Hazard By-law	Adopted?	Y	Y	Y	Y	Y	Y	Y	Y
	Comment	Section 440 Flood Hazard District	Table 2.7 Flood Hazard Overlay District	Section 309 Floodplain Development	Table 2.5 Flood Hazard Overlay District	Article V Floodplain Zoning Regulations	No Zoning. Standalone Inundation Hazard Areas Regulations. Goes above NFIP minimum, no new structures in floodplain, does allow from small accessory structures.	Standalone Inundation hazard Area Regulation. Goes above NFIP minimum, no new structures in floodplain, does allow from small accessory structures.	No Zoning. Standalone Flood Hazard Area Ordinance.
Flood Resilience in Town Plan	Completed?	N	N	Y	Y	Y	N	N	N
	Comment	in progress							
Municipal By-law or	River/Stream buffer	Y	Y	N	Y	Y	N	Y	N

Central VT Counties	Status	Marshfield	Middlesex	Montpelier	Moretown	Northfield	Orange	Plainfield	Roxbury
Zoning District for Water Resource Setback (provide needs assessment for outreach and technical assistance along with appropriate partner)		75 ft to 125 ft dependent on bank slope. Water Conservation Overlay District which purpose is to protect surface waters on all streams and on ponds over 5 acres.	Section 3.9 Protection of Water Resources . 25-75 ft.	Section 715 Rivers, Streams and Rivers/Stream Bank section includes "sufficient setbacks" but doesn't specify	Section 4.11 Protection of Streams, Stream banks and Wetlands includes 25 ft +	Section 603 Conservation and Forestry District includes 100ft setback on any brook or stream. Section 607 Mill Hill Industrial/Commercial District includes 50 ft from edge of stream.		Section 3.14 Construction along Watercourses, Waterbodies, and Scenic Roads include 50 ft setback from stream, brook or pond.	
	Comment								
	Wetland	Y	N	N	Y	N	N	N	N
	Comment	references State wetland regulations	references state regulations		Section 4.11 Protection of Streams, Stream banks and Wetlands includes 50 ft from class II, 100 ft from class I				
	Lake/Pond	Y	Y	N	N	N	N	Y	N
	Comment	75 ft to 125 ft dependent on bank slope. Water Conservation Overlay District which purpose is to protect surface waters on all streams and on ponds over 5 acres.	Section 3.9 Protection of Water Resources . 25-75 ft.					Section 3.14 Construction along Watercourses, Waterbodies, and Scenic Roads include 50 ft setback from stream, brook or pond.	

	Status	Warren	Washington	Waterbury	Williamstown	Woodbury	Worcester
Town Plan rewrite timeframe (expiration date)		**Expired**	**Nov-18**	**Dec-18**	**Apr-24**	**expired**	**expired**
New Zoning adoption scheduled							
National Flood Insurance Program (NFIP)	Enrolled?	Y	Y	Y	Y	Y	Y
Road and Bridge Standards	Adopted?	Y	Y	Y	Y	Y	Y
Hazard Mitigation Plan (LHMP)	Adopted?	Y	Y	Y	Y	Y	Y
River Corridor Protection	Adopted?	Y	N	N	N	N	Y
Comments		Table 2.14 Fluvial Erosion Hazard Overlay District					Included within standalone Flood Hazard Area Regulations.
ERAF	Percent	17.5	12.5	12.5	12.5	7.5	17.5
	Adopted?	Y	Y	Y	Y	Y	Y
Flood Hazard By-law	Comment	Table 2.14 Flood Hazard Overlay District. Goes above NFIP minimum, no new structures in floodplain, does allow from small accessory structures.	Standalone Flood Hazard Area regulations (should be updated)	Article VI Flood Hazard Area Regulations and Overlay District	No zoning. Standalone Flood Hazard Area Bylaws (should be updated)	Should be a standalone document, not included in zoning. Cannot find document.	No zoning. Standalone Flood Hazard Area Regulations.
Flood Resilience	Completed?	N	N	N	Y	N	N
	Comment	in progress				in progress	in progress

in Town Plan	Status	Warren	Washington	Waterbury	Williamstown	Woodbury	Worcester
Municipal By-law or Zoning District for Water Resource Setback (provide needs assessment for outreach and technical assistance along with appropriate partner)	River/Stream buffer	Y	Y	N	N	N	N
	Comment	Section 3.13 Surface Water Protection includes 50 ft setback.	Section C applies to streams, rivers and shores of naturally occurring lakes and ponds. 50 ft setback.				
	Wetland	Y	Y	N	N	N	N
	Comment	Section 3.13 Surface Water Protection includes 50 ft setback.	Section B wetlands includes 50 ft setback.				
	Lake/Pond	Y	Y	N	N	Y	N

Status	Warren	Washington	Waterbury	Williamstown	Woodbury	Worcester
Comment	Section 3.13 Surface Water Protection includes 50 ft setback on ponds over 1 acre.	Section C applies to streams, rivers and shores of naturally occurring lakes and ponds. 50 ft setback.		Williamstown does not have zoning regulations, except those for the special hazard flood zones	Section 4.3 Shoreland District applies to all lakes and ponds which are 20 acres or larger, includes setbacks from brooks, streams and wetlands 50-100 ft and other setbacks for other activities.	

Appendix E - Regulatory and Non-Regulatory Programs Applicable to Protecting and Restoring Waters in Vermont

The Vermont Surface Water Management Strategy maintains a roster of regulatory and non-regulatory technical assistance programs.

Regulatory programs may be accessed at:

http://dec.vermont.gov/sites/dec/files/documents/wsmd_swms_Appendix_A_Vermont_Regulations_Pertaining_to_Water_Quality.pdf

Non-regulatory programs may be accessed at:

http://dec.vermont.gov/sites/dec/files/documents/wsmd_swms_Appendix_D_Toolbox.pdf

Appendix F – Existing Use Tables

During the Basin 8 planning process, the Agency collected sufficient information to document and determine the presence of existing uses for swimming (contact recreation, fishing and boating on flowing waters. All surface waters used as public drinking water sources were also identified. The Agency presumes that all lakes and ponds in the basin have existing uses of fishing, contact recreation and boating. This simplified assumption is being used because of the well-known and extensive use of these types of waters for these activities based upon their intrinsic qualities and, to avoid the production and presentation of exhaustive lists of all of these waterbodies across Basin 8. Likewise, the Agency recognizes that fishing activities in streams and rivers are widespread throughout the state and can be too numerous to document. Also recognized is that streams too small to support significant angling activity provide spawning and nursery areas, which contribute to fish stocks downstream where larger streams and rivers support a higher level of fishing activity. As such, these small tributaries are considered supporting the use of fishing and are protected at a level commensurate with downstream areas. This presumption may be rebutted on a case-by-case basis during the Agency's consideration of a permit application, which might be deemed to affect these types of uses.

The following lists are not intended to represent an exhaustive list of all existing uses, but merely an identification of well-known existing uses. Additional existing uses of contact recreation, boating and fishing on/in flowing waters may be identified during the Agency's consideration of a permit application or in the future during subsequent basin planning efforts.

Table 43. Determination of existing uses of flowing waters for boating in Basin 8.

Waterbody	Town(s)	Basis for determining the presence of an existing use	Rating of water (class) [33]	Public access: Put in [34]	Public access: Take out
Winooski River: Down town Marshfield	Marshfield	Regularly paddled by Vermont Paddlers Club members(VPC) [35]	II/III	Below Mollys Falls Power House, Cabot Road, Marshfield	Old School House Commons, Marshfield
Winooski River: Marshfield to Winooski #8 Dam	Marshfield, Plainfield, East Montpelier,	WWRV[36] and FWR[37]	I-III	Old School House Commons, Marshfield	Dam Road – adjacent to Winooski #8 Dam
Nasmith Brook	Marshfield	VPC use	III – V	Holt Road	Twinfield High school
Great Brook	Plainfield	VPC use	I-II	Maxifield Road	Recreation Field Road off Mill St.
Winooski River – Kingsbury branch	E. Montpelier	VRC[38] conservation easement for boating access	I	Off Coburn Road, approx. ¾ mile, past the bridge on right.	Winooski main stem take outs
Stevens Branch	Williamstown, Barre Town, Barre & Berlin	FWR & VPC use	I-IV	Brockway Hill Road, Williamstown	Confluence with Winooski, Montpelier

[33] Class rating pertains to the difficulty of whitewater passage.
[34] The list of put in and take out points for boats allow for the use of the entire Winooski river between dams for flat water boating.
[35] Pers. Communication, Vermont Paddler's Club Secretary, Ryan McCall, 5/18/11
[36] Jenkins J. and Zika P 1992. *The Whitewater Rivers of Vermont: The Biology, Geography and Recreational Use.* Agency of Natural Resources, Waterbury, VT.,
[37] Friends of the Winooski River, *A Paddling and Natural History Guide to One of Vermont's Great Rivers* www.winooskiriver.org

[38] Vermont River Conservancy

Waterbody	Town(s)	Basis for determining the presence of an existing use	Rating of water (class) [33]	Public access: Put in [34]	Public access: Take out
Jail Branch	Barre Town	VPC	III-V	Washington Road at base of Reservoir, Barre Town	Ayers Street, Barre City
North Branch Winooski River	Elmore, Worcester, Middlesex, Montpelier	Let it rain, VPC, FWR	I-V	Route 12 in Elmore	Confluence with Winooski, Montpelier
Hancock Brook	Worcester	VPC and VRC	IV-V	Hampshire Hill Road Worcester	Route 12 Worcester
Minister Brook	Worcester	VPC	III-IV	Minister Brook Road, Worcester	Route 12 in Worcester
Martins Brook	Middlesex	VPC	III-IV	Macey Road, Middlesex	Shady Rill Park, Middlesex
Winooski River: Montpelier to Middlesex Dam	Montpelier, Middlesex	FWR	I/II	Montpelier High School: Put in is `100 yards below the Bailey Ave. bridge. Path is off the bike path.	Just above Middlesex Dam: The take out is on the left just beyond the Rte. 100B bridge.
Dog River	Roxbury, Northfield, Berlin, Montpelier	VPC, WWRV, FWR	I-II	Rabbit Hollow Road, Northfield	Confluence with Winooski River, Montpelier under I-89 bridge
Stony Brook	Northfield	VPC	III-IV	Chamberlin Road, Northfield	Confluence with Dog River, Northfield
Cox Brook/Devils Washbowl	Moretown, Berlin & Northfield	VPC	III-V	Devils Washbowl Road, Moretown	Confluence with Dog River, Northfield
Winooski River: below Middlesex Dam to Waterbury	Middlesex, Waterbury	FWR	I/II	south side of river at Middlesex Dam Powerhouse off Rte. 100B	Waterbury Recreation Fields: Take out is on the right, near the mouth of Thatcher Brook.

Waterbody	Town(s)	Basis for determining the presence of an existing use	Rating of water (class) [33]	Public access: Put in [34]	Public access: Take out
Mad River-Austin Brook confluence park to confluence with Winooski River	Warren, Waitsfield, Fayston, Duxbury, Moretown	WWRV, VPC, FWR	I-V	Picnic area at confluence of Austin Brook and Winooski – Route 100, Warren	Route 2, west of bridge over Winooski River (west of the state highway garage) with parking
Mill Brook	Fayston	VPC	III-IV	German Flats Road, Fayston	Route 17, Fayston
Little River	Stowe, Waterbury	WWRV, VPC	I-III	Tansy Hill Road, Stowe	Confluence with Winooski River
Sterling Brook	Stowe	VPC	III-IV	Sterling Valley Road, Stowe (Stowe Land Trust)	Cole Hill Road, Stowe
Ranch Brook	Stowe	VPC	III-IV	Ranch Valley, Stowe	Route 108, Stowe
Notch Brook/West Branch Little River	Stowe	VPC	III-IV	Bingham Falls, Stowe	Route 108, Stowe
Gold Brook	Stowe	VPC	III-IV	Covered Bridge Road, Stowe	Route 100, Stowe
Winooski River: Bolton to Richmond	Bolton, Richmond	FWR	I/II	Bolton Dam Take Out is located on the left side of the river.	Volunteer Green Richmond: under the Bridge St. bridge
Ridley Brook	Duxbury	VPC, Let it Rain	IV-V	Upper Monroe Trail parking area, Duxbury	River Road, Duxbury
Joiner Brook	Bolton	VPC, Let it Rain	IV-V	Bolton Valley Access Rd	Route 2, Bolton

Waterbody	Town(s)	Basis for determining the presence of an existing use	Rating of water (class) [33]	Public access: Put in [34]	Public access: Take out
Winooski River: Richmond to Essex	Richmond, Jericho, Essex	FWR	I	Volunteer Green Richmond	GMP Access off IBM access rd.
Huntington River – 10 miles from Hanksville to just before Huntington Gorge and below lower Huntington gorge to Winooski	Huntington, Starksboro, Richmond	WWRV	II-IV	North of Carse Road bridge, Huntington	Dugway Road, Richmond
Brush Brook	Huntington	VPC, Let it Rain	IV-V	Camel's Hump State Forest	Camel's Hump Road, Huntington
Winooski River: Essex to Winooski	Essex, Williston, Winooski,	FWR	I	Below Essex Dam: off 2A below power generating station. Park at Overlook Park,	Winooski Gorge Dam: After passing through Lime Kiln Gorge, the river turns right. Take out is on the left before river narrows into the gorge.
Mill Brook	Jericho	VPC, Let it Rain	II-IV	Fitzsimonds Road, Jericho	Route 117, Jericho
Winooski River: Winooski to Colchester	Colchester, Burlington, Winooski	FWR	I/II	Millyard Canoe Access in Winooski off Canal St.	VFWD Colchester Point access area off Windermere Road. .

Table 44. Determination of existing uses of flowing waters for fishing in Basin 8.

Surface Water	Location of Use	Town	Documentation
Winooski River	Mainstem Winooski in Marshfield downstream to the Bolton Dam in Duxbury.	Marshfield to Duxbury	Stocked by VFWD
Winooski River	Duxbury and Waterbury, from the top of the Bolton Dam in Duxbury and Waterbury upstream to the Route 2 Bridge (east side of Waterbury Village	Duxbury/Waterbury	Special fishing regulations
Winooski River	Ridley Brook mouth upstream to the top of the Bolton Dam in Duxbury and Waterbury.	Bolton/Duxbury/Waterbury	Special fishing regulations
Winooski River	From Preston Brook mouth upstream (approximately 4.4 miles) to the Ridley Brook mouth	Bolton/Duxbury/Waterbury	Special fishing regulations
Winooski River	From the Winooski One Hydro Dam west of Main Street (US 7) in Winooski and Burlington upstream to Preston Brook, Bolton	Duxbury	Special fishing regulations
Winooski River	From the Winooski One Hydro Dam west of Main Street (US 7) in Winooski and Burlington and extending downstream to the downstream side of the first railroad bridge.	Winooski, Burlington	Special fishing regulations
Winooski River	Lake Champlain upstream to the first railroad bridge (approximately 9 mile) in Winooski and Burlington.	Winooski, Colchester, Burlington	Special fishing regulations
Jail Branch	Upstream and downstream of East Barre Dam.	Washington, East Barre	VFWD document good wild trout populations present. Access at VDEC dam in E. Barre, off Washington St.
North Branch	Worcester Rt 12 brdg north of Russ Pond Bk to Rt 12 brdg north of Hancock Bk	Worcester	Stocked by VFWD
North Branch	Below Rt. 12 bridge south of Washington/Lamoille county line to access across from Moose Hollow road	Middlesex	Stocked by VFWD

Dog River	Downstream edge of the Junction Road Bridge in Berlin/Montpelier upstream to the top of Northfield Falls Dam in Northfield.	All applicable towns	Special fishing regulations
Chase Brook	From its confluence with the Dog River upstream approximately 1/2 mile to the top of the natural falls in Berlin - – closed to fishing second Saturday in April – May 31st	Berlin	Special fishing regulations
Mad River	Below Warren Village	Applicable towns	Stocking by VFWD
Little River	From the confluence with Winooski River upstream to the top of the Waterbury Dam	Waterbury	Special fishing regulations
Ridley Brook	Winooski River upstream approx. 1700 ft to first falls	Duxbury	Special fishing regulations
Ridley Brook	First falls to headwaters	Duxbury	Special fishing regulations
Ridley Brook	End of Camels Hump Road to River Road	Duxbury	Stocking by VFWD
Pinneo Brook	Winooski River upstream approx. 100 ft to railroad crossing	Bolton	Special fishing regulations
Pinneo Brook	Railroad crossing to headwaters	Bolton	Special fishing regulations
Joiner Brook	Winooski River upstream approx. 1900 feet to first falls	Bolton	Special fishing regulations
Joiner Brook	First falls to headwater	Bolton	Special fishing regulations
Preston Brook	Winooski River upstream approx. 2600 feet to first falls	Bolton	Special fishing regulations
Huntington River	Entire river	Huntington, Richmond	Stocking by VFWD

Table 45. Determination of existing uses of flowing waters for swimming in Basin 8.

Waterbody	Town	Aesthetic values and use by public confirmed	Public Access
Winooski River Main Stem – Hidden Dam	East Montpelier	Deep pools above barely submerged remains of dam	VTrans owned land, Rt. 2 provides parking area. Also trail from high school and CrossVermont trail goes by
Nasmith Brook – Paradise swimming hole	Plainfield	VSH[39]	Pull off on Nasmith Brook Road. Access from road and bridge ROW
North Branch at Nature Center	Montpelier	Sandy beach at walking bridge with deep pool	City land. Parking at city park and nature center.
Martins Brook - Shady Rill Park	Middlesex	Swimming hole, bedrock controlled grade to create deep swimming holes	Town land with parking. Opposite of Wrightsville parking lots,
Hancock Brook – Upper Pots	Worcester	VSH	VRC conservation easement. Parking .4 miles from the beginning of Hancock Brook Road
Dog River – Jacuzzi swimming hole	West Berlin	VRC	Owned by Town of Berlin. Parking at Fire Department before bridge over Route 12. Trail to swimming hole with wooden steps. Mowed lawn and picnic table above river.
Mad River-River side park	Warren	Friends of Mad River[40]	Public land. Parking lot opposite the Sugarbush Access Road,
Mad River-Picnic Area Cascades		VSH, Friends of Mad River	Public land and parking
Stetson Brook Cascades (Stetson Brook)		VSH, Friends of Mad River	Public land and parking
Mad River-Warren Falls	Warren	VSH, Friends of Mad River	Federal Land. Parking along the right side of Route 100 in front of Forest Service access gate.

[39] Jerry Jenkins, *Vermont Swimming Hole Study* Agency of Natural Resources, Waterbury, VT
[40] Pers. correspondence with Caitrin Noel, Director, Friends of the Mad River 6/30/11

Waterbody	Town	Aesthetic values and use by public confirmed	Public Access
Mad River-Lareau's Swimming Hole	Waitsfield	VSH, Friends of Mad River	Public land. Parking lot and sand beach off Route 100
Mad River-Moretown Gorge	Moretown	VSH	Parking lot north of 100B bridge over the Mad River. Take trail to sandy beach below gorge
West Branch - Bingham Falls	Stowe	VSH	State land. Access from a dirt pull off the Mountain Road or through the Stowe Land Trust owned Mill Trail
Moss Glen Brook - Moss Glen Falls	Stowe	VSH	State Land with parking lot
Gold Brook under bridge before Gold Brook Circle	Stowe	VSH	Road and Bridge ROW. Parking pull offs on road
Ridley Brook	Duxbury	VLT easement includes swimming	Duxbury Land Trust property. Parking on Camels Hump Road opposite Marshall Road
Huntington River -Horsebend swimming hole	Huntington	VSH	Audubon Center land. Parking at trail.
Huntington River -Audubon River Trail Swimming (Audubon Hemlock)	Huntington	VSH	Audubon Center land. Parking at center, accessible by trail.
Huntington River - Lower Audubon Swimming hole (River loop trail swimming hole)	Huntington	VSH	Audubon Center Land. Parking at center, accessible by trail.
Lower Huntington River Gorge (Huntington Gorge Cascade Chain)	Richmond	Richmond Land Trust (RLT) website and VSH study	16 acres of shoreland owned by Richmond Land Trust. Pull offs on Dugway Road

Table 46. Determinations of existing uses of waters for public surface water supplies in Basin 8

Surface Water	Town	Water Supply	Use Status
Thatcher Brook and tributaries	Waterbury	Village of Waterbury	Active
Unnamed tributary to the West Branch	Stowe	Village of Stowe	Emergency use only
Thurman Dix, Lower Reservoir and tributaries	Barre & Orange	City of Barre	Active
Standard & consolidated quarries	Barre	Websterville	Active
Berlin Pond	Berlin, Northfield, Williamstown	City of Montpelier	Active