Basin 1-Batten Kill, Hoosic, and Walloomsac Tactical Basin Plan

June-July 2021 | DRAFT

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

Approved:

_____ _____

X, Commissioner Date

Department of Environmental Conservation

_____ _____

X, Secretary Date

Agency of Natural Resources

Plan prepared by: Angie R. Allen

GIS & Mapping support: Sean Regalado

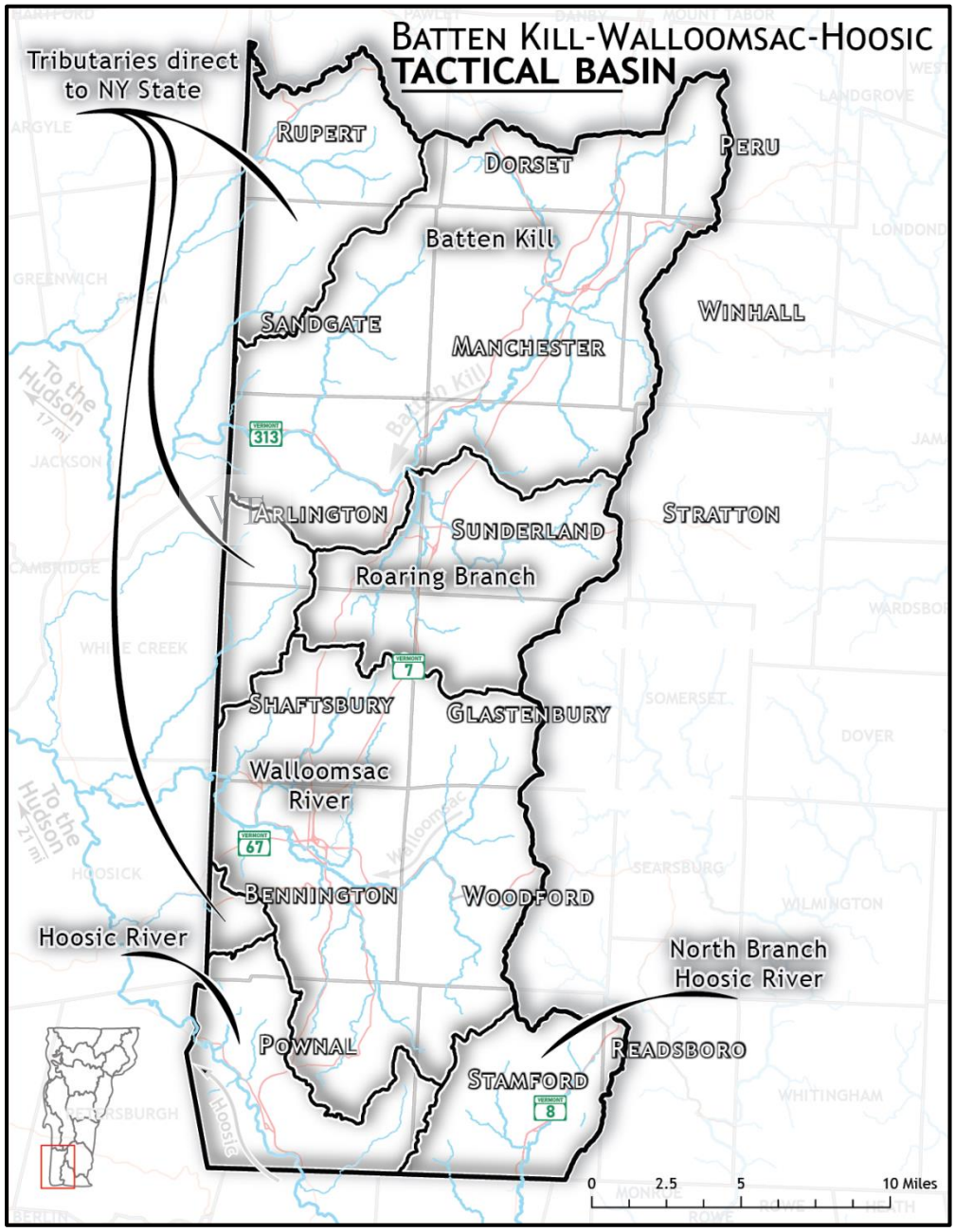
Cover Photo: Angie R. Allen

Basin 1 Towns

Arlington	Manchester	Rupert	*Stratton
Bennington	*Peru	Sandgate	Sunderland
Dorset	Pownal	Shaftsbury	*Winhall
Glastenbury	*Readsboro	Stamford	Woodford

**Only a small area of the town is in the basin and is covered in more detail in corresponding basin plans.*

Basin 1 Watershed Boundary and Towns



Basin 1 Tactical Plan Overview

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Executive Summary

Basin 1 is comprised of the Batten Kill, Hoosic, and Walloomsac sub-basins, which are part of the larger Hudson River regional basin. The basin is in southwestern Vermont, drains Bennington county and a small portion of Windham county, and covers 16 individual towns. The Basin 1 Tactical Basin Plan (TBP) provides a detailed description of current basin condition and identifies water quality focused strategies to protect and restore the basin's surface waters.

The goal of the Tactical Basin Plan is to "Protect the Best and Restore the Rest" when it comes to surface waters of the State of Vermont.

Adaptively managing and using our surface waters in the face of climate change is one of the principal challenges for Basin 1 (State of Vermont, 2015). In Vermont, climate change is causing increases in storm intensity and total precipitation (Betts, 2011) (National Oceanic and Atmospheric Administration, 2013). These changes will likely lead to increased flooding, water quality and ecosystem impairments, and reduced water-based recreational availability to Vermonters (Pealer & Dunnington, 2011).

Protective measures, such as strategic land acquisition and limitations on development in riparian areas, may be the most economical solution to achieve healthy surface waters (Watson, Ricketts, Galford, Polasky, & O'Neil-Dunne, 2016) (Weiskel, 2007). But where pollution from historic and current land use occurs, strategies are identified in this plan that will complement protective measures, such as river corridor easements, riparian area plantings, floodplain and wetland restoration, dam removals, and agriculture, logging and stormwater best management practices. To implement these strategies, significant investments of time and funds by federal, state, and local stakeholders are required. These coordination efforts are ongoing.

Between 2016 and 2020 over 219 water quality monitoring events took place at five lakes, three reservoirs, thirty-four rivers, and six wetlands in Basin 1. The information from these monitoring events has been incorporated in Chapters 1, 2, and 3 which cover the condition of surface waters, and protection and restoration priorities, respectively. Overwhelmingly, the waters in Basin 1 meet or exceed water quality standards. Target areas for protection and restoration are outlined in Figure 1 and Table 1.

In Chapter 2, a total of 46 rivers, lakes, ponds, and wetlands are identified for protection or additional monitoring. Of the 46 waters, 22 rivers and 1 lake meet reclassification criteria for fishing, aesthetics, or aquatic biota. Seven rivers and two lakes and ponds are identified for additional monitoring to determine if they meet reclassification criteria. One wetland is identified as potential Class I candidate and three are recommended for additional assessment to determine if they meet Class I wetland criteria (Figure 1).

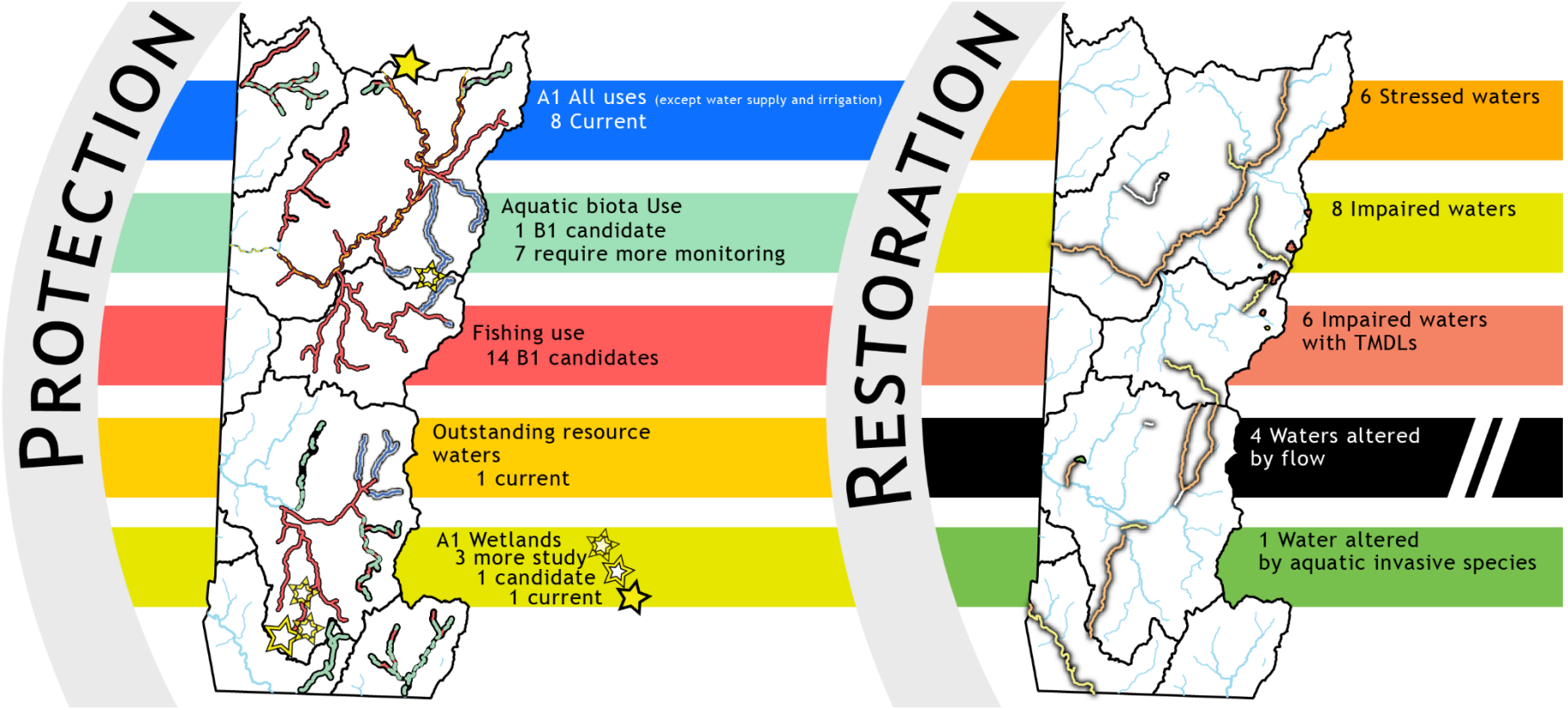


Figure 1. Surface waters prioritized for protection and restoration in Basin 1.

Table 1. Focus areas and priority strategies for protection and restoration in Basin 1.

Focus Areas	Priority Strategies
Agriculture	
White Creek, Mill Brook, Warm Brook, Walloomsac River, Batten Kill mainstem and direct tributaries	• Support outreach and project identification for best management practices (BMPs), riparian area plantings, river corridor and wetland easements, and riparian area and wetland restoration. • Implement water quality monitoring on farms to measure effectiveness of restoration efforts. • Continue nutrient management planning and funding for cover crop and other field BMPs. • Coordinate with agricultural service providers to determine if there is a gap in outreach and implementation of water quality BMPs along the Batten Kill and Walloomsac Rivers.
Developed Lands - Stormwater	
Batten Kill, Munson Brook	• Develop a stormwater master plan in Manchester and Bennington. • Support watershed partners and municipalities to prioritize stormwater projects in Basin 1. • Identify and remediate stormwater sources of impairment to Munson Brook.
Developed Lands - Roads	
Batten Kill, Munson Brook, Ladd Brook, Big Pond	• Identify and implement BMPs on *Very high* and *High* priority road segments. • Identify and address sources of runoff from municipal sand and salt storage areas as well as roads along Munson Brook and Big Pond. • Provide and support training for road crews on culvert replacements through the VT River and Roads workshops, and installation and maintenance of road BMPs through the DEC Stormwater Program.
Wastewater	
Walloomsac River, Lake Paran	• Address Bennington WWTF effluent degrading the condition of the Walloomsac River leading to possible stressed/303(d) listing. • Promote septic system maintenance through local outreach and education programs, such as a septic social.
Natural Resources - Rivers	
Green River, Paran Creek, Broad Brook, Prospective A(1) & B(1) Rivers & Streams	• Develop and implement projects from River Corridor Plans. • Implement strategic wood addition to increase habitat and channel stability. • Restore stream connectivity through floodplain restoration. • Replace or retrofit high priority stream crossings that have been identified in bridge and culvert assessments by municipalities and the Vermont Agency of Transportation. • Support strategic dam removal project development, design, and implementation. • Provide outreach to communities on floodplain and river corridor protections. • Provide technical support for river and stream reclassification protection efforts.
Natural Resources - Lakes	
Big Pond, Lake Paran,	• Support Lake Wise planning, assessment, and implementation. • Support aquatic invasive species monitoring and spread prevention efforts.

Lake Shaftsbury, Prospective B(1) Lakes	• Support lake watershed partners focused on education and outreach efforts.
Natural Resources - Wetlands	
Pownal Bog, Batten Kill Headwaters, Maple Grove Swamp, Middle Pownal Road/South Stream wetland	• Complete site visits and/or location specific restoration maps for potential wetland restoration locations. • Conduct studies on potential Class I candidates and support local outreach to municipalities and landowners to gauge interest in supporting Class I designations. • Provide technical support for parties interested in submitting Class I petitions.
Natural Resources - Forests	
Existing & Candidate A(1) & B(1) watersheds	• Implement forest infrastructure restoration projects on state-owned forest lands. • Provide outreach, technical assistance, and workshops to private forestland owners, foresters, and loggers on Acceptable Management Practices and Use Value Appraisal Program, use of skidder bridges, and voluntary harvesting guidelines. • Support forestland conservation and skidder bridge program.

Although many surface waters monitored in Basin 1 meet or exceed water quality standards, there are waters in need of restoration. In Chapter 3, a total of 25 lakes, ponds, or rivers are identified for restoration. Six rivers are stressed, seven rivers and one lake are impaired, six lakes have a TMDL for acidity, one lake is altered by invasive aquatic species, and three rivers and one lake have altered flow regimes (Figure 1).

Chapters 4 and 5 outline sector-based strategies to meet protection and restoration goals, by providing a list of 39 detailed strategies and 29 monitoring priorities for the next five years.

The 2015 Basin 1 plan identified 60 strategies to protect and restore surface waters. Of the 60 strategies identified, 11 are complete, 18 are ongoing, 12 are in progress, 15 are awaiting action, and 4 are discontinued (Figure 2). Sixty-eight percent of the strategies identified in the 2015 TBP are active or complete[1]. The Basin 1 report

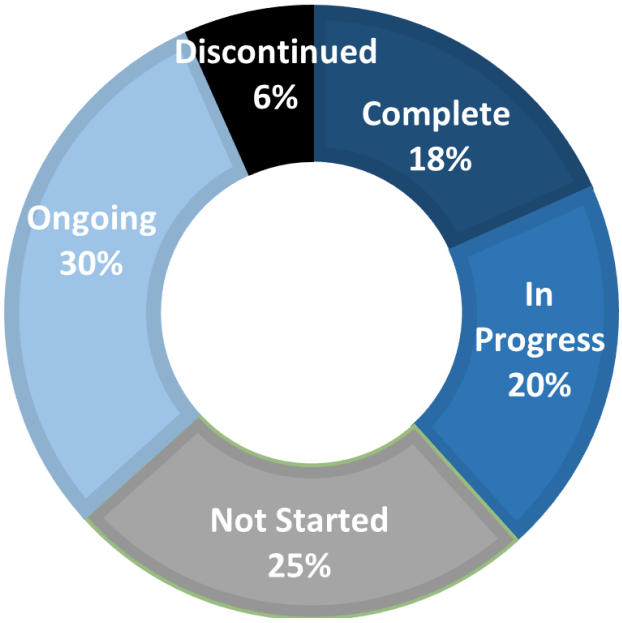


Figure 2. Status of the 60 strategies from the 2015 Basin 1 TBP.

[1] Complete = strategies with an explicit start and end point. In progress = strategies actively being pursued and have the potential for completion. Ongoing = In progress programmatic strategies or initiatives that have no defined end date. Awaiting action = strategies that have not been initiated for various reasons such as a lack of resources or local support, or low priority (i.e. other projects need to be completed first).

card in Appendix A includes the 2015 list of strategies with detailed updates on progress.

While water quality improvements are underway in Basin 1, a lack of organizational capacity and interest are primary challenges to implementation. Broad input was solicited during the development of the 2021 plan, and the 39 strategies prioritized herein reflect input from the public, state and federal water quality staff, watershed groups, and regional planning commissions. Basin 1 partners expressed that outreach, technical support, and training on how to best protect and maintain our natural resources, in addition to continued financial assistance, are critical to meet water quality goals.

What is a Tactical Basin Plan?

A Tactical Basin Plan (TBP) is strategic guidebook produced by the Vermont Agency of Natural Resources (ANR) to "protect the best and restore the rest" of Vermont's surface waters.

Tactical basin planning is carried out by the Water Investment Division (WID) in collaboration with the Watershed Management Division (WSMD) and in coordination with watershed partners. Tactical basin plans are developed in accordance with the Vermont Surface Water Management Strategy (VSWMS) and the Vermont Water Quality Standards (VWQS) to protect, maintain, enhance, and restore the biological, chemical, and physical integrity of Vermont's water resources. The basin-specific water quality goals, objectives, strategies, and projects described in the TBPs aim to protect public health and safety and ensure public use and enjoyment of VT waters and their ecological health.

The TBP process (Figure 3) allows for the issuance of plans for Vermont's fifteen basins every five years, as required by statute 10 V.S.A. § 1253. The plans incorporate the U.S Environmental Protection Agency's (EPA) 9-element framework for watershed plans (Environmental Protection Agency, 2008) and meet obligations of the Vermont Clean Water Act.

The basin planning process includes:

1. Monitoring water quality,
2. Assessing and analyzing water quality data,
3. Identifying strategies and projects to protect and restore waters,
4. Seeking public comment and developing the plan,
5. Implementing and tracking plan priorities (ongoing throughout the planning cycle).

Figure 3. Steps of the 5-year basin planning process.

The plans communicate opportunities for protection by providing a list of recommended waters for special state designations, conservation, and local ordinance protection based on water quality data. They justify opportunities for restoration by providing a list of waters with an explanation of

their causes and sources of pollution, and in some cases, identify reductions needed to restore water quality including those necessary to meet Total Maximum Daily Load (TMDL) targets.

Chapters 1-4 in the Basin 1 TBP provide an overview of the basin, identification of protection and restoration priorities, and surface water strategies to achieve sector-based protection and restoration priorities. Chapter 5 provides a list of sector specific strategies to achieve water quality goals and a progress report for the strategies identified in the 2015 TBP (Figure 4).

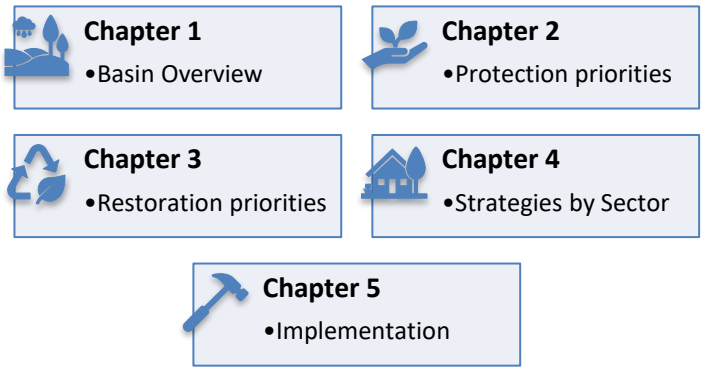


Figure 4. The five chapters in the Vermont Tactical Basin Plans.

One of the most utilized parts of the plan is the implementation table in Chapter 5. The 2015 Basin 1 Report Card located in Appendix A provides a status update for each of the objectives identified in the previous basin plan. These strategies target individual projects that are tracked via its online counterpart, the Watershed Projects Database (WPD). The WPD is found on ANR's Clean Water Portal and is continuously updated to capture project information from the TBP process, on the ground assessments, and emerging projects due to natural and anthropogenic events.

ANR's Clean Water Portal is an online platform that houses a variety of clean water tools to assist with project planning, searching existing projects, funding opportunities, and more. Tools on the portal used for watershed planning include:

- Clean Water Project Explorer,
- WPD Search,
- Water Quality Project Screening Tool,
- Funding Opportunities Tool,
- Stormwater Treatment Practice (STP) Calculator, and the
- Clean Water Dashboard.

TBPs target strategies and prioritization of resources to those projects that will have the greatest influence on surface water protection or remediation.

Chapter 1 – Basin Description and Conditions

A. Basin 1 Overview

The Vermont portions of the three rivers which comprise Basin 1 have the unique distinction of being the only watersheds within Vermont that are part of the larger Hudson River basin[2]. The Batten Kill, Walloomsac, and Hoosic Rivers and their associated tributaries originate in the southwest corner of Vermont and collectively comprise what is referred to as Basin 1 (Figure 5).

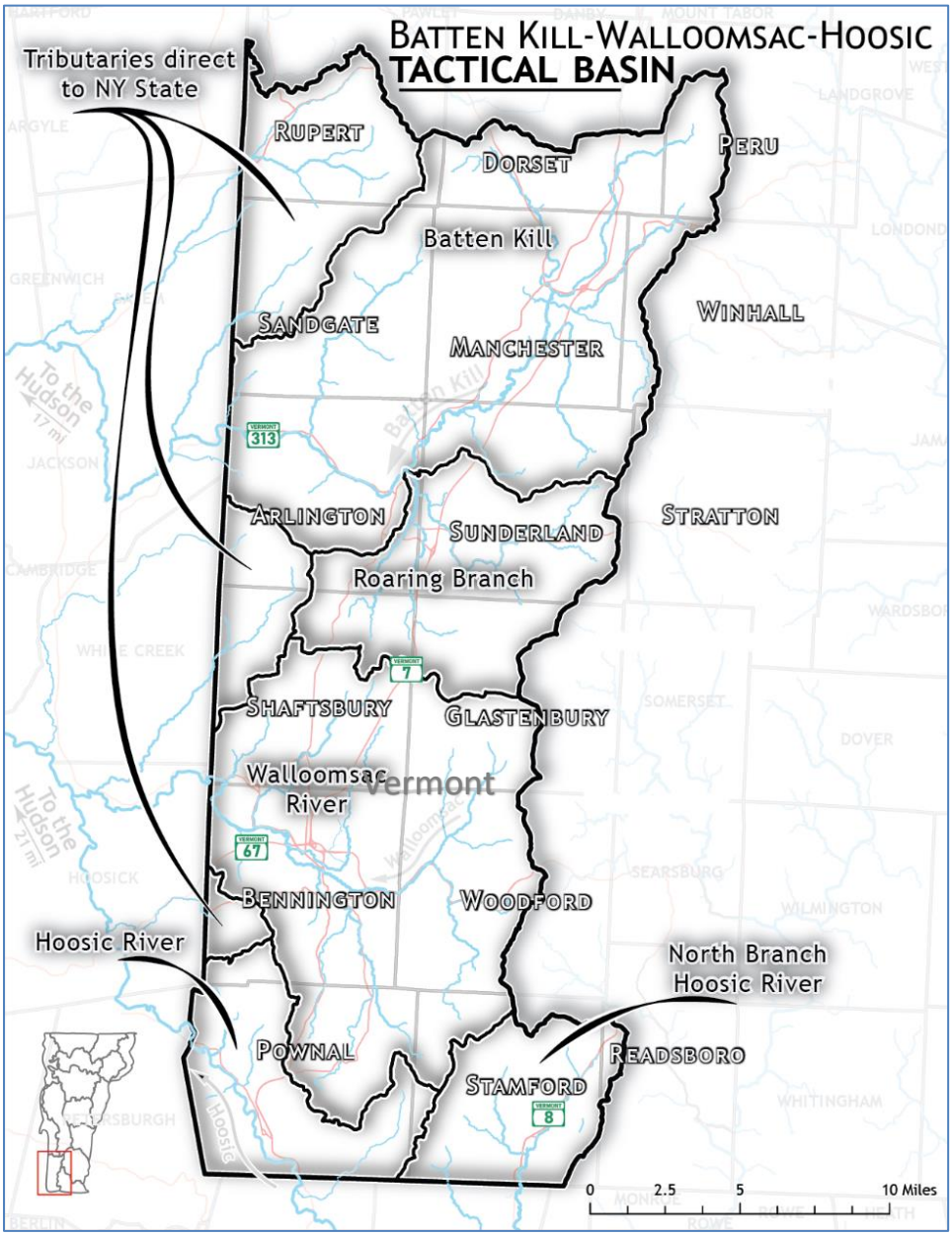


Figure 5. Basin 1 is located in south west VT and is a 428 square mile area drained by the Batten Kill, Walloomsac, and Hoosic Rivers.

The Vermont portion of the Batten Kill watershed drains much of northern Bennington County and has an area of about 200 square miles. The Batten Kill originates in East Dorset and flows south with Mad Tom Brook soon joining it from the southern slope of Mount Tabor. It flows in a southwesterly direction to Arlington and then in a westerly direction to the Hudson

[2] A river basin is an area of land drained by a river and its tributaries. The terms 'basin' and 'watershed' are used interchangeably in this report. The Batten Kill, Walloomsac, and Hoosic River Basin is also referred to as Basin 1.

River in New York, which it enters at a point one mile north of Schuylerville, New York. Two hundred and seven square miles of the drainage area of the basin are located in the New York portion of the watershed. From source to mouth following the major windings, it measures approximately 55 miles. The length of the river in Vermont is approximately 24 miles.

The Walloomsac River watershed drains much of the south-central portions of Bennington County being bounded by the Batten Kill watershed to the north and the upper Hoosic River watershed to the south. The headwaters of the Walloomsac River are located in Vermont draining 139 square miles of the state before entering New York. The Walloomsac River is a significant tributary to the Hoosic River. The Walloomsac River begins where South Stream and Jewett Brook join just south of Bennington village. The river winds through Bennington in a northwesterly direction. Just north of Bennington village, the Roaring Branch enters from the east. As a larger river now, the Walloomsac flows northwestward through the northwest portion of the town of Bennington then into New York and to Hoosic Junction where it joins the Hoosic River. In addition to South Stream and the Roaring Branch, the major direct tributaries in Vermont include Jewett Brook, Furnace Brook, Paran Creek, and Cold Spring Brook.

The Hoosic River has its source about 2 miles northwest of Dalton, Mass., at an elevation of 1,500 feet above sea level. It flows through the southwest corner of VT where it drains a small portion of southern Bennington County, an area of approximately 89 square miles. The Vermont tributaries have narrow watersheds and mostly drain the steep slopes of the Green Mountain Range. The North Branch of the Hoosic River begins in the town of Stamford, VT, and flows southwestward to the city of North Adams, Mass., where it joins the Hoosic River. Its length is 11 miles. Its principal tributary in Vermont is Roaring Brook. A number of small tributaries also flow down from the mountainsides of the Hoosic Range to join the North Branch. Detailed information about the Batten Kill, Walloomsac, and Hoosic Rivers can be found in the individual basin assessment reports.

Lakes and ponds are not abundant in the Basin, but a few large and popular lakes are noteworthy. In the Batten Kill watershed, Bourn Pond in Sunderland lies within the Lye Brook Wilderness of the Green Mountain National Forest. It is a true wilderness pond with an attractive sphagnum mat floating island and is critical breeding habitat for the common loon. Branch Pond, also in Sunderland, lies outside the Lye Brook Wilderness Area, but has a wilderness-like feel. The pond is undeveloped, essentially in a primitive state, but is relatively easily accessed. Lake Shaftsbury State Park is on an 84-acre parcel surrounding the small, picturesque Lake Shaftsbury in southwestern Vermont. In the Walloomsac watershed, Lake Paran is an impoundment of Paran Creek in Bennington and is an important recreation site. Current uses of Lake Paran and adjacent lands include swimming, fishing, nonmotorized boating, ice-skating, hiking, and aesthetic appreciation.

Dorset Marsh covers 262 acres and lies at the headwaters of both the Batten Kill and the Mettowee Rivers. The Vermont Fish and Wildlife Natural Heritage Inventory Program identified the [alder] shrub community type as providing rich, water tolerant vegetation habitat, while also exhibiting the best example of open sedge and cattail meadow in the county. This wetland is a dynamic system offering a variety of habitats for different species and supports a number of rare, threatened, and

endangered species, e.g., Hill's pondweed (*Potamogeton hillii*), showy yellow lady's slipper (*Cypripedium reginae*), Makasin's yellow lady's slipper (*Cypripedium parviflorum*), water sedge (*Carex aquatilis*), and a grass species (*Alopecures dequalis*). This wetland supports a diversity of wildlife habitat through natural communities, structural diversity, interspersion of habitats, and edges. The Dorset Marsh wetland complex has at least seven community types present. Four additional wetlands have been identified as potential Class I wetlands in this plan in Chapter 3.

Land Use and Land Cover

The Batten Kill, Walloomsac, and Hoosic Basin is predominantly covered by forest (81.8%) while agricultural lands cover 5.9%, developed lands cover 5.8% (including the interstate and roads), and wetlands cover 4.5% (Figure 6). An analysis of land use change in the basin comparing land use in 2001 to 2016 did not show significant differences. Basin wide there was a very small decrease in forest cover (<2%) and negligible increases in other land cover classes. When looking at land cover change by sub-watershed, one of the largest shifts was in the Little White Creek where forest cover

changed from 83.3% to 79.6%.

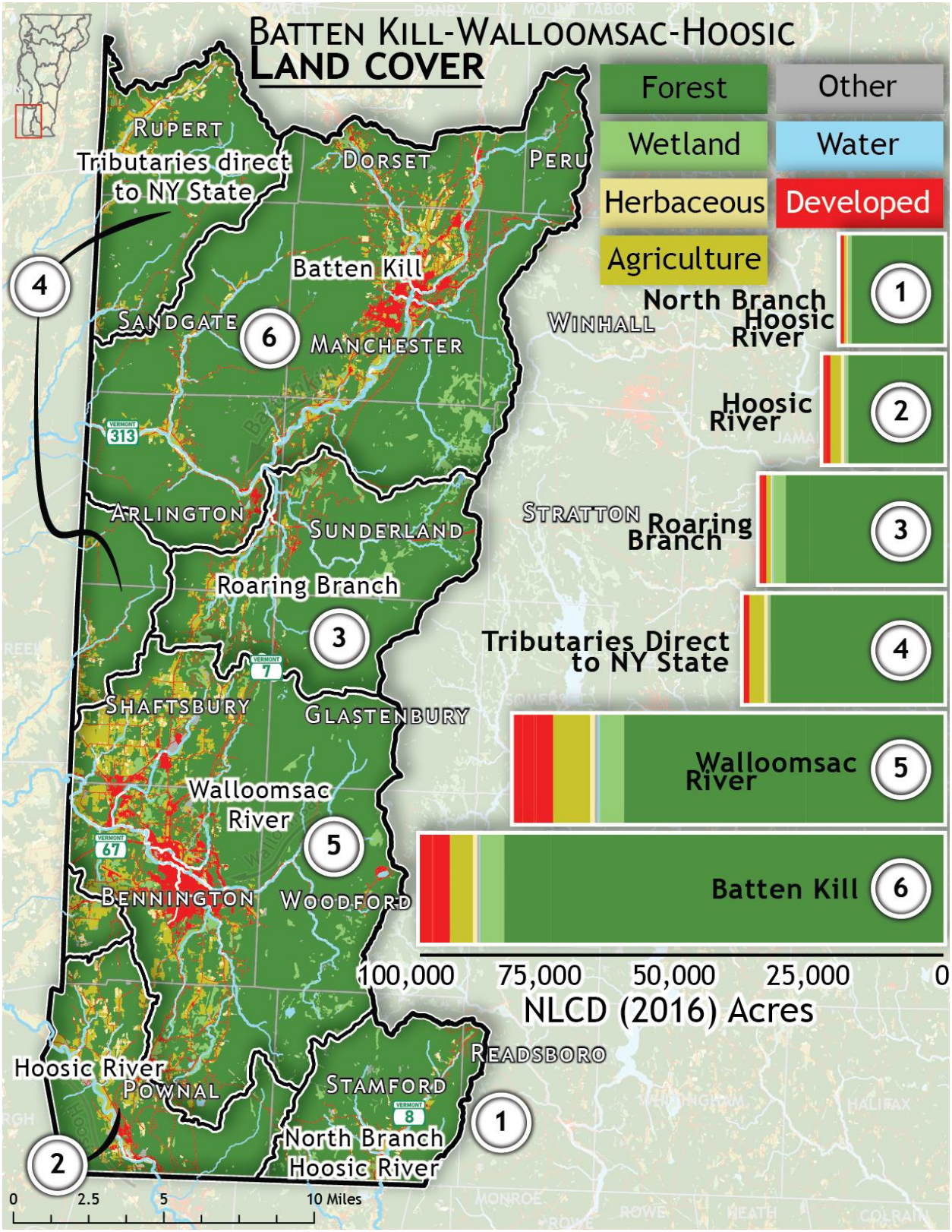


Figure 6. Land cover estimates by acreage for the 6 sub-basins of Basin 1.

The forested landscape is largely responsible for the good water quality in upstream areas in the basin. The areas in Basin 1 that are experiencing degraded water quality trends are near concentrated residential and road development (Batten Kill, Munson Brook, Walloomsac, Big Pond), concentrated agriculture in the Batten Kill and Walloomsac River valleys, higher elevation ponds and streams that are impaired due to atmospheric acid deposition (Little Mud Pond, Bourn Pond, Lye Brook-N Pond (note: this pond is drained), Lye Brook-S Pond (note: this pond is drained), Branch Pond, Beebe Pond, Lost Pond and Lye Brook, Branch Pond Brook, Fayville Branch, Bolles Brook, Bickford Hollow Brook), and dams (Broad Brook, Paran Creek). Managing land use to reduce discharge of polluted runoff and allowing adequate space for treatment can both improve and protect water quality. The amount of forest land cover, good existing management practices, and quality local stewardship account for the overall superior water quality of this basin.

Climate Change and Implications for Basin 1

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

The impact of increased runoff and streamflow in a watershed depends on local land use and land cover. In developed areas, more precipitation can increase stormwater volume and velocity thereby mobilizing larger pollutant loads (Galford, et al., 2014). In addition, increased streamflow will increase bed and bank erosion and deliver more sediments downstream. In areas where non-point source pollution is a concern more runoff can increase sediment, nutrient, and pathogen loading to surface waters (Galford, et al., 2014). Changes in climate increasingly require watershed restoration projects to preserve natural sediment attenuation locations and incorporate stormwater and non-point source runoff controls to counteract pollutant transport as well as consider the potential for higher peak flows. Restoring floodplain connectivity along streams is essential to provide space for sediment, wood, and nutrients to settle and store naturally and to maintain ecosystem resilience as the climate changes.

Aquatic habitats affected by increased runoff and streamflow could experience increases in sediment mobilization, nutrients and scouring in addition to increased water temperature. In response, local freshwater plant and animal species may shift their geographic ranges and seasonal activities and alter their abundance. Maintaining habitat connectivity, river and lake riparian buffers, and stream equilibrium conditions will help reduce the impacts of climate change on Vermont's rivers, lakes and ponds, and wetlands.

To understand patterns of streamflow in the basin, long-term datasets for the Walloomsac River (N. Bennington, VT) and the Batten Kill (Battenville, NY) were analyzed by DEC staff. Although the Batten Kill stream gage is in NY, the majority of its contributing area is within Basin 1. The U.S. Geological Survey operates streamflow gages on these minimally regulated rivers and provides both daily average and annual peak streamflow. The Walloomsac River site has been monitored since 1931 and the Batten Kill since 1922. However, the Batten Kill has a significant gap in daily streamflow data from 1969 to 1998, which limits its utility for trend analysis. Results showed statistically significant increasing October and December average daily flows for the Walloomsac River. Other characteristics such as annual average daily flows and annual peak flows at the Walloomsac site showed little or no trends. No trends in annual peak flows were detected for the Batten Kill, and tests on average daily flows were not assessed due to the aforementioned data gap.

Streamflow is influenced by several environmental factors with precipitation being the most important. Daily precipitation data were analyzed for the Batten Kill and Walloomsac River watersheds from the PRISM climate dataset for the period 1981-2019. The analysis showed total December precipitation is significantly increasing in both watersheds, while total November precipitation is decreasing in the Walloomsac. These data represent total depth of liquid precipitation (rain and liquid equivalent of snow) and do not distinguish between rain and snow. A change in drought severity could be reflected in trends for the Standardized Precipitation Index (SPI), the most used drought index worldwide. SPI was shown to significantly increase in Winter (Dec. – Feb.) in both watersheds. This indicates increasing winter precipitation over time, which appears to be driven by greater December totals, although a distinction between rain and snow is not made. This is likely related to the increased average December streamflows in the Walloomsac River, with December conditions driving the wetter trend over time. Theoretically, precipitation in December could translate more readily to streamflow should it occur as rain or runoff during melt events, both of which seem more likely in December as compared to January or February.

It is important to note any trends or lack thereof found in this type of analysis reflect what has been observed in the past and may or may not persist into the future. For example, many models and the information in the 2014 Vermont Climate Assessment suggest an increased frequency and severity of low-flow, drier conditions for Vermont due to predictions of longer periods between heavy rainfall events in future decades. Additional information on climate change in Vermont can be found here.

B. Water Quality Conditions in Basin 1

A wide variety of water quality monitoring and assessments are supported by DEC and its partners, which are described in detail in the Water Quality Monitoring Program Strategy. The results of these efforts provide a window into the condition of the Basin's surface waters.

Several monitoring programs are active in this basin, most of which are led by programs in the WSMD. These include the Monitoring and Assessment Program (MAP) Ambient Biomonitoring Network (ABN) that focuses on biological monitoring of macroinvertebrate and fish communities

as well as targeted chemistry sampling around Wastewater Treatment Facilities (WWTF) or other pollution concerns. MAP also supports the LaRosa volunteer water quality monitoring program and the Acid Lakes Long-Term Monitoring Program. The Rivers Program supports stream geomorphic assessments that evaluate geomorphic and habitat conditions of rivers. The Lakes and Ponds Management and Protection Program supports the Spring Phosphorus and Lay Monitoring Programs, which evaluate nutrient conditions and trends on lakes, as well as shoreland condition, and more in-depth lake assessments in addition to surveys for aquatic invasive species. Additionally, the Wetlands Program conducts chemical and biological assessments of wetlands.

In addition to the WSMD programs, a network of streamflow gages is funded and operated in partnership among DEC, Vermont Agency of Transportation (VTrans), and Vermont Department of Public Safety (DPS). The Vermont Fish and Wildlife Department (FWD) conducts fishery assessments and temperature monitoring to understand recreational fish populations and evaluates streams for strategic wood addition to restore habitat.

Condition of Rivers and Streams

Stream Bioassessments

The WSMD in DEC assesses the health of a waterbody using biological, chemical, and physical criteria as described in the Vermont Water Quality Monitoring Program Strategy 2011-2020, which was updated in 2015. Most of these data can be accessed through the Vermont Integrated Watershed Information System (IWIS) online data portal. The biological assessment of streams in VT is carried out by the WSMD MAP using biological indices that measure the health of streams by looking at multiple structural and functional aspects of the macroinvertebrate and fish communities. Biological communities integrate the effects of multiple stressors over space and time, and biomonitoring is the best tool for detecting water quality impairments and assessing their relative severity. By comparing biological data with communities in streams that are at or near a reference condition, it is also possible to identify streams that may warrant higher levels of protection through reclassification. The ratings for the community assessments range from *Poor* - not meeting Vermont's water quality standards (VWQS) - to *Excellent* - exceeding VWQS. The monitoring information below was collected in Basin 1 from 2016 to 2020.

Macroinvertebrate Monitoring Results

Thirty-three macroinvertebrate assessments were completed in Basin 1 in 2018. From these assessments, five streams exhibited macroinvertebrate communities in *Very Good* or better condition. Streams in *Very Good* or better condition exceed VWQS and are considered at or near the reference or natural condition. Fourteen samples failed to meet VWQS and most of these were targeted sites already suspected of being stressed or impaired.

To ensure a comprehensive understanding of basin water quality, a gap analysis was conducted by DEC to identify sites without current monitoring data (Figure 7). These sites were also ranked by

the relative amount of agriculture and developed land use in their watersheds. This analysis was used to further prioritize sites for future monitoring and assessment as these land uses are known to degrade water quality condition. These areas will be prioritized for the 2023 monitoring season and can be found in Chapter 5 in the Basin 1 Monitoring and Assessment Table.

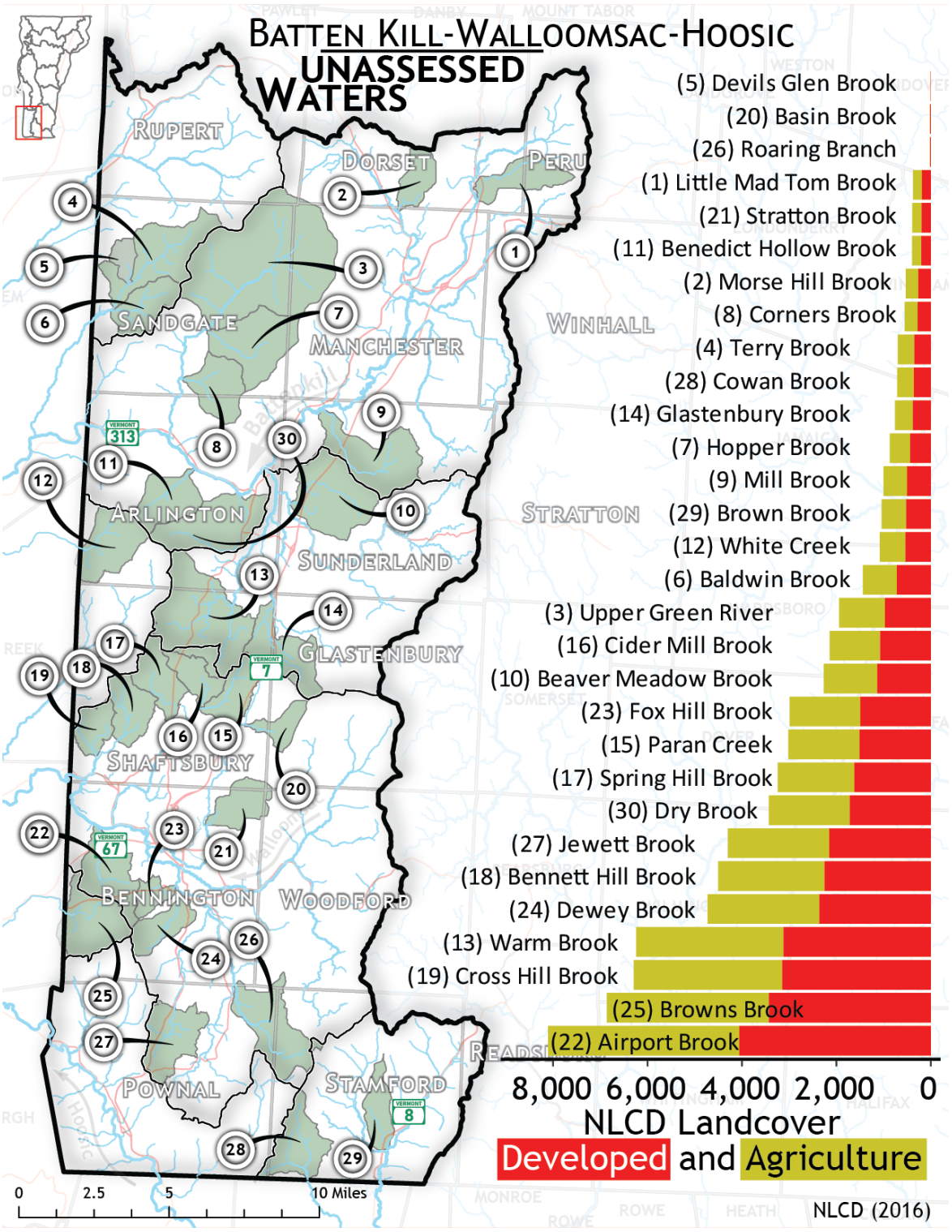


Figure 7. Priority watersheds for biological monitoring in 2023 for Basin 1. Priority areas for monitoring are numbered and highlighted in green. NLCD = National Land Cover Database.

Fish Monitoring Results

Sixteen fish community assessments were completed in Basin 1 in 2018. Four fish sampling events were unable to be assessed using the VWQS numeric biocriteria as only one species (Brook Trout) was present. Those streams were Bickford Hollow Brook (river mile 0.1), Branch Pond Brook (river mile 0.1), Cardinal Brook Tributary 1 (river mile 0.1), and Fayville Branch (river mile 3.7). Each of these streams are maintaining Brook Trout populations with a density and age class distribution suggesting B(1) or A(1) condition for aquatic biota use.

Three sampling events exhibited fish communities in *Excellent* condition: Broad Brook (river mile 2.4), City Stream (river mile 2.0), and Ladd Brook (river mile 0.3). Four sampling events exhibited fish communities in *Very Good* condition: Bourn Brook (river mile 1.6), Little White Creek (river mile 8.6), North Branch Hoosic River (river mile 5.7), and Stamford Brook (river mile 0.1). Streams in *Very Good* or better condition exceed the VWQS.

Four sampling events exhibited fish communities in *Good* condition: Barney Brook (river mile 0.3), Mill Brook (river mile 0.2), Tributary to Walloomsac River (river mile 0.5), and White Creek (river mile 12.2). No streams were assessed as having a *Fair* or *Poor* fish community. More information about the results of these sampling sites can be found in the Vermont Integrated Watershed Information System (IWIS).

Stream Geomorphic Assessments

There is limited coverage of Phase I or Phase II Stream Geomorphic Assessments (SGAs) in Basin 1 (Figure 8). There are 447 unassessed river miles in the basin. Of 97 river miles assessed in Basin 1, 55% are in fair geomorphic condition, 32% are in good condition, 6% are in poor condition, and 7% are in reference condition. Historic channelization, major stream alterations following flooding events like Tropical Storm Irene, and more recent flooding events are major drivers of degraded

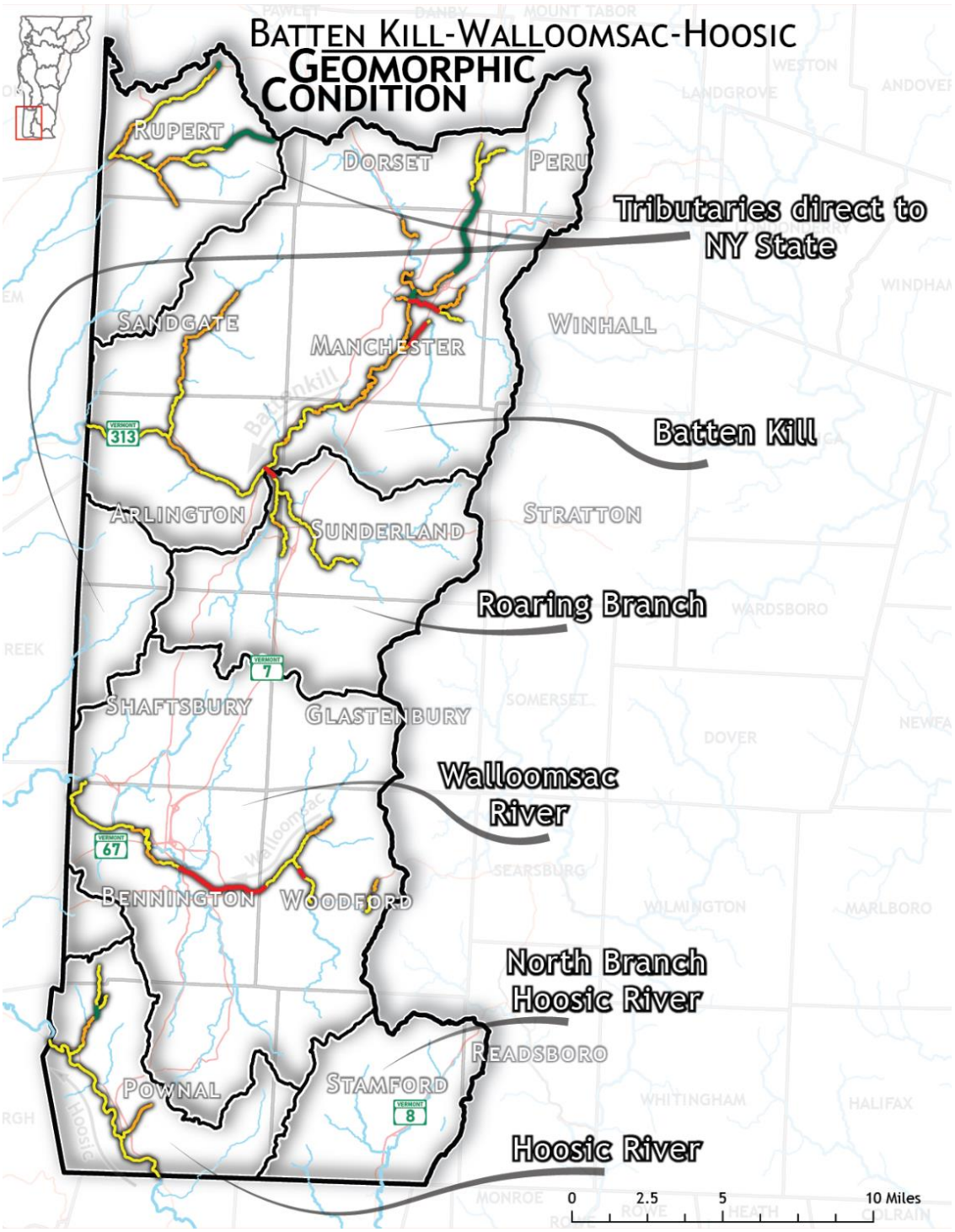


Figure 8. Geomorphic condition of assessed streams in Basin 1 from reference to poor condition. Reference=green, good=orange, fair=yellow, poor=red.

geomorphic conditions in Basin 1. Between 2005 and 2009 six Phase 2 SGAs were completed in Basin 1. Figure 8 also shows the geomorphic condition for those streams with completed Phase 2 SGAs. Final SGA reports and River Corridor Plans (RCPs) can be accessed here.

Condition of Lakes and Ponds

There are 15 lakes and ponds in Basin 1 that are ten acres or larger in size. Twelve of the 15 lakes are 20 acres or larger. The three largest lakes in order from largest to smallest are Bourn Pond (56.7 acres), Lake Hancock (55.9 acres), and Branch Pond (44.1 acres). Lakes that are ten acres or greater that are managed, should be done so in accordance with the Vermont Hydrology Policy and meet the Hydrology Criteria (§29A-304) in the 2017 VT Water Quality Standards.

Fifteen lakes in Basin 1 have at least one rating on the VT Inland Lakes Scorecard (Figure 9). These ratings are driven by data availability. The VT Inland Lake Score Card is a user-friendly interface developed by the Vermont Lakes and Ponds Management and Protection Program (VLPP) to share available data on overall lake health by providing a rating of a waterbody's nutrient trend, shoreland and lake habitat, atmospheric pollution, and aquatic invasive species (AIS). For more information about the lakes and ponds scoring process, please read 'How Lakes Are Scored' and watch the recorded webinar. In addition, lake-specific water quality and chemistry data can be accessed online through the VT Lay Monitoring Program webpage.

Seven of the 15 lakes monitored in Basin 1 received *poor* condition scores. Three lakes have *poor* ratings for watershed condition (Barber Pond, Lake Paran, Lake Shaftsbury). Only one lake has a *poor* condition rating for shoreland and lake habitat (Big Pond), although three other waterbodies received *fair* scores. Two lakes are in *fair* condition for nutrient trend (Big Pond and Bourn Pond). Thompsons Pond in Pownal is the only lake in *good* condition for all parameters except for mercury pollution, which is reported in *fair* condition statewide.

Eight lakes in the basin received *good* scores indicating the absence of AIS. A *poor* score indicates the presence of at least one AIS, regardless of its abundance or 'nuisance' level. Two lakes are in *poor* condition for AIS: Lake Paran (Eurasian Water Milfoil (EWM), Water Chestnut (WC), and Curly-leaf Pondweed (CLP)) and Lake Shaftsbury (EWM, WC) (Figure 9). More information about how lakes are being managed is found in the Natural Resources – Lakes section of Chapter 4.

Long-Term Monitoring of Acid Sensitive Lakes

There are three main airborne pollution types that affect lakes and ponds in Vermont: sulfur oxides, nitrogen oxides, and mercury. Mercury contamination has resulted in fish consumption advisories in nearly every lake in Vermont and those of nearby states as well, so all lakes in Basin 1 get a fair

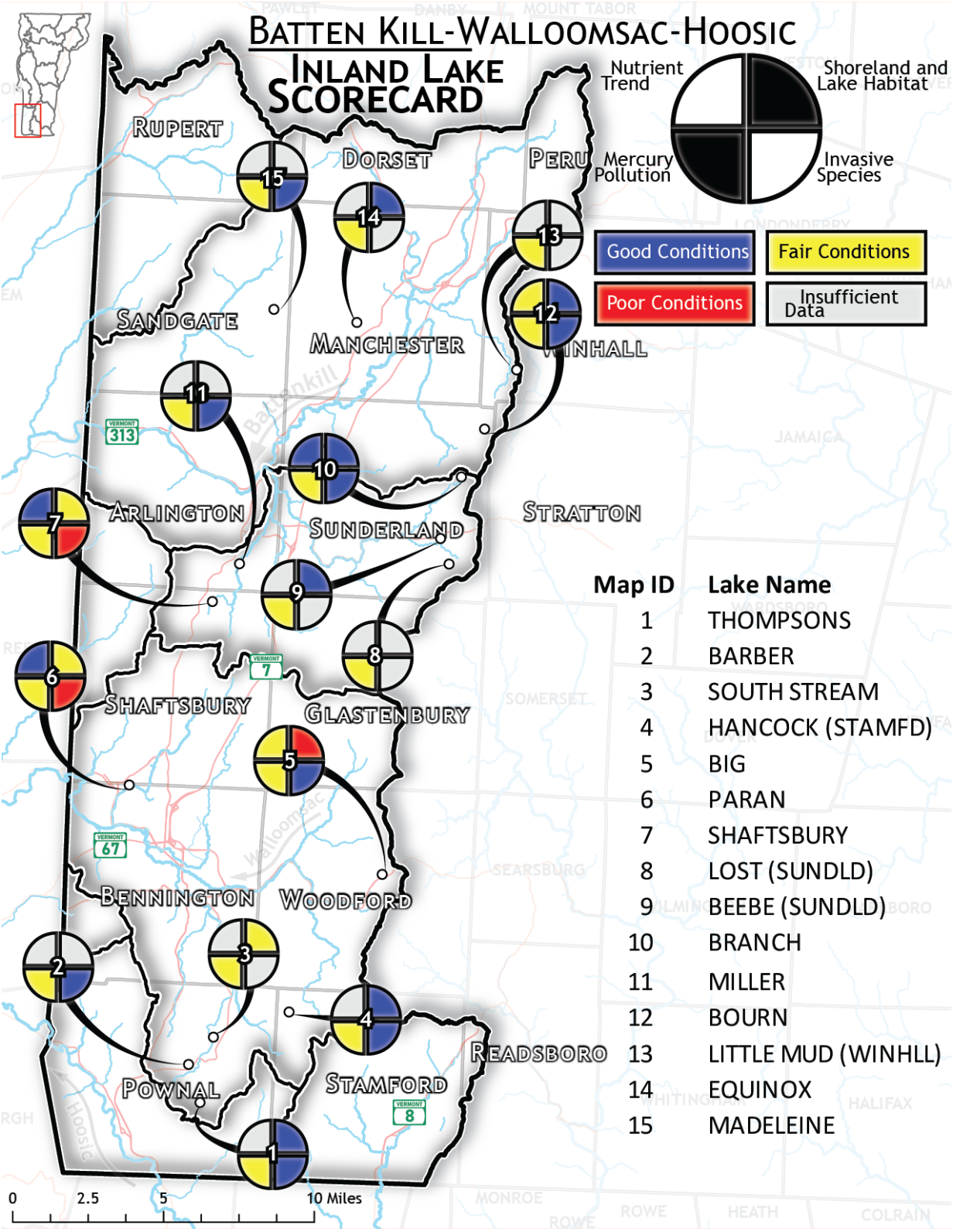


Figure 9. Scorecard information for Basin 1 lakes and ponds over 10 acres in size.

condition score (Figure 9).

Sulfur and nitrogen oxides are largely transported to VT from out of state air emissions. As part of the VT acid lake impaired TMDL, the State of Vermont urged the USEPA to enforce the Clean Air Act and its amendments to meet emission reduction targets. Vermont joined the USEPA, 7 states, and 13 citizen groups to sue a major emitter of air borne pollutants and won a settlement in 2007. Nationwide emissions and deposition of acid forming pollutants have declined. As a result, Vermont's in-lake acid concentrations have declined. While achieving pre-industrial conditions is unlikely, the improvements are notable.

Lakes and ponds in Basin 1 are regularly monitored for low pH (i.e., high acidity), which impacts biological communities. Two ponds located in Sunderland, Bourn and Branch, are monitored by the EPA sponsored Vermont Long-Term Lake Monitoring Program to determine their acid status and trends. The following four lakes have a TMDL for acidity, because of their low pH: Little Mud, Bourn, Branch Pond, and Beebe Pond. Lost Pond has low pH and is listed as acid impaired, but does not yet have a TMDL. More information about long-term monitoring of VT's acid lakes can be found here.

Condition of Wetlands

Wetland Monitoring

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

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

Generally, poor condition wetlands are associated with agriculture and development in the lower valleys, while excellent wetlands occur at higher elevations, in remote headwater regions.

A total of 28 wetlands in Basin 1 have been assessed using the Vermont Rapid Assessment Method (VRAM). Of these, 19 were assessed during 2018 which was the most recent year in which this basin was assessed using rotational basin planning.

The VRAM assigns each wetland a score ranging from 15 to 100 with higher numbers representing more intact ecological condition and higher levels of wetland functioning and value. The highest scoring wetlands scored in the low 90s including three of the many wetlands in the remote high elevations of Sunderland and Pownal Bog in Pownal. The lowest scoring wetland received a 28 and is a disturbed clayplain in Bennington with abundant invasive species. A recently-grazed wetland

meadow along Basin Brook also scored low at 38. All other VRAMs scored over 50 points and the average score was 71. Wetlands in the headwater areas of the Green Mountains tended to score very high, whereas wetlands in the human-impacted areas in the lower valleys varied widely in score from very low to very high. Excellent-condition wetlands are found throughout the basin, but many wetlands experiencing human-caused disturbance occur in the wider river valleys. Note that the VRAM assessments in this basin are not necessarily representative of basin wide wetland condition, as random sampling was not conducted and a full inventory of all the wetlands in the basin is not possible at this time.

Interested organizations and citizens can help build the dataset of wetlands in the Basin 1 by conducting VRAM analysis. Individuals or groups interested in learning the VRAM protocol should contact Wetlands Program staff for further information.

Condition of Fisheries

Flowing Water Fisheries

The Batten Kill is located in Bennington County and is recognized as one of VT's top trout fishing streams and ranks among other important trout fisheries of the United States. Prior to the introduction of Brown Trout to the river around 1900, the native Brook Trout was the only salmonid inhabiting the river. Following the initial releases of Brown Trout, the species established itself as a self-sustaining, wild population around which the sport fishery developed further and built upon the river's reputation as Vermont's pre-eminent trout stream. In 1991, the river was designated by the VT Water Resources Board as the state's first Outstanding Resource Water (ORW). The status of the Batten Kill's Brook and Brown Trout fishery has been monitored since 1984 at several index sites. Both creel and electroshocking surveys by the FWD have shown a decline in the wild trout populations in the Batten Kill during the 1990s.

The Batten Kill is an exceptional fishery because of its ability to provide high-quality habitat for Brook Trout and Brown Trout. This exceptional habitat is provided by comparatively high summer flows, limestone in the drainage, extensive gravel beds for spawning, good shade along the banks, stable banks only occasionally subject to serious erosion and sedimentation, consistently cold summer water temperatures, a well-vegetated watershed with minimal nutrient and sediment pollution, and a naturally reproducing Brook Trout and Brown Trout fishery. The river has stable flows, cool water temperatures favorable to salmonids, good physical habitat providing necessary cover, refuges, spawning and rearing habitats, as well as the food quality and quantity necessary to support a healthy salmonid population.

However, in the mid-1990s, there was a dramatic decline that has led to investigations and subsequent actions to aid recovery in this nationally-known resource. In response, the FWD designated the lower 20 miles of the mainstem from the now-removed Dufresne Pond Dam downstream to the New York state line as no-harvest "catch-and-release" fishing only. This took effect at the start of the 2000 open-water trout fishing season and continues today. Also in 2000, an

interdisciplinary team of fishery and aquatic biologists determined insufficient cover habitat was likely limiting trout abundance, particularly yearling and larger fish. Consequently, FWD partnered with the United States Forest Service (USFS), Batten Kill Watershed Alliance (BKWA), Trout Unlimited (TU), private landowners, towns, other state and federal government entities, and nongovernmental organizations to undertake in-stream and riparian habitat enhancements. The FWD continues to monitor trout population response to habitat conversion.

Summary

Most Basin 1 surface waters meet or exceed water quality standards and waters that exceed standards outnumber the waters that do not meet standards. However, both protection and restoration efforts are required to maintain and improve water quality in Basin 1. The following chapters provide an overview of priority waters for protection and restoration and sector specific strategies to meet our water quality goals.

Chapter 2 – Priority Areas for Surface Water Protection

In order to protect VT surface waters and their designated uses, the VWQS establish water quality classes and associated management objectives. In addition to the pathways provided by the VWQS, tactical basin plans identify opportunities to increase protection of high-quality waters through land stewardship programs, local protection efforts, conservation easements, and land acquisition.

As specified in the VWQS, all surface waters are managed to support designated uses valued by the public at a level of Class B(2) (i.e., good condition) or better. Designated uses include: swimming, boating, fishing, aquatic biota, aquatic habitat, aesthetics, public water source, and irrigation. This section of the plan identifies surface waters where monitoring data indicate conditions may meet or exceed the VWQS use-specific management objectives and criteria for A(1) and B(1). These high-quality waters may be protected by the anti-degradation policy of the VWQS or by upward reclassification through one of the following protection pathways:

- Reclassification of surface waters
- Class I Wetland designation
- Outstanding Resource Waters designation
- Designation of waters as cold-water fisheries
- Identification of existing uses

In Basin 1, eight waters are currently classified as A(1) for all uses (except irrigation and water supplies), one water meets criteria for A(1) aquatic biota, one water meets criteria for B(1) aquatic biota, one pond meets criteria for B(1) aesthetics, 14 waters meet criteria for B(1) fishing, one wetland is identified as a Class I wetland candidate, and three wetlands have been identified for further study for Class I wetland designation. Eight abandoned A(2) public water sources are identified for evaluation for reclassification, and seven rivers and two lakes have been identified as

potential reclassification candidates in need of additional monitoring for B(1) (Figure 10). These are highlighted in the monitoring and assessment table in Chapter 5.

The VWQS establish water quality classes and associated management objectives. The protection of water quality and water-related uses can be promoted by establishing specific management objectives for bodies and stretches of water. The management objectives describe the values and uses of the surface water that are to be protected or achieved.

Figure 10. Surface water protection highlights in Basin 1.

The ANR 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 ANR establishes a management goal, the Agency manages state lands and issues permits to achieve all management objectives established for the associated surface water.

Before the ANR recommends management objectives through a classification or designation action, input from the public on any proposal is required and considered. While the public may present a proposal for establishing management objectives for ANR consideration at any time, the Agency typically relies on tactical basin plans to identify candidates for reclassification (10 V.S.A. § 1424a). The DEC is developing and updating relevant procedures, forms, and guidance documents, as necessary, to enable submission, evaluation, and implementation of petitions to reclassify streams and lakes, and to designate ORW. The DEC has developed these procedures and documents for Class I wetland designations. When the public develops proposals regarding management objectives, the increased community awareness can lead to protection of uses and values by the community and individuals.

Public involvement is an essential component to restoring and protecting river and lake ecology. The VWQS indicate that in the basin planning process, "*Public participation shall be sought to identify and inventory problems, solutions, high quality waters, existing uses and significant resources of high public interest.*" Emphasis on the identification of values and expectations for future water quality conditions can only be achieved through public contributions to the planning process. The public, watershed partners, and stakeholders are encouraged to make recommendations for additional monitoring and research where very high-quality waters appear to exist.

A. Surface Water Classification

Vermont's surface water classification system establishes management goals and supporting criteria for uses in each class of water. The VWQS begin classification with two broad groups based on elevation:

- All waters above 2,500 feet altitude, National Geodetic Vertical Datum, are designated Class A(1) for all uses, unless specifically designated Class A(2) for use as a public water source.
- All waters at or below 2,500 feet altitude, National Geodetic Vertical Datum, are designated Class B(2) for all uses, unless specifically designated as Class A(1), A(2), or B(1) for any use.

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(2) and A(1), 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, fishing, boating, or swimming) may be individually classified, so a specific lake or stream may have individual uses classified at different levels. Act 79 indicates that uses may be reclassified independently to Class A(1) or B(1) for individual uses if the quality of those uses are demonstrably and consistently of higher quality than Class B(2). The extent of the water being reclassified is subject to review based on documented conditions.

Current classifications of surface waters and their uses are identified through the tactical basin planning process or on a case-by-case basis. The current classification, however, does not signify that the A(1) or B(1) criterion is not met. Additional waters suitable for reclassification may be identified in the future as some waters have not been monitored. Table 2 lists the possible classes into which each use may be placed.

Table 2. Uses that can be placed into each water class in the Vermont Water Quality Standards.

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

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

A(2) Public Water Sources

Ten waters are designated as A(2) public water sources in Basin 1. Eight of the 10 waters have been abandoned as public water sources and could be reclassified to reflect their current condition for each designated use (Table 3).

Table 3. Class A(2) designated public water sources in the Basin 1.

Waters	Water Source	Description
Unnamed tributaries	Village of Pownal	**Abandoned**. That portion of unnamed tributaries and their watersheds on Mann Hill in the Town of Pownal upstream of the water intake in Oak Hill Cemetery.
Ladd Brook	Village of Pownal	**Abandoned**. Ladd Brook and all waters within its watershed in the Town of Pownal.
Reservoir Hollow Brook	Village of North Pownal	**Abandoned**. Reservoir Hollow Brook and reservoir and all waters within its watershed. (Reservoir is approximately 0.5 miles upstream of the Hoosic River).
Roaring Branch	Town of Bennington	**Abandoned**. That portion of Roaring Branch and all waters within its watershed in the Town of Stamford upstream of the water intake in Pownal.
Basin Brook and Furnace Brook	Village of North Bennington	**Abandoned.** Basin Brook and all waters within its watershed to and including the North Bennington Reservoir in the Towns of Glastenbury and Shaftsbury.
Unnamed tributary to Bromley Brook	Village of Manchester	**Abandoned.** The first unnamed tributary to Bromley Brook and all waters within its watershed upstream of the Manchester Water Company intake. The tributary is the first tributary on the right upstream of Bromley Brook.
Unnamed tributary to South Stream	Village of Bennington	**Abandoned.** That portion of unnamed tributary to South Stream and all waters within its watershed in the Town of Woodford upstream of the water intake in Bennington.

Barney Brook	Village of Bennington	**Abandoned.** That portion of Barney Brook and all waters within its watershed in the Town of Woodford upstream of the water intake.
Sucker Pond (Lake Hancock) and tributaries	Village of Bennington	**Emergency**. Lake surface and all waters within its watershed in Stamford.
Bolles Brook	Village of Bennington	**Permanent.** That portion of Bolles Brook and all waters within its watershed in the Towns of Glastenbury and Woodford upstream of the Bennington water intake.

A(1) & B(1) Waters for Aquatic Biota

Based upon biomonitoring assessments conducted by the DEC WSMD, two surface waters in Basin 1 consistently and demonstrably attain a higher level of quality than Class B(2), meeting Class A(1) or Class B(1) criteria for aquatic biota. There are seven surface waters that are classified as A(1) due to their location within a Wilderness Area and one water that is A(1) because it is above 2500 feet altitude. (Table 4 and Figure 11).

There are seven sites requiring additional sampling to determine if they meet B(1) criteria for aquatic biota (Table 4 and Figure 11).

Table 4. Rivers and streams that meet criteria for A(1) or B(1) for aquatic biota, are A(1) due to being above 2500 feet altitude or require additional monitoring. Map #'s correspond with Figure 11. *Potential A(1) or B(1).

Map #	Name	Use	Protection Class	Status
4	Bourn Brook	All Uses except water supply and irrigation which are B(2)	A(1)	Designated as part of 2017 reclassification of all waters in Lye Brook Wilderness
5	Lye Brook		A(1)	Designated as part of 2017 reclassification of all waters in Lye Brook Wilderness Area
6	Mill Brook		A(1)	Designated as part of 2017 reclassification of all waters in Lye Brook Wilderness Area
8	Branch Pond Brook		A(1)	Designated as part of 2017 reclassification of all waters in Lye Brook Wilderness Area
9	South Alder Brook		A(1)	Above 2500 feet altitude

17	Bickford Hollow Brook		A(1)	Designated as part of 2017 reclassification of all waters in Glastenbury Wilderness Area
18	Bolles Brook		A(1)	Designated as part of 2017 reclassification of all waters in Glastenbury Wilderness Area
19	Hell Hollow Brook		A(1)	Designated as part of 2017 reclassification of all waters in Glastenbury Wilderness Area
27	Broad Brook	Aquatic Biota	B(1)	Meets Criteria
2	Headwaters Battenkill	Aquatic Biota	B(1)*	Needs Additional Monitoring
3	Goodman Brook	Aquatic Biota	B(1)*	Needs Additional Monitoring
10	White Creek	Aquatic Biota	B(1)*	Needs Additional Monitoring
16	Furnace Brook	Aquatic Biota	B(1)*	Needs Additional Monitoring
22	Stamford Brook	Aquatic Life	B(1)*	Needs Additional Monitoring
23	City Stream	Aquatic Biota	B(1)*	Needs Additional Monitoring
29	North Branch Hoosic River	Aquatic Biota	B(1)*	Needs Additional Monitoring
31	Cardinal Brook	Aquatic Biota	A(1)	Meets Criteria

B(1) Waters for Recreational Fishing

Certain Basin 1 waters support productive populations of cold-water salmonids. Rivers and streams classified as B(1) recreational fishing waters support wild, self-sustaining salmonid populations characterized by the presence of multiple age classes and a minimum abundance of 1000 individuals per mile (all species/ages/sizes); and/or 200 large (> 6 inches total length) individuals per mile; and/or 20 pounds/acre (all species/ages/sizes)[3]. The 13 streams that meet B(1) criteria for recreational fishing (§29A-306) and 1 stream requiring additional monitoring are shown in Table 5 and Figure 11.

[3] It should be recognized that wild trout populations vary widely from year to year and therefore an individual population may sometimes go below or greatly exceed these values in 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. 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.

Table 5. List of rivers and streams that meet criteria for B(1) for fishing or require additional monitoring. Map #'s correspond with Figure 11.

Map #	Name	Use	Protection Class	Status
2	Mad Tom Brook	Fishing	(B)1	Meets Criteria
3	Goodman Brook	Fishing	(B)1	Meets Criteria
10	White Creek	Fishing	(B)1	Meets Criteria
11	Green River	Fishing	(B)1	Needs Additional Monitoring
12	West Branch Batten Kill	Fishing	(B)1	Meets Criteria
13	Upper Batten Kill	Fishing	(B)1	Meets Criteria
14	Batten Kill	Fishing	(B)1	Meets Criteria
15	Fayville Branch	Fishing	(B)1	Meets Criteria
20	Bolles Brook	Fishing	(B)1	Meets Criteria
21	Walloomsac River	Fishing	(B)1	Meets Criteria
22	Stamford	Fishing	(B)1	Meets Criteria
23	City Brook	Fishing	(B)1	Meets Criteria
28	North Branch Hoosic River	Fishing	(B)1	Meets Criteria
30	Roaring Brook	Fishing	(B)1	Meets Criteria

These waters shall be managed to achieve and maintain very good quality fishing. The 13 waters identified may be adjusted in the future based on new surveys and as protocols are refined. Waters that meet the revised criteria in the water quality standards for both B(1) and A(1) fishing use will be continually identified and updated. It is important to note that all waterbodies that would naturally support fish populations are protected and maintained in perpetuity.

A(1) & B(1) Waters for Aesthetics

The 2017 VWQS contains a designated use for aesthetic conditions, and DEC developed numeric nutrient criteria for lakes and ponds in relation to this use. Only Big Pond in Basin 1 meets the nutrient criteria for B(1) aesthetics (Table 6). Although it exceeds the VWQS for B(2) waters, it is stressed due to a significantly increasing total phosphorus trend. Strategies to address this trend are described in Chapter 4 and 5.

Branch Pond and Lake Shaftsbury require additional monitoring to determine if they meet the relevant B(1) criteria. Monitoring recommendations are covered in Chapter 5 in the Basin 1 Monitoring and Assessment Table.

Table 6. Lakes that meet the combined nutrient criteria for B(1) aesthetics or require additional monitoring to determine their status. *Potential B(1) water.

Name	Use	Protection Class	Status
Big Pond	Aesthetics	B(1)	Meets Criteria
Branch Pond	Aesthetics	B(1)*	Needs Additional Monitoring
Lake Shaftsbury	Aesthetics	B(1)*	Needs Additional Monitoring

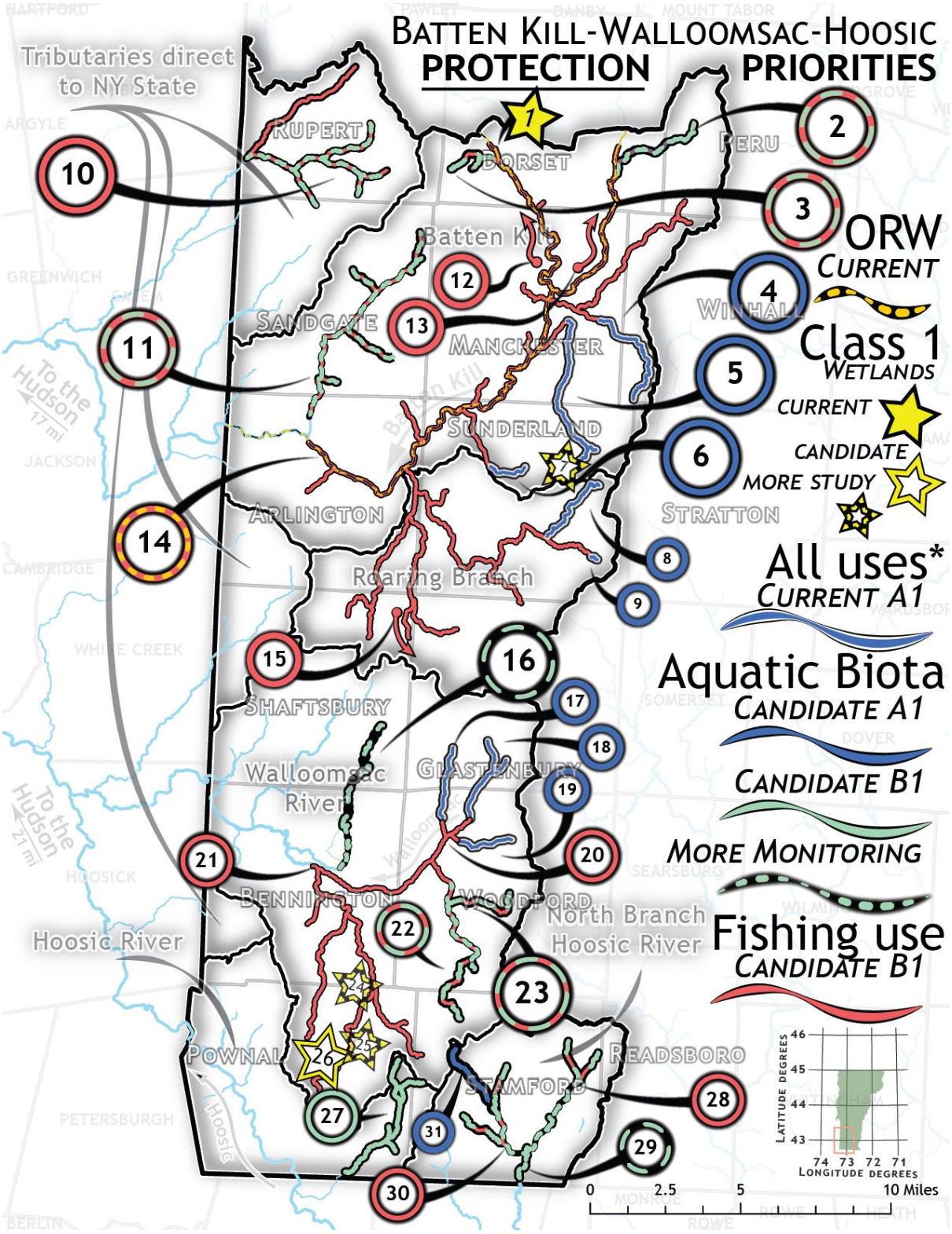


Figure 11. Map of Outstanding Resource Waters (ORW), Class I Wetlands, and A(1) and B(1) candidates in Basin 1 for aquatic biota and fishing uses that either exceed the 2016 VWQS or need additional sampling to determine their status. Map #'s correspond with Table 4 and 5.

B. 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 II nor a Class I wetland.

Impacts to Class I wetlands may only be permitted when the activity is necessary to meet a compelling public need for health or safety. The VT Wetlands Program created a Class I website with an interactive map. This website includes the determinations for nine Class I wetlands: Dorset Marsh, Northshore Wetland, Tinmouth Channel, Chickering Fen, Dennis Pond Wetlands, Sandbar Wetlands, Peacham Bog, LaPlante River Wetlands, and Beaver Meadows Wetland. The last six wetlands were added since 2016.

Dorset Marsh is the only Class I wetland in Basin 1 (Figure 11). The 262-acre marsh was designated in 1992 and lies at the headwaters of both the Batten Kill and Mettowee Rivers. The wetland complex is significant for all 10 functions and values as identified under VT Wetland Rules and is considered exemplary or irreplaceable for the following three: 1. Rare, Threatened, or Endangered (RTE) Species habitat, 2. wildlife and migratory bird habitat, and 3. education and research opportunities.

The Dorset Marsh Wetland Complex also meets the Class I wetland sub-criteria including landscape association and being the headwaters to the Batten Kill and Mettowee Rivers, containing RTE species, and providing habitat connectivity. The VT Wetlands Program welcomes recommendations for Class I candidates.

Wetlands for Further Study for Class I Designation

Three wetlands have been identified for further study for Class I wetland designation and one is a Class I candidate (Table 7).

Table 7. One Class I wetland candidate and three that require additional monitoring to determine their status. Map #'s correspond with Figure 11.

Map #	Name	Protection Level	Use	Status
26	Pownal Bog	Class I	Wetland	Candidate
7	Batten Kill Headwaters	Class I	Wetland	Needs further study

24	Maple Grove Swamp	Class I	Wetland	Needs further study
25	Middle Pownal Road Swamp/South Stream wetland complex	Class I	Wetland	Needs further study

Wetlands that satisfy criteria may be proposed for Class I designation through departmental rulemaking authority, and as consistent with the Vermont Wetland Rules.

C. Warm- and Cold-Water Fish Habitat Designations

Warm Water Fish Habitat

All surface water wetlands, except those designated as cold-water fish habitats, and the following waters are designated as warm water fish habitat for purposes of the VWQS:

- Lake Hancock (Sucker Pond), Stamford
- Thompsons Pond, Pownal

The VWQS specify a lower minimum dissolved oxygen concentration for warm-water Fish habitat than waters in the remainder of the basin, which are Cold-Water Fish Habitat. There are no proposed changes to warm-water fish habitat designations currently.

Cold-Water Fish Habitat

All waters not designated as warm-water fish habitat are designated as cold-water fish habitat in Basin 1, as noted in the VWQS (Vermont Department of Environmental Conservation, 2017). This includes the wetland adjacent to the Batten Kill from a point 0.75 miles north of East Dorset and extending to its confluence with Dufresne Pond in Manchester, a distance of approximately 5.5 miles (VWQS §A-02).

D. Outstanding Resource Waters Designation

Vermont Act 67 ("An Act Relating to Establishing a Comprehensive State Rivers Policy," 1987) provides protection to rivers and streams that have "exceptional natural, cultural, recreational, or scenic values" through the designation of ORW. ORW designation may protect exceptional waters through permit conditions in stream alterations, dams, wastewater discharges, aquatic nuisance controls, solid waste disposal, Act 250 projects, and other activities. ORWs are waters which can be designated by the ANR through a petition process. On January 8, 1991, the Vermont Water Resources Board designated all Vermont portions of the Batten Kill mainstem and the West Branch of the Batten Kill as ORW (Figure 11). They were designated for their exceptional natural,

recreational, cultural, and scenic values. They continue to provide the values they were designated for in 1991.

There are currently no waters recommended for ORW designation in Basin 1. Although no other waters have been identified as ORW in this plan, there may be waters in the basin which merit this designation and for which ORW status should be pursued. The ANR will support collaborative efforts to develop the materials, and to conduct outreach necessary to support rulemaking for ORW designation of these waters, should there be public interest. On receipt of a signed written request, the Secretary shall consider the adoption, amendment, or repeal of rules regarding ORW designation and shall take appropriate action as required under 3 V.S.A. § 806. After consideration of all relevant information, the Secretary shall determine whether to enter rulemaking to designate the waters as ORW if it finds that they have exceptional natural, recreational, cultural, or scenic values. (10 V.S.A. § 1424a).

E. Identification of Existing Uses

The ANR may identify existing uses of 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 VWQS stipulate 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 Class B(1) in Act 79, the ANR may identify an existing use as Class B(1) when that use is demonstrably and consistently attained.

The ANR stipulates that all lakes and ponds in the basin have existing uses of swimming, boating, and fishing. The ANR recognizes that fishing activities in streams and rivers are widespread and too numerous to thoroughly document for Basin 1. In the case of streams too small to support significant fishing activity, the ANR recognizes these as potential spawning and nursery areas, which contribute fish stocks downstream where fishing may occur. These small streams support the use of fishing and therefore, are protected at a level commensurate with downstream areas.

Existing uses in Basin 1 should be viewed as a partial accounting of known existing uses based upon limited information. The list does not change protection under the Clean Water Act or VWQS for unlisted waters. The existing uses in Basin 1 of swimming, boating, fishing, and drinking water supply are here. The public is encouraged to recommend waters for existing uses of swimming, boating, fishing, drinking water, and ecological significance given that they provide evidence of such use. For existing uses of waters, the level of water quality necessary to protect those existing uses shall be maintained and protected regardless of the water's classification (DEC, 2017).

Chapter 3 – Priority Areas for Surface Water Restoration

A. Stressed or Impaired Surface Waters

The DEC monitors and assesses the chemical, physical, and biological status of individual surface waters to determine if they meet the VWQS per the 2019 Vermont Surface Water Assessment and Listing Methodology (Vermont Department of Environmental Conservation, 2019). Surface waters are assessed as: full support, stressed, altered, or impaired. To address Section 303(d) of the Federal Clean Water Act, the DEC develops the 303(d) List of Impaired Waters, which includes impaired lakes, ponds, rivers, and streams that do not meet VWQS.

The State also produces the Priority Waters List, which identifies other waters that do not meet water quality standards, but do not require a TMDL as other pollution control mechanisms are in place. Sections of that list include: Part B- impaired waters that have other required remediation measures in place; Part D-impaired waters with TMDLs in place; Part E-waters altered by AIS; and Part F-waters altered by flow modifications. These lists can be viewed on the DEC Assessment and Listing webpage. For a more detailed description of monitoring results use the Vermont Integrated Watershed Information System (IWIS) online data portal. Figure 12 and Table 8 show the known stressed, impaired, or altered waterbodies in Basin 1.

A primary goal of the plan is to identify and address pollutants degrading the listed waters with strategies listed in the Chapter 5 Implementation Table. The types of strategies prescribed are based on the sector-specific practices outlined in the Vermont Surface Water Management Strategy.

Table 8. Basin 1 priority waters and pollutants. Map #s correspond with Figure 12. Note: Lye Brook-N (20) and Lye Brook-S (21) are drained and will be reviewed during the 2022 listing cycle.

Map #	Name	Pollutant/Problem	Stressed/Impaired Uses	List
1	Hopper Brook	Unlicensed hydroelectric Project, remediation year-2022	Aquatic Life Support	Flow
2	Munson Brook (NEW)	Sediment, Chloride	Aquatic Life Support	Impaired
3	Battenkill	Sediment, temperature, habitat alteration	Aquatic habitat, Recreational Fishing	Stressed
4	Lye Brook (rm 2.5 to headwaters)	Acidity	Aquatic Life Support	Impaired

Map #	Name	Pollutant/Problem	Stressed/Impaired Uses	List
5	Branch Pond Brook	Acidity	Aquatic Life Support	Impaired
6	Bickford Hollow Brook (mouth to headwaters)	Acidity	Aquatic Life Support, Recreational Fishing	Stressed
7	Fayville Branch (rm 3.7 to headwaters)	Acidity	Aquatic Life Support	Impaired
8	Bolles Brook (mouth to headwaters)	Acidity	Aquatic Life Support, Recreational Fishing	Stressed
9	Bolles & Branch Confluence to City Stream	Flow Modification	Aquatic Life Support	Flow
10	Basin Brook	Flow Modification	Aquatic Life Support	Flow
11	Paran Creek below Lake Paran (NEW)	Temperature modification due to impoundments	Aquatic Life Support	Stressed
12	Barney Brook (mouth to rm 1.5)	Sediment, Iron	Aesthetics, Aquatic Life Support	Impaired
13	Jewett Brook	Temperature	Aquatic Life Support	Stressed
14	Hoosic River (through VT)	Metals, Toxicity	Contact Recreation, Recreational Fishing	Stressed
15	Hoosic River	PCBs	Fish Consumption	Impaired
16	Ladd Brook (mouth to rm 0.4)	Sediment	Aquatic Life Support	Impaired
17	Lake Madeleine	Flow Modification	Aquatic Habitat, Aquatic Life Support	Flow
18	Little Mud	Acidity	Aquatic Habitat, Aquatic Life Support	TMDL
19	Bourn Pond	Acidity	Aquatic Habitat, Aquatic Life Support	TMDL
20	Lye Brook - N	Acidity	Aquatic Habitat, Aquatic Life Support	TMDL

Map #	Name	Pollutant/Problem	Stressed/Impaired Uses	List
21	Lye Brook - S	Acidity	Aquatic Habitat, Aquatic Life Support	TMDL
22	Branch Pond	Acidity	Aquatic Habitat, Aquatic Life Support	TMDL
23	Beebe Pond	Acidity	Aquatic Habitat, Aquatic Life Support	TMDL
24	Lost Pond	Acidity	Aquatic Habitat, Aquatic Life Support	Impaired
25	Lake Paran	Aquatic Invasive Species (Eurasian watermilfoil)	Aesthetics, Aquatic Habitat, Aquatic Life Support, Contact Recreation, Recreational Boating	Altered

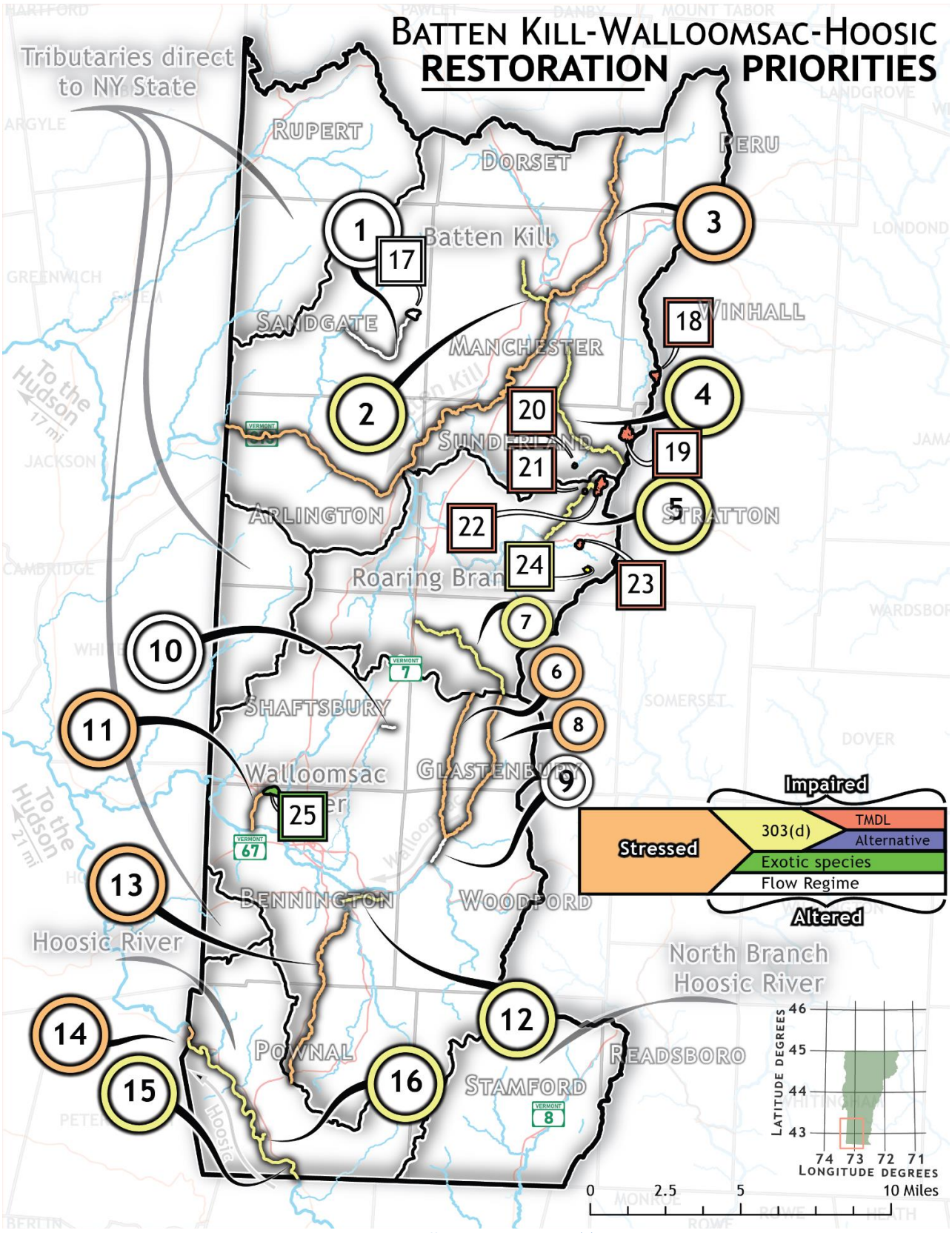


Figure 12. Priority waters for restoration in Basin 1. Map #'s correspond with Table 8.

B. Basin Specific Total Maximum Daily Loads (TMDLs)

A Total Maximum Daily Load (TMDL) is the calculated maximum amount of a pollutant that a waterbody can receive and still meet Vermont Water Quality Standards. In a broader sense, a TMDL is a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards and develops a means to implement those reductions. TMDLs can be calculated for reducing water pollution from specific point source discharges or for an entire watershed to determine the location and amount of needed pollution reductions. Tactical Basin Plans serve as the implementation plan to guide the actions necessary to meet TMDL reduction targets specific to each planning basin.

TMDLs for Basin 1 include:

1. 2003 TMDL for 30 Acid Impaired Lakes in Vermont
2. 2004 TMDL for 7 Acid Impaired Lakes in Vermont
3. Northeast Regional Mercury Total Maximum Daily Load

The Acid Impaired Lakes and Mercury TMDLs are primarily focused on regional efforts to reduce atmospheric deposition and as a result are not described in greater detail beyond the link provided above.

Chapter 4 – Strategies to Address Pollution by Source Sector

Tactical basin plans address water quality by sector as summarized in the following sections which are consistent with the Clean Water Initiative Program's (CWIP) 2020 Performance Report (Vermont Agency of Natural Resources, 2020). The following sections provide specifics about protection and restoration efforts underway or recommended for each source sector. A summary table of the strategies for each sector is found in the Executive Summary in Table 1. A more detailed list of priority strategies by source sector is included in Chapter 5 in the Implementation Table Summary.

Agriculture

- Conservation practices that reduce sources of pollution from farm production areas and farm fields.

Developed Lands--Stormwater

- Practices that reduce or treat polluted stormwater runoff from developed lands, such as parking lots, sidewalks, and rooftops.

Developed Lands--Roads

- Stormwater and roadside erosion control practices that prevent erosion and treat road-related sources of pollution.

Wastewater

- Improvements to municipal wastewater infrastructure that decrease pollution from municipal wastewater systems through treatment upgrades, combined sewer overflow (CSO) abatement, and refurbishment of aging infrastructure.

Natural Resource Restoration

- Restoration of "natural infrastructure" functions that prevent and abate pollution. Natural infrastructure includes: floodplains, river channels, lakeshores, wetlands, and forest lands.

A. Agriculture

Agricultural land use makes up 5.9% of the land cover in Basin 1 (Figure 6). Eighty-five percent is hay or pasture and 15% is annual crops (Figure 13). The highest concentrations of agricultural lands are found in the valleys along the Batten Kill (#5) and Walloomsac (#6) Rivers as well as along tributaries draining directly to New York (#4). In these watersheds, the total land area used for agriculture ranges from 2% to 9%.

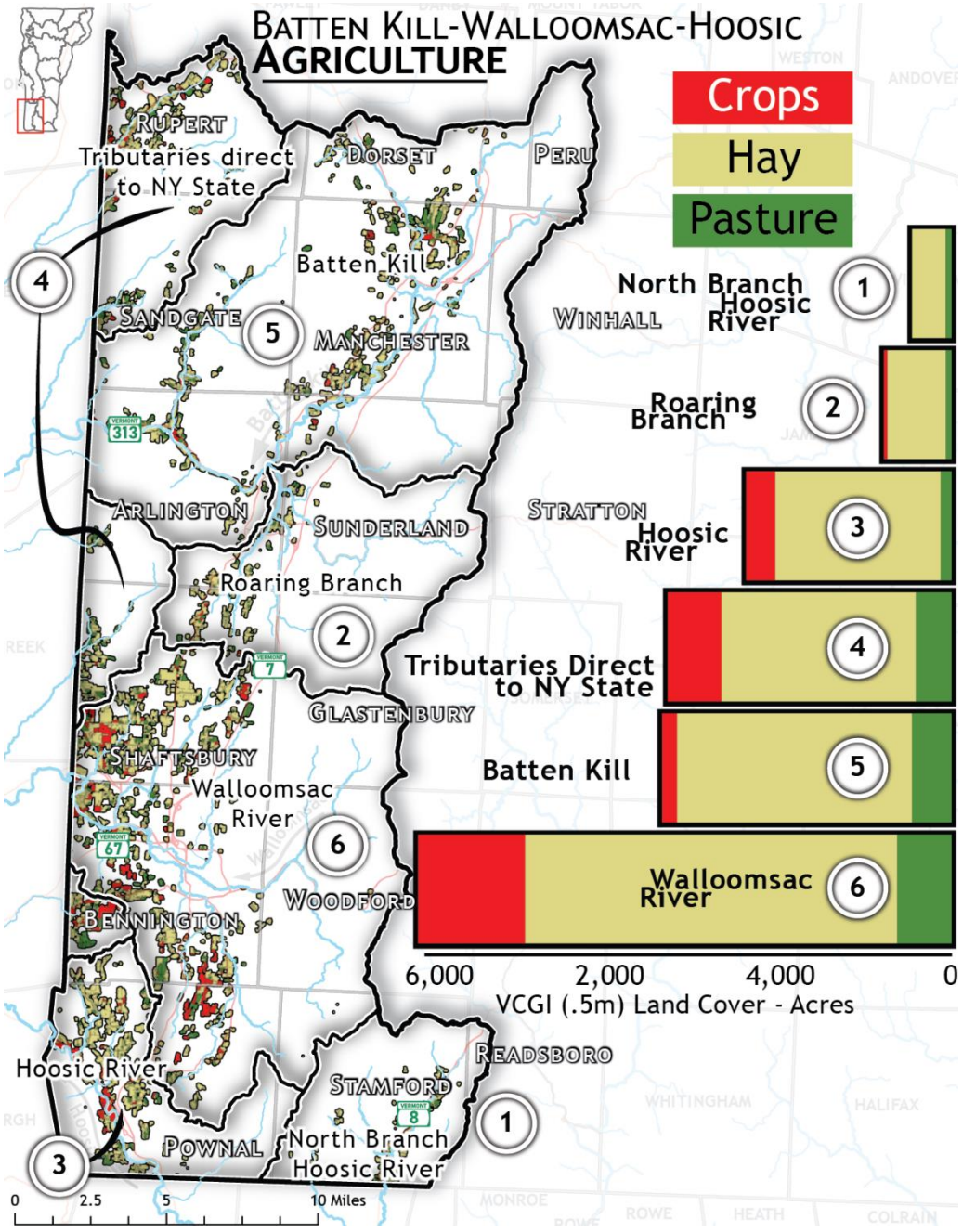


Figure 13. Agricultural land cover and farms in Basin 1. For a comparative view of agricultural land cover to other major land cover types, follow this link to the landcover map in Chapter 1.

As of September 2020, Vermont Agency of Agriculture, Food, and Markets (AAFM) reported 32 farm operations in Basin 1 with 10 (31%) of those located

in the Walloomsac River drainage. There are no Large Farm Operations (LFOs), two Medium Farm Operations (MFOs) and six Certified Small Farm Operations (CSFOs) in the basin. MFOs are inspected at least once every three years and CSFOs are inspected at least once every seven years by the AAFM. These farms must comply with the Required Agricultural Practices (RAPs), MFO and CSFO permitting program requirements, and Vermont's Water Quality Standards.

Twenty-four (75%) of the farms in the basin are Small Farm Operations (SFOs). These farms are not required to certify annually with the AAFM, but still need to comply with the RAPs. These operations are likely comprised of multiple types of farming, from dairy to vegetable, to equine, to sheep. Full understanding of SFOs active in the Basin may rely more on local agricultural partners, because much of the AAFM's data tracking focuses on farms that have annual reporting requirements or are routinely visited (CSFOs, MFOs, and LFOs). It is also important to acknowledge that the agricultural landscape is changing rapidly, especially for smaller dairy farms, which have been in flux as many farmers have gone out of business, downsized, or shifted management. This underscores the key role of local agriculture partners in providing education and outreach to SFOs around RAPs and implementation of field and farmstead practices for water quality. Additional assessments through voluntary farm visits will help to locate areas for targeted action.

Technical and financial assistance throughout the basin is provided by AAFM, the Natural Resources Conservation Service (NRCS), and the Bennington County Conservation District (BCCD). AAFM inspections assess farm nutrient management plans (NMPs), production areas of all facilities associated with the permitted or certified operation, and cropland management in accordance with RAPs and permit rules as applicable. Together these groups help farmers understand the RAPs and program rules, facilitate compliance with water quality regulations, and the voluntary adoption of conservation practices. AAFM and NRCS funded programs provide most of the financial support directly to farmers as well as to the agricultural partner organizations. Education, outreach, technical assistance, and financial assistance is available for farmers to implement field BMPs, such as cover cropping, crop rotation, and reduced tillage practices, and farmstead BMPs, such as waste storage facilities or clean water diversion practices.

In 2019, the AAFM launched the Multi-Partner Agricultural Conservation Practice Tracking and Planning Geospatial Database ("Partner Database") to improve planning and tracking of NRCS, AAFM, and farmer-funded agricultural field and farmstead BMP implementation across the state. Data from the Partner Database was uploaded into the CWIP Clean Water Reporting Framework and is reported here as acres of field BMPs (Figure 14) and number of farmstead BMPs (Figure 15) implemented during SFY2016-2020. Crop rotation and cover cropping practices were the most popular field BMPs (Figure 14). An analysis of the spatial distribution of these field BMPs shows that most were implemented in the South Stream-Walloomsac River and Walloomsac River watersheds, which also have the most cultivated crop lands. On the other hand, the Batten Kill, Tributaries to NY, and the Hoosic River that have significant acres of cultivated crop lands saw little field practice implementation based on records of NRCS and State programs. The higher level of

cumulative agricultural intensity in these watersheds make them a priority for outreach and implementation of field and farmstead BMPs for water quality.

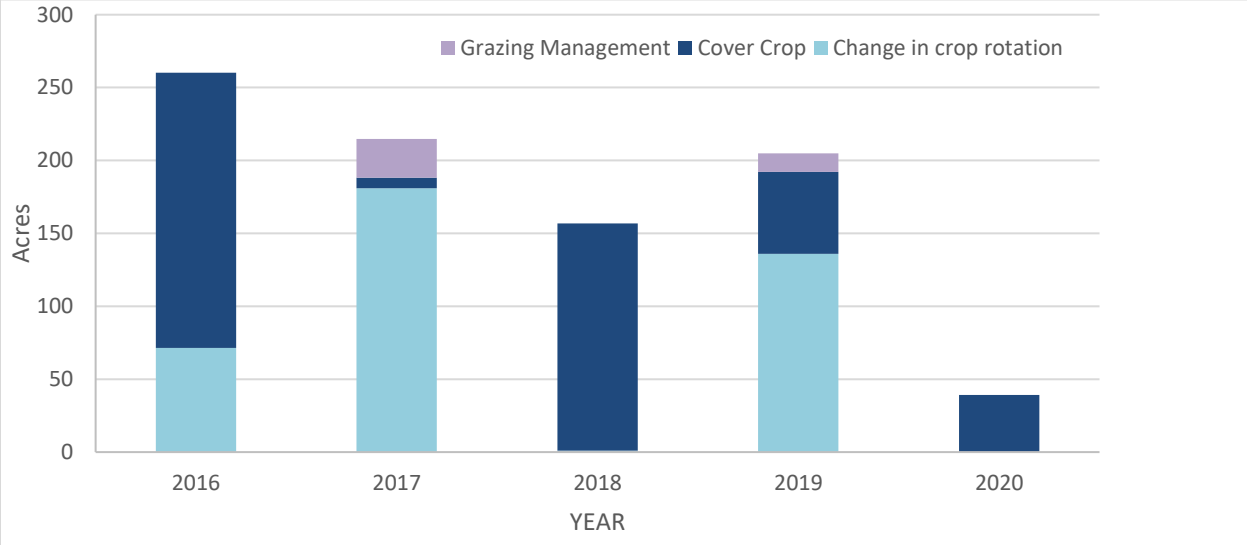


Figure 14. Acreage of AAFM and NRCS funded field BMPs installed in Basin 1 from State FY2016-2020.

The most farmstead BMPs were installed in the basin in 2018 (Figure 15). These were primarily installed in the Walloomsac River watershed. Since 2018, few or no farmstead BMPs were implemented through State and Federal cost share programs in the basin. Compared to other Ag BMPs, farmstead BMPs are expensive to install, but if maintained they have a long practice life of 10-15 years and effectively manage nutrients and *E. coli*.

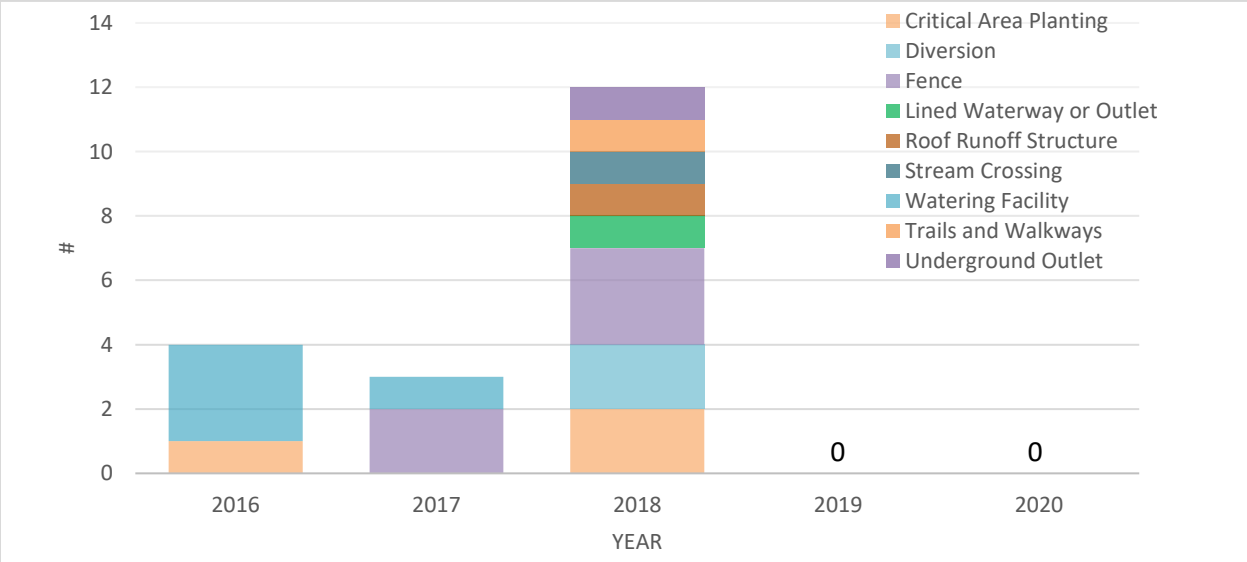


Figure 15. Number of AAFM and NRCS funded farmstead BMPs installed in Basin 1 from State FY2016-2020.

Conservation practice adoption may be higher throughout the Basin 1 watershed as DEC's accounting does not currently include practices that farmers may implement on their own without State or Federal assistance or continue to adopt annually beyond the original cost-share agreements. State and Federal cost share and practice implementation data is reported to the CWIP annually. A summary of State investments and outcomes in the Basin 1 watershed can be found in the 2020 annual performance report.

Regional agricultural partners are essential service providers that assist farms directly through education, outreach, and technical assistance, and can leverage additional resources and financial assistance for farms. The BCCD is partnered with the Poultney Mettowee NRCD and Rutland County NRCD to form the Southwest Regional Partnership with support from the VAAFM Agricultural Clean Water Initiative Program (ACWIP). The partnership serves farmers and producers in Bennington and Rutland Counties and employs two agricultural outreach specialists to provide a variety of services, education, and outreach to farmers with support from the district managers. Services currently offered include: equipment rental, soil and manure sampling, manure cart weights, NMP development, consultations on BMPs to address water quality issues, and referrals to funding programs or agencies. The partnership also provides education and outreach through on-farm visits, mailers, workshops, and articles in publications like AgriView. Sustaining and coordinating with these groups is an important strategy in this plan to effectively target agricultural BMP implementation to improve water quality. Examples of other priority actions include:

- Hosting annual workshops on improving soil health, RAPs, implementing conservation tillage and cover cropping practices,
- Supporting farmers in developing NMPs and creating a program to continue to work with priority farms on implementing NMPs,
- Sustaining regional equipment rental programs to support the implementation of field BMPs,
- Conducting outreach to promote buffer planting programs across the basin.

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

B. Developed Lands

Stormwater

Developed lands cover 5.9% of Basin 1 and are concentrated along the Batten Kill and Walloomsac Rivers in Manchester and Bennington, respectively (Figure 6). Stormwater runoff from developed lands is generated during or after a storm event or because of snowmelt. In developed areas, infiltration of stormwater runoff is reduced by impervious surfaces such as roads, rooftops, and driveways, which also increase the velocity and volume of polluted runoff into waterbodies. This leads to an increased frequency and intensity of flooding as well as a greater likelihood that runoff will become contaminated with pollutants.

This section integrates basin-specific information on stormwater-related water resource impairments, regulatory programs, stormwater master plans (SWMP), Illicit Discharge Detection and Elimination (IDDE) studies, implementation efforts, and partnerships to inform strategies to address stormwater-related water resource impairments. Tactical basin planning engages local, regional, and federal partners in the development of strategies needed to accelerate adoption and monitoring of stormwater-related BMPs to meet the state's clean water goals. This section is organized around the 3-acre permit, stormwater master planning, and IDDE studies, which are the primary drivers for voluntary implementation efforts in the basin.

General Permit 3-9050 (Three-Acre General Permit)

General Permit 3-9050 is a permit for stormwater runoff from impervious surfaces except for public roads. As an important component of the Vermont Clean Water Act of 2015 (Act 64), the permit is designed to assist in the implementation of clean-up efforts in Lake Champlain, Lake Memphremagog, and stormwater-impaired waters, while also protecting high quality surface waters statewide. The permit covers all operational stormwater permitting, including new development, redevelopment, and permit renewal. Additionally, it serves as the "Three-Acre General Permit" as required under the Clean Water Act.

Three-acre parcels in Basin 1 will need to apply for permit coverage by 2033. Since this date is well beyond the timeframe for this plan, voluntary stormwater efforts through stormwater master planning are likely to be the primary drivers for stormwater implementation efforts for this planning cycle.

Stormwater Mapping and Master Planning

Stormwater infrastructure mapping projects are completed for municipalities by the CWIP to supplement the existing drainage data collected by towns and with the intention of providing a tool for planning, maintenance, and inspection of the stormwater infrastructure. Stormwater Master Plans and Stormwater mapping reports were completed for significant areas of 12 towns in Basin 1 (Table 9).

The reports and maps from each project are meant to provide an overall picture and understanding of the connectivity of the storm system on both public and private properties to raise the awareness of the need for regular maintenance. These reports identify potential priority projects in the study areas and provide information necessary to develop a SWMP. The highlighted projects can be completed separately or in conjunction with the development of a stormwater master plan.

Projects identified as high priority in the stormwater mapping reports may be implemented by towns with the aid of Regional Planning Commissions or other partners where necessary. Towns with significant development should consider developing a SWMP, while a multi-town stormwater masterplan can be developed for smaller towns. SWMPs have been completed for Arlington, Sandgate, Rupert, Shaftsbury, and Sunderland in Basin 1. In Basin 1, Manchester and Bennington are recommended to complete a SWMP using the stormwater mapping reports for reference. The remaining 5 towns that had projects identified in stormwater mapping reports are recommended for single project implementation (Table 9). These towns should determine which projects they can pursue and move towards completing single or batch preliminary designs for those projects identified in Basin 1.

Table 9. Towns with completed stormwater mapping plans/reports ranked by number of high priority projects identified in the mapping report. Click on the town to link to report.

Town Name*	Year Completed	Recommendations for Implementation	High Priority Projects Identified (#)	
			Highest	High
Arlington	2019	SWMP	6	11
Bennington Area	2015	Single projects	4	NA
N. Bennington	2018	Single projects	1	NA
Dorset	2018	Single projects	3	NA
Manchester	2018	SWMP to be completed in 2022	7	5
Pownal	2018	Single projects	3	1
Rupert	2015	SWMP	5	0

Town Name*	Year Completed	Recommendations for Implementation	High Priority Projects Identified (#)	
			Highest	High
Sandgate	2017	SWMP	5	0
Shaftsbury	2019	SWMP	5	0
Stamford	2018	Single projects	1	0
Sunderland	2017	SWMP	5	0
Woodford	2018	Single projects	1	1

*Towns with mapping that do not have stormwater infrastructure in Basin 1 were not included. **SWMP** = Stormwater Master Plan.

The Vermont Green Infrastructure Toolkit is a clearinghouse of information useful to Vermont municipalities to explore how to promote the adoption of Green Infrastructure policies and practices to combat the problems caused by urban, suburban, and rural stormwater runoff.

Illicit Discharge Detection & Elimination Studies

In 2000, the VT Legislature required DEC to implement a statewide program to promote detection and elimination of improper or illegal connections and discharges. Illicit discharges are discharges of wastewater or industrial process water into a stormwater-only drainage system. Eight towns and villages in Basin 1 participated in this project, including Arlington, Dorset, Manchester, Pownal, Shaftsbury, Stamford, Sunderland, and Woodford, as well as Bennington College. The outcomes of these IDDE studies are listed in following report:

- Detecting and Eliminating Illicit Discharges in Basin 1 and Basin 12: Final Report (2020) and
- Bennington and Pawlet IDDE Study- Final Report (2016)

In Basin 1, suspected illicit discharges were found in Arlington, Manchester, Pownal, Readsboro, Shaftsbury, Sunderland, and at Bennington College.

The DEC and local conservation partners are working together to set watershed specific priorities that are consistent with the VWQS. In order to coordinate stormwater related water quality improvement efforts identified through the basin planning process, the Bennington County Regional Commission (BCRC) and the BCCD have taken the lead by working closely with local communities. Examples of stormwater strategies to improve water quality include:

- Identify towns in need of SWMPs/reports.
- Support funding of stormwater practice implementation.
- Implement high priority practices from municipal SWMPs. See VDEC's Stormwater Infrastructure Mapping directory.

- Identify and correct potentially errant connections identified by IDDE assessment.

Click the following hyperlink to view strategies to address Stormwater pollution.

Roads

It is estimated that more than 75% of Vermont roads were constructed prior to any requirements for managing stormwater runoff (Otter Creek Basin plan, 2012). Where road networks intersect stream networks, roads and their ditches effectively serve as an extension of the stream network (Wemple et al., 1996). Runoff from roads can increase stormwater runoff and, in this basin unpaved roads are an important source of sediment to receiving waterbodies. Roads can also impinge on stream floodplains and be a barrier to aquatic organism passage (AOP) with undersized culverts. In Basin 1, road runoff likely results in sediment, phosphorus, and chloride loading to adjacent waterbodies, e.g., Big Pond, Ladd Brook, the Batten Kill, and Munson Brook.

This section integrates basin-specific information on road-related water resource impairments, regulatory programs such as the Municipal Roads General Permit (MRGP), existing implementation efforts, and partnerships to inform strategies to address road-related water resource concerns. Tactical basin planning engages local, regional, and federal partners needed to accelerate transportation-related practice implementation in the development of these strategies in order to meet the state's clean water goals. The following details information about regulatory programs including the Transportation Separate Storm Sewer System Permit (TS4) and the MRGP as they are the driving road water quality implementation efforts in the basin.

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

The Transportation Separate Storm Sewer System (TS4) General Permit covers stormwater discharges from all VTrans owned or controlled impervious surfaces. The TS4 general permit combines the stormwater requirements for VTrans associated with its designated regulated small municipal separate storm sewer systems (MS4s), industrial activities, commonly regulated under the Multi-Sector General Permit (MSGP), and previously permitted, new, redeveloped, and expanded impervious surface, commonly regulated under State Operational Stormwater permits. The permit also requires VTrans to reduce the discharge of pollutants from the TS4 to the maximum extent practicable through compliance with the six minimum control measure requirements throughout the entire state.

Municipal Roads General Permit

Road Erosion Inventories

Road Erosion Inventories (REI) are used by Vermont municipalities to:

- identify sections of local roads in need of sediment and erosion control,

- rank road segments that pose the highest risks to surface waters, and
- estimate costs to remediate those sites using required practices such as: road crowning, lowering of road shoulders, grass- and stone-line ditching, and upgrading driveways, drainages, and intermittent stream culverts.

REI's of municipal roads are required by the MRGP as part of the Road Stormwater Management Plan. The MRGP is intended to achieve significant reductions in stormwater-related erosion from municipal roads, both paved and unpaved. MRGP practices disconnect and infiltrate road stormwater into vegetated areas before entering waterways. Where disconnection and infiltration are not possible, practices focus on stabilizing conveyances. The MRGP also requires any bare soils within municipal connected segments to be stabilized with vegetation and or stone-lining within 5 days of disturbance.

Towns are required to bring 15% of connected segments scoring *Partially Meeting* or *Not Meeting* to the MRGP standards or *Fully Meeting* status by December 31, 2022. *Very High Priority* connected segments will have to meet standards by December 31, 2025, for all road types, except for Class 4 roads, which will have to meet standards by December 31, 2028. All *Partially* and *Not Meeting* scoring segments are required to meet standards by December 2036. Towns will report and manage their implementation progress annually via the MRGP Implementation Table Portal database. The permit is required by the VT Clean Water Act (Act 64).

Upgrading high priority connected segments identified in REIs to meet the MRGP standards will reduce sediment, phosphorus, road salt and other pollutants associated with stormwater-related erosion generated from unpaved municipal roads that contribute to water quality degradation. The inventories are conducted for "hydrologically-connected roads". Hydrologically connected roads are those municipal roads within 100' of or that bisect a wetland, lake, pond, perennial or intermittent stream or a municipal road that drains to one of these water resources. These road segments can be viewed using the "Municipal Road Theme" on the ANR Natural Resource Atlas and REI results by town can be view in the MRGP Implementation Table.

All Basin 1 towns have completed municipal REIs. This plan recommends that technical and financial assistance be prioritized for interested towns based on the water quality benefit of a project. Road segments that *Do Not Meet* and *Partially Meet* standards and are in sub-basins with impairments related to road stormwater runoff are water quality priorities, e.g., the tributaries of the Batten Kill and along the Walloomsac River (Figure 16). Resources available from the Clean Water Fund (e.g., VTrans Grant-in-Aid and Better Roads grants) assist with development of designs, capital budgets, cost estimates, and implementation of road projects. Completion of these projects that bring connected roads up to the MRGP standards may be counted towards meeting the requirements of the MRGP. Additionally, the DEC has made available funding for small equipment purchases to assist municipalities in implementing required road standards, through its Small Equipment Grant. Funding for types of equipment include small hydroseeders, hay bale shredders, roller-compactors,

plate compactors, and shoulder discs. For additional information see the DEC Municipal Roads Program.

The DEC and the Agency of Digital Services have developed a new REI template to assess private roads. The private roads REI tools include Survey 123 assessment forms and Collector Mapping applications for field data collection. Private roads are segmented into 100 meter lengths with unique identification numbers for geo-location purposes and to determine hydrologic connectivity, or proximity to water resources. Private roads will be inventoried to determine if DEC's recommended road best management practices are in place for each road segment and document areas of erosion. Field collected data are then imported to the private roads database portal where road segments are prioritized for water quality remediation projects. This plan recommends that technical and financial assistance be prioritized for interested landowners and watershed partners based on the water quality benefit of a project. Road segments that require remediation and are in sub-basins with impairments related to road stormwater runoff are water quality priorities, e.g., the tributaries of the Batten Kill and along the Walloomsac River.

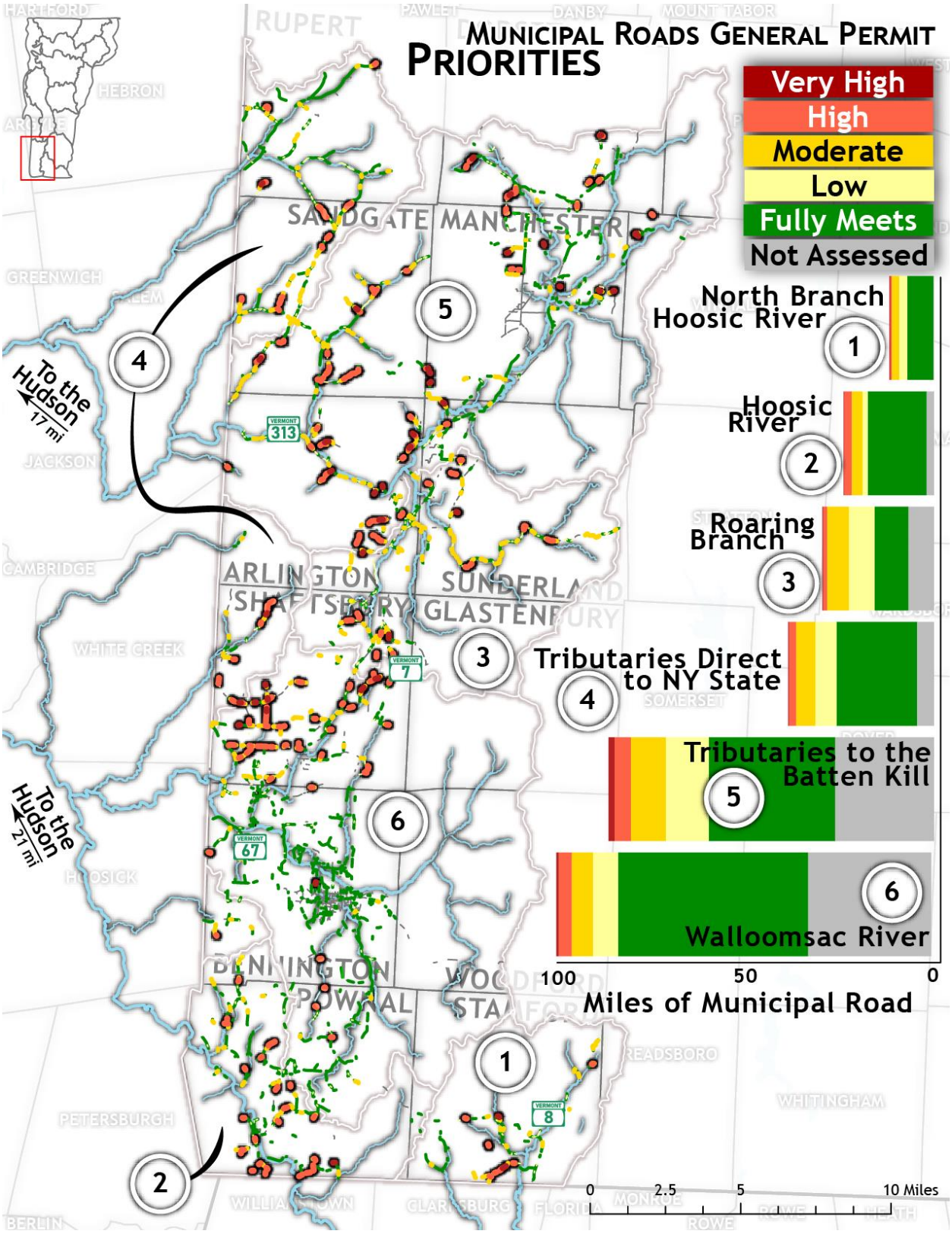


Figure 16. Basin 1 project priority for roads based on REI's as part of the Municipal Road General Permit as of March 2021.

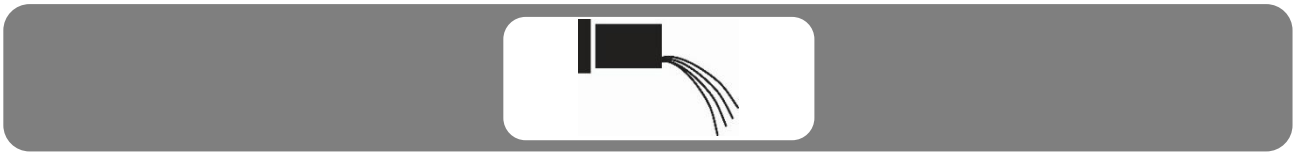
Local planning efforts are enhanced through tactical basin planning grant agreements, which fund the BCRC and BCCD to provide support to towns. The BCRC natural resource and transportation committee(s) also provide technical support training to assist towns with the MRGP requirements, assistance prioritizing road BMPs, help for towns developing Capital Improvement Plan (CIP) budgets, and applying for funding to implement projects.

In addition to the MRGP, towns can voluntarily adopt the most current version of the Vermont Road and Bridge Standards. These standards are administered by VTrans and go above and beyond MRGP standards. For example, municipalities may adopt MRGP standards for non-hydrologically connected roads. Towns adopting the Vermont Road and Bridge Standards, may be entitled to higher cost share rates in federally declared flood event reimbursements.

Managing for road runoff in upper watershed areas will reduce the pressure on the areas receiving larger contributions of runoff. Lack of good management in the upper parts of the watersheds can often be the cause of water quality issues further downstream because of cumulative impacts. For this reason, road BMPs for water quality are recommended basin wide. Examples of road strategies to improve water quality include:

- Prioritize technical and financial assistance to interested towns, landowners, and watershed partners based on the water quality benefit of a project targeting *Very High* and *High* priority segments,
- Conduct outreach on REIs for private roads and driveway BMPs,
- Implement projects on *Very High* Priority Class 4 roads, and legal trails.

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



C. Wastewater

Wastewater Treatment Facilities (WWTF)

The Basin 1 municipal wastewater treatment facilities in Bennington, Manchester, and Pownal are subject to State of VT issued NPDES discharge permits (Table 10). As part of a necessary refinement of the facility-specific phosphorus wasteload allocations, the WSMD is conducting an extensive sampling effort to document the current loading conditions for phosphorus and determine the "reasonable potential" of WWTFs to cause or contribute to downstream water quality impairment. Results of these investigations are recorded as part of permit issuance documentation.

Certain permit conditions for the below facilities are aimed at further clarifying the discharges' impact on the water quality of the receiving waters by requiring instream monitoring.

Table 10. Basin 1 WWTFs and other facilities subject to NPDES Direct Discharge Permits.

Facility (permit ID)	Permit effective date	Permit expiration date	Permitted flow (MGD)	IWC* 7Q10 /LMM	Current Percent of Design Flow (2014-2019)	Treatment type	# of CSOs	Receiving water
Arlington School District (3-1372)	5/2/2014	3/31/2019	0.018	0.005/0.002	32%	Rotating Biological Contactor (RBC) with UV disinfection	0	Warm Brook
Bennington WWTF (3-1261)	11/29/2011	9/30/2016	0.137	0.010/0.004	64%	RBC with chlorine disinfection	0	Walloomsac River
Manchester WWTF (3-1153)	11/1/2018	9/30/2023	0.600	0.046/0.024	47%	Secondary/ lagoon with chlorine disinfection	0	Batten Kill
Pownal WWTF (3-1493)	4/1/2018	3/31/2023	0.260	0.005/0.002	29%	Sequencing batch reactor with UV disinfection	0	Hoosic River

* Instream Waste Concentration (IWC) – 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

Arlington School District

The Arlington School District operates the Arlington School WWTF. The WWTF receives wastewater from an elementary school, a high school, an administrative building, a library, and a day-care. The treatment system consists of septic tanks located at the elementary school and high school for primary solids settling prior to flowing into the RBC for treatment, disinfection, and discharge to Warm Brook. Discharge is continuous during the school year. During the summer months however,

the discharge is significantly less and can be intermittent since school is not in session and the flow into the system is significantly reduced.

Bennington

The facility was upgraded from primary treatment in 1985 and consists of two primary settling tanks, four trains of rotating biological contactors (RBCs), and secondary clarification followed by chlorine disinfection and de-chlorination. Due to water quality considerations, the facility also has a sand filtration system that is operated in the summer months to meet effluent limits. Discharge permit conditions require upstream and downstream nutrient and biomonitoring in the Walloomsac River to assess the impact of the discharge.

Manchester

The Manchester WWTF was initially constructed in 1979 and currently provides secondary treatment of wastewater and consists of a two-cell lagoon system followed by chlorine disinfection and de-chlorination. A 20-year engineering evaluation was completed in 1999. Because of reportedly mild nutrient enrichment observed below the discharge to the Batten Kill, permit conditions require upstream and downstream nutrient and biological assessments.

Pownal

The Pownal WWTF consists of sequential batch reactor technology with ultraviolet disinfection prior to discharge to the Hoosic River. Due to the capacity of the UV disinfection system in attaining only a consistent *E. coli* concentration of 160 colonies/100 mls rather than the customary 77 colonies/100mls, a mixing zone of 200 feet from the outfall was established for *E. coli* in the Hoosic River. From a public health perspective, it was determined that there was less risk associated with the *E. coli* mixing zone than from toxicity risk to aquatic biota and human health of chlorinated compounds by using chlorine disinfection.

Wastewater Project Outcomes in Basin 1

The town of Bennington was funded from 2017-2019 to complete designs and construction for a WWTF and wastewater collection system refurbishment. More information about the Basin 01 wastewater investments can be found in Appendix A of the 2020 Clean Water Performance Report.

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

Septic Systems

The State of Vermont adopted, on July 1, 2007, universal jurisdiction over the design, permitting, and installation of all new wastewater systems and potable water supplies including septic systems. All new wastewater systems and potable water supplies need to obtain a Wastewater System and Potable Water Supply Permit for activities such as: subdivision of land; construction of a new

building that needs a wastewater system (often referred to as sewage disposal or a septic system) or water supply; and repair and/or replacement of a failed wastewater system or water supply. Wastewater systems that have wastewater surfacing, backing up into the building or discharging to the waters of the State are considered failed systems. A permit is also required when there is an existing wastewater system and/or potable water supply but there will be an increase in water or wastewater design flows due to either a modification to, or a change in use of, a connected building.

Systems installed before July 1, 2007 and systems installed or receiving increased flows after 2007 that did not receive a permit could potentially discharge into surface waters if the system was not installed correctly and is located in close proximity to a river, lake, or wetland. Failed or poorly functioning systems can contribute *E. coli*, phosphorus, or nitrogen to surface waters. Failed systems that discharge pollutants into surface waters are difficult to identify without landowner permission and there is no current regulatory tool that requires inspections of pre- or post-2007 wastewater systems on a regular basis unless specified in their permit. If a citizen observes signs of a failed septic system, they should contact their Town Health Officer. There are programs that provide financial assistance to qualifying homeowners that need to upgrade their systems, but costly upgrades prevent many homeowners from upgrading their systems.

Septic Socials

Failing septic systems pose a particular threat to water quality when they are adjacent to a waterbody. For example, many camps along lakeshores were built before July 1, 2007, and were built for seasonal occupancy. If a lake is experiencing an increase in nutrients or *E. coli*, it is often difficult to pinpoint the exact source(s). Septic systems may be a source and one way to inform landowners about the health of their systems is to host a septic social. Septic socials are neighborhood gatherings where a septic system specialist discusses operation and maintenance of septic systems, maintenance practices, and the importance of water quality protection. Septic socials are best for areas with old septic systems that may be affecting water quality, e.g., lakes with old camps or buildings built for seasonal use that are now seeing activity year-round. Septic socials can also be held in riverbank communities. Areas in Basin 1 that would benefit from septic socials are all the larger populated lakes including Lake Paran and Big Pond, but other interested lake communities are encouraged to participate. More information about septic socials can be found here.

Click the following hyperlink to view summary strategies to address Septic Systems.

D. Natural Resources

Rivers

Most VT rivers, in response to historic intensive channel management, floodplain and riparian corridor encroachments, and watershed land use change, are actively adjusting their shape, size, and course as they seek to re-establish equilibrium (i.e., balance). Human activities can prevent or disrupt this balance by changing flow inputs to the channel (e.g., deforestation, increasing impervious surfaces and runoff, or water withdrawals) or by changing the sediment regime (e.g., dams, dredging). In Basin 1, development within riparian corridors, channel straightening, berming, damming, removal of riparian vegetation, and logging have contributed to stream instability. A key consequence of these activities is the loss of the resilience and ecosystem services provided by rivers able to fully achieve dynamic equilibrium.

This section includes basin specific information on how to encourage river equilibrium by improving longitudinal, lateral, vertical, and temporal connectivity. Equilibrium is essential for good water quality, healthy aquatic habitat, and flood resilience in the basin and will help to mitigate impacts of increased runoff and streamflow described in the Climate Change section. Tactical basin planning engages local, regional, and federal partners in the development of strategies needed to accelerate practices to increase river connectivity and meet the state's clean water goals. The following details information about river corridor plans (RCP) and planting projects, strategic wood additions, AOP restoration, and community efforts to regulate floodplain and river corridor development, which together guide project implementation in the basin to increase river connectivity.

River Corridor Plans

A RCP is a synthesis of the physical data collected during Phase I and II SGAs based on protocols and guidelines developed by the Vermont River Management Program. These plans identify causes of channel instability and make recommendations for restoration. All SGAs and RCPs can be found here. Where funding, local support, and interest exists, priority projects and objectives identified in these plans for the Batten Kill, Walloomsac, and Hoosic Rivers and their tributaries watersheds should be pursued.

While water quality in Basin 1 is satisfactory, the degraded geomorphic condition (Figure 8) of the basin's streams may impact:

1. wildlife and fish habitat (e.g., riparian buffer removal that reduces shading and habitat for insects that feed fish, and channel alteration that destroys aquatic habitat),

2. public safety (e.g., loss of floodplains that store floodwaters, accelerated streambank erosion which results in infrastructure damage, and channel straightening that increases flow velocity during rain events), and

3. water quality (e.g., higher *E. coli* populations caused by increased fine sediment resuspension and bank soil erosion, and nutrient and chemical runoff from encroachment of impervious surfaces and agricultural land).

Additional project development is occurring among watershed groups in Basin 1 to advance restoration of floodplain access and stream stability. Projects such as floodplain excavation, berm removal, channel restoration, and/or river corridor easements are being pursued where feasible. These projects will be key to restoring stream stability and water quality, especially in sub-watersheds where nutrient and/or sediment impairment is of concern.

Dam removals are another project type identified in RCPs that are being implemented in the basin. The 2013 removal of the Dufresne Dam by ANR resulted in the VT portion of the Batten Kill being undammed. This project restored ≈ 2,192 feet of channel to free-flowing river habitat. There are ≈ 49 dams of different types, sizes, and condition in Basin 1. While dams are used to generate energy and recreational opportunities such as boating, fishing, and swimming, they can also:

- impede a stream's ability to transport flow and sediment;
- cause streambank erosion and flooding problems;
- degrade and alter fisheries habitat;
- create barriers to fish movement and migration;
- alter downstream temperature;
- degrade water quality; and
- impede river-based recreational activity.

Of the 49 inventoried dams, 39 are in service, 2 are fully breached, 5 are partially breached, 1 is drained, and 2 are not in use. The 39 in service and 5 partially breached dams constrict the stream channel enough to reduce sediment transport, prevent lateral movement, and inhibit AOP. A detailed list of known non-historic dams in the basin can be found in Table B1. In this plan, the removal of two small dams and associated waterworks located on Broad Brook, in the headwaters of the Hoosic River in Pownal, is currently underway. Trout Unlimited, BCRC, BCCD, and the USFS have secured National Fish and Wildlife Foundation (NFWF) funding to complete a topographic survey and feasibility study for removal project. More information about dams in Basin 1 can be found in Appendix B.

Aquatic Organism Passage and Geomorphic Compatibility

Undersized or poorly installed culverts can increase sediment loading and pose a risk to public health when they fail or act as a barrier to sediment movement, which causes erosion downstream of the structure. Culverts can also act as a barrier to AOP, which can negatively affect fish and other species that need to move to gain access to colder water habitats, feeding and spawning locations, and for natural dispersal. The FWD have completed ANR Bridge and Culvert assessments of most culverts in Basin 1. The ANR developed a bridge and culvert assessment and screening tool to identify infrastructure in need of replacement or retrofit to restore AOP (Figure 17) or address geomorphic issues (Figure 18). In addition, a guide for Implementing AOP Enhancement Projects

in Vermont (Kirn, 2016) is available, and a culvert mapping tool has been developed by the WSMD MAP assessment program and can be viewed at http://arcg.is/19eqSD0.

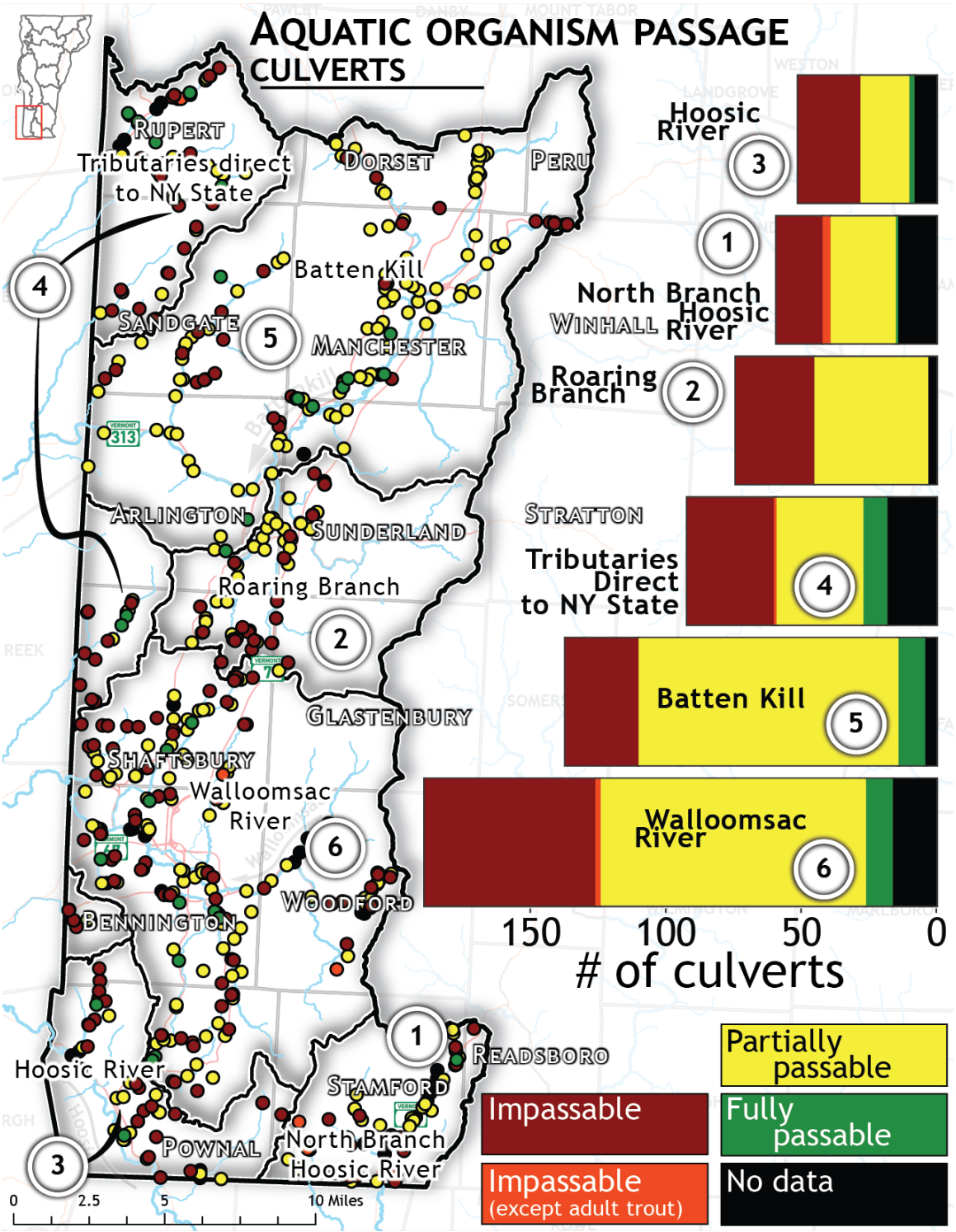


Figure 17. AOP assessment results for Basin 1 bridges and culverts.

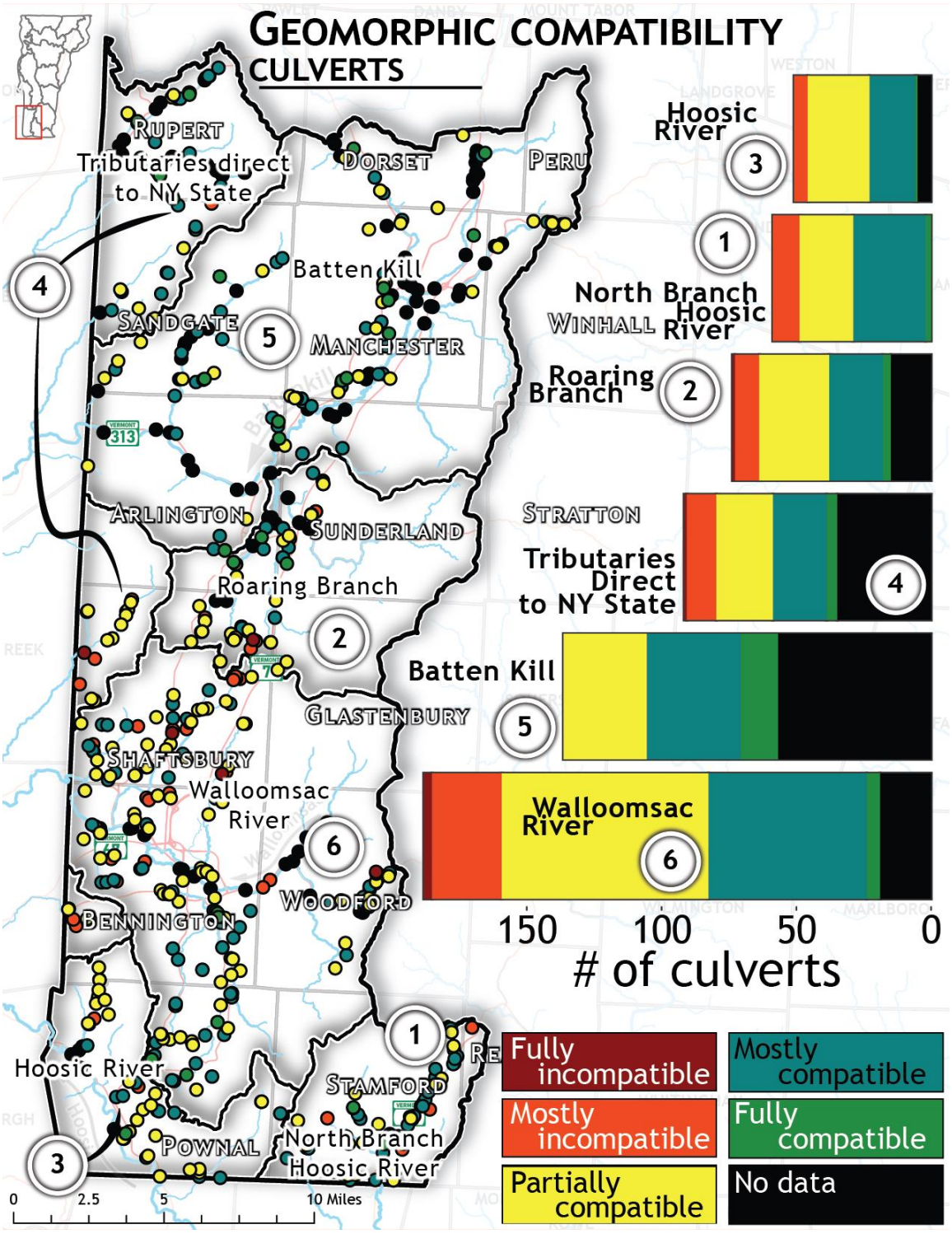


Figure 18. Geomorphic compatibility assessment of Basin 1 bridges and culverts.

In Basin 1, AOP of 539 bridges and culverts was assessed. Ninety-four percent have reduced AOP, 1.1% are passable only by adult trout, and 35% are impassable. As little as 6% provide full AOP.

Areas with the most impassable culverts are the Walloomsac River and tributaries to NY sub-watersheds.

An assessment of geomorphic compatibility of Basin 1 bridges and culverts show just 6% are fully compatible, 38% are mostly compatible, 42% partially compatible, and 14% are mostly or fully incompatible. The Walloomsac River sub-watershed has the most culverts with low geomorphic compatibility. A geomorphically incompatible structure is fully incompatible with the river channel and has a high risk of failure. Re-design and replacement should be performed as soon as possible to improve geomorphic compatibility.

For Basin 1, it is a priority to provide this information to towns as part of the road inventory and capital budget process and to assist in identifying grant funding to address the most significant AOP and geomorphically incompatible structures. These screening tools are a desktop analysis used to flag incompatible culverts and bridges that are candidates for replacement or retrofit to restore AOP or address geomorphic issues. Follow-up field visits are needed to fully assess their condition along with coordination with road commissioners to match town priorities with potential funding.

Riparian Area Planting Projects

Scientific research strongly supports the value of planting trees and shrubs along river and lake shorelines for both water quality and wildlife habitat (Figure 19). Shoreline vegetation filters and polluted runoff from uphill land uses, provides shoreland and shallow water habitat, stabilizes banks, and increases lake and river aesthetics. New research also indicates that streams in the lower, flatter reaches of the watershed are more likely to release carbon dioxide as a biproduct of ecosystem respiration when temperatures in streams rise compared to streams in steep watersheds (Jankowski & Schindler, 2019). Reducing soil erosion to streams by capturing stormwater and stabilizing soils and increasing riparian buffers (vegetation

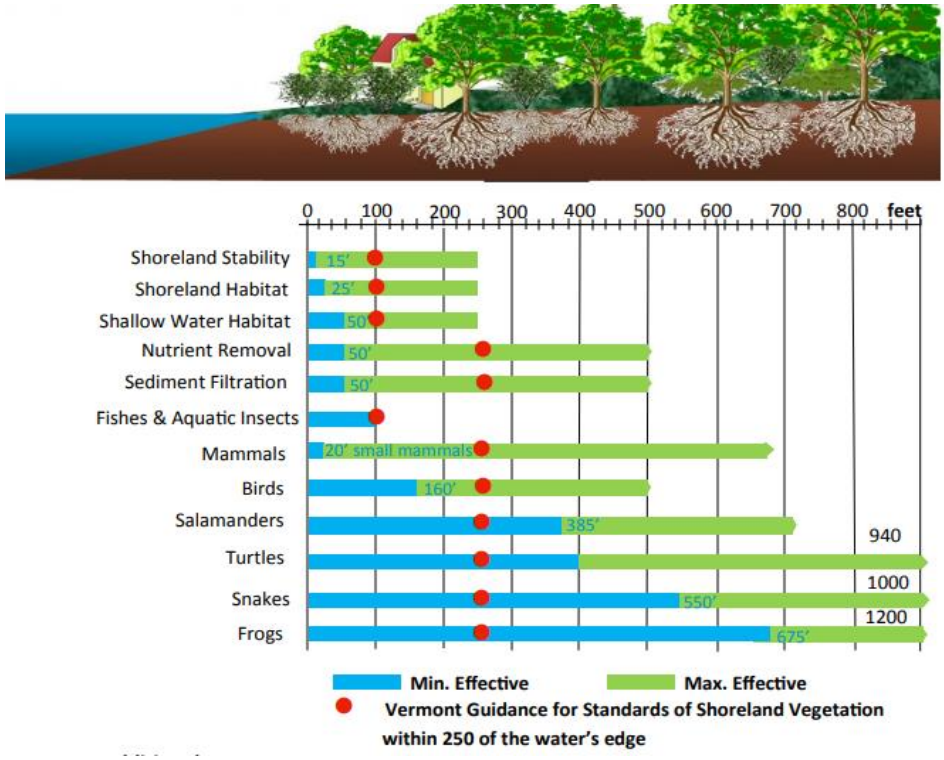


Figure 19. Recommended widths of shoreline vegetation for protection.

Source: https://dec.vermont.gov/sites/dec/files/wsm/lakes/Lakewise/docs/lp_shorewidth.pdf

along shorelines) on low elevation streams may help to mitigate temperature increases and their impact on the carbon cycle.

Most riparian area planting projects in the basin are coordinated and carried out by the BCRC, BCCD, BKWA, and TU. During SFY 2016 to 2020, partners restored 266 acres of forested riparian buffer through buffer planting using state and federal funding. Much of the planting occurred along the mainstem of the Batten Kill, Mill Brook, and White Creek. The BCCD manages the Trees for Streams Program and works with watershed partners and private landowners to plant riparian buffers to enhance riverbank stability and water quality. There remains a need to restore floodplain forests and forested riparian buffers, as well as to protect river corridors along many sections of the Batten Kill and its tributaries. These restoration projects are a priority in this plan as they restore fish and wildlife habitat, provide shading, reduce river temperatures, stabilize riverbanks, and reduce channel migration, and reduce sediment and nutrient loading to receiving waters.

Strategic Wood Addition to Rivers and Streams

Adding large woody material to rivers has many benefits such as increasing fish production, stream stability (Gurnell, 2002), (Camporeale, 2013), channel roughness (Comiti, 2008), and floodplain access (Jeffries, 2003) (Sear, 2010). Wood structures also help reduce nutrients downstream through sediment storage (Gurnell, 2002), (Davidson, 2013) and nutrient processing (Roberts, 2007), (Krause, 2014). In this age of increasing flood frequency and severity, restoring large wood loading to upland streams can benefit not only the aquatic organisms, but also humans living downstream. Large wood can improve floodplain connection in headwater areas, thereby providing a key ecosystem service by reducing flood impacts downstream through flood storage and sediment retention.

A focus of this plan is on the implementation of strategic wood additions for fishery stream health. Large woody material provides several fish habitat and fluvial benefits in streams, but it is generally lacking in many VT streams due to past and present river management practices to accommodate land used for logging, agriculture, and urban and residential development. Large wood has been strategically added to the Batten Kill and on streams in the Green Mountain National Forest, where it has improved Brook Trout habitat and fluvial functions. In 2021, TU is coordinating with TNC to implement strategic wood additions in 0.75 miles of the headwaters of Munson Brook and up to 1.25 miles in Mill Brook. An additional 5 miles of aquatic habitat assessments on TNC-owned properties in the Batten Kill watershed are planned to determine wood addition projects for 2022.

Flood Hazard Mitigation and Resiliency

Functioning floodplains allow floodwaters to spread out and slow down and are areas where communities can protect water resources and increase community flood resilience. Municipalities can either adopt stand-alone flood hazard and river corridor regulations or include them in local zoning bylaws. Flood hazard area regulations that meet or exceed federal minimum standards also allow a community to participate in the National Flood Insurance Program (NFIP), which is

administered by FEMA and makes flood insurance available to residents. Current Flood Insurance Rate Maps for communities in the basin are posted at www.msc.fema.gov. In Basin 1, 13 of the 15 towns participate in the NFIP program (Table C1). While the minimum NFIP standards provide some protection for new development, these standards have not been enough to prevent significant flood damages in VT, especially in relation to fluvial erosion, nor have they been adequate for protection of water quality from stressors associated with increased development encroachment. Higher than minimum standards vary by community, but typically include: avoiding new building in hazardous areas, limiting fill or other changes that may displace floodwater, and siting development back from the stream to preserve space for stream channels to move and change over time.

Act 16 (2014) requires that municipal and regional plans incorporate a "flood resilience" component. Resiliency means proactively reducing vulnerabilities to flooding and flood damage and improving response and recovery efforts to flood events, so communities recover quickly and minimize long-term economic, social, and natural resource impacts. Flood hazard maps help communities identify local flood hazard areas and specific areas that warrant protection as they provide important ecosystem services such as slowing down or attenuating floodwaters (e.g., floodplains, river corridors, forests, and wetlands). ANR is providing technical resources and financial assistance to make flood resiliency an integral part of town planning including river corridor maps and model language for town plans. The towns of Manchester, Manchester Village, Sunderland, and Stamford are the only towns in Basin 1 that have adopted river corridors into their flood hazard bylaws.

Financial incentives for municipalities have been established in accordance with the requirements of 10 V.S.A. §§ 1427 and 1428 for the adoption and implementation of municipal zoning bylaws that protect and preserve river corridors, shorelands, and buffers. Communities become eligible for financial incentives for river corridor and floodplain protection based on a rating system that considers a suite of mitigation activities including the implementation of Standard River Management Practices. Emergency Relief and Assistance (ERAF) rules now recognize towns that have increased river corridor and floodplain protection and provide an increased state cost share for emergency relief funding.

ERAF provides State funding to match Federal Public Assistance after federally-declared disasters. Eligible public costs are reimbursed by federal taxpayers at 75%. For disasters after 2014, the State of Vermont will contribute an additional 7.5% toward the costs leaving the municipal share of 17.5%. For communities that take specific steps to reduce flood damage, the State's contribution will increase to 12.5% or 17.5% of the total cost.

The four mitigation measures towns must have in place to receive 12.5%:

1. National Flood Insurance Program (NFIP) – participate in or have applied to;
2. Town Road and Bridge Standards – annually certify adopted standards that meet or exceed the standards in the most current VTrans Orange Book: Handbook for Local Officials;
3. Local Emergency Operations Plan (LEOP) – adopted annually after town meeting;

4. Local Hazard Mitigation Plan - adopt a FEMA-approved local plan (valid for five years).

To receive 17.5% - eligible communities also must:

5. Protect River Corridors from new encroachment or protect flood hazard areas from new encroachments and participate in the FEMA Community Rating System.

After a declared disaster, the damage to public infrastructure including roads and culverts can exceed a million dollars. Adoption of these resiliency measures can mean significant savings for municipal taxpayers.

As of March 2021, Manchester and Bennington have completed this process and qualify for the 17.5% contribution. Dorset qualifies for the 12.5% contribution and the remaining towns remain at the 7.5% rate. Towns with high development pressure, significant impervious surface cover including roads, and significant development within proximity to water resources are a high priority for protection, as well as those areas with deficiencies related to their protective policies, zoning, or bylaws. A list of towns in and existing natural resource protection regulations is available in Appendix C.

Tactical basin planning support grants (TBPSG) provide funding to statutory partners (i.e., RPCs) to help communities in becoming more flood resilient. Information about municipal flood resilience planning efforts is available online. Questions regarding the flood hazard bylaws or flood resilience planning should be directed to the appropriate DEC Regional Floodplain Manager. Examples of strategies to mitigate municipal flood hazards and improve flood resilience include:

- Assist municipalities in adopting floodplain and river corridor protections to achieve greater ERAF funding levels,
- Assist municipalities to complete Hazard Mitigation Plans and Emergency Management Plans,
- Limit development on steep slopes, ridgelines, and landslide hazard areas to protect high quality water resources and prevent excessive erosion and sedimentation to receiving waters.

Click the following hyperlink to view strategies to address issues related to Rivers.

Lakes

The recommendations below were developed based on the VT Inland Lakes Scorecard status of lakes and ponds in Basin 1. More information about the VT Inland Lakes Scorecard and Basin 1 lakes and ponds is found in Condition of Lakes and Ponds section of Chapter 1.

Recommendations for Restoration

Effective July 1, 2014, the Vermont Legislature passed the Shoreland Protection Act (Chapter 49A of Title 10, §1441 et seq.), which regulates shoreland development within 250 feet of a lake's mean water level for all lakes greater than 10 acres in size. The intent of the Act is to prevent degradation of water quality in lakes, preserve habitat and natural stability of shorelines, and maintain the economic benefits of lakes and their shorelands. The Act seeks to balance good shoreland management and shoreland development.

Shoreland developed prior to July 1, 2014 is not required to retroactively meet standards. The Lake Wise Program, an ANR initiative that awards lake-friendly shoreland property, including that of state parks, town beaches, private homes and businesses, is available to lakeshore owners and Lake Associations to assess shoreland property for improvements that benefit water quality and wildlife habitat. Lakes with a fair shoreland score will benefit from implementing Lake Wise Program best management practices. More information on the program can be found here.

Big Pond in Woodford is the only lake in Basin 1 that has a *poor* shoreland condition score and thus, is a high priority for Lake Wise. The pond has a developed shoreline with numerous residences and camps as well as an being surrounded on all sides by roads. These land uses likely contribute to the significantly increasing spring TP trend and the significantly decreasing summer water clarity observed in recent years. In addition, LPP scientists have recorded very high chloride levels in the pond. Lake users interested in becoming involved in the health of their favorite lake or pond should use the Lake Score Card Checklist of Lake Protection Actions, on the DEC Lakes and Ponds website, as a first step to moving toward a healthier lake or pond.

Preventing Aquatic Invasive Species

Aquatic invasive species have been confirmed in two Basin 1 lakes, Lake Paran and Lake Shaftsbury. Both lakes are currently being monitored for AIS by the DEC LPP. South Stream in Pownal has not been surveyed, but has a boat access and therefore, is recommended as an addition to the AIS monitoring list.

Lakes with the highest risk potential for invasive species introduction should take preemptive measures to prevent spread. Those lakes and ponds with public access areas (Fish and Wildlife Accesses) are good sites to host spread prevention signage and materials, public greeters, and Vermont Invasive Patrollers (VIP). Lake Paran is a priority lake for AIS outreach. The lake has motorized boat access at the FWD Access Area and may wish to consider the VT Public Access Greeter Programs supported by DEC's Grant-in-aid. Greeters interact with boaters, inspect watercraft, identify any suspicious matter, collect and report data, and distribute educational material on aquatic invasive species. The Grant-in-aid Program is offered by DEC and provides financial assistance to municipalities and agencies of the state for aquatic invasive and nuisance species management programs. Funding for Grant-in-aid grants comes from a portion of annual revenues

from motorboat registration fees and federal funds. This grant program has supported over 70 municipalities since 1994.

Click the following hyperlink to view strategies to address issues related to Lakes.

Wetlands

Wetlands cover 4.5% of Basin 1 and are important for safeguarding the many high quality surface waters in the basin. As recently as the 1950s, wetlands were seen as obstacles to development, agriculture, and transportation, and consequently, were systematically drained and altered. These losses and alterations compromise the important ecosystem services provided by wetlands such as sediment and nutrient attenuation, wildlife habitat, and flood water storage. While protecting remaining wetland resources is an important strategy in the basin (see Ch. 2), restoring degraded wetlands is essential to improving water quality.

This section is organized around wetland conservation and restoration and identifying sites with the greatest potential for improving water quality.

Wetland Conservation and Restoration

The conservation and restoration of floodplain forests and wetlands, which effectively attenuate nonpoint source pollution, is important for improving water quality in the basin. Conservation of wetlands can prevent continued loss of remaining intact wetlands and restoration is essential for rehabilitating those that have already been degraded or lost. River Corridor Easements are used by the DEC and partner organizations to purchase channel management and development rights in the most sensitive and important areas along stream channels to encourage stream equilibrium, sediment and nutrient attenuation, and flood protection. Wetland conservation easements can be used in a similar way to protect and restore wetlands with significant function and values related to water quality, flood protection, climate change mitigation and wildlife habitat. This plan recommends that opportunities for wetland conservation be explored where water pollution reduction and flood protection is evident. Other clean water goals for wetland restoration include assessing restoration potential of prior converted wetlands and hydric soils and implementing restoration projects as sites and opportunities are identified. Recommendations for wetland protection and restoration can be found in Stream Geomorphic Assessments and River Corridor Plans. Examples of other priority actions in this plan include:

- Continue to pursue accurate wetland mapping and VRAM assessments of wetland resources, particularly in areas lacking data (e.g., Southern Green Mountains and the Taconic Mountains).
- Fully assess high quality wetlands for Class I designation.
- Support outreach to municipalities and landowners to gauge interest in supporting Class I designations.

- Provide technical support for parties interested in submitting petitions.
- Recommendations for wetlands restoration include: a disturbed clayplain in Bennington with abundant invasive species (VRAM = 28) and a recently-grazed wetland meadow along Basin Brook (VRAM = 38).

Click the following hyperlink to view summary strategies to address Wetland Restoration.

Forests

Forest lands cover 81.8% of Basin 1 and are important for safeguarding many high-quality surface waters in the basin. Management activities take place on a portion of those lands for the benefits of maintaining healthy forest communities, improving wildlife habitat, addressing non-native invasive plants, contributing to the working landscape economy, and addressing poorly designed legacy road infrastructure. Improving management and oversight of harvesting activities can help reduce sediment, nutrients, petroleum products, and woody debris that can end up in surface waters if Acceptable Management Practices (AMPs) are not followed. As the dominant land cover type in Basin 1, reducing runoff and erosion from forests is important to meeting the state's clean water goals.

This section is organized around the Vermont Department of Forest Parks and Recreation (DFPR) Acceptable Management Practices for Logging Jobs, Vermont Voluntary Harvesting Guidelines to protect forest health and Sustainability, local skidder bridge programs, and forest land conservation efforts.

Forestry AMPs and Skidder Bridge Programs

The DFPR updated the AMPs for Maintaining Water Quality on Logging Jobs in Vermont effective as of October 22, 2016. Vermont first adopted these rules 1987. The AMPs are intended and designed to prevent any mud, petroleum products, and woody debris 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 2019 manual can be downloaded from DFPR website.

Compliance with Vermont's Use Value Appraisal program (UVA) requires that the AMPs be employed to the maximum practicable extent. If the AMPs are not employed on UVA enrolled forestland, but no discharge occurs, it may affect UVA eligibility without presenting a water quality violation. However, if the AMPs are not employed to the maximum practicable extent on the UVA parcel resulting in a discharge, it may affect parcel eligibility in UVA and be a water quality violation. While there is overlap between requirements of the AMPs and UVA, they should be viewed as distinct from each other. Almost 50% of the State's forestland employs the AMPs as a requirement of the UVA program or because of state ownership (Figure 20). This does not mean that the other forestland areas are not employing the AMPs, but may be less likely to require AMPs on their property. The Batten Kill and Walloomsac sub-watersheds have the largest areas of forest lands that

are not under the UVA program in Basin 1. These areas are priority for outreach and education for AMPs and the UVA program.

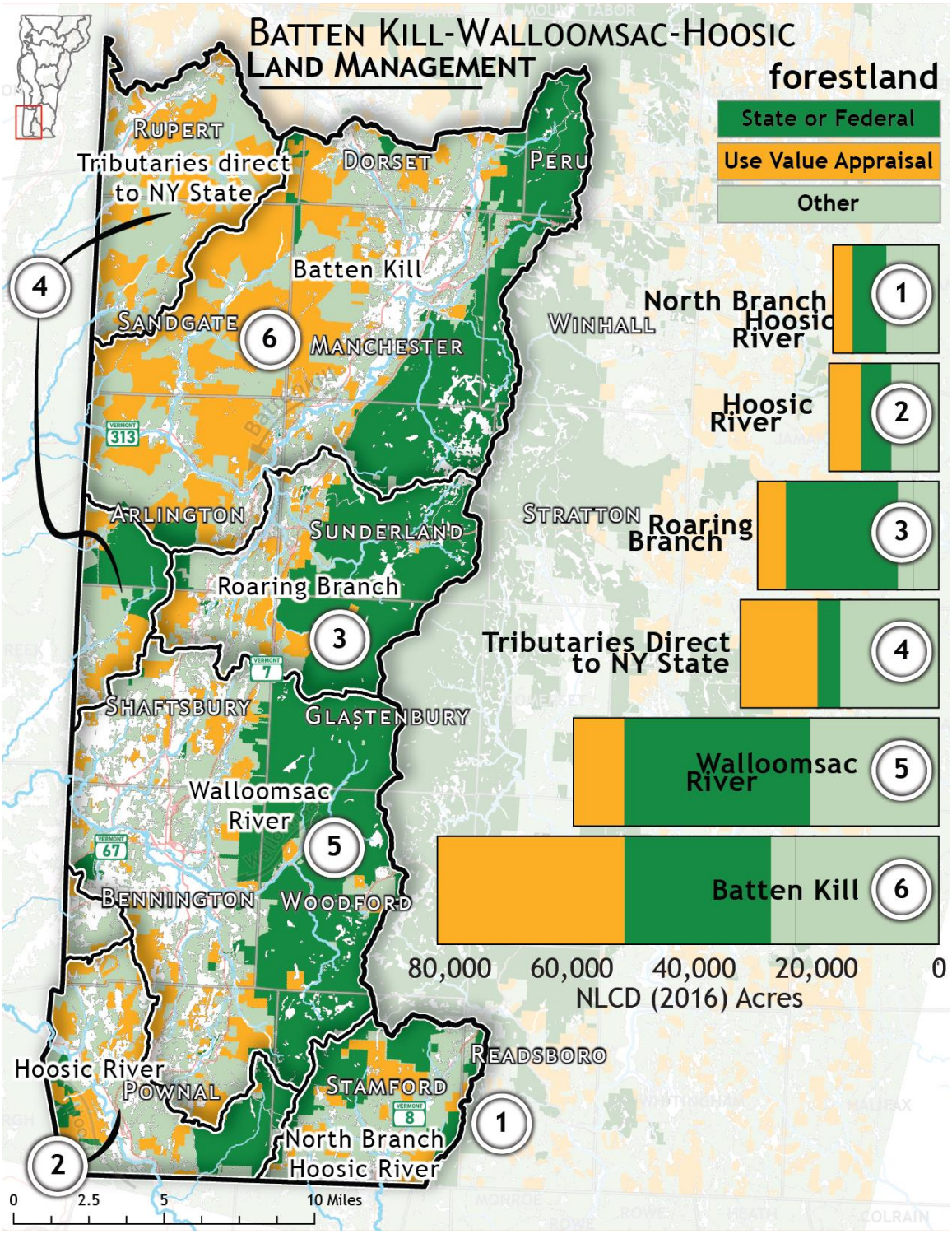


Figure 20. Forestland in Basin 1 represented by forestland management and ownership types. Note: The UVA category represents privately-owned lands.

The DFPR provides temporary portable skidder bridge rental opportunities for loggers during timber harvests. When properly installed, used, and removed, these bridges minimize stream bank and stream bed disturbance as compared with alternative devices, such as culverts or poled fords. Portable skidder bridges are also economical because they are reusable, easy to install, and can be transported from job to job. In addition, these bridges reduce the occurrence of sedimentation, channeling, and any degradation of aquatic habitat, while allowing loggers to harvest timber in compliance with the AMPs. More information on the bridge rental program can be found here.

In March 2018, the DFPR held a temporary skidder bridge lottery, and 12 loggers and logging companies were chosen to receive bridges that were constructed by Fontaine Millworks in East Montpelier. The DFPR will also be offering workshops for building bridges throughout the state. Specifications for building your own skidder bridge can be found here.

In addition to the AMP and skidder bridge rentals programs, AMP county foresters are available for consultation when questions arise about practices to protect water quality. Portions of the Walloomsac River, Roaring Branch, and the Batten Kill watersheds are in public land management by the DFPR, FWD, and USFS. DFPR has replaced and removed many of their stream crossing structures under forest roads to restore geomorphic condition of streams. DFPR is also collaborating with DEC on the development of a forest road stormwater inventory process to assess the condition of forest roads and recommend BMPs to prevent erosion of logging road infrastructure and sedimentation into streams.

The DFPR, the DEC, and partner organizations are offering training, technical assistance, outreach, and funding to maintain forest lands for water quality as well as many other benefits. Local planning efforts are enhanced through formal TBPSGs, which fund the RPCs, NRCDs, and watershed groups to provide support to Basin 1 towns. Examples of other priority actions in this plan include:

- Complete forest REIs on state lands in the basin and implement *Very High* and *High* priority projects,
- Provide outreach necessary to maximize the use of the bridges to improve water quality in the basin,
- Support outreach to private forestland owners, foresters, and loggers on AMPs and voluntary harvesting guidelines.

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

Chapter 5 – The Basin 1 Implementation Table

A. Progress in Basin 1

The Tactical Basin Plan addresses all impaired, stressed, and altered waters in the basin as well as protection needs for high quality waters. The list of strategies in the Implementation Table (Table 11) and the Monitoring and Assessment Table (Table 12) cover future assessment and monitoring needs, as well as projects that protect or restore waters and related education and outreach.

The Implementation Table lists 39 priority strategies created with the intention to be used as the go-to guide in the first step toward watershed action. A list of related individual project entries is found in the online Watershed Projects Database (WPD). The projects vary in level of priority based on the strategies outlined in the summary. All projects in WPD are not expected to be completed over the next five years, but each action in the summary is expected to be pursued and reported upon in the following plan and updated in the WPD.

As projects are developed, priority for CWIP funding will be given to those projects that achieve the highest water quality benefits. Additionally, projects that provide cumulative benefits (i.e., flood resiliency, water quality improvement, water resource protection, AOP) will receive additional consideration for prioritization.

The previous Basin 1 plan (2015) and identified 60 strategies to protect and restore surface waters. Of the 60 strategies identified, 11 are complete, 18 are ongoing, 12 are in progress, 15 are awaiting action, and 4 are discontinued (Figure 2). Sixty-eight percent of the strategies identified in the 2015 TBP are active or complete. The Basin 1 report card in Appendix A includes the 2015 list of strategies with detailed updates on progress.

The 2021 Basin 1 plan builds upon those original plan recommendations by promoting specific, geographically explicit projects in areas of the basin that have been identified for intervention, using environmental modeling and on-the-ground monitoring and assessment data where available.

B. Coordination of Watershed Partners

There are several partner organizations undertaking watershed monitoring, assessment, protection, restoration, and education and outreach projects in Basin 1. These partners are non-profit, private, state, and federal organizations working on both private and public lands. Partnerships are crucial in carrying out non-regulatory projects to improve water quality. Bennington County Conservation District (BCCD), Bennington County Regional Commission (BCRC), Trout Unlimited (TU), Batten Kill Conservancy (BKC), Batten Kill Watershed Alliance (BKWA), US Forest Service (USFS), Vermont River Conservancy (VRC), Vermont Land Trust (VLT), Native Fish Coalition (NFC), lake associations, and municipal groups including local conservation commissions are active in:

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

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

The large amount of work that is necessary to meet water quality targets in this basin require collaborations among all these groups to maximize the effectiveness of watershed partners. Without funding or partners, little of this work would be possible.

C. Basin 1 Implementation Table

The process for identifying priority strategies is the result of a comprehensive compilation and review of both internal ANR monitoring and assessment data and reports, and those of our watershed partner organizations. The monitoring and assessment reports include, but are not limited to, stormwater mapping reports, geomorphic assessments, river corridor plans, bridge and culvert assessments, Hazard Mitigation Plans, agricultural modeling and assessments, road erosion inventories, biological and chemical monitoring, lake assessments, fisheries assessments, and natural communities and biological diversity mapping.

A summary of priority strategies to address water quality in Basin 1 are identified in Table 11. The summary is the guiding list to go to as a first step for watershed action. The strategies can be linked to the on-going detailed list of projects in the online Watershed Projects Database.

The following tables serve to identify high priority implementation strategies and tasks that provide opportunities for all stakeholders in surface water management across each major river basin to pursue and secure technical and financial support for implementation. For these priorities to be achieved, partners and stakeholders must help to carry out the strategies identified in the basin plan.

The Implementation Table Summary (Table 11) provides a summary of strategies and actions to address water quality priorities by land use sector.

Table 11. Summary implementation strategies for the Basin 1 tactical basin plan. *See list of acronyms on page 90.

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
Strategies to address runoff from Agricultural Lands				
1. Support implementation of agricultural farmstead and field Best Management Practices (BMPs) in areas with known water quality issues.	Walloomsac River, Ladd Brook, Jewett Brook, Batten Kill mainstem and direct tributaries	Rupert, Manchester, Shaftsbury, Bennington, and Pownal	BCCD, AAFM, NRCS, UVM Extension	TBPSG, Ag-CWIP, CREP, EQIP, FAP
2. Provide education, outreach, and technical assistance for farmers about field BMPs such as: no till and cover cropping, nutrient application, crop rotation, and use of innovative equipment.	Walloomsac River, Tribs to NY	Bennington, Shaftsbury, Rupert, Arlington	BCCD in partnership with the Poultney Mettowee NRCD and Rutland County NRCDs (Southwest Regional Partnership), VAAFM, UVM Extension	Ag-CWIP, FAP
3. Continue the annual meeting of the VT Ag. water quality partnership with PMNRCD, BCCD, RNRCD for this basin.	Basin wide	All towns	BCCD (Southwest Regional Partnership), AAFM, NRCS, DEC WPP	TBPSG, Ag-CWIP
4. Coordinate with agricultural service providers to determine if there is a gap in outreach and implementation of water quality BMPs.	Basin wide, especially along the Walloomsac and Batten Kill	All Towns	BCCD (Southwest Regional Partnership), UVM ext., NRCS, AAFM	TBPSG, Ag-CWIP

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
5. Provide technical assistance in updating Nutrient Management Plans for existing farms including assistance with soil and manure sampling.	Walloomsac, Tribs to NY	Bennington, Shaftsbury, Rupert, Arlington	BCCD (Southwest Regional Partnership), UVM ext., NRCS	Ag-CWIP
6. Provide technical and financial support to farmers to acquire equipment necessary for effective implementation of BMPs such as cover cropping and no/min tillage.	Basin wide, especially along the Walloomsac and Batten Kill	All towns	BCCD (Southwest Regional Partnership), UVM ext., NRCS	Ag-CWIP, CEAP
7. Identify a process and priorities for including floodplain and wetland restoration projects as farms ownership changes or are conserved to support sustainability for the farm and maximize water quality benefits.	Basin wide, especially along the Walloomsac and Batten Kill	All towns	BCCD, UVM Ext., NRCS, VLT, DEC	ERP, CREP, EQIP, WRE
Strategies to address runoff from Developed Lands - Stormwater				
8. Work with watershed partners and municipalities to prioritize stormwater projects where SWMPs and Stormwater Mapping Reports have been completed.	Basin wide	Manchester, Arlington, Bennington, Rupert, Sandgate, Shaftsbury, Sunderland, Dorset, Pownal, Stamford, Woodford	DEC, BCCD, BCRC, Municipalities	CWI, TBPSG, Grant-in-Aid

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
9. Develop stormwater master plans.	Manchester, Bennington	Manchester, Bennington	BCCD, BCRC, DEC, Manchester, Bennington	CWI, TBPSG
Strategies to address runoff from Developed Lands - Roads				
10. Provide support and training for road crews on culvert size standards, replacements, and installation and maintenance of road BMPs.	Basin wide	All towns	BCRC, TU, DEC, VTrans	DEC Stormwater Program, River & Roads Training Program
11. Apply for Better Road Category A grants for towns to develop Capital Budgets for *Very High* and *High priority* segments.	Basin wide	All towns	Better Roads, BCRC, VTrans, DEC	Better Roads
12. Implement BMPs for *Very High* and *High priority* road segments identified in REIs to meet MRGP requirements.	Basin wide	All towns	Municipalities, BCRC, TU, DEC	VTrans MAB Grants, Grant-in-Aid, CWI, Better Roads
13. Conduct outreach on REIs for private roads and driveway BMPs.	Basin wide	All towns	BCRC, TU, Municipalities, landowners, DEC	TBPSG, WG

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
14. Address erosion and runoff sources causing sediment and chloride impairments in receiving waters.	Munson Brook and Ladd Brook	Manchester, Pownal	Manchester, Pownal, DEC, BCRC, TU, BCCD	Grant-in-Aid, CWI, Better Roads
Wastewater				
15. Monitor aquatic biota above and below the Bennington WWTF to determine the condition of the downstream reach and if a stressed or impaired listing is warranted.	Walloomsac River (RM 10 and 9.2)	Bennington	Bennington, DEC	DEC
16. Promote septic system maintenance through local outreach and education programs, such as a septic social.	Paran Lake, Big Pond, village centers along the Batten Kill	Bennington, Woodford, Manchester	DEC, BCRC, BCCD, Paran Lake Association	FWD Watershed Grant, AVCC Tiny Grant
Natural Resource Protection and Restoration - Rivers				
17. Develop and prioritize a map or list of potential floodplain restoration locations including areas where existing buffers can be expanded to restore functional floodplain or wetlands.	Basin wide	All towns	BCCD, BCRC, BKWA, TU, DEC	ERP, TBPSG, NFWF
18. Work with partners to implement priority floodplain restoration projects.	Batten Kill and lowest reaches of tributaries	Manchester, Dorset, Sunderland, Arlington	BCCD, BCRC, TU, BKWA, HooRWA, FWD, TNC, VLT	ERP, NFWF, CREP, EQIP
19. Provide information on the benefits of the NFIP program and technical support for towns that are interested in joining the program and provide information on the flood hazard map update process.	Basin wide	All towns	DEC, BCRC, Towns	TBPSG, MPG

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
20. Provide support to local communities as they consider river corridor protections in towns plans or zoning bylaws.	Basin wide	All towns	DEC, BCRC, Towns	TBPSG, MPG
21. Identify potential wetland, River Corridor Easement, or lake conservation opportunities when there may be landowner interest in floodplain/wetland restoration or conservation.	Basin wide with focus on Roaring Branch	All towns with focus on Sunderland	BCCD, BCRC, VLT DEC, FWD	ERP, RCE grants
22. Assess water quality monitoring needs throughout the basin. Coordinate with watershed partners to develop a plan about how to address lack of sampling.	Basin wide	All towns	BCCD, BCRC, TU, BKWA, HoorWA, DEC	TBPSG, LaRosa Partnership Program
23. Implement strategic wood addition to increase habitat and channel equilibrium.	Basin wide with focus on headwater areas, Munson Brook, Mill Brook, Green River, and Batten Kill Mainstem, East Branch, and West Branch.	All towns	BCCD, BCRC, BKWA, TU, TNC, NRCS, Municipalities, Landowners, USFS	CREP, RCE Block Grant, Woody Riparian Buffer Block Grant, WQEP Grant (Act 76)
24. Develop high priority actions identified in river corridor plans as the opportunity presents itself and resources are available.	Basin wide with focus on White Creek and Mill Brook, Batten Kill, Walloomsac River, Roaring Branch	All towns	DEC, BCRC, TU, Municipalities, Landowners, BCCD	TBPSG, CWI, WISPr, WQEP Grant (Act 76)

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
25. Work with towns and private landowners to retrofit or replace priority culverts and bridges to restore AOP and geomorphic compatibility.	Basin wide	All towns	BCCD, Municipalities, BCRC, FWD, TU, USFWS	ERP, Better Roads, SWIG, VTrans Structures Grant
26. Identify and implement dam removal projects in the basin.	Broad Brook dams and waterworks, Cushman Dam on Paran Creek, and Hale Co. Dam on Warm Brook	Pownal, Bennington, Arlington	BCCD, BCRC, FWD, TU, USFS, VLT, DEC	TBPSG, RCPP, NFWF, USFWS
27. Reclassify waters on municipal, FPR, and USFS lands that have been identified in the 2021 Basin 1 TBP. Additional monitoring is recommended to determine if these waters meet criteria for reclassification for aquatic biota.	Headwaters Battenkill, Goodman Brook, White Creek, Furnace Brook, Stamford, City Brook, North Branch Hoosic River	Peru, Dorset, Rupert, Shaftsbury, Woodford, Stamford	DEC, FPR, BCRC, USFS, Municipalities	TBPSG, DEC
28. Initiate riparian buffer planting and protection projects as the opportunity presents itself and resources are available.	Batten Kill Mainstem, Paran Creek below Lake Paran, Warm Brook, Jewett Brook, Lye Brook, Green River, Roaring Branch, Bromley Brook	Manchester, Bennington, Arlington, Pownal, Sandgate, and Sunderland	BCCD, BCRC, TU, TNC, DEC, VAAFM, NRCS	CWI, SWG, CREP
Natural Resource Protection and Restoration - Lakes				

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
29. Support volunteer water quality monitoring on lakes in the basin.	Lake Paran, Big Pond	Bennington, Woodford	DEC Lakes, Lay Monitors	VLMP
30. Conduct Lake Wise assessments and implement identified shoreland BMPs on priority waterbodies.	Lake Paran, Big Pond	Bennington, Woodford	DEC Lakes, BCCD, BCRC, Lake Paran Association, FPR	ERP, TBPSG, Watershed Grant
31. Implement and support local Access Greeter programs.	Lake Paran	Bennington	DEC, lake Volunteers	ANC Grant
32. Implement an aquatic invasive species spread prevention plan throughout the basin that includes hosting a Volunteer Invasive Patrol (VIP) training in the watershed and initiating a VIP Program at priority lakes, installing signage on public accesses, conducting aquatic plant surveys.	Lake Paran, Lake Shaftsbury	Bennington, Shaftsbury	DEC, Lake Volunteers, Lake Paran Association, BCCD	ANC Grant
33. Continue to monitor lakes being used for long term acid rain research purposes.	Bourn Pond, Branch Pond	Sunderland, Sunderland	DEC, UVM, USFS	DEC
Natural Resource Protection and Restoration - Wetlands				
34. Conduct studies on potential Class I candidates and local outreach to municipalities and landowners to gauge interest in supporting Class I designations. Provide technical support for parties interested in submitting petitions.	Batten Kill headwaters, Maple Grove Wetland, South Stream Wetland Complex, Pownal Bog	Sunderland, Pownal, Bennington	Municipalities, local stakeholders, DEC, FPR, FWD, BCRC, BCCD, BKWA	TBPSG, 604(b) funds, FWD Watershed Grants, Local Conservation Funds
35. Update wetland mapping.	Basin wide	All towns	DEC, Municipalities	Municipal Planning

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
				Grants, EPA Grants
36. Provide outreach and training to interested communities on conducting Vermont Rapid Assessment Method inventories.	Basin wide	All towns	DEC, Municipalities	DEC Wetlands Program, Municipal Planning Grant, VT Watershed Grant
Natural Resource Protection and Restoration - Forests				
37. Provide outreach, technical assistance, and workshops to private forestland owners, foresters, and loggers on AMPs, use of skidder bridges, and voluntary harvesting guidelines.	Basin wide	All towns	FPR, DEC, BCCD, BCRC, TU	TBPSG, CWI
38. Promote skidder bridge funding to increase applications for the purchase and use of skidder bridges.	Basin wide	All towns	DFPR, BCCD	Skidder Bridge program
39. Complete forest road erosion inventories on state lands and implement BMPs on high priority segments where water quality benefits are identified.	State lands	Rupert. Arlington, Bennington, Woodford	FPR, FWD, TU	CWI, ERP

D. Basin 1 Monitoring and Assessment Table

The Monitoring and Assessment Table is a preliminary list of water quality monitoring priorities to guide monitoring over the next 5 years. This list has more sites than there is capacity to sample and as a result, will need further prioritization. This will occur during a monitoring summit before the 2023 field season.

Table 12. Basin 1 priorities for monitoring and assessment. Monitoring on private lands requires landowner permission.

Waterbody	Project Description	Location	Partner(s)	Purpose
Lakes and Ponds				
Lake Paran	Lay monitor to collect in-lake chemistry, Lakes and Ponds staff to complete an Aquatic Macrophyte Survey, monitor presence/absence of AIS	Bennington	DEC Lakes & Ponds, Lay Monitoring Volunteer, VIP	Initiate summer monitoring to track trends. Identify, track, and prevent aquatic invasive species.
Big Pond	Lay monitor to collect in-lake chemistry	Woodford	DEC Lakes & Ponds, Lay Monitoring Volunteer	Identify source(s) of increasing phosphorus and chloride.
Bourn Pond	Lay monitor to collect in-lake chemistry	Sunderland	DEC Lakes & Ponds, UVM	Continue to monitor lakes being used for long term acid rain research purposes.
Branch Pond	Lay monitor to collect in-lake chemistry	Sunderland	DEC Lakes & Ponds, UVM	Continue to monitor lakes being used for long term acid rain research purposes.
Lake Shaftsbury	Continue WQ monitoring and cyanobacteria monitoring	Shaftsbury	DEC Lakes & Ponds, Lay Monitoring Volunteer	Identify, track, and prevent aquatic invasive species.
Rivers and Streams				
Roaring Brook	Biological monitoring at rm 2.4	Stamford	DEC MAP	Determine reclassification status for aquatic biota, need fish data.

Waterbody	Project Description	Location	Partner(s)	Purpose
Ladd Brook	Biological and chemical monitoring at rm 0.3	Pownal	DEC MAP	303(d) list for sediment possibly from road runoff, need more monitoring
Bourn Brook	Biological monitoring at rm 1.6	Sunderland	DEC MAP	Determine reclassification status for aquatic biota. 2018 data suggest B(1) status.
City Stream	Biological monitoring at rm 2.0	Woodford	DEC MAP	Determine reclassification status for aquatic biota. 2018 data suggest B(1) status.
Green River	Biological monitoring at rm 0.1	Arlington	DEC MAP	Determine reclassification status for aquatic biota.
Mad Tom Brook	Biological monitoring at rm 1.2	Dorset	DEC MAP	Determine reclassification status for aquatic biota. A(1)/B(1) reclassification potential, need fish data.
Gilbert Brook	Biological and chemical monitoring at rm 0.9	Rupert	DEC MAP	Need to assess possible stressed condition.
Mill Brook	Biological and chemical monitoring at rm 2.8	Rupert	DEC MAP	Need more recent data at this site. 2003 data for aquatic biota are good.
Batten Kill	Biological and chemical monitoring at rm 55.5	Manchester	DEC MAP	Determine reclassification status for aquatic biota. 2013 data are very good.
Munson Brook	Biological and chemical monitoring at rm 0.2	Manchester	BCCD and TU	Added to 303d in 2020, needs more monitoring to determine extent of stressors. BCCD and TU will sample two LaRosa sites in 2021.
Walloomsac River	Biological and chemical monitoring at rm 9.2	Shaftsbury	DEC MAP	Downstream of WWTF, degrading condition, possible stressed/303(d) listing
Walloomsac River	Biological and chemical monitoring at rm 10.1	Shaftsbury	DEC MAP	Above WWTF to help determine extent of stress.

Waterbody	Project Description	Location	Partner(s)	Purpose
Paran Creek	Biological and chemical monitoring at rm 0.1	Bennington	DEC MAP	2020 stressed listing, needs follow up monitoring, stressor ID and additional locations to determine extent
Cold Spring Brook	Biological and chemical monitoring at rm 0.2	Shaftsbury	DEC MAP	Didn't meet aquatic biota standards when first sampled in 2018, needs follow up monitoring.
Hewitt Brook	Biological and chemical monitoring at rm 1.8	Bennington	DEC MAP	Inconsistent assessments, needs follow-up including fish monitoring.
Bolles Brook	Biological and chemical monitoring at rm 1.6	Glastenbury	DEC MAP	Stressed list for acidification; needs more data including fish and spring water chemistry
Bickford Hollow Brook	Biological and chemical monitoring at rm 0.1	Woodford	DEC MAP	Stressed list for acidification; needs more data including spring water chemistry, and macroinvertebrates.
Barney Brook	Biological and chemical monitoring at rm 1.5	Woodford	DEC MAP	Impaired 303d list, but unlikely to have changed since 2018. Sample one site on this stream to update data.
South Stream	Biological and chemical monitoring at rm 0.1	Pownal	DEC MAP	Didn't meet aquatic biota standards when first sampled in 2018. Needs follow up monitoring
South Stream	Biological and chemical monitoring at rm 2.0	Pownal	DEC MAP	Below hatchery. Need to update data; WW program planning to prioritize permit renewal in 2021.
Jewett Brook	Biological and chemical monitoring at rm 2.3	Bennington	DEC MAP	Added to stressed list, needs more monitoring to determine types and extent of stress.
Wetlands				

Waterbody	Project Description	Location	Partner(s)	Purpose
South Stream/Jewett Brook Wetland Complex	Bioassessment, WQ monitoring, wetland functions and values assessment	Pownal	DEC Wetlands, DEC MAP	Determine biological condition and if site meets Class I wetland criteria
Batten Kill Headwaters Wetland Complex	Bioassessment, WQ monitoring, wetland functions and values assessment	Manchester	DEC Wetlands, DEC MAP	Determine biological condition and if site meets Class I wetland criteria
Maple Grove Wetland	Bioassessment, WQ monitoring, wetland functions and values assessment	Pownal, Bennington	DEC Wetlands, DEC MAP	Determine biological condition and if site meets Class I wetland criteria

List of Acronyms

319	Federal Clean Water Act, Section 319
604(b)	Federal Clean Water Act, Section 604b
AAFM	Vermont Agency of Agriculture, Food, and Markets
A(1)	Class A(1) Water Classification
A(2)	Class A(2) Water Supply Classification
AAP	Accepted Agricultural Practice
ACWIP	Agricultural Clean Water Initiative Grant Program
Agency	Vermont Agency of Natural Resources
AIS	Aquatic Invasive Species
AMA	Agricultural Management Assistance Program
AMPs	Acceptable Management Practices (for logging)
ANS	Aquatic Nuisance Species
AOP	Aquatic Organism Passage
AR	American Rivers
B(1)	Class B(1) Water Classification
B(2)	Class B(2) Water Classification
BASS	Biomonitoring and Aquatic Studies Section
BCCD	Bennington County Conservation District
BCRC	Bennington County Regional Commission
BMP	Best Management Practice
BR	Better Roads (VTrans)
BRAT	Black River Action Team
BWQC	Basin Water Quality Council
CAP	Conservation Activity Plan
CCNRCD	Caledonia County Natural Resources Conservation District
CCP	Corridor Conservation Plan
CEAP	Capital Equipment Assistance Program
CISMA	Cooperative Invasive Species Management Area
CNMP	Comprehensive Nutrient Management Plans
CRC	Connecticut River Conservancy
CREP	Conservation Reserve Enhancement Program
CRJC	Connecticut River Joint Commissions
CRP	Conservation Reserve Program
CRREL	Cold Regions Research and Engineering Laboratory
CRWFA	Connecticut River Watershed Farmers Alliance
CSP	Conservation Stewardship Program, NRCS
CVRPC	Central Vermont Regional Planning Commission
CWA	Federal Clean Water Act
CWI	Clean Water Initiative Grant Funding
CWIP	Clean Water Initiative Program
CWSP	Clean Water Service Provider
CWSRF	Clean Water State Revolving Fund
Department	Vermont Department of Environmental Conservation
DPW	Department of Public Works
DRWA	Deerfield River Watershed Alliance

DWSRF	Drinking Water State Revolving Fund
EBTJV	Eastern Brook Trout Joint Venture
EQIP	Environmental Quality Incentive Program, NRCS
ERP	Ecosystem Restoration Program
EU	Existing Use
FAP	Farm Agronomic Practices
FEH	Fluvial Erosion Hazard
FERC	Federal Energy Regulatory Commission
FSA	Farm Service Agency (USDA)
FWRT	Friends of the West River Trail
GIS	Geographic Information System
GMNF	Green Mountain National Forest
GMP	Green Mountain Power
GRWA	Green River Watershed Alliance
GSI	Green Stormwater Infrastructure
IDDE	Illicit Discharge Detection (and) Elimination
LCBP	Lake Champlain Basin Program
LFO	Large farm Operation
LID	Low Impact Development
Lidar	Light Detection and Ranging
LIP	Landowner Incentive Program
LIS-FF	Long Island Sound Futures Fund
LTP	Land Treatment Planner
LULC	Land Use Land Cover
LWD	Large Woody Debris
MAB	Municipal Assistance Bureau
MAP	Monitoring and Assessment Program
MARC	Mount Ascutney Regional Commission
MEF	Upper Connecticut River Mitigation and Enhancement Fund
MFO	Medium Farm Operation
MPG	Municipal Planning Grant
MRGP	Municipal Roads General Permit
NASS	National Agricultural Statistics Service
NEAS	New England Agricultural Statistics
NEGEF	New England Grassroots Environmental Fund
NFC	Native Fish Coalition
NFIP	National Flood Insurance Program
NFWF	National Fish and Wildlife Foundation
NMP	Nutrient Management Plan
NOAA	National Oceanic and Atmospheric Administration
NOFA	Northeast Organic Farming Association of Vermont
NPDES	National Pollution Discharge Elimination System
NPS	Non-point source pollution
NRCD	Natural Resource Conservation District
NRCS	Natural Resources Conservation Service
NVDA	Northeast Vermont Development Association
NWSC	North Woods Stewardship Center
ONRCD	Ottauquechee Natural Resources Conservation District

ORG	Ottauquechee River Group
ORW	Outstanding Resource Water
PDM	Pre-Disaster Mitigation
PFW	Partners for Fish and Wildlife
PUC	Public Utility Commission
R,T&E	Rare, Threatened and Endangered Species
RAP	Required Agricultural Practices
RC&D	Resource Conservation and Development Council of USDA
RCPP	Regional Conservation Partnership Program
RMP	River Management Program
RPC	Regional Planning Commission
RRP	Rock River Preservation
SCA	Student Conservation Association
SEP	Supplemental Environmental Program
SeVWA	Southeaster Vermont Watershed Alliance
SFO	Small Farm Operation
SGA	Stream Geomorphic Assessment
SIT	School for International Training
SPA	Source Protection Area
SRWC	Saxtons River Watershed Collaborative
SVNMP	Southern Vermont Nutrient Management Program
SWG	State Wildlife Grant
SWMP	Stormwater Master Plan
TBP	Tactical Basin Plan
TBPSG	Tactical Basin Planning Support Grants
TFS/T4S	Trees for Streams
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TPL	Trust for Public Lands
TRORC	Two Rivers Ottauquechee Regional Commission
TS4	Transportation Separate Storm Sewer System General Permit
TU	Trout Unlimited
USACE	United States Army Corp of Engineers
USDA	United States Department of Agriculture
USEPA/EPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UVA	Use Value Appraisal program, or Current Use Program
UVM Ext.	University of Vermont Extension Service
UVM	University of Vermont
VAAFM/AAFM	Vermont Agency of Agriculture, Food and Markets
VABP	Vermont Agricultural Buffer Program
VACD	Vermont Association of Conservation Districts
VANR	Vermont Agency of Natural Resources
VTrans	Vermont Agency of Transportation
VDEC	Vermont Department of Environmental Conservation
VFPR/FPR	Vermont Department of Forests, Parks and Recreation

VFWD/FWD	Vermont Department of Fish and Wildlife
VDHP	Vermont Department of Historic Preservation
VDOH	Vermont Department of Health
VEM	Vermont Emergency Management
VFB	Vermont Farm Bureau
VGS	Vermont Geological Survey
VHCB	Vermont Housing and Conservation Board
VINS	Vermont Institute of Natural Science
VIP	Vermont Invasive Patrollers
VLCT	Vermont League of Cities and Towns
VLRP	Vermont Local Roads Program
VLT	Vermont Land Trust
VNNHP	Vermont Nongame and Natural Heritage Program
VNRC	Vermont Natural Resources Council
VRC	Vermont River Conservancy
VSA	Vermont Statutes Annotated
VTrans	Vermont Agency of Transportation
VWQS	Vermont Water Quality Standards
VYCC	Vermont Youth Conservation Corp
WCNRCD	Windham County Natural Resources Conservation District
WHIP	Wildlife Habitat Incentive Program
WISPr	Water Infrastructure Sponsorship Program
WQEP	Water Quality Enhancement and Protection
WQRP	Water Quality Remediation Plan
WQS	Water Quality Standards
WRC	Windham Regional Commission
WRNRCD	White River Natural Resources Conservation District
WRP	Water Resources Panel
WWTF	Wastewater Treatment Facility

References

Astor, S. (2019). *Spatially referenced models of streamflow and nitrogen, phosphorus, and suspended-sediment loads in streams of the Northeastern United States: U.S. Geological Survey Scientific Investigations Report 2019–5118*. doi:https://doi.org/10.3133/sir20195118

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

Camporeale, C. E. (2013). Modeling the Interactions Between River Morphodynamics and Riparian Vegetation. . *Reviews of Geophysics, 51*, 379–414.

Clift, A. E., & Springston, G. (2012, December 31). Protocol for Identification of Areas Sensitive to Landslide Hazards in Vermont. Vermont: Vermont Geological Survey. Retrieved from http://dec.vermont.gov/sites/dec/files/geo/TechReports/VGTR2012-1LandslideProtocol.pdf

Coles, J. M. (2012). *Effects of urban development on stream ecosystems in nine metropolitan study areas across the United States.* Reston: U.S. Geological Survey. Retrieved from https://pubs.usgs.gov/circ/1373/pdf/Circular1373.pdf

Comiti, F. A. (2008). Wood storage in three mountain streams of the Southern Andes and its hydro-morphological effects. *Earth Surface Processes and Landforms, 33*, 244–262.

Connecticut Council on Soil and Water Conservation. (2015). Long Island Sound Watershed RCPP. Retrieved May 7, 2018, from http://www.lisw-rcpp.com/about.html

Davidson, S. L. (2013). Modeling channel morphodynamic response to variations in large wood: Implications for stream rehabilitation in degraded watersheds. *Geomorphology, 202*, 59–73.

Environmental Protection Agency. (2008, March). *Handbook for Developing Watershed Plans to Restore and Protect Our Waters.* Retrieved from US Environmental Protection Website: https://www.epa.gov/sites/production/files/2015-09/documents/2008_04_18_nps_watershed_handbook_handbook-2.pdf

Fulton, S., & West, B. (2002). Forestry Impacts on Water Quality. In D. N. Wear, & J. G. Greis, *Southern Forest Resource Assessment* (p. 635). Ashville, North Carolina: U.S. Department of Agriculture, Forest Service, Southern Research Station. Retrieved from srs.fs.usda.gov/sustain/report/pdf/chapter_21e.pdf

Gale, M. (2020, January 14). Basin 14 Geology. (D. B. Owczarski, Interviewer)

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

Galford, G. L. (2014). *Considering Vermont's Future in a Changing Climate: The First Vermont Climate Assessment.* Gund Institute for Ecological Economics, Burlington. Retrieved from http://dev.vtclimate.org/wp-content/uploads/2014/04/VCA2014_FullReport.pdf

Galford, G. L., Carlson, S., Ford, S., Nash, J., Palchak, E., Pears, S., . . . Baker, D. V. (Eds.). (2014). Considering Vermont's Future in a Changing Climate: The First Vermont Climate Assessment. 219.

Gannett, S. (1936). *Special Commission on the Boundary between Vermont and New Hampshire, 1934-1936.* United States Supreme Court. Washington D.C.: Press of Judd & Detweiler.

Gurnell, A. M. (2002). Large wood and fluvial processes. . *Freshwater Biology, 47*, 601–619.

Jankowski, K., & Schindler, D. (2019, November 26). Watershed geomorphology modifies the sensitivity of aquatic ecosystem metabolism to temperature. *Scientific Reports*, 9. doi:https://doi.org/10.1038/s41598-019-53703-3

Jeffries, R. S. (2003). The influence of vegetation and organic debris on flood-plain sediment dynamics: case study of a low-order stream in the New Forest, England. . *Geomorphology, 51*, 61–80.

Krause, S. M.-J. (2014). The potential of large woody debris to alter biogeochemical processes and ecosystem services in lowland rivers. . *Wiley Interdisciplinary Reviews: Water 1*, Wiley Interdisciplinary Reviews: Water 1.

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

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

Redstart Consulting. (2014, July 17). First Branch White River Watershed: Stream Geomorphic Assessment and River Corridor Plan 2012-2013. (D. Ruddell, H. Wahlstrom, A. Spencer, E. McLane, C. Haynes, & B. Machin, Eds.) Vermont.

Roberts, B. J. (2007). Effects of upland disturbance and instream restoration on hydrodynamics and ammonium uptake in headwater streams. *Journal of the North American Benthological Society, 26*, 38–53.

Sear, D. A. (2010). Logjam controls on channel:floodplain interactions in wooded catchments and their role in the formation of multi-channel patterns. . *Geomorphology, 116*, 305–319.

Springston, G. (2019). *Landslide Inventory of Orange County, Vermont*. Montpelier: Vermont Geological Survey. Retrieved from https://dec.vermont.gov/sites/dec/files/geo/HazDocs/OrangeCountyLandslideStudy.pdf

State of Vermont. (2015, August 15). *Climate Change in Vermont*. Retrieved from Water Quality: https://climatechange.vermont.gov/our-changing-climate/what-it-means/water-quality

State of Vermont. (2016, April 21). *More Total Precipitation* . Retrieved from Climate Change in Vermont: https://climatechange.vermont.gov/our-changing-climate/dashboard/more-annual-precipitation

Stone Environmental, Inc. (2005). *Warren, Vermont: A Different Approach for Managing Wastewater in Rural Villages*. US EPA Case Study, Warren. Retrieved February 31, 2020, from https://www.epa.gov/sites/production/files/2015-06/documents/warren_report_1.pdf

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

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

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

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

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

Vermont Department of Environmental Conservation. (2017, January). *Vermont Surface Water Management Strategy*. Retrieved from VT Department of Environmental Conservation Website: http://dec.vermont.gov/watershed/map/strategy

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

Vermont Lakes and Ponds Program. (2019). Vermont Lakes Database.

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

Weiskel, P. K. (2007). *The Charles River, Easter Massachusetts: Scientific Information in Support of Environmental Restoration.* US Geological Survey. Retrieved from https://pubs.usgs.gov/gip/2007/47/pdf/gip-47.pdf

Appendix A. 2015 Basin 1 TBP Status Update

Overall, work completed in the watershed since the publication of the previous Tactical Basin Plan has allowed several assessments and efforts to support the implementation of specific strategies. This includes mapping and assessing road and stormwater infrastructure, rivers and streams, agricultural land, and wetlands. Extensive work has been done in partnership with the BCCD, BCRC, BKWA, TU, HooRWA, town based organizations, non-profits, and divisions of state and federal government as well as landowners to work towards restoring impaired waters and managing the watershed for healthier rivers, wetlands, and lakes. Conservation projects and especially buffer projects have increased the total land under conservation, and towns and villages throughout the watershed are working to increase flood preparedness, reduce erosion and green their infrastructure for better water quality.

Table A1. 2016 Basin 1 report card with 2021 updates from local, state, and federal watershed partners.

Subbasin	Town	Stream segment	Stressor	Project Description	Source	Partners	Status (Complete, In Progress, Ongoing, Awaiting action, Discontinued)	% complete	Explanation
Batten kill									
1. Mad Tom	Dorset, East Dorset		Protection	Reclassification – A1	BASS data	VDEC, USFS, BKWA	Complete	100	All streams above 2500 are now A1.
2. Mad Tom	East Dorset	T7.01	Channel erosion	Modeling of berm removal	Batten Kill RCP	VDEC – RMP, VTrans, BCCD	In progress	25	TU met with VTrans about this site for habitat restoration, but need to identify next steps (e.g., maybe relocate gravel, Rivers Program will do site visit)
3. West Branch	Manchester	T6.01, T6.02	Channel erosion, Land erosion, nutrient loading	Identify and implement GSI stormwater management projects for village. Encourage centralized stormwater treatment system where dense development	Urban sources	Town of Manchester, VDEC – ERP, BCCD	In Progress	25	BCCD and BCRC-Manchester SWMP effort will address this strategy, CWIP funds and bundle towns for SWMPing

				exists. Locate treatment areas based on locations of soils with high infiltration potential					
4. Bromley Brook	Manchester	First tributary US from confluence with Bourn Brook	Flow alteration	Reclassification from A2 to B (abandoned)	No longer used	Manchester Water Co., VDEC - GWDWPP	Awaiting action	0	Bromley Brook (rm 0.4) had very good bugs in 2008, but needs to be sampled again.
5. Bourn Brook	Manchester, Bondville	(where not Wilderness lands)	Protection	Reclassification – (USFS "Wild & Scenic" candidate) scenic beauty, cultural significance, recreational trail	BASS data (?), USFS monitoring and assessment	VDEC – MAPP, USFS, BKWA	Complete	100	Currently Class A(1)
6. Bourn Brook	Manchester	T4.01	Encroachment	Modeling of berm removal	Batten Kill RCP	VDEC - RMP, Town of Manchester, landowners, BKWA, BCCD	Awaiting action	0	Possible RCE at the site. To-date, landowner is unwilling to remove berm. Rivers program staff suggest carrying this over into the 2021 Basin 1 plan.
7. Bourn Pond	Sunderland	Lakeshore (T4.06)	Thermal modification, land erosion, encroachment	Address unsanctioned camping encroachment into shoreline areas	Lye Brook Monitoring Coop	USFS, VDEC – LPMPP, BCCD	Ongoing	75	Working with FS Recreation staff to reduce camping of shoreline areas through site obliteration and messaging.
8. Lye Brook	Manchester, Sunderland,	Portion forming boundary between Lye Brook Wilderness and non-wildernes	Protection	Reclassification – A1 (also W&S)	BASS data (?)	VDEC – MAPP, USFS, BKWA	Complete	100	Current A(1)

		s GMFLNF lands							
9. Lye Brook	Manchester	T3.02-A & B	Channel erosion, encroachment	Berm removal, river corridor easement, wetland protection	Lye Brook RCP	Town of Manchester, VDEC – RMP, BCCD, BKWA	In Progress	50	A alternatives analysis (2019) evaluated a berm along western Lye Brook in Manchester preventing the brook from flowing into the floodplain during storm events. The grantee evaluated 1) the potential effects of modification or removal of the berm on existing properties and Richville Rd., 2) potential modifications to channel geometry and wetlands resulting from removal or modification of the berm, and 3) structural improvements along Richville Rd. and the adjacent railroad given these modifications and the need to make those transportation systems more flood resilient. Number of projects identified = 5 Stream miles assessed/covered by plan miles = 2
10. Lye Brook	Sunderland	headwaters	Atmospheric deposition	Acid deposition mitigation	Atmospheric deposition LRTAP	VDEC, EPA approved TMDL, USFS	Ongoing	100	Atmospheric particulate matter is being monitored over the Lye Brook Airshed at the Lye Brook REMOVE station on Mt. Snow.
11. Branch Pond	Sunderland	headwaters	Encroachment, land erosion, thermal modification	Address unsanctioned camping encroachment into shoreline areas	Lye Brook Monitoring Coop	USFS, VDEC – LPMPP, GMC	Ongoing	100	Working with FS Recreation staff to reduce camping on shoreline areas through site obliteration and messaging.
12. Branch Pond Brook	Sunderland		Protection	Reclassification – A1	BASS data (?)	VDEC – MAPP, USFS, BKWA	Complete	100	Current A(1)
13. Roaring Branch	Sunderland	T2.04-B & C	Protection	River Corridor easement (highest priority from SGA-RCP). Town of	TS Irene scour, So. Of	VDEC - RMP, Town of Sunderlan	Awaiting action	0	Sunderland has RCP Rivers Program recommend carrying strategy over into 2021 Basin 1 Plan to pursue a RCE.

				Sunderland has adopted FEH	Rte. 7 IRP	d, landowners, BKWA, BCCD			
14. Roaring Branch (South Branch, US of the Kelly Stand RD/ FR 6)	Sunderland	T2S2.01, T2S2.02	Protection	Reclassification to A1 (below 2500')	BASS data (?)	VDEC – MAPP, USFS, Town of Sunderland, BKWA, BCCD	Ongoing	50	Reclassification potential, at rm 0.1, good bug data in 2018, but need fish data
15. Munson Brook	Manchester	RM 0.2 and upstream of Route 7A	Channel erosion, Land erosion, nutrient loading	Conduct SWMP to identify highest priorities for SW retrofit and GSI implementation (scheduled for 2016)	BASS data	VDEC – ERP, Town of Manchester, BCRC, BCCD, Orvis	In Progress	25	New 303(d) listing for sediment and chloride, runoff from developed lands, chloride stress of biological community. BCCD/TU will monitor 2 stations along Munson Brook beginning Summer 2021. BCCD/BCRC pursuing Manchester SWMP.
16. Munson Brook	Manchester	RM 0.2 and upstream of Route 7A	Channel erosion, Land erosion, nutrient loading	Identify and implement GSI stormwater management projects for village. Encourage centralized stormwater treatment system where dense development exists. Locate treatment areas based on locations of soils with high infiltration potential	BASS data	VDEC - ERP, Town of Manchester, BCCD, Orvis	In Progress	25	BCCD/BCRC are pursuing SWMP and will implement high-medium priority projects as funding allows.
17. Green River	Sandgate	Basin-wide	Land erosion	Work with towns in the Basin to implement back road BMPs to address sedimentation	RERA, BBR inventories (category A)	VDEC – SW, VTrans – BBR, BCRC, Town of	Ongoing	25	REI complete, culvert inventory updated in 2018, and have SWMP and using these to ID projects through GIA and BR

				from gravel road runoff		Sandgate, BCCD			
18. Batten Kill mainstem	Manchester	Mainstem reaches	Channel erosion, Land erosion, nutrient loading	Identify and implement GSI stormwater management projects for village. Encourage centralized stormwater treatment system where dense development exists. Locate treatment areas based on locations of soils with high infiltration potential	BASS data, VDFW	VDEC – ERP, BCCD, Town of Manchester, BKWA	In progress	25	BCRC/BCCD Manchester SWMP
19. Batten Kill mainstem	Manchester	M10, M11	Nutrient loading	Work with Ekwanok and Manchester Country Clubs to become "VT Green Links" courses	VDEC-BASS	VDEC, Vermont Small Business Development Center, Ekwanok and Manchester Country Clubs, BKWA, BCCD	Ongoing	25	Manchester CC is implementing 2020-2023 invasive plant management plan to become Audubon certified, BCRC will follow up with outreach regarding nutrient runoff management to country clubs in the basin, e.g., the Ekwanok Country Club – Manchester, the Equinox Golf Course – Manchester, and the Mt. Anthony Country Club – Bennington
20. Batten Kill mainstem	Manchester, Sunderland, Arlington	Entire mainstem	Encroachment, land erosion, thermal modification	Promote rebuffering opportunities through BCCD "Trees for Streams" program	Loss of riparian veg, streambank erosion, runoff,	BCCD, VDEC – RMP, VDEC – BASS, VDFW, BKWA	Ongoing	50	BCCD, BCRC, BKWA, and TU are promoting riparian buffer planting through education and outreach as well as landowner visits and implementing planting projects.

					lack of habitat features				
21. Batten Kill mainstem	Dorset	Entire mainstem	Nutrient loading	Work with VSFHS to ensure manure management activities and watering activities are adhering to RAPs	Equine management activities	VAAFM, BCCD, NRCS	Awaiting Action	0	No Progress.
22. Batten Kill mainstem	Manchester	M8	Protection	Potential river corridor easement just upstream from confluence with Bourn Brook	Batten Kill RCP	VDEC - RMP, landowners, BKWA	In Progress	50	A river corridor easement covering approximately 42 acres along the Batten Kill. The project includes planting approximately 11 acres in CREP and restoring the wetlands to the west and north of the Batten Kill as well as planting a buffer on the east side of the stream that will migrate as the channel moves.
23. Batten Kill mainstem	Manchester	M5(E)	Encroachment, Thermal modification	Re-buffer western portion of streambank (RB)	NRCS, CREP	VAAFM, BCCD, NRCS, VLT, BKWA	Awaiting action	0	No planting to date. Partners plan to follow up w/ landowner and pursue potential wetland restoration.
24. Batten Kill mainstem	All towns in Basin	All waters	Land erosion	Develop and implement stormwater management plan for private and public roads. Use Road erosion Risk layer and map points of stormwater inputs to ditches to assist in project prioritization	VDEC Erosion and RERA/ Sediment Source Risk Maps	VDEC - SW, Municipalities, VTrans-BBR, BCRC, BCCD	Ongoing	50	REIs are complete for all towns in the basin and data are available at the MRGP implementation table database portal, The MRGP requires towns to upgrade 15% of non-compliant hydrologically-connected road segments to MRGP standards by December 31, 2022 and towns are working to meet this requirement. DEC is developing a Survey 123 form for private roads.
25. Batten Kill mainstem	All towns in Basin	Mainstem and tributaries	Invasives	Assist in the development of, and Implement Batten Kill CISMA	BK CISMA	Principle and supporting partners of the	Ongoing	50	BCCD is working with CISMA to develop and distribute AIS pamphlets to landowners and may host workshops.

						CISMA, BCSFC, BCCD			
26. Batten Kill	All towns in Basin	All waters	Land erosion, encroachment, channel erosion	Identify and implement needed Better Backroads BMPs for roads identified in BBR – Category "A" inventories	VDEC Erosion and Sediment Source Risk Maps	BCRC, VDEC, Municipalities, VTrans-BBR, BKWA, BCCD	Ongoing	50	REIs are complete for all towns in the basin and data are available at the MRGP implementation table database portal, The MRGP requires towns to upgrade 15% of non-compliant hydrologically-connected road segments to MRGP standards by December 31, 2022 and towns are working to meet this requirement.
27. Warm Brook	East Arlington	Entire mainstem	Encroachment, land erosion, thermal modification	Promote rebuffering opportunities through BCCD "Trees for Streams" program	Loss of riparian veg, streambank erosion, runoff, lack of habitat features	BCCD, VDEC – RMP, VDEC – BASS, VDFW	Ongoing	25	AAFM, VLT, and BCCD are actively working to implement field BMPs along Warm Brook. BCCD and TU have will conduct landowner outreach about buffer plantings.
28. Fayville Branch	East Arlington	T2S1S1.03 and T2S1S1.02 -B*	Channel erosion	Berm removal *Pending alternatives analysis	Batten Kill RCP	VDEC-RMP, Town of Arlington, BCCD	Awaiting action	0	No action to-date.
29. Fayville Branch	East Arlington	T2S1S1.01 -A* and T2S1S1.01 -B**	Protection	Protection/ attenuation/ river corridor easement **Highest priority from SGA	Batten Kill RCP Prouty Hill RD	VDEC-RMP, BKWA, Town of Arlington, BCCD	Awaiting action	0	No action to-date.
30. Fayville Branch	East Arlington, Glastenbury	Entire basin US of Route 7	Protection	W&S candidate for scenic values	VDEC-BASS	VDEC-BASS, USFS, BKWA	Discontinued	0	This is a Dept. of the Interior determination.
31. Black Brook (Trib to Fayville Branch)	Glastenbury	Black Brook and tributaries upstream	Protection	Reclassification – A1	BASS data	VDEC-MAPP, USFS, BKWA	Discontinued	0	No update or progress.

		of confluence with Fayville Branch							
32. Mill Creek	Rupert	M01T1.04	Protection	Bank stabilization using LWD revetments and riparian buffer plantings	Mill/ White RCP	BKWA, BCCD, VDEC-ERP	Ongoing	25	BCCD and TU will conduct landowner outreach about LWD/riparian buffer plantings.
33. Mill Creek	Rupert	Basin-wide	Land erosion, encroachment	Identify and implement needed Better Backroads BMPs for roads identified in BBR – Category "A" inventories	VDEC Erosion and Sediment Source Risk Maps	BCRC, VDEC, Municipalities, VTrans-BBR, BCCD	Ongoing	25	BCRC is coordinating a GIA project on Mill Creek (i.e., along Kent Hollow Rd.) to replace culverts and stone line ditches.
34. Mill Creek	Rupert	M01T1S1.01	Land erosion	SW LID mitigation project at Rupert Town Garage	Rupert SWMP	VDEC – ERP, BCRC, Town of Rupert, BCCD	Complete	100	In 2018, BCCD completed this road project. It vegetated and stabilized a ditch that drains a driveway and parking area shared with the Fire Department. The ditch drains to another ditch along the D&H Rail Trail, and from there to Mill Brook and White Creek. The Town of Rupert topsoiled and hydroseeded the ditch and adjacent spaces totaling ≈5000 s.f. The Town also installed a sediment pond at the mouth of a culvert running under the driveway to the ditch, and rock-hardened the outlet of that amended culvert outlet and inlet will collect sediment-laden runoff from about 2.7 acres of ungrassed area adjacent to the ditch, and from about 150 linear feet of impervious State highway.
35. Mill Creek	Rupert	M01T1.04	Land erosion	Stabilize large gully where concentrated	Rupert SWMP	VDEC – ERP, Town of Rupert,	Complete	100	BCCD installed LWD along a stream on Anton View Rd.

		(Antone Mountain View RD)		runoff enters Mill Brook		BCCD, BKWA			
36.Sandgate Brook (Mill Creek)	Rupert	M03T1.03 (Sandgate RD)	Land erosion/ channel erosion	Stabilize downstream incision from culvert outfall – plunge pool, check dams, armoring	Rupert SWMP	BBR, VDEC – ERP, Town of Rupert, BCCD	Awaiting action	0	No progress to-date.
37. Mill Creek	Rupert	M05 (Kent Hollow RD)	Land erosion	Replace Undersized Culvert	Rupert SWMP	BBR, VTrans, Town of Rupert, BCCD	In progress	25	A GIA project is planned for Summer 2021 to replace the culvert.
38. Mill Creek	Rupert	M01T1.01 , M01T1.02 (Youlin RD, Hebron RD)	Land erosion	Backroad erosion issues - ditching	Rupert SWMP	BBR, Town of Rupert, BCCD	Complete	100	Town of Rupert road crews completed using BR grants.
39. White Creek	Rupert	Basin-wide	Land erosion, encroachment	Identify and implement needed Better Backroads BMPs for roads identified in BBR – Category "A" inventories	VDEC Erosion and Sediment Source Risk Maps	BCRC, VDEC, Municipalities, VTrans-BBR, BCCD	Complete	100	Town of Rupert road project (2018)-vegetated/stabilized a ditch formerly conveying runoff from Rte. 153, the driveways of the Town garage and salt shed, the Rupert Fire House parking area, and a space behind the Fire House to a swale along the D&H Rail Trail and eventually to Mill Brook. The project reduced and captured sediment from a state road and two community facilities by vegetating and improving an existing gravel ditch and a culvert feeding it. The newly grassed ditch and amended culvert outlet/inlet will collect sediment-laden runoff from about 2.7 acres of ungrassed area adjacent to the ditch, and from

									about 150 linear feet of impervious State highway.
Walloomsac									
40. Paran Creek	North Bennington, Shaftsbury	Basin US of Lake Paran	Land erosion, encroachment	Identify and implement GSI stormwater management projects for village. Locate LID retrofits and treatment areas based on locations of soils with high infiltration potential	VDEC-BASS	Lake Paran Inc., VDEC-SW, Town of North Bennington, BCCD	In progress	50	N. Bennington SW infrastructure mapping report (2018) identified 1 high priority project. BCCD is working with Bennington College to implement the project.
41. Lake Paran	North Bennington	Developed lakeshore areas within 250'	Land erosion, encroachment – fostering the spread of invasives	Conduct LakeWise assessment and implement LID-GSI projects	VDFW access area, North Bennington Recreation Area	Lake Paran Recreation Inc., VDEC-LPMPP, BCCD	Ongoing	25	BCCD will pursue LakeWise training and conduct assessments.
42. Barney Brook	Bennington, Woodford	RM 0.2 - 1.5	Toxics	Mitigate sources of iron precipitate	Potential landfill leachate	VDEC-WMD, VDEC-BASS, Town of Bennington	Ongoing	50	Burgess Brothers Superfund Landfill site status update: the waste disposal area was capped and drainage routed around the cap to prevent any clean groundwater from infiltrating the contaminated landfill. Down gradient of the site, 2 groundwater pump and treat trenches hydraulically control groundwater before it leaves the site. The water from these trenches is pumped through a treatment system before being discharged to an unnamed tributary of Barney Brook. Water treatment consists of air stripping of VOCs (chlorinated solvents – PCE, TCE, and DCE), sediment and iron floc settling, and carbon treatment of the water to

									remove any remaining dissolved VOCs. Monitoring reports are available here. Surface water samples are taken from the unnamed tributary. When it leaves the site this unnamed tributary contains treated groundwater, surface water that drains off the landfill cap, and surface water from upgradient of the landfill that was routed around the landfill. Barney Brook remains on the 303(d) list for sediments and iron from mouth to river mile 1.5. BASS sampled 2 stations on the Brook in 2018 and did not see improvement in aquatic biota (river miles 0.3 & 1.5). It remains a monitoring priority.
43. Roaring Branch	Bennington, Stamford, Woodford	GMNF reaches	Channel erosion	Increase instream LWD – up to 175 pieces/ mile	TS Irene scour, So. Of rte. 9 IRP	USFS, TU	Awaiting Action	0	Implementation is contingent on funding from Timber Sales which have not been advertised/awarded at this time.
44. Roaring Branch	Bennington	M06T3.03	Protection, Channel erosion, encroachment	Acquire property adjacent to channel to prevent future development; modeling of fill removal to restore floodplain access	Channel Management and River Corridor Protection Plan, Roaring Branch SGA	VDEC-RMP, F&W, BCCD, Town of Bennington	In Progress	25	The 2020 floodplain restoration project develops designs for a 10 acre site located on the Roaring Branch. The project will develop final designs and permitting needs for the removal of fill and, possibly, historic flood berms, to result in the restoration of the site.
45. Bolles Brook	Woodford	M6T3.05A	Land erosion, encroachment	Remove new RB berm to open access to flood chute	Woodford RCP, Roaring Branch SGA	VDEC-RMP, BCCD, Town of Bennington	Awaiting action	0	Rivers Program staff will follow-up with a site visit.
46. Stamford Stream	Woodford, Stamford	Headwaters and areas	Class 4 road erosion/	Work with ATV/ 4WD clubs to develop and	So. Of rte. 9 IRP	USFS, BCCD, VDEC-ERP	In Progress	25	A plan is being developed among FS program areas (Recreation, Soils, Fisheries, etc.) and partners (VAST,

		around Sucker Pond/ Hancock Lake	Land erosion	implement back road BMPs on Stagecoach Road					VASA) to mitigate erosion issues and unauthorized access.
47. Sucker Pond/ Lake Hancock		Headwaters and areas around Sucker Pond/ Hancock Lake	Class 4 road erosion/ Land erosion	Controlled access points	So. Of rte. 9 IRP	USFS, BCCD, VDEC-ERP	In Progress	25	A plan is being developed among FS program areas (Recreation, Soils, Fisheries, etc.) and partners (VAST, VASA) to mitigate erosion issues and unauthorized access.
48. City Stream	Woodford	M6T3.05S 1.01A	Protection	Protect confluence area from further development/FEH	Woodford RCP	VDEC-RMP, Town of Woodford, landowners	Awaiting action	0	BCRC approached the town and they are unlikely to adopt river corridor protections, because village is almost entirely in floodplain.
49. City Stream	Woodford	M6T3.05S 1.04D	Encroachment, land erosion	Move parking area out of river corridor	Woodford RCP	VDEC-RMP, Town of Woodford, landowners	Discontinued	0	The Long Trail parking area is well-established and paved, so this is unlikely to happen.
50. Jewett Brook	Pownal, Bennington	Approximately 1 mile downstream of Pownal Center	Thermal modification	Bank stabilization using LWD revetments and riparian buffer plantings	VDEC-BASS	VDEC-RMP, BCCD, Towns of Bennington and Pownal	Awaiting action	0	Rivers Program staff will follow-up with a site visit.
51. Walloomsac mainstem	Bennington	M06, M07, M08, and Tribs	Channel erosion, Land erosion, nutrient loading	Conduct SWMP to identify highest priorities for SW retrofit and GSI implementation (scheduled for 2016)	BASS data	VDEC – ERP, Town of Bennington, BCRC, BCCD	Complete	100	Bennington SW Mapping Report (2015), N. Bennington SW report (2019), and Bennington College SW report (2019) are here.
Hoosic									

52. Broad Brook	Pownal	GMNF reaches	Habitat restoration / Channel erosion	Increase instream LWD – up to 175 pieces/ mile	TS Irene scour, So. Of rte. 9 IRP	USFS, TU	Awaiting Action	0	Implementation is contingent on funding from Timber Sales which have not been advertised/awarded at this time.
53. Tubbs Brook	Pownal	Basin-wide	Land erosion, encroachment	Identify and implement needed Better Backroads BMPs for roads identified in BBR – Category "A" inventories	RERA ground truthing, road inventory and assessment	VTrans-BBR, VDEC-SW, BCRC, Town of Pownal, BCCD	Complete	100	The 2018 road project addressed stormwater runoff from Fowlers Way and Mt. Anthony Rd. that spills onto the floodplain through a ditch turnout. Large plumes of fine sediment are visible on the floodplain and into the channel.
54. Ladd Brook	Pownal	Basin-wide	Land erosion, encroachment	Identify and implement needed Better Backroads BMPs for roads identified in BBR – Category "A" inventories	RERA ground truthing, road inventory and assessment	VTrans-BBR, VDEC-SW, BCRC, Town of Pownal, BCCD	Ongoing	50	REI complete in Pownal (https://anrweb.vt.gov/DEC/IWIS/MRGPReportViewer.aspx?ViewParms=False&Report=BaselineSummary&MunicipalityID=161) REI for Pownal includes the following results: · 1206 total segments in Pownal. ·582 hydrologically connected segments in Pownal. ·29 total segments are required to be brought up to MRGP standards before 12/31/2022. · 1 segment is Very High Priority. The MRGP requires that all Very High Priority segments be brought up to MRGP standards before 12/31/2025. For Class 4 roads this date is 12/31/2028.
55. Hoosic	Pownal, North Pownal	Entire 7 miles segment in VT	PCBs/ Toxics	Site remediation complete, ongoing M&A indicates effective treatment, no further action proposed at this time	PCBs	VDEC-WMD, VDEC-BASS, EPA	Complete	100	Brownfields project at Pownal Tannery dam, town to redev. dam and remove all PCB laden sediments
56. Hoosic River	Pownal	M02	Encroachment,	Relocate berm adjacent to WWTF to accommodate a	Hoosic Phase 2 SGA	VDEC-ERP, VDEC-RMP,	Discontinue	0	Project is unlikely to be completed, because the berm may protect WWTF, it is on a superfund site, and

			channel erosion	small floodplain for flow and sediment attenuation		Town of Pownal (WWTF), BCCD			there's little room to relocate the berm.
57. Hoosic River	Pownal	M06	Protection	Bank stabilization using LWD revetments and riparian buffer plantings	Hoosic Phase 2 SGA	BCCD, HooRWA, VDEC-ERP, VDEC-RMP	Awaiting action	0	BCCD did landowner outreach, but no leads in this area. Rivers Program staff confirm this reach needs buffers and should remain in the planning queue.
58. Basin-wide	All towns	All waters Land erosion, nutrients	Land erosion, encroachment	Install riparian buffers and enhance nutrient management on agricultural land	Farm assessments	NRCS, VAAFM, UVM extension, BCCD	Awaiting action	0	Opportunities for more riparian buffers and NMP outreach and technical assistance along Batten Kill, Walloomsac are included in the 2021 plan update.
59. Basin-wide	All towns	All waters	Land erosion, nutrients	Identify and implement needed BMPs for agricultural fields identified as at moderate to high risk for erosion.	DEC Erosion and Sediment Source Risk Maps	NRCS, VAAFM, UVM extension, BCCD	Ongoing	50	During SFY2016-2020, the most popular field BMPs were cover cropping (447 acres) and crop rotation (388 acres). These were primarily implemented in the South Stream-Walloomsac River and Walloomsac River drainages. The most popular Farmstead BMP was Barnyard Management in the Walloomsac River drainage.
60. Basin-wide	All Towns	All impounded surface waters	Flow alteration	Identify opportunities for dam removal and/or retrofits	VT Dam Task Force Dam statewide assessment of candidate dams	VDEC, USFWS, VT Dam task Force, TU, municipalities	Ongoing	25	Removal candidates: 1. Broad Brook Dam and waterworks - TU has NFWF funding for survey and feasibility study. Land acquisition proposal adjacent to FS lands, 2. Cushman Dam on Paran Creek, 3. Hale Co. Dam.

Appendix B. Dams in Basin 1

There are approximately 49 dams of different types, sizes, and condition in Basin 1. Of the 49 inventoried dams, 39 are in service, 2 are fully breached, 5 are partially breached, 1 is drained, and 2 are not in use. The 39 in service and 5 partially breached dams constrict the stream channel enough to reduce sediment transport, prevent lateral movement, and inhibit AOP. A detailed list of known non-historic dams in the watershed can be found in Table B1.

On January 18, 2018, H.554 or Act 161, the Dam Safety bill, passed the Vermont House of Representatives and received final approve on May 10th of the same year. The bill was developed collaboratively with the DEC, Vermont Natural Resources Council, Vermont TU, the Vermont Section of the American Society of Civil Engineers, and other partners. The bill addresses gaps in inspection requirements for hundreds of small dams. Under the bill, DEC will be required to maintain an inventory of all dams in the state and develop rules that will require all dams to be regularly inspected.

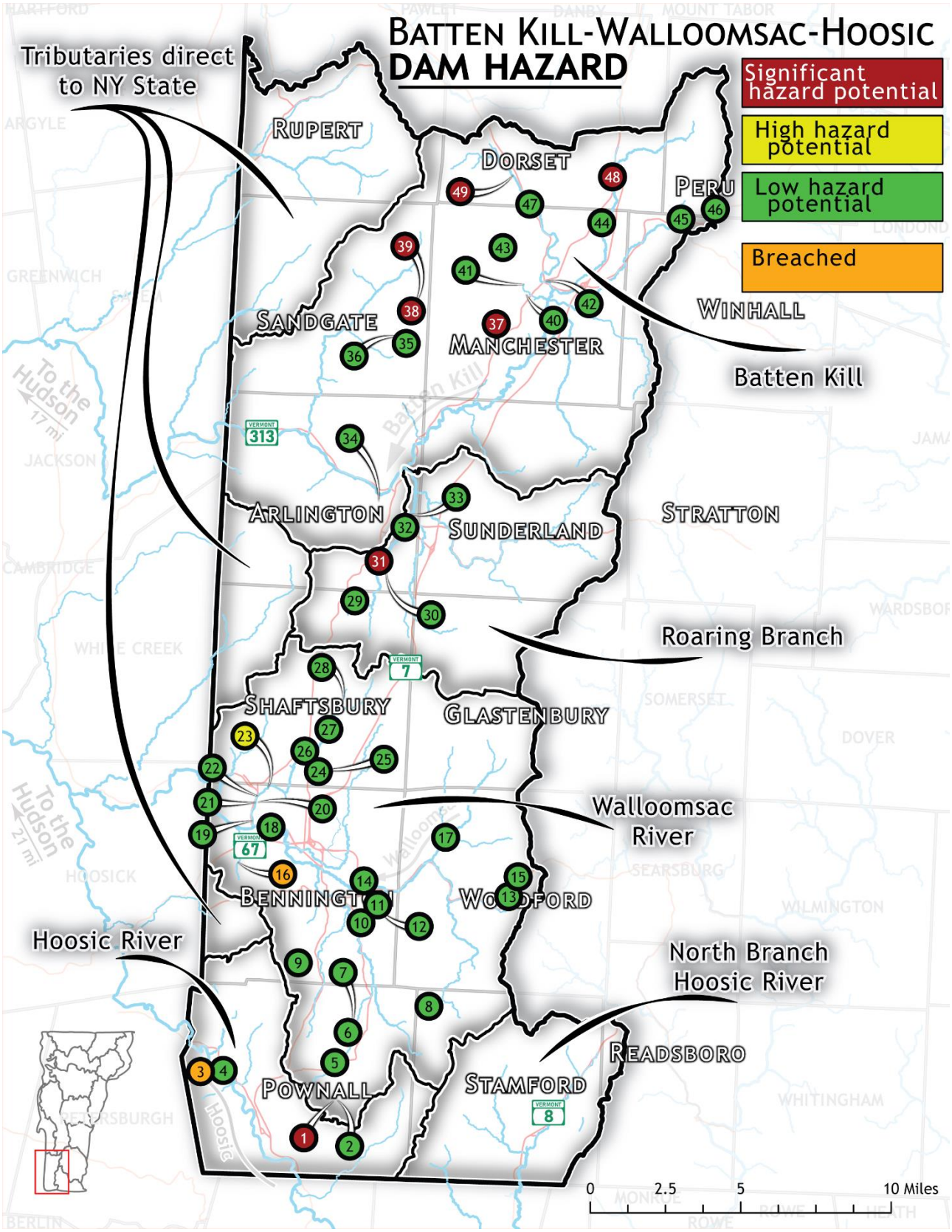


Figure B1. Non-historic dams located in Basin 1. Map #'s in table C1 correspond to the numbers in this map. Source: Source: Vermont Dam Inventory (accessed: 10/29/2020).

Table B1. Dams in Basin 1 organized by town name. These dams are either in service, not in use, partially breached, or deleted. Source: Vermont Dam Inventory (accessed: 10/29/2020).

Map #	Dam Name	Town	Stream	Owner Type	Surface Acres	Drainage (m^2)	Dam Status	Purposes	Year Built	Original Purpose	State Regulation	Fed Regulation
1	Thompson Pond Upper	Pownal	South Stream-TR	Private	30	0.83	In Service	Recreation	1900	Recreation	DEC	None
2	Thompson Pond (Lower)	Pownal	South Stream-TR	Private	2	0.83	In Service	Recreation	NA	NA	None	None
3	North Pownal Reservoir	Pownal	Reservoir Hollow	Private	0		Breached	Water Supply	NA	Water Supply	None	None
4	Pownal Tanning Co.	Pownal	Hoosic River	Local Government	8	224	Not in Use	Other	1907	NA	Public Service Board	Federal Energy Regulatory Commission
5	Barber Pond	Pownal	South Stream-TR	Private	19	1.34	In Service	Recreation	1910	NA	DEC	None
6	South Stream Pond	Pownal	South Stream	State	23	5.26	In Service	Recreation	1958	Wildlife	DEC	None
7	Morey Pond	Pownal	South Stream	Private	4	5.4	Breached (Partial)	NA	1943	NA	DEC	None
8	Sucker Pond	Stamford	Sucker Pond Brook	Local Government	55	0.5	In Service	NA	NA	NA	DEC	None
9	Southern Vermont Orchard	Bennington	Jewett Brook	Private	3	0.29	In Service	NA	1963	Irrigation	DEC	None
10	Beech Street	Bennington	South Stream-TR	Private	1.6	0.7	In Service	NA	NA	NA	None	None
11	Bennington Reservoir	Bennington	Barney Brook-OS	Local Government	1	0	Drained	Water Supply	NA	NA	None	None
12	Bennington Reservoir Lower	Bennington	NA	Local Government	0		Not in Use	Water Supply	NA	NA	None	None
13	Bugbee Mill Pond	Woodford	City Stream	Private	8	2.1	In Service	Other	1936	NA	DEC	None
14	Vermont Veterans Home	Bennington	Roaring Branch-TR	Private	1	0.27	In Service	Water Supply	1890	Water Supply	None	None
15	Big Pond	Woodford	City Stream	Private	31	1.11	In Service	NA	NA	NA	DEC	None
16	Bennington-15	Bennington	Walloomsac River - TR	Private	7	2.15	Breached	NA	NA	NA	None	None
17	Bennington Water Supply Diversion Structure	Bennington	NA	Local Government	0.2	18.1	In Service	Water Supply	NA	NA	None	None
18	Vermont Tissue	Bennington	Walloomsac River	Private	3.5	94.5	In Service	NA	NA	NA	Public Service Board	Federal Energy Regulatory Commission
19	Polygraphic	Bennington	Paran Creek	Private	4	16.4	In Service	NA	NA	NA	None	None
20	Cushman	Bennington	Paran Creek	Private	4	15.9	In Service	NA	NA	NA	DEC	None
21	Stark Mill	Bennington	Paran Creek	Private	0.5	15	In Service	NA	1918	NA	None	None
22	Whites Mill	Bennington	Paran Creek	Local Government	0.9	15.4	In Service	NA	NA	NA	None	None
23	Lake Paran	Bennington	Paran Creek	State	38	14.55	In Service	Recreation	1851	Mill Storage	DEC	None
24	Shaftsbury-10	Shaftsbury	Paran Creek-OS	NA	1.4		In Service	NA	NA	NA	None	None
25	Shaftsbury-9	Shaftsbury	Paran Creek-OS	NA	0.65		In Service	NA	NA	NA	None	None
26	Shaftsbury-2	Shaftsbury	Paran Creek	NA	0.2		In Service	NA	NA	NA	None	None
27	Cider Mill	Shaftsbury	Paran Creek	NA	2.4		In Service	NA	NA	NA	None	None
28	Shaftsbury-7	Shaftsbury	Paran Creek	NA	3.3		In Service	NA	NA	NA	None	None
29	Lake Shaftsbury	Shaftsbury	Warm Brook-TR	State	27	3.61	In Service	Recreation	1937	Recreation	DEC	None
30	Arlington-5	Arlington	Warm Brook-TR	Private	2.4	0.04	In Service	Recreation	NA	NA	None	None

31	Miller Pond	Arlington	Warm Brook	Private	14	10	In Service	Recreation	1937	Recreation	DEC	None
32	Ice Pond	Arlington	Warm Brook	Private	0.95	11.9	In Service	NA	NA	NA	None	None
33	Hale Co.	Arlington	Warm Brook	NA	0.6	26.1	Breached (Partial)	NA	NA	NA	None	None
34	Howell	Arlington	Dry Brook	NA	2.9	3.92	In Service	NA	NA	NA	None	None
35	Barbos Lake	Sandgate	Hopper Brook-TR	Private	5	0.02	In Service	Hydroelectric	1957	Storage	Public Service Board	None
36	Hopper Pond	Sandgate	Hopper Brook	Private	1	1.1	In Service	Hydroelectric	1920	NA	Public Service Board	None
37	Equinox Pond	Manchester	Batten Kill-TR	Private	9	0.72	In Service	Recreation	1890	Recreation	DEC	None
38	Lake Madeleine Dike	Sandgate	Green River-TR	Private	35	0.53	In Service	Hydroelectric	1957	Hydro Power	Public Service Board	None
39	Lake Madeleine	Sandgate	Hopper Brook	Private	35	0.53	In Service	Hydroelectric	1957	Hydro Power	Public Service Board	None
40	Manchester-5	Manchester	Munson Brook	NA	0.7		Breached (Partial)	NA	NA	NA	None	None
41	Manchester-6	Manchester	Munson Brook	NA	0.4		Breached (Partial)	NA	NA	NA	None	None
42	Manchester Center	Manchester	West Branch Batten Kill	Private	0.2	18.5	In Service	NA	NA	NA	None	None
43	Adler	Manchester	NA	Private	0.8		In Service	NA	NA	NA	None	None
44	Pickerel Pond	Manchester	Batten Kill-TR	Private	5	0.02	In Service	Recreation	1965	NA	DEC	None
45	Maud	Winhall	Bromley Brook	Private	3.2		In Service	NA	NA	NA	DEC	None
46	Lords Prayer Pond	Peru	Mill Brook-OS	Private	2	0.02	In Service	NA	1966	NA	DEC	None
47	Dorset-4	Dorset	West Branch Batten Kill	NA	1.4		Breached (Partial)	NA	NA	NA	None	None
48	South Village Pond	Dorset	Batten Kill-TR	Private	6	0.83	In Service	Recreation	1890	Recreation	DEC	None
49	Marble Mill	Dorset	West Branch Batten Kill	Private	19	7.61	In Service	Recreation	1875	Mill Power	DEC	None

Appendix C. Municipal Water Quality Protectiveness Table

Table C1. Municipal Water Quality Protectiveness Table for the Basin 1.

Town	ERAF Rate (%)	NFIP Community	Road and Bridge Standards (2019)	Emergency Operations Plan (LEOP)	Local Hazard Mitigation Plan	River Corridor Protection	Flood Regulations	Flood Regulations Last Updated	Flood Resilience Element in Municipal Plans	Corridor Protection, Setbacks and Buffers	Steep Slope/Ridgeline Development	Stormwater/LID Requirements
Arlington	7.5	Yes	Yes	Yes	Yes	No	Flood hazard areas incorporated in the "Special Designations" section of the Zoning Bylaw.	2019	Yes	No setback requirement in the Zoning Bylaw, but the Town Plan contains a Surface Waters and Riparian Areas section which says "An undisturbed buffer of native vegetation SHOULD be established along rivers, streams and other water bodies to reduce nutrient input and attenuate overland flow. This buffer SHOULD be 50 feet on smaller streams with minimal potential for lateral or vertical adjustment and 100 feet for larger streams and rivers with significant potential for such adjustments. For wetlands, the buffer should be 100 for class 1 wetlands 50 feet for class 2 wetlands".	There is no mention of steep slopes/ridgeline development in the Bylaw, but the Town Plan contains the following Forest Policy: "Large, unfragmented forests should remain intact to protect wildlife habitats, to slow and retain runoff, to protect water and air quality, and to provide sustainable forest uses such as timbering and maple sugaring and to provide recreational and scenic resources."	No mention of stormwater/LID regulations in either the Bylaw or Town Plan.
Bennington	17.5	Yes	Yes	Yes	Yes	Only FEH zones derived from Geomorphic Assessments. Statewide data are not incorporated.	Fluvial Erosion Hazard Zones and Special Flood Hazard Areas regulations are incorporated in the zoning bylaws as Overlay Districts.	2013	Yes	No, but Town Plan has an action item for shorelines and streambanks, including buffer strips: these shall be protected from uses, reclamation and development which would cause erosion, prohibit public access, or reduce scenic qualities.	Zoning requires location of fragile features and natural and cultural resources to be mapped/platted, as identified in the Town Plan including steep slopes.	Stormwater and erosion control plans are required as supporting documentation for subdivision applications. These plans must be prepared by a licensed VT engineer and be based on BMPs for managing stormwater and controlling erosion as defined by VANR.
Dorset	12.5	Yes	Yes	Yes	Yes	Only FEH zones derived from Geomorphic Assessments. Statewide data are not incorporated.	Fluvial Erosion Hazard Zones and Special Flood Hazard Areas regulations are incorporated in the zoning bylaws as Overlay Districts.	2013	Yes	Zoning requires 100 foot setback from class 1 wetlands, 50 feet from class 2 wetlands and 50 feet from the top of bank of lakes, ponds, rivers and streams for all structures. Zoning also requires site design to protect surface waters, associated setbacks and vegetative buffers.	In all zones construction of any new buildings shall not be permitted where slopes are 20% or greater in their natural, ungraded state.	No mention of stormwater/LID regulations in either the Bylaw or Town Plan.
Glastenbury	7.5	No	Yes	Yes	Yes	No	There are no mapped flood hazard areas in this high elevation town.	N/A	Yes	All structures, fill, and excavation are prohibited with 100 feet of the all surface waters and all timbering activities must conform to the BMPs as defined by VANR.	All development on slopes greater than 20% is prohibited.	No mention of stormwater/LID regulations in either the Bylaw or Town Plan.

Town	ERAF Rate (%)	NFIP Community	Road and Bridge Standards (2019)	Emergency Operations Plan (LEOP)	Local Hazard Mitigation Plan	River Corridor Protection	Flood Regulations	Flood Regulations Last Updated	Flood Resilience Element in Municipal Plans	Corridor Protection, Setbacks and Buffers	Steep Slope/Ridgeline Development	Stormwater/LID Requirements
Manchester	17.5	Yes	Yes	Yes	Yes	Yes	Special Flood Hazard Areas and River Corridor regulations are incorporated in the zoning bylaws as Overlay Districts.	2018	Yes	Setbacks from surface waters are 50 feet for most zoning districts, but are 10 feet in the downtown district and 20 feet in commercial districts.	The Town Plan states that steep slopes are not an appropriate location for development but does not specify any regulatory requirements. Most discussion of development in steep slopes and ridgelines address scenic impacts.	Development disturbing 10,000 Ft2 requires an erosion control plan prepared by a professional engineer in accordance with VT Standards and Specifications for Erosion Prevention and Erosion Control. GSI practices are required in the SFHA.
Manchester Village	7.5	Yes	No	Yes	Yes	Yes	Flood Hazard Regulations and FEH are incorporated together as "Civil Ordinances".	2014	Yes	No new structures shall be placed and no land shall be excavated, filled or graded in any zoning district w/in 70 feet from the normal bank of any stream, pond or lake except with the approval of the DRB as a conditional use.	No mention in the zoning bylaw. The town plan states "Lands with slopes greater than 15% may be limited for development, because of thin soils, susceptibility to erosion and difficulty siting roads. Lands with slopes greater than 20% have severe limitations and should not be developed."	No mention of stormwater/LID regulations in either the Bylaw or Town Plan.
North Bennington	7.5	Yes	Yes	Yes	Yes	No	Unified Zoning and Subdivision: Flood Hazard Overlay District	2013	Yes	No structures shall be placed and no land shall be excavated, filled or graded in any zoning district within 100 feet from the normal bank of any waterbodies. Land within 50 feet from any stream shall not be stripped of natural vegetation and shall remain as an undisturbed natural buffer. The Shoreland Protection Zone extends these setbacks to 200 feet from Lake Paran.	No mention in the zoning bylaw. A policy in the natural resources section of the town plan states "Development on lands with slopes greater than 20 should be avoided. Carefully plan development with a required erosion control and soil stabilization plan for any development on slopes in excess of 15%.	Sud-division regulations require stormwater management plans that comply with all applicable state standards and shall not lead to adverse impacts on the municipal drainage system, surface or ground water, or any other property in the area.
Old Bennington	7.5	No	No	Yes	Yes	Not applicable.	No mapped flood hazard areas.	NA	No	No	No	No mention of stormwater/LID regulations in either the Bylaw or Town Plan.

Town	ERAF Rate (%)	NFIP Community	Road and Bridge Standards (2019)	Emergency Operations Plan (LEOP)	Local Hazard Mitigation Plan	River Corridor Protection	Flood Regulations	Flood Regulations Last Updated	Flood Resilience Element in Municipal Plans	Corridor Protection, Setbacks and Buffers	Steep Slope/Ridgeline Development	Stormwater/LID Requirements
Pownal	7.5	Yes	Yes	Yes	No	No	Unified Zoning and Subdivision: Flood Hazard Overlay District	2020 Draft	Yes	No structures or on-site sewage system shall be placed and no land shall be excavated, filled or graded in any zoning district within 50 feet from the top of bank except with the approval of the DRB. Town plan flood resiliency section calls for a 100 foot vegetated buffer along all surface waters.	Any development requiring a site plan or conditional use review that involves development on lands 20% or greater in slope must include a Stormwater Master Plan that includes provisions for erosion control, treatment of runoff and re-vegetation of any disturbed soils.	Any development requiring a site plan or conditional use review that involves development on lands 20% or greater in slope must include a Stormwater Master Plan that includes provisions for erosion control, treatment of runoff and re-vegetation of any disturbed soils.
Rupert	7.5	Yes	Yes	Yes	Yes	Only FEH zones derived from Geomorphic Assessments. Statewide data are not incorporated.	Fluvial Erosion Hazard Zones and Special Flood Hazard Areas regulations are incorporated in the zoning bylaws as Overlay Districts.	2011	No	As a condition of conditional use, subdivision or PUD approval the DRB shall require a 25 foot undisturbed riparian buffer from class 3 wetlands and 50 feet undisturbed buffers from class 2 wetlands and all surface waters.	All development involving the excavation, filling or regrading of land on slopes greater than 15% shall require a conditional use permit including erosion cand sediment control plans. Development is prohibited on lands with slopes greater than 30%.	SWMPS may be required as conditional use, subdivision or PUD on lands with slopes greater than 15%
Sandgate	7.5	Yes	Yes	Yes	Yes	Only FEH zones derived from Geomorphic Assessments. Statewide data are not incorporated.	Fluvial Erosion Hazard Zones and Special Flood Hazard Areas regulations are incorporated in the zoning bylaws as Overlay Districts.	2013	Yes	No structures shall be placed and no land shall be excavated, filled or graded in any zoning district within 100 feet from the normal bank of any waterbodies nor should land within 25 feet from any stream be stripped of natural vegetation except with the approval of the Planning Commission.	Not addressed in the bylaw, but is mentioned in both the HMP and Town Plan, which states "Development should be restricted in high elevations, steep slopes or poor soils where environmental damage is likely to occur."	Not addressed in the bylaw, but the Town Plan contains sections and policies on stormwater planning, LID and GSI.
Shaftsbury	7.5	Yes	Yes	Yes	Yes	No, but an action item in the 2019 Town Plan calls for the adoption of the DEC river corridor protections.	Unified Zoning and Subdivision: Flood Hazard Overlay District	2017	Yes	No new structures shall be placed and no land shall be excavated, filled or graded in any zoning district w/in 50 feet from the normal bank of any stream, pond or lake except with the approval of the DRB as a conditional use.	No mention of steep slopes in the zoning bylaw but the Town Plan natural features section states that "Slopes greater than 15% are generally not suitable for development including road and driveway construction and maintenance."	No mention of stormwater/LID regulations in either the Bylaw or Town Plan.
Stamford	7.5	Yes	Yes	Yes	Expired	Yes	Special Flood Hazard Areas and River Corridor regulations are incorporated in the zoning bylaws as Overlay Districts.	2020	Yes	No setback requirement in the Zoning Bylaw, but the Town Plan contains a Surface Waters and Riparian Areas section which says "An undisturbed buffer of native vegetation SHOULD be established along rivers, streams and other water bodies to reduce nutrient input and attenuate overland	In the Forest district all structures must be located below 2,500 feet in elevation and on slopes less than 25%.	A site plan is required for conditional uses and shall contain provisions for erosion control or a stormwater management plan.

Town	ERAF Rate (%)	NFIP Community	Road and Bridge Standards (2019)	Emergency Operations Plan (LEOP)	Local Hazard Mitigation Plan	River Corridor Protection	Flood Regulations	Flood Regulations Last Updated	Flood Resilience Element in Municipal Plans	Corridor Protection, Setbacks and Buffers	Steep Slope/Ridgeline Development	Stormwater/LID Requirements
										flow. This buffer SHOULD be 50 feet on smaller streams with minimal potential for lateral or vertical adjustment and 100 feet for larger streams and rivers with significant potential for such adjustments. For wetlands, the buffer should be 100 for class 1 wetlands 50 feet for class 2 wetlands".		
Sunderland	7.5	Yes	Yes	Yes	Yes	Yes	Special Flood Hazard Areas and River Corridor regulations are incorporated in the zoning bylaws as Overlay Districts.	2020	Yes	Subdivision regulations require establishing setbacks and buffer areas at least 75 feet from the mean water level of all surface waters and class 1 and 2 wetlands.	No development shall occur on lands where slopes exceed 20%.	Subdivisions creating three or more lots may require stormwater management plans, erosion control plans and sedimentation plans. No mention of LID.
Woodford	7.5	Yes	No	Yes	Expired	No	Flood Hazard Regulations as stand-alone bylaw.	2015	Yes	As per the zoning bylaw, no structures or on-site septic systems shall be placed, and no land shall be excavated, filled or graded in any zoning district within 50 feet of the mean water level of all surface waters and wetlands except with conditional use approval by the ZBA. The Town Plan suggest a 50 foot native vegetation buffer along all rivers and streams.	Not addressed in the bylaw, but is mentioned in the Town Plan, which states "In areas where slopes exceed 15% very careful planning and design are required to overcome problems caused by thin soils, erosion hazards and difficult road construction. Grades in excess of 20% pose particularly severe problems and development in these areas should be avoided."	Not addressed in the bylaw or the Town Plan.