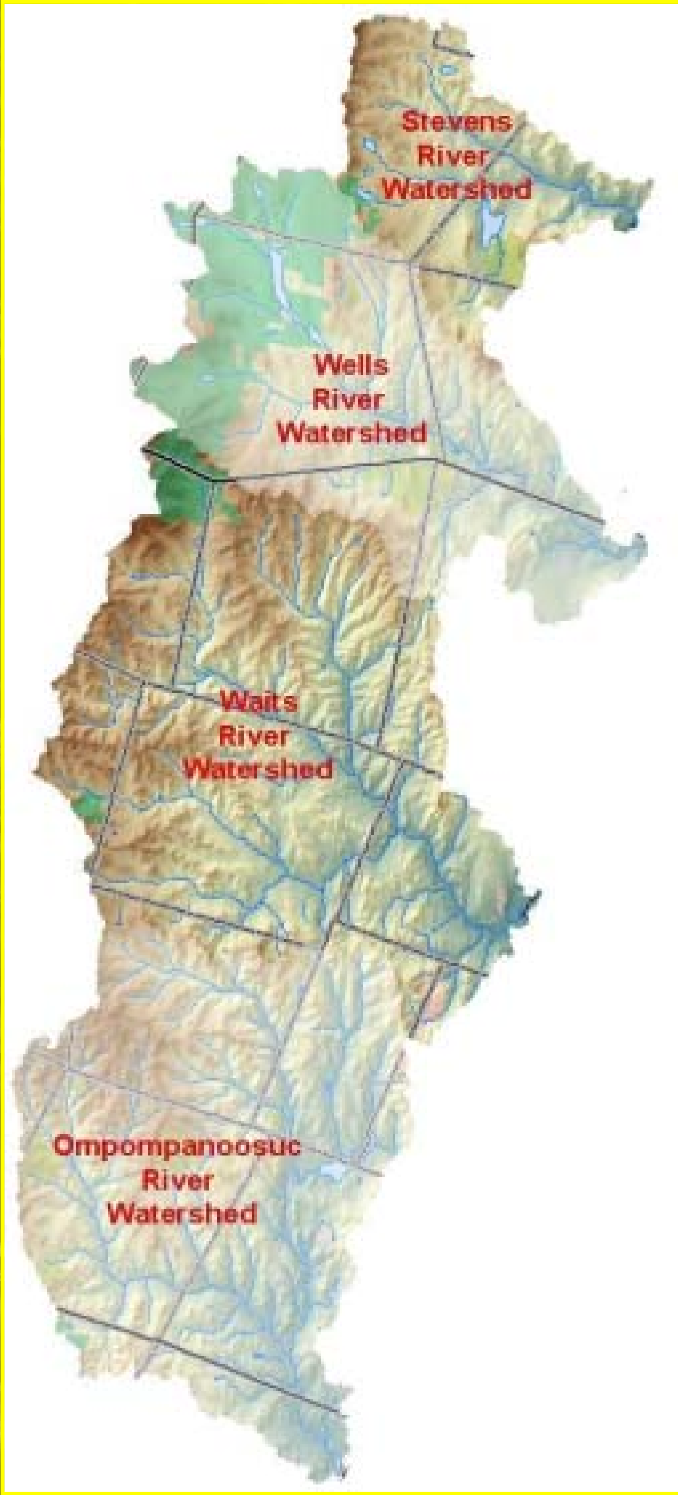

Basin 14 "Little Rivers" Water Quality Management Plan

Covering the Stevens, Wells, Waits, and Ompompanoosuc River Watersheds

June 2008

THE BASIN 14 "LITTLE RIVERS" WATER QUALITY MANAGEMENT PLAN WAS PREPARED IN ACCORDANCE WITH 10 V.S.A. § 1253(D), THE VERMONT WATER QUALITY STANDARDS, THE FEDERAL CLEAN WATER ACT AND 40 CFR 130.6

Approved and adopted:

Laura Pelosi
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Vermont Department of Environmental Conservation

6/26/08
Date

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6/26/08
Date

ACKNOWLEDGEMENTS

While this plan was produced by the Vermont Agency of Natural Resources `its development would not have been possible (or effective) with out the considerable involvement of numerous outside individuals, watershed and lake organizations, conservation commissions, and state and federal agencies too numerous to list completely.

However, particular recognition is deserved for the members of the Stevens, Wells, Waits and Ompompanoosuc River Watershed Councils who spent many hours in meetings discussing issues and developing strategies as well as ensuring their effectiveness at a local level. Other organizations that have been heavily involved in the watershed planning process include a number of town selectboard, planning and conservation commissions and members, the White River, Caledonian County and the Association of Natural Resource Conservation Districts, the Natural Resources Conservation Service as well as the Northeast Vermont Development Association, and Two Rivers Ottauquechee Regional Planning Commissions. Three watershed groups, the Friends of the Ompompanoosuc River, Save Everyone's Wells River and Connecticut River Joint Commissions have also played a key role in the development of this plan as well all of the many lake associations in the watershed.

Finally, the development of this plan would not have been possible with out the many towns, organizations and schools that provided meeting space for the regular meetings that were required for the development of this plan. These include town meeting spaces in the towns of Strafford, Bradford, Corinth, Groton, Norwich and West Fairlee, the South Ryegate Presbyterian Church, Northern Woodlands, the Corinth, Bradford, Baldwin, Groton, Latham and Peacham Libraries, and the Blue Mountain, Barnet, and Waits River Valley schools, as well as the Thetford Academy.

EXECUTIVE SUMMARY

This river basin water quality management plan provides an overview of the health of Basin 14 and a description of the prospective and ongoing steps to restore and protect its waters. With the purpose of improving both water quality and aquatic habitat, this plan presents the recommendations of local watershed residents, stakeholders from varying interests, the Agency of Natural Resources (ANR) and natural resource professionals from other state and federal agencies to guide efforts in this basin.

Basin 14 includes the watersheds of the Stevens, Wells, Waits and Ompompanoosuc rivers. Differences among these four watersheds and recommendations from local residents led to the formation of separate watershed councils and the identification of many issues and strategies for each of the four individual watersheds in the basin. Waters in this basin support many uses including swimming, boating and fishing in the basin's many rivers, streams, lakes and ponds. Threats to these uses across all four watersheds include stream channel instability, sedimentation and nutrient enrichment. A number of surface waters in the watershed are also impaired by elevated phosphorus levels (Ticklenaked Pond), elevated *E. coli* levels (the Ompompanoosuc River) and copper mine runoff (Copperas Brook, Schoolhouse Brook, the West Branch of the Ompompanoosuc River, and Pike Hill Brook).

This water quality management plan includes strategies developed for Basin 14 as a whole, listed in Chapter One, and for each watershed individually, listed in Chapters Two through Five. These strategies address nonpoint source (NPS) pollution, river corridor management issues, transportation-related water quality impacts, lake and dam issues, and a lack of water quality awareness. Strategies were developed for reducing NPS pollution from developed, agricultural and forested lands. River corridor management strategies were developed for each watershed to protect stable reaches and river corridors, increase the participation of local residents in river corridor protection, and complete restoration projects identified through watershed assessments. Strategies to address water quality impacts from transportation infrastructure include reducing conflicts between streams and culverts, and minimizing stormwater and sediment runoff from roads. Lake and dam related strategies were developed to address exotic invasive species, acid precipitation and elevated mercury levels, threats to wetlands, impacts from dams on aquatic habitat, and the effects of shoreline development. Chapters covering the Stevens, Wells and Waits river watersheds include strategies for improving water quality awareness through increased volunteer water quality monitoring and assessment, and by promoting water quality education and outreach.

Remediation plans for impaired waters and waters of concern were identified in each watershed in the final sections of Chapters Two through Five including an overview of acid mine drainage in the Ompompanoosuc and Waits River watersheds. Methods for setting management goals are discussed in Chapter Six, although a water management typing proposal is not included in this Water Quality Management Plan due to ongoing uncertainties in this process and discussions before the Vermont Water Resources Panel.

Over the next five years the Agency of Natural Resources will focus its efforts in these areas in collaboration with the community and other state or federal agencies as set forth in the plan to improve and restore waters in this Basin.

List of Figures and Tables

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Figure 2-2. Ben's Mill Trust
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Figure 3-3. Andy Mosedale
Figure 5-4. Mike Blazewicz
Figure 5-9. Army Corps of Engineers

Chapter 1 – Introduction and Common Concerns in Basin 14

Section 1-1 Introduction

Purpose of the Basin Plan and the Basin Planning Process

This river basin water quality management plan describes strategies to restore and protect the values and beneficial uses of surface waters in Basin 14, such as swimming, boating and aquatic habitat. The surface waters in Basin 14 include the small rivers and streams that drain into the Stevens, Wells, Waits and Ompompanoosuc rivers along with the ponds and wetlands in their respective watersheds. The four watersheds of Basin 14, also referred to as the Little Rivers watershed, are tied together as one of 17 river basins in the State of Vermont (see Figure 1-1). Planning for the Stevens, Wells, Waits and Ompompanoosuc river watersheds has been done separately at the request of community participants because each river forms a discrete watershed.

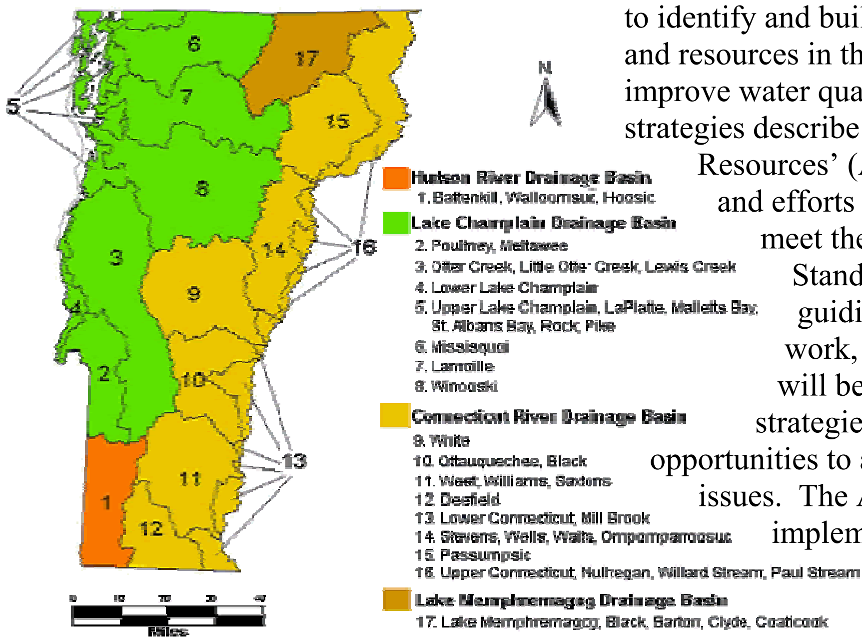


Figure 1-1. Major Planning Basins in Vermont

The majority of strategies identified in this plan are the result of a basin planning process that sought community involvement to identify and build upon existing interest and resources in the basin to protect and improve water quality. The remaining strategies describe the Agency of Natural Resources' (ANR) existing programs and efforts to have all surface waters meet the Vermont Water Quality Standards. In addition to guiding the Agency in its work, individuals and groups will be able to use these strategies to identify resources and opportunities to address water quality issues. The Agency and others began implementing strategies during the basin planning process and will continue implementation until the planning process begins again in five years.

Planning at the Watershed Level

A watershed, or a larger unit such as a basin, is a distinct land area that drains into a particular waterbody either through channelized flow or surface runoff. Preparing a plan at a watershed level allows for the consideration of all contributing sources of surface water runoff to the waterbody.

The Agency of Natural Resources has conducted water quality assessment and improvement efforts at a watershed level since the 1970s. The state is divided into 17 planning basins for this purpose, with each basin including one or more major river watersheds. The Agency is responsible for preparing river basin water quality management plans for each of the 17 major basins and updating them every five years after the plan is originally approved.

Plan Development as a Collaborative Process

Planning through a collaborative process with the communities in the basin, local, state, and federal governments, private organizations and individuals is an effective method for addressing present water quality problems in Vermont. This is because the state's water quality problems are predominantly the result of runoff from many dispersed activities on the land, such as cropping, lawn care and landscaping, and urban stormwater management which are all considered nonpoint source pollution. Reducing the load of pollutants from these activities requires the participation of many different sectors of the community, each composed of numerous parties.

As many as 65 volunteer-based groups in the state have already begun this collaborative planning process as they are working with members of their community and resource agencies to improve water quality within their own watersheds. The Agency's basin planning process helps advance existing efforts within the community as well as its own efforts by documenting community-voiced problems and solutions, facilitating the exchange of information among resource agencies, groups, and individual citizens, and finally, directing existing resources towards the priorities of active groups and landowners within the communities. Opening the basin planning process to the entire community also serves to increase public awareness of opportunities to promote and preserve water quality in the basin.

Watershed Council and Watershed Plan Development

In the winter of 2003/2004, the Agency sent out an open invitation to the communities within the Little Rivers watershed to participate in the development of a water quality management plan. The community members that came together as a watershed council represented a diverse mix of stakeholders from within the watershed. They included farmers, foresters, business owners, municipal officials, anglers, local watershed and lake shore organizations, environmental groups, teachers, and regional planners. The Department of Environmental Conservation (DEC) watershed coordinator and the watershed council went through the following steps over a three-year period:

- Issue identification
- Issue prioritization
- Strategy and solution development; and
- Identification of resources and funding

The DEC watershed coordinator worked with conservation commissions and conservation districts in each watershed and watershed groups such as Save Everyone's Wells River, and Friends of the Ompompanoosuc River in developing this plan as well as implementing water quality improvement projects during the watershed planning process.

Council membership and meeting attendance was continually open to the public. Technical advisors provided the council and watershed coordinator with information necessary to develop strategies to be included within the watershed plan. The watershed council was integral in the development of this document. Each of the council members took on a variety of roles including:

- Encouraging constituents' participation and conducting outreach and education to inform constituents about known watershed issues
- Developing and conducting watershed forums to identify water resources issues (assets and problems), related community needs, and potential solutions
- Identifying immediate or ongoing water quality improvement projects to be undertaken during the planning process
- Guiding the plan through review, revision, and approval process

The planning process will occur for each watershed on a five-year cycle, incorporating planning, implementation, monitoring, and evaluation. Every fifth year, the renewed plan will direct a continually evolving course of watershed improvement activities for the basin.

How to Read this Basin Plan

This document is a compilation of work done by four independent watershed councils covering the Stevens, Wells, Waits and Ompompanoosuc River watersheds. Common issues across all four watersheds are covered in Chapter One of the plan. Chapters Two through Five of the plan each cover one of the four watersheds in the basin. Each of these chapters begins with a description of the watershed, including water-based resources, and water quality conditions. This is followed by five to six sections covering the top concerns and impaired and altered waters specific to each watershed. The organization of the basin plan with separate chapters for each of the four watersheds in Basin 14 has allowed for the development of individualized strategies and the engagement of active partners in each of the subwatersheds which would have been challenging working with Basin 14 as a whole.

Each section, with the exception of introductory sections for each chapter, begins with an overview of a watershed problem and a goal to address the problem. The goal is then broken down into objectives, which will be carried out through strategies, listed sequentially for the whole plan. Each strategy lists potential key players, funding sources, and a timeframe for the strategy to be completed. Due to the limited space, acronyms are used for many partners and funding sources that are defined at the end of this document on page 90. A glossary of terms is provided on page 91.

Section 1-2 DEC Monitoring Strategy

DEC is responsible for monitoring and assessing ambient water quality and support of designated uses for surface waters in the state. In addition, DEC determines whether or not selected waters are in compliance with Vermont's Water Quality Standards. The Water Quality Standards contain a large number of narrative standards and numeric chemical and biological criteria. DEC monitors and assesses water quality for selected criteria on selected waters in a watershed on a five-year rotating schedule. DEC sampled sites in the Little Rivers Basin during the 1997 and 2002 field seasons, and collected samples for processing again in 2007.

In addition, since 1979, the Agency, through the Department of Environmental Conservation, has worked with volunteer monitors to sample the water quality in lakes and ponds. The Vermont Lay Monitoring Program equips and trains local lake users to measure the nutrient enrichment of lakes by collecting water samples according to the program's EPA-approved Quality Assurance Project Plan. The state has also managed a program called LaRosa Analytical Partnership Program that has supported volunteer groups sampling waters to meet local needs. Details on assessments completed in each watershed are listed individually in Chapters Two through Five.

Section 1-3 Nonpoint Source Pollution in Basin 14

Similar to other areas of Vermont, nonpoint source (NPS) pollution is the major threat to the quality of surface waters in Basin 14. Unlike point source pollution, such as a direct discharge or outfall pipe, NPS pollution is more diffuse, harder to quantify and more difficult to control. Examples of this are nutrients, sediments and pathogens that run off from parking lots, gravel roads, fertilized lawns, logging operations, and agricultural fields.

The watershed approach helps communities address these water quality problems caused by NPS pollution and looks at not only a waterbody but also the entire area that drains into it. Public and private groups have developed and used pollution prevention and reduction initiatives and NPS pollution controls, referred to as strategies in this Basin Plan, to clean up Vermont waters efficiently.

Impacts of Nutrient Enrichment, Sediment and Pathogens

High levels of nutrients, sediment and pathogens impact the health of our rivers and their quality for recreation. High levels of nutrients, primarily nitrogen and phosphorus, increase levels of algae in the water, which reduce the quality of water for recreation, and reduce dissolved oxygen levels, affecting fish and aquatic communities. Sediment can alter the habitat of the river, cover fish eggs and reduce the clarity of the water and its appeal for swimming and other recreational activities. Sediments also carry phosphorus, so in addition to direct impacts sediments also increase nutrient levels in surface waters. Finally, high levels of pathogens, generally measured as *Escherichia coli (E. coli)* increase the risk of gastrointestinal sickness limiting recreational uses of waters. Sources of *E. coli* can arise from nonpoint sources and point sources. Major nonpoint sources of pathogens include failing septic systems, runoff from agricultural lands, and pet and wild animal waste that washes into the river. Point sources can include straight pipes, point source discharges from agricultural operations, and stormwater discharges from urban areas.

Developed Land

Basin 14 is still primarily rural but the continued development of lands in the watershed threatens to increase NPS pollution if precautions are not taken. Developed land has the highest levels of phosphorus runoff compared to other land uses, as shown by a recent study of land use in the Lake Champlain watershed which estimated that 53% of phosphorus entering the lake came from urban lands covering just 6% of the watershed (Troy 2007). NPS pollution results from the initial construction of houses, commercial buildings, parking lots, and driveways, during which the rate of erosion is between 20 to 2000 times the rates of erosion from other land uses (Vermont Geological Survey, 1987). Even when the construction is finished, developed land can cause an ongoing discharge of sediment and NPS pollution from increased areas of compacted and impervious surface if not properly designed, stabilized and maintained. This stormwater runoff can be reduced by the installation of effective stormwater treatment systems and by using low impact development techniques such as careful siting, minimization of site clearing and the inclusion of rain gardens and other pollution abatement techniques.

The use of fertilizers on lawns is another source of phosphorus to surface waters in the watershed. This source can be reduced by using phosphorus free fertilizers, or eliminating the use of fertilizers altogether, since most lawns have sufficient phosphorus and only need nitrogen for full growth. The proper maintenance of healthy lawns can also reduce phosphorus pollution since bare soil in a poorly maintained lawn can result in the erosion of sediments into surface waters. Roads associated with development are also a source of NPS pollution, and are discussed in detail in Section 1-5 on page 10.

Agricultural Land

Agriculture gives the Little Rivers watershed much of its character. It also supports the economic base, cultural identity, and patchwork landscape of open and forested lands so highly valued in the watershed. In addition, as agricultural land is converted to suburban development, there is generally a net increase in nutrient production, so keeping agricultural land in active production along with NPS runoff control measures can support better water quality.

All farms in Vermont must meet the Accepted Agricultural Practices (AAPs) which are statewide regulatory requirements for agricultural land use practices created to reduce the amount of agricultural pollutants entering waters of the state from farmland. The AAPs were designed to reduce nonpoint pollutant discharges through implementation of improved farming techniques rather than investments in structures and equipment. Appendix B discusses the AAPs in greater detail and has a link to where these can be found online. In addition to the AAPs, large and medium sized farms, which are defined roughly as farms with more than 700 and 200 mature cows respectively, must meet stricter regulations. These regulations state that no waste (manure, spoiled feed, milkhouse liquids, or barnyard runoff) may leave the production area and enter surface water, and require the completion of a nutrient management plan. While there are no large farms in Basin 14, there are two medium sized farms in each of the Stevens and Wells River watersheds (Agency of Agriculture Farms and Markets 2007a&b).

Beyond the AAPs and large and medium farm regulations, many farms install Best Management Practices (BMPs), which are voluntary practices to correct a current waste management problem on a specific farm. BMPs typically involve the installation of structures, such as manure storage systems, milkhouse waste treatment, stream fencing to reduce agricultural NPS pollution, and a variety of other practices that improve water quality. The expense of installing many of these practices makes federal and state funding necessary to make them affordable for farmers. An example of this is the Conservation Reserve Enhancement Program (CREP) which funds the establishment of buffers between agricultural lands and surface waters, paying farmers a rental rate for taking land out of production in addition to sharing the costs of fencing and tree plantings. The Environmental Quality Incentives Program (EQIP) and state best management practices cost share program are the primary funding sources for structural improvements on farms, and can fund a number of conservation practices. The local Natural Resource Conservation Service (NRCS) works closely with farmers to implement BMPs. For all of Basin 14, including the Stevens, Wells, Waits and Ompompanoosuc river watersheds, there have been 29 Best Management Practices implemented over the past decade that have involved cost share dollars (AAFM 2007c).

The consolidation of farms in the watershed is concentrating animals and their associated pollution in just a few places. This has made implementation of manure storage on those individual farmsteads ever more important. Manure storage facilities that were adequate 10 years ago are frequently undersized today. Upgrading and maintenance of pollution control practices on farmsteads will be a priority in the watershed.

While there has been a consolidation of dairy farms in the watershed, there has also been an increase in number and diversity of small farms. This is shown in the trend of the past 15 years in both Caledonia and Orange counties of an increase in the number of farms which have, on average gotten smaller. In total, this has resulted in a decrease in the total number of acres in agricultural production in these two counties but an increase in the number of small farms. Many of the smaller farms are not involved in current Best Management Practices (BMP) programs but will likely play a larger role in reducing NPS pollution in Basin 14 as their numbers are likely to continue to grow in the future.

There has been a significant increase in the number of organic dairy farms in Vermont over the past few years. This transition may be beneficial to water quality as the use of pesticides is eliminated and daily pasturing means there is less concentration of manure. As of 2006, there were 34 organic dairy farms covering 8681 acres in Orange and Caledonia counties and it is expected that number will rise in future years (AAFM 2007a&c). Additional organic vegetable, field crop, fruit and livestock operations cover over 2000 acres in Orange and Caledonia counties. In total, over 5% of agricultural land in Orleans and Caledonia counties has been certified as organic (AAFM, 2007a&c).

Logging and Forested Land

Forested lands contribute the lowest amounts of nutrients, sediment and other pollutants into Vermont streams per acre as compared to other land use. This, however, does not mean that this watershed land use should be ignored for possible improvements to water quality, especially because forestland makes up over 82% of Basin 14. The major sources of NPS pollution from forested lands are erosion from logging operations and associated roads and staging areas.

Much of the erosion can be prevented by following Acceptable Management Practices (AMPs) for maintaining water quality on logging jobs in Vermont. These practices list buffers along streams and road construction guidelines among other practices that protect water quality, and provide protections for the landowner and logger if the practices are followed.

Landowners can play a large part in encouraging good silvicultural practices by working with a forester to develop a management plan. On lots over 25 acres landowners can enroll in Vermont's Use Value Appraisal Program which requires the development of a 10 year forest management plan certified by the Department of Forests Parks and Recreation (DFPR) in exchange for property tax rates based on forestland value. Landowners can also make a contract when hiring a logger stipulating certain protective practices to limit erosion.

COMMON GOAL: REDUCE THE AMOUNT OF NPS POLLUTION AND SEDIMENT ENTERING BASIN 14 STREAMS, RIVERS AND LAKES.

Objective: Reduce levels of NPS pollution from agricultural, developed, and forested lands.

1. Enroll farmers into CREP or State BMP buffer programs on one mile of riverbank in Basin 14.

Potential key players: NRCS, AAFM
Potential funding sources: CREP, State BMP funding
Time-frame: 2012

2. Continue offering Nutrient Management Plan (NMP) courses and financial incentives with a goal of 50% of the acreage of agricultural lands in the watershed with current NMP and 100% in the Ticklenaked Pond watershed.

Potential key players: NRCS, AAFM, UVM -Ext
Potential funding sources: EQIP, NMPIG
Time-frame: 2012

3. Continue and expand work with agricultural producers to reduce runoff from farmsteads and farm fields with a priority on farms within the Ticklenaked Pond watershed.

Potential key players: NRCS, AAFM
Potential funding sources: EQIP, State BMP
Time-frame: ongoing

4. Lead a series of educational workshops for part-time farmers and horse owners in Basin 14 covering best management practices.

Potential key players: NRCS, WRNRCD, CCNRCD, UVM - EXT
Potential funding sources: CRJC PG
Time-frame: 2010

5. Provide outreach to landowners about impacts of over-fertilizing lawns and the importance of establishing and maintaining buffer strips along streams and ponds to reduce NPS pollution. Distribute "Don't P on the Lawn" brochure.

Potential key players: conservation commissions, CCNRCD, WRNRCD
Potential funding sources: CRJC PG, WEF, C&C,
Time-frame: 2010

6. Hold educational workshops for forest landowners with forestry groups such as Vermont Coverts.

Potential key players: NRCS, DFPR, Local Vermont Coverts cooperators, Center for Woodland Education
Potential funding sources: WEF
Time-frame: 2008 ongoing

7. Increase logger education on water quality issues through the Center for Woodland Education, the LEAP program and the Vermont Loggers Association's Forestry Academy to encourage good forestry practices in the watershed.

Potential key players: NRCS, DFPR, Local Vermont Coverts cooperators, Center for Woodland Education, LEAP program
Potential funding sources: WEF
Time-frame: 2008 ongoing

Section 1-4 River Corridor Management in Basin 14

Towns in the Little Rivers watershed, like many others in America, were established and developed along rivers and waterways. Before roads and electricity, the benefits of a river as a source of transport and power far outweighed the risks of flooding for most settlements. In addition, less was understood about the environmental impacts caused by development along rivers and modifications of river banks and channels. As towns and communities have grown, so have the costs of flood damage and the impacts to the riverine environment. The past century has been one of great change for the Little Rivers watershed. The watershed was cleared of forests, wetlands were lost, rivers and streams in the watershed were channelized and armored. In addition riparian vegetation was removed and areas of the floodplain were filled. The result of all these activities has been significant changes to the stability of the Stevens, Wells, Waits, and Ompompanoosuc rivers and their tributaries.

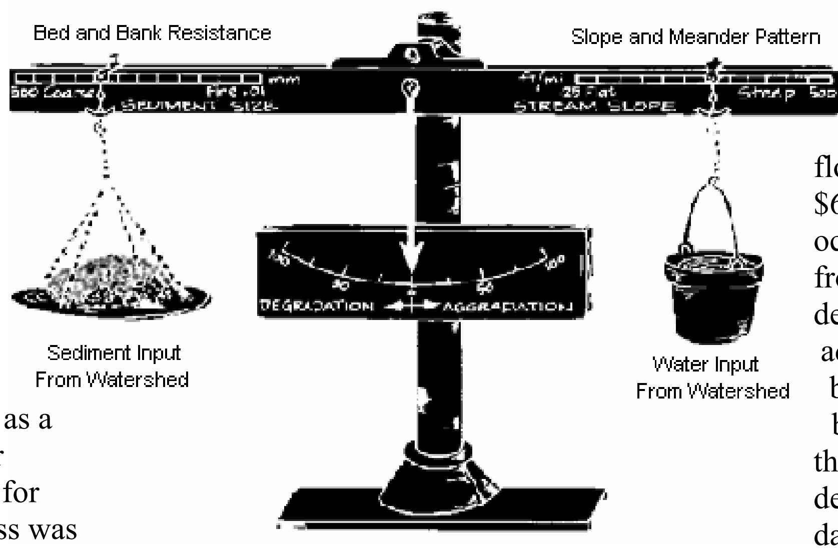


Figure 1-2. Stable channel equilibrium (Lane 1955)

Experience and science have shown that a stable, balanced river—one that is just wide enough, deep enough and long enough to move the amount of water and gravel produced in its watershed—will erode its banks and change course only minimally, even in a flood situation. However, if a river becomes "unbalanced," then it will change course, slope, depth, or width—or all four— until it becomes balanced again (see Figure 1-2). An important way to keep rivers from becoming unbalanced, or to allow them to re-establish balance, is to protect their "river corridors." River corridors consist of the river channel, the banks on either side, and the areas close to the river that carry flood water and accommodate the meander pattern of the river (DEC 2004).

Unbalanced rivers increase the risk of damage from flooding to our communities—and it's an expensive risk. From 1995 through 1998, flash flooding damage in Vermont approached $60,000,000. Much of this damage occurred where rivers had been separated from their floodplains by some kind of development, or where rivers had been adjusting their length, depth or width because activities in the river, on the banks, or in the flood plains, had caused the rivers to become unbalanced and destabilized. The dollar cost of such damage may well be equaled by other economic losses including diminished recreation opportunities, impaired ecological functions, and long-term channel instability.

Until recently, river management has largely focused on water and how to contain or withstand the force of its flow. Throughout North America river scientists and managers are now bringing the principle of river "stability" into the management of river corridors. This has meant understanding that human activity near rivers must not only withstand the forces of running water but must avoid changing the movement of sediment (sediment regime) in the river in order to remain secure. Stream or river channels are a reflection of what goes into them (water, ice, sediment and woody debris) and the valley type within which the stream is located. The shape of a river channel including its dimension (the width and depth), its pattern (or plan form), and its profile (or slope), is developed and maintained over time by the action of water, sediment, and debris that drains from the surrounding area. This "channel forming flow" is approximated by the average annual high water event, which, by virtue of its frequency, does the greatest amount of "work" on the channel and floodplain and transports the greatest volume of sediment over time. Stable rivers are recognizable by their ability to carry water, sediment and debris, even during high water, without changes occurring in the depth, width, length, or slope of the channel. Figure 1-2 illustrates a stable channel balance and indicates the relationship between the watershed inputs of water and sediment, channel slope, channel boundary resistance (sediment size), and the physical response of the channel either by aggradation (building up of sediment) or degradation (eroding down). A change in any one of these parameters will cause adjustments of the other variables or a physical response of the stream channel until the system regains its balance. Human land uses, especially within river corridors, that significantly alter the runoff patterns of water or sediment will trigger a channel adjustment process. When these processes change the relationship of the river with its floodplain it becomes increasingly difficult to plan and very expensive to maintain those land uses.

Floodplain Access and Channel Evolution

Cutting a river off from its floodplain by raising bank heights, armoring, or deepening a channel will cause a river to attempt to regain its balance through physical change. The result of containing greater flows in the channel, or preventing access to the floodplain, is to increase the stream's power that must be resisted by the channel boundary materials; i.e., the rocks, soil, vegetation or manmade structures that make up the bed and banks of the river. Figure 1-3 shows channel evolution as predicted by the model published by Shumm (1984). These diagrams only illustrate channel response at one cross section. There are equally profound physical adjustments that occur upstream and downstream from the site of alteration as bed degradation in the form of head cuts migrate up through the system and sedimentation occurs downstream. It is important to recognize the temporal aspect of channel response to change. Fluvial systems are energized by episodic events, such as large floods. Channel adjustment in response to management practices or encroachments may begin immediately but may also persist for decades depending on the sensitivity and morphology of the affected stream, the magnitude of

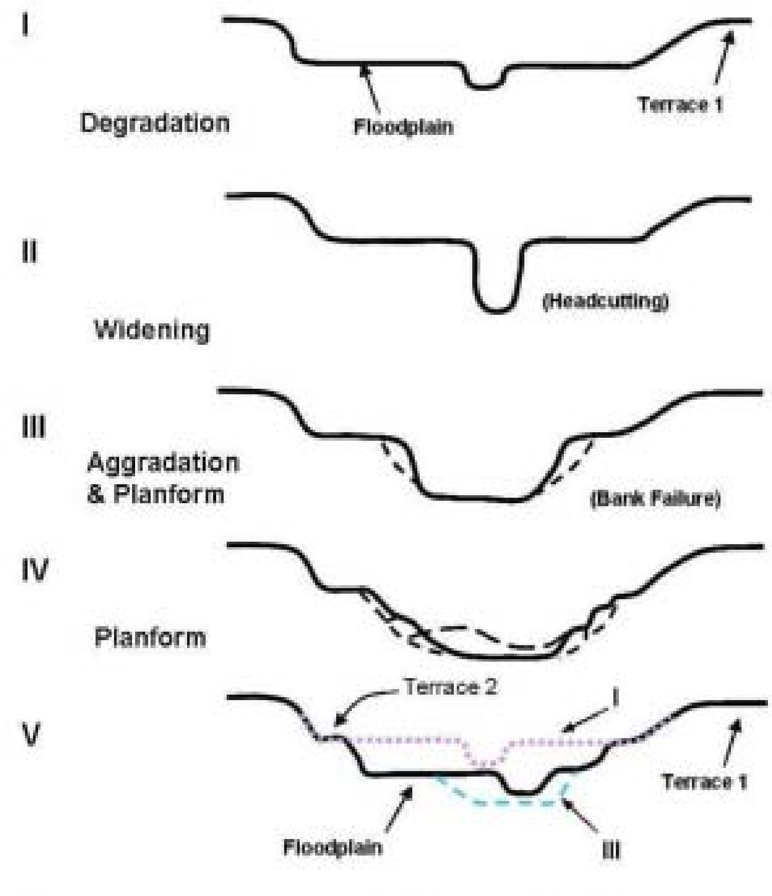


Figure1-3. Five Stages of Channel Evolution in Vermont Rivers Shumm (1984)

alteration, and the frequency of high flow events. The first three stages might occur within a few months to a few years. The last three might not reach completion for one hundred years or more (DEC 2004).

Geomorphic Assessments

The River Management Program at DEC has developed fluvial geomorphic assessments to help lay people understand how human activities over time within a watershed can be conducted in a manner that is both ecologically and economically sustainable and to allow for sound land use practices and planning at the watershed scale. These assessments are broken down into three phases to identify the physical condition, sensitivity, and adjustment process for rivers and streams in the watershed. **Phase 1**, the remote sensing phase, involves the collection of data from topographic maps and aerial photographs, from existing studies, and from limited field studies, called "windshield surveys." **Phase 2**, the first field assessment phase, involves the collection of data from measurements and observations at the reach or sub-reach (segment) scale. A reach is defined as a section of a stream having similar attributes such as width, depth and substrate. Finally **Phase 3**, the survey-level field assessment phase, involves the collection of detailed field measurements at the sub-reach or site scale and is used for designing specific restoration projects (DEC 2006).

River Corridor Planning and Fluvial Hazard Mitigation

The results from geomorphic assessments in progress or completed for much of Basin 14, can be used to develop river corridor plans for rivers in the Little Rivers watershed. Such plans will be important to restoring or maintaining the equilibrium condition of rivers in the watershed by reducing current or future constraints on the river that cause instability. A river corridor plan includes a process for selecting and implementing river corridor management alternatives and provides a basis for corridor protection through various land use planning and incentives programs.

River corridors plans can also define flood hazard zones or overlay districts. Fluvial (or river-related) Erosion Hazard (FEH) mapping identifies areas of high risk for bank failure and erosion during flooding. These fluvial erosion hazards cause most of the flood damage in Vermont as opposed to damage from inundation which is what current Federal Emergency Management Agency (FEMA) flood maps address through the National Flood Insurance Program (NFIP). All towns in the basin participate in the National Flood Insurance Program with the exception of the towns of Peacham and Vershire.

Through the development of an FEH map, towns can clearly identify areas where development is inadvisable. Once produced an FEH map could be used to develop a zoning overlay district to place limits on structures, land use activities, or even vegetative condition to protect property from fluvial erosion hazards and to allow the river the space it needs to return to an equilibrium condition.

Riparian Buffers

Even in areas where the river channel is stable, the river bank will likely be subject to accelerated erosion if riparian vegetation is absent. Riparian vegetation includes trees, shrubs, and herbaceous plants that grow naturally on, and adjacent to, the banks of rivers and streams. As defined by the Agency of Natural Resources buffer guidance procedure, the width of riparian vegetation needed for maintaining healthy streams and rivers varies depending on the size, slope and geomorphic stability of the river, as well as the erodability of the soils. Significant natural communities or wildlife travel corridors can also justify wider buffers to protect these resources.

Riparian buffers also play important roles in maintaining a healthy riverine ecosystem. Vegetated buffers provide shade to reduce surface water temperatures; filter sediments, nutrients, and other pollutants from runoff; provide shade and food for aquatic organisms; provide cover and substrate for fish and aquatic insects; provide habitat to species whose life cycles include water and upland; offer cover for species traveling between habitats; slow floodwaters; and control ice damage.

Goals and strategies related to river corridors are listed separately for each watershed in Basin 14 in Chapters Two through Five due to the importance of local support and involvement for implementing strategies related to river corridor management.

Section 1-5 Transportation-Related Pollution in Basin 14

Transportation infrastructure is essential to the Vermont economy by allowing people and goods to move through the rural landscape. Transportation infrastructure includes roadways, road approaches and embankments, road drainages, rail systems, driveways, recreation paths, airport runways, and culverts. Despite the often quoted Vermont saying that "you can't get there from here," Vermont has an extensive network of over 14,000 miles of paved and gravel roads (over 80% of which are maintained by local municipalities) 600 miles of operating rail lines (305 state owned), over 70 miles of bicycle/ pedestrian facilities, and countless miles of private driveways. In Basin 14, there are over 850 miles of state and town roads, and nearly an equal length of private roads and driveways. Transportation infrastructure can be a significant source of NPS pollution to rivers and streams if infrastructure is not properly sited, constructed and maintained.

Railroads and roadways have historically followed rivers and streams. This close proximity contributes to runoff of pollutants, sediment, and stormwater into waterways. *The Vermont Better Backroads Manual* (Northern Vermont Resource and Development Council 1995) explains: "Sediments impact aquatic ecosystems by smothering spawning and feeding habitat, disturbing the reproductive cycle of many organisms, decreasing water clarity, and adding excess nutrients to the water." Undersized bridges and culverts, and floodplain fill for transportation infrastructure constrain the natural movement of waterways, thus exacerbating flooding, erosion, sediment transport and other problems. Road-related fill that causes the river to lose access to its flood plain concentrates more energy within the channel, and will cause erosion and increased flooding in the watershed as discussed in Section 1-4. Undersized culverts are also an ecological challenge. They can be a barrier to fish and wildlife and prohibit movement through the landscape, thus cutting off and eliminating essential habitat.

Transportation infrastructure leads to NPS pollution in a number of ways, but many of these have to do with the amount and rate of water flowing over the surface of un-stabilized soils. An obvious example is the erosion of the road surface itself when it is not built or maintained with proper drainage. Other sources of sediment include: erosion from ditches that are not vegetated or lined with stone, bank failures near the road, bridges and culverts that wash out, erosion during road construction and maintenance, and sand runoff from winter maintenance of both paved and gravel roads. While these sources of sediment can involve significant amounts of money to fix, addressing sources of NPS pollution can save money over time by reducing the need for yearly road maintenance. For example, a Better Backroads funded project - the construction of rock and grass lined ditches along Manning Road in Hyde Park, Vermont, costing less than $6,000 - eliminated the need for yearly maintenance that would cost an estimated $18,250 over 10 years. This resulted in a net savings of over $12,000 to the town and cleaner water downstream. Another area with potential financial and environmental benefits is in increasing the effectiveness of sand and salt application in the watershed by developing guidance on their use as has been done in the Town of Norwich.

Towns can also adopt road and bridge standards consistent with those recommended by the Vermont Agency of Transportation in the *Handbook for Local Officials* to help reduce erosion and sedimentation (VTrans 2007). These standards include minimum requirements for seeding and mulching ditches, installing stone lined ditches and roadway and culvert standards. By adopting these standards the town match on class 2 projects is reduced from 30% to 20% and the town can receive increased disaster relief to rebuild roads up to adopted standards not just current road conditions. Another important policy for towns to adopt is a highway access policy. Poorly designed driveways are a common cause of flood damage to road systems and contribute a disproportionate amount of sediment to surface waters in Vermont (Vermont Local Roads Program 2004).

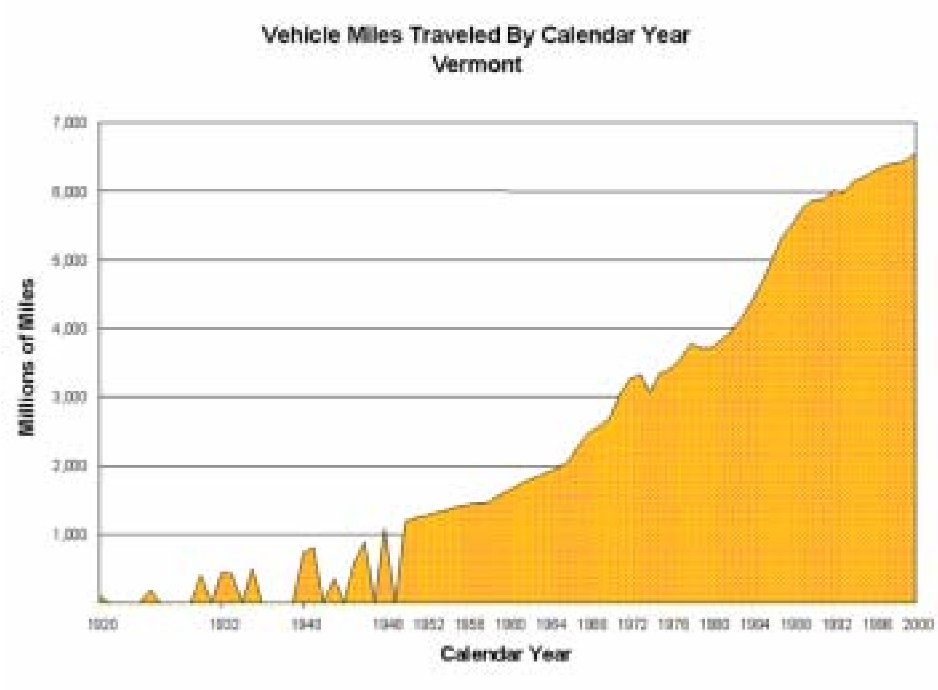


Figure 1-4. Vehicle miles traveled in Vermont

The increasing amount of traffic on Vermont roadways is another concern. To accommodate these increases, new roadways are often needed or existing roads are widened or left inadequate for the traffic they serve. New and wider roads, without adequate stormwater infrastructure, increase stormwater runoff, thus resulting in increased NPS pollution. Towns and regional planning commissions can work to reduce the miles driven in the watershed by encouraging land use planning and public infrastructure that supports compact, mixed use development. Increased density and mixed use is necessary for public transportation and walking and biking to be viable transportation alternatives. Rideshare programs, and appropriately designed and maintained park and ride, bicycle and pedestrian facilities also contribute to reducing the number of single occupancy vehicles on Vermont's roadways.

Transportation facilities are linked to growth and development patterns that affect the watershed. Transportation accessibility – the availability of well maintained roadways adequate to serve traffic volumes now and in the future - is a key determining factor in the *location* of land uses within the watershed. In addition, land use patterns that are spread across the landscape, such as car-oriented commercial strip development on the edges of towns and villages, require more transportation infrastructure such as numerous parking lots and thus more impervious surface than compact patterns. The quantity of impervious surface within the watershed and the adequacy of the treatment of storm water discharge from those surfaces greatly affect water quality.

Bridge and Culvert Surveys and Capital Improvement Budgets

The Agency has developed new bridge and culvert survey protocols to examine the size and configuration of bridges and culverts to determine: if they are large enough to accommodate the flows of the stream, and if they allow for the passage of sediment that is necessary to maintain a stable stream and if they provide for the passage of fish and wildlife. Using this information along with information on other problematic road sites, towns can apply for grants through the Better Backroads program to develop capital improvement budgets. Capital improvement budgets compare the total costs of projects with the potential savings along with considerations about ecological impacts. This information helps to prioritize road improvements over the five years of the plan. Towns can also apply for Better Backroads grants to correct specific road-related erosion problems impacting local lakes and streams.

Partners for Water Quality

In both 2006 and 2007, the Caledonia County Natural Resources Conservation District received funding through the Upper Connecticut Mitigation and Enhancement Fund to support area towns in reducing impacts from roads and culverts on water quality and aquatic resources. The goal of this grant has been to address erosion from roads and barriers to fish passage including undersized and poorly designed culverts. The approach has been to provide grants to towns to fix the highest priority road and culvert projects, as wells as provide administrative and technical assistance as needed. The CCNRCD has worked with the Town of Peacham on a number of projects and has been trying to engage the Town of Barnet in a similar way.

COMMON GOAL: MINIMIZE CONFLICTS BETWEEN STREAMS' NATURAL FUNCTIONS AND TRANSPORTATION INFRASTRUCTURE.

Objective: Reduce erosion from road surfaces, ditches and banks in Basin 14.

8. Hold a series of Local Roads workshops in Basin 14 to increase awareness of maintenance measures that will reduce gravel road erosion. Encourage the participation of all town highway managers and road crews in the watershed.

Potential key players: town selectboards and road commissioners, Local Roads Program, RMP
Potential funding sources: NVRCDC, CRJC PG
Time-frame: 2010

9. Develop capital road improvement budgets for all towns in Basin 14.

Potential key players: town selectboards, road commissioners
Potential funding sources: Better Backroads grants
Time-frame: 2012

10. Identify Better Backroad grant opportunities by touring watersheds with road commissioners from each town. Apply for Better Backroad grants in all watershed towns to address the most serious road-related erosion problems.

Potential key players: DEC, road commissioners, selectboards, Local Roads Program
Potential funding sources: Better Backroads grants, municipal stormwater mitigation grants, town highway funds
Time-frame: 2012

11. Compile guidance on winter sanding and salt application and distribute to towns in Basin 14 to encourage the development of policies that will reduce salt and sand application in the watershed. Provide outreach to the general public on the impacts of salt and sand application to reduce the pressure for their expanded use.

Potential key players: Road commissioners, VTrans, Local Roads Program, DEC
Potential funding sources: N/A
Time-frame: 2010

12. Work with road crews in the watershed to put in a grant for a hydroseeder that could be used by all towns in the watershed and possibly landowners to stabilize ditches.

Potential key players: Road crews and commissions, conservation commissions, and selectboard members in the basin, VTrans
Potential funding sources: Municipal Stormwater Mitigation Grant, Better Backroads grant
Time-frame: 2008

13. Work with all municipalities in the watershed to adopt and actively implement the following programs or standards:

A. Town road and bridge standards consistent with or exceeding those listed under Town Roads & Bridges Standards, Handbook for Local Officials, VTrans 2004.

B. Driveway/highway access (curb cut) construction ordinances meeting the standards outlined in the Highway Access Policy and Program Guidance and Model Ordinance, VT Local Roads Program, May 1997.

Potential key players: Road crews and commissioners, conservation commissions, and selectboard members in the basin, VTrans
Potential funding sources: Town Funds, Increased state match for class 2 road projects and reimbursement for disaster relief.
Time-frame: 2012

14. Compile available bridge and culvert survey data in the basin and present this information to watershed towns and develop a list of priority culverts for replacement based on likely hood of culvert failure, geomorphic impacts and aquatic species passage concerns.

Potential key players: Road crews and commissions, conservation commissions, and selectboard members in the basin, VTrans, TRORC, NVDA, RMP, DFW
Potential funding sources: Better Backroads grant, UCM&E
Time-frame: 2009

15. Work with town road commissioners and selectboard members to replace top priority culverts in each town.

Potential key players: Road crews and commissions, conservation commissions, and selectboard members in the basin, VTrans, TRORC, NVDA, RMP, DFW
Potential funding sources: Better Backroads grant, UCM&E
Time-frame: 2010

Section 1-6 Lakes, Dams and Wetlands in Basin 14

The Little Rivers watershed includes a number of lakes and ponds that range in size from Mud Pond in Peacham, covering 20 acres, to Lake Fairlee, covering 457 acres. Concerns about lakes and ponds in the watershed include nutrient enrichment, exotic invasive species, acidification and toxins, and lakeshore protection and enhancement. Dams and wetlands are also discussed in this chapter as they are often associated with lakes and ponds.

Exotic Invasive Species

Eurasian watermilfoil, zebra mussels, rusty crayfish, *Didymosphenia geminata* (also called didymo or rock snot) and water chestnut are exotic invasive species that currently can be found in a number of Vermont lakes and rivers. Several other problematic exotic species (e.g. hydrilla and spiny water flea) are on Vermont's doorstep. In addition to aquatic invasive species there are also a number of wetland and riverbank exotic invasive species, including purple loosestrife, phragmites, and Japanese knotweed which can reduce the quality of aquatic habitats and spread along river corridors. In Basin 14, Eurasian watermilfoil is only found in Lake Fairlee although it is also found in nearby waterbodies including Lake Morey, Round Pond, Halls Pond, and in the Connecticut River south of Orford New Hampshire. Rusty crayfish have been found in the White River just to the south of the basin and have been identified in the Ompompanoosuc River Watershed. In the summer of 2007 didymo was also identified near the basin in the upper Connecticut River and at two locations in the White River.

The key to addressing the threat of invasive species in the basin is to prevent the further spread of these species because of the high costs of control once species are established. Invasive species are often spread during the movement of boats and other water-based recreational equipment between water bodies. This incidental transport can be prevented by washing and drying boats and equipment, and physically removing any visible plants or animals from any equipment that has been in contact with the water body. Recreational users can become informed about these techniques through signage, access area greeters at boat launches, and other public outreach. Spread prevention for other species like the alga didymo, also includes using HOT tap water and lots of soap to scrub boats, other "hard" items and to soak "soft" items like clothes and felt-sole waders, thoroughly for a minimum of 30 minutes.

Invasive species watch programs like the state's VIPs or Vermont Invasive Patrollers can also help slow the spread of invasive species by catching infestations in their early stages when control is more feasible. To prevent the further spread of Eurasian watermilfoil and other aquatic invasives water body associations must work together to combat the spread of these species, and raise public awareness about the threats these species cause to Vermont waters.

Low pH and Other Toxins

In Basin 14 Levi Pond is impaired and Norford and Mud ponds are listed as threatened due to low alkalinity. No lakes in Basin 14 are impaired due to elevated mercury levels but the levels of mercury in fish across Vermont have lead to state wide fish consumption advisories recommending that some people limit the consumption of certain species of fish taken in the state. This advisory and more general information about mercury pollution is available online at www.mercvt.org . Not all waters in the watershed have been sampled for mercury and water level fluctuations at Harveys Lake and Lake Fairlee increase the likelihood of elevated mercury levels warranting additional follow up.

The primary sources of mercury and acid in the basin are from atmospheric deposition. While some of the sources of mercury and acid deposition may differ, Midwestern power plants are a significant contributor of both of these constituents. Other sources of acid deposition are industrial and motor vehicle emissions. There are also local sources of mercury, including many consumer products such as fluorescent lights, batteries and thermostats which can end up in surface waters if not properly disposed of.

Vermont is a national leader in efforts to reduce mercury contamination from sources in-state, contributes to the implementation of regional mercury controls and research initiatives, and actively pushes for meaningful national-level controls on mercury emissions. Under a 2005 Vermont law (10 V.S.A . Chapter 164), and in coordination with the Vermont Advisory Committee on Mercury Pollution, the Agency is implementing pollution reduction and prevention from numerous source sectors within the waste stream, while identifying remaining unaddressed mercury sources and mechanisms for their control. Vermont is also in compliance with the recently approved Northeast Regional Mercury TMDL.

There are other threats from toxic substances such as lead sinkers that have been a leading cause of death in loons in

New England although this threat should be reduced with the passage Vermont law 10 V.S.A. section 4606 and 4614 which has prohibited the sale and use of lead sinkers. In addition the unburned oil and gas discharged from motor boat engines (up to 30% for two stroke engines) is another concern expressed by residents in Lake Fairlee due to the heavy boat traffic at certain times of the year and occasional oil sheens near the boat launch.

Wetlands in the Watershed

There are numerous significant wetlands in Basin 14. Wetlands absorb flood water and stormwater, filter pollutants and nutrients, provide habit for many species of plant and animals, provide open space, and opportunities for education and recreation. Because of these values, wetlands in the watershed are protected through the Vermont Wetland Rules, and the identification, restoration and conservation of important wetlands is recommended in this plan.

Dams in the Watershed

As in most of New England, dams played an important role in the development of the Little Rivers watershed providing power for a number of historic mills in the watershed. There are still a number of dams that provide hydropower in the watershed including the Bradford Dam, the Barnet Dam, the Adams Paper Company Dam, and the Boltonville Falls Dam. The largest dam in the watershed is the Union Village Dam flood control structure, which provides flood control for the lower Ompompanoosuc River valley and the Connecticut River valley and is operated by the United States Army Corps of Engineers (USACE). Many of the other dams in the watershed are located at the outlets of lakes and ponds.

Dams change the physical and ecological characteristics of lakes and rivers and have multiple effects on aquatic and riparian habitat. These changes range from a minor alteration of depth and velocity in the case of low-head, run-of the-river dams, to a complete change from river to lake characteristics in the case of large dams. Dams can flood upstream habitat and act as barriers to upstream and downstream movement of aquatic organisms including fish. Dam operations alter the natural flow regime in a way that can reduce downstream habitat quality and quantity. In addition to channel adjustments that may affect the structure of in-stream habitat, additional flow diversion from the bypassed reach of the stream can expose streambed substrates, effectively reducing the amount of habitat area available for aquatic organisms. Dams can also change the temperature of the water, and reduce dissolved oxygen levels. The customary pre-winter practice of drawing down dammed lakes drains surrounding wetlands and is harmful to the many animals that rely on this habitat for overwintering, in addition to increasing mercury levels.

As global warming becomes a more prominent issue, there is more pressure to increase the use of hydropower in the state to reduce carbon emissions. The installation of hydroelectric facilities at some existing dams may be possible with limited environmental impacts but the construction of new dams or water diversions would be likely to conflict with the management objectives of the Vermont Water Quality Standards.

Shoreline Protection

The removal of natural shoreline vegetation can increase erosion of the lakeshore and reduce or eliminate the filtration functions of the riparian zone. Runoff from roofs, driveways, lawns, playing fields and uphill development can increase shoreline erosion (ANR 2005). Improper design and installation of shoreline stabilization measures, such as riprap, seawalls, and grading, can actually increase erosion and sedimentation along that shoreline. Unlike rivers, lakes retain 80-90% of pollutants that enter them. Runoff from lawns and playing fields on which fertilizers, herbicides, and pesticides are used results in toxins and excess nutrients, in the form of nitrates and phosphates, entering a lake. An excessive influx of nutrients causes algal blooms which harm native flora and fauna and decrease water clarity. Runoff from eroding driveways, roads, paths and increasing development carry nutrients and sediment to adjacent waters.

Many animal species (birds, reptiles, fish, amphibians and mammals) rely on natural shoreland vegetation to breed, feed and over winter. Removal of the natural vegetation along a lakeshore has negative impacts on this habitat. For instance, overhanging branches shade shallow water, reducing algal growth, and also provide fish food in the form of fallen insects. Trees, branches, and leaves that fall in the lake also provide important habitat structure to aquatic organisms (ANR, 2005).

There are a number of ways that communities can protect or restore lakeshore vegetation. On lakes and ponds with undeveloped shoreline, conservation measures can protect natural shoreline through land purchases or conservation easements. Another tool for protecting existing riparian lands is town zoning with language requiring the maintenance of riparian buffers, and building setbacks. The Agency of Natural Resources (2002) has developed a reference for guiding towns in this area called *Local Planning and Zoning Options for Water Quality Protection*, and the Vermont League of Cities and Towns has developed a model guidance to assist towns in improving protections of these important riparian lands in town zoning. In addition the Agency of Natural Resources has produced riparian buffer guidance which is used in Act 250 determinations but is also helpful for towns developing shoreland zoning (ANR 2005). A review of town zoning in Basin 14 is in Appendix A7. Communities can also work with landowners on existing developed shoreline to restore riparian vegetation and reduce erosion and nutrient runoff from these lands.

COMMON GOAL: PROTECT AND RESTORE THE NATURAL ENVIRONMENTS OF LAKES AND PONDS IN BASIN 14 TO SUPPORT WATER QUALITY, RECREATION AND AESTHETICS.

Objective: Prevent the spread of aquatic and riparian invasive species in Basin 14.

16. Hold a Vermont Invasive Patrollers workshop in Basin 14 and form survey groups to patrol the watershed to identify and control new riparian or aquatic species populations before they are well established.

Potential key players: lake associations, VIP, DEC - AIS, NEKISI
Potential funding sources: ANC, Watershed Grants, CRJC
Time-frame: 2009

Objective: Define levels of mercury contamination in Harveys Lake and Lake Fairlee.

17. Evaluate the levels of mercury in Harveys Lake and Lake Fairlee and tailor fish advisories to these results.

Potential key players: DEC, DOH, DFW
Potential funding sources: State funds
Time-frame: 2012

Objective: Protect and restore wetlands in the Basin 14.

18. Work with conservation commissions to map existing wetlands and wetland functions and values covering at least half of the towns in the watershed. Use this information to prioritize the protection or restoration of wetlands in the watershed.

Potential key players: conservation commissions. VT Wetlands Section
Potential funding sources: UCM&E, CRJC PG, Watershed Grant
Time-frame: ongoing

19. Complete one wetland protection or restoration project in Basin 14.

Potential key players: VT Wetlands Section, UVLT, conservation commissions.
Potential funding sources: UCM&E, CRJC PG
Time-frame: 2012

Objective: Increase the length of natural flow conditions in Basin 14.

20. Identify existing dams which are no longer used in the watershed and are candidates for removal. Remove one dam in Basin 14 and restore the natural flows and riverine habitat.

Potential key players: Dam Task Force, CRWC, Hydrology Program, private dam owners
Potential funding sources: UCM&E
Time-frame: 2012

Chapter 2 - The Stevens River Watershed

Section 2-1 Watershed Description

The Stevens River flows into the Connecticut River in Barnet and its watershed covers about 49 square miles in area mostly in Peacham and Barnet, but with small portions in Danville and Ryegate as shown in Figure 2-1. The origin of the river's waters are the tributaries that flow from the eastern sides of Lookout Mountain and Macks Mountain into Willow Brook and from the wetlands and ponds in the northern part of Peacham including Ewell Pond to form Peacham Hollow Brook (East Peacham Brook on the USGS map). The other major tributary to the Stevens River is South Peacham Brook, which drains tributaries and ponds on the eastern side of Morse Mountain, Devils Hill, and Jennison Mountain and includes Martins, Mud and Fosters ponds. The southern Stevens River watershed is Jewett Brook which flows through extensive wetlands before entering Harveys Lake which then drains into South Peacham Brook in West Barnet. Peacham Hollow Brook and South Peacham Brook join about a mile east of West Barnet to become the Stevens River, which then flows east to the Connecticut River collecting water from a few small streams, the largest of which is Cloud Brook. On its way to the Connecticut River, the Stevens River goes under Interstate 91 then is impounded by the Barnet Dam just above Route 5 in the center of Barnet. After flowing free for a short stretch after the Barnet dam, the Stevens River meets the backwater of the Connecticut River caused by McIndoes Dam. At the confluence with the Connecticut River, the Stevens River flows through a wetland complex that provides flood storage and wildlife habitat along the Connecticut River corridor.

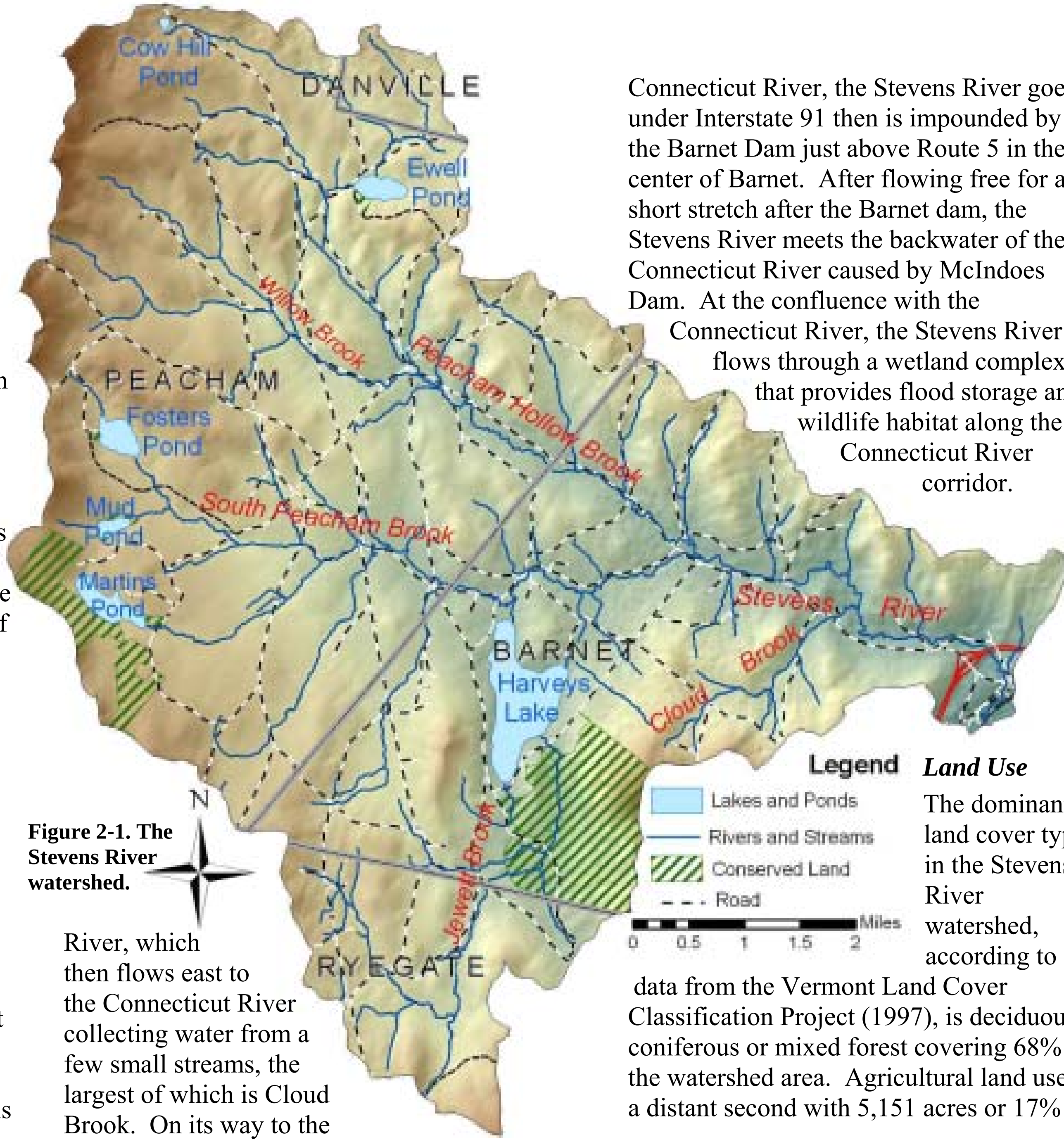


Figure 2-1. The Stevens River watershed.

Land Use

The dominant land cover type in the Stevens River watershed, according to data from the Vermont Land Cover Classification Project (1997), is deciduous, coniferous or mixed forest covering 68% of the watershed area. Agricultural land use is a distant second with 5,151 acres or 17% of the watershed in either row crops, hay, orchards, or other agricultural activities. Developed land covers 7% or 2,275 acres of the watershed of which 5% is roads, highways and other transportation uses. Surface water covers 5% of the watershed and wetlands cover the remaining 3% (DEC 1999). There are numerous large and significant wetlands in the Stevens River watershed. The largest wetland in the watershed, surrounding Jewett Brook, is mostly within the Roy Mountain Wildlife Management Area.

Just less than 5% of the Stevens River watershed is permanently conserved as part of the Roy Mountain Wildlife Management Area and the Groton State Forest. These protected lands make up large portions of the Martins Pond and Harveys Lake watersheds, and include the shoreline of Mud Pond in Peacham.

Dams in the Watershed

Like most of New England, dams played an important role in the development of the Stevens River watershed providing power for a number of historic mills in the watershed. This history is still visible at Ben Threshers Mill which was built in 1872 as a dye and print works and hosted a number of businesses, until the dam washed away in the 1970s. The mill is currently owned by the Ben's Mill Trust for the purpose of restoring the mill to use as a working power museum which is strongly supported by the local community. There are at least 13 historical dams in the watershed of which many (including Threshers mill dam) have been breached or have washed away entirely. A number of the dams in the watershed are located at lakes and ponds. An example of this is Harveys Lake dam, which has an unusual design where the dam is not at the natural lake outlet but was instead sited downstream below South Peacham Brook. This situation can cause water to flow back into the lake from South Peacham Brook during periods of high flow. This arrangement may have historically worked well for mills in West Barnet but has lead to concerns about nutrients entering Harveys Lake from South Peacham Brook and has sparked efforts to modify the dam to prevent these backflows.

Figure 2-2. Ben Threshers Mill

Water-based Resources

Although the Stevens River watershed is small, its waters play a large role in the community providing opportunities for swimming, boating, fishing, wildlife viewing, and an indirect source for drinking water. Waters in the Stevens River watershed are protected in order to support uses valued by the public including swimming, boating, and fishing. Some uses are protected specifically if the Agency of Natural Resources identifies them as existing uses under the anti-degradation policy of the Vermont Water Quality Standards (VWQS § 1-03). Existing uses in Basin 14 are listed in Chapter Six in tables 6-1 through 6-3 on page 83.

Swimming

Most of the swimming in the Stevens River watershed is in the many lakes and ponds in the watershed. The most popular of these is the Barnet Town Beach at Harveys Lake. There are also a few informal swimming or wading holes in the Stevens River and tributary streams used by local residents.

Boating

Most of the boating in the Stevens River watershed occurs on the lakes and ponds. Harveys Lake has a large number of boats during the summer months, with fewer boats at Martins, Fosters, and Ewell ponds.

Fish Habitat and Fisheries

There is a diversity of fish habitat in the lakes and streams in the Stevens River watershed. Harveys Lake covers just 351 acres but is a very deep lake supporting populations of lake and rainbow trout which draw anglers from the surrounding area. The smaller Ewell Pond and Martins Pond are stocked with rainbow trout and brook trout respectively. The Stevens River is stocked with brook and brown trout by the Vermont Department of Fish and Wildlife (DFW) from South Peacham Brook to the confluence with the Connecticut River and very few wild trout are found within this stretch of river. Brown trout will be replaced with rainbow trout starting in 2010. Both Peacham Hollow Brook and South Peacham Brook are managed as wild brook trout fisheries (Kratzer 2007).

The Stevens River is stocked with Atlantic salmon fry as part of an effort to restore salmon to the Connecticut River basin. The Stevens mainstem contains an estimated 829 100-meter^2 units of salmon rearing habitat. Over the past 5 years an average of 25,000 fry have been stocked annually, at an average density of 31/unit. Typically it takes salmon fry two years to attain smolt (migratory) size. Growth rates of salmon have been consistently higher in the Stevens River than in any other Northeast Kingdom salmon nursery stream, to the extent that in some years young salmon are reaching smolt size and leaving after only a single year. Over the past 5 years, the Stevens River has contributed an average of 3000 smolts annually to the Connecticut River basin outmigration, roughly 3.6/unit.
A large falls in Barnet Village probably prevented Atlantic salmon from accessing the Stevens River in the past, but it is used as a nursery stream as compensation for the vast amounts of mainstem spawning and nursery habitat that have been destroyed. The idea of the nursery stream is to stock salmon fry, hoping that they will survive and grow into smolts and migrate out to the ocean. Returning adult salmon currently can ascend as far up the Connecticut River as the dam at Dodge Falls in East Ryegate, about 4 miles upstream of the mouths of the Wells and Ammonusooc Rivers. Upstream fish passage may be required at the Dodge Falls and McIndoes dams in the future, allowing salmon access to the lower Stevens River. Salmon will not be able to ascend into to the upper Stevens and Wells rivers because of the dams or falls close to their confluence with the Connecticut River. It is the intention that these nursery streams will boost the total numbers of salmon returning to the Connecticut River and ascending the accessible tributaries.

Fish species collected in the Stevens River during our annual salmon sampling include: Atlantic salmon, brook trout, longnose dace, longnose sucker, pumpkinseed, blacknose dace, white sucker, common shiner, slimy sculpin, creek chub, and brown trout (Kratzer 2007).

Irrigation and Animal Watering
According to the AAFM approximately 34% of known surface water withdrawals and 45% of known ground water withdrawals in Caledonia County are used for irrigation of vegetables, orchards, and other crops. These statistics may be considerably different for the Stevens River as this is only a small portion of the county, but are still a significant use of waters in the watershed.

Drinking Water Supplies
Drinking water in the Stevens River watershed is supplied by private wells, and public groundwater sources covering the villages of Peacham and Barnet. No surface waters are designated as public water supplies. Surface waters are likely used for drinking supplies by an unknown number of private residencies and seasonal camps in the watershed.

Section 2-2 Improving Water Quality Awareness in the Stevens River Watershed

Understanding the existing conditions of surface waters is one of the first steps in any water quality protection program. The DEC monitoring strategy is described on page 3 but this section includes specific water quality information related to the Stevens River watershed as well as efforts to provide this information to the wider community.

Lake Monitoring Including Lay Monitoring and Spring Phosphorus Testing

Existing water quality sampling in the Stevens River watershed includes lay monitoring at Harveys Lake and Fosters and Martins ponds. Harveys Lake and Fosters Pond are sampled on a weekly basis during the summer season for water clarity, chlorophyll, and phosphorus. Water sampling results in these three lakes indicate that these bodies of water are mesotrophic meaning they have a moderate level of nutrient enrichment.

The State of Vermont also monitors many lakes for phosphorus in the spring. This includes the three lay monitoring lakes as well as Ewell Pond which is classified as mesotrophic. These databases establish a reference point from which to measure

Figure 2-3. Dave Magnus and Ron Miller taking water samples on Peacham Hollow Brook.

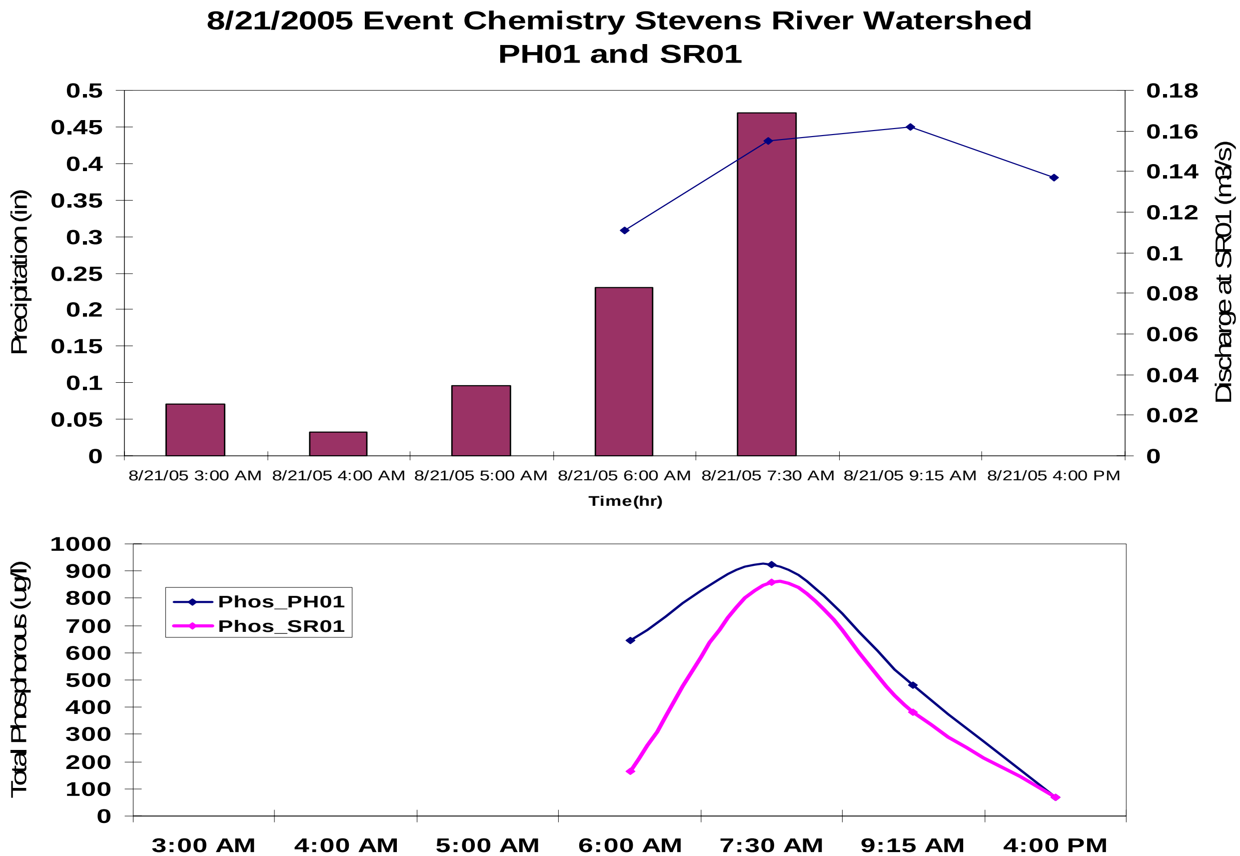


Figure 2-4. Rainfall, flow and phosphorus levels measured during a rainfall event at Peacham Hollow Brook (PH 01) and South Peacham Brook (SR 01) near their confluence. The upper graph shows rainfall (bars) and stream discharge (line) (Peacham Conservation Commission 2005).

future changes in water quality. The citizen lake monitors, together with the Lake Association, share a strong interest in improving the lake's water quality and have worked to reduce nutrient runoff from roads in the watershed. The citizen lake monitors have also assisted DEC in identifying exotic invasive species.

Stevens River Watershed Council Water Quality Monitoring Project

The Stevens River Watershed Council began a volunteer monitoring program in 2005 for the purpose of developing an overall picture of water quality in the watershed and providing this information to the public. The monitoring program was completed in partnership with the Peacham Conservation Commission and with funding through the Connecticut River Joint Commissions (CRJC) partnership grant and analytical services provided through the LaRosa analytical partnership program. Samples were taken for total nitrogen, nitrate/nitrite, phosphorus, chloride, and turbidity along with dissolved oxygen, temperature, pH and flow. Five sites were sampled, two on Peacham Hollow Brook, one on South Peacham Brook and two on the Stevens River. During routine sampling, all of these parameters were well with in the ranges expected in a healthy Vermont river system. The exception to this, as is often the case in rivers in Vermont, were the sampling results from a storm event which showed high levels of phosphorus and elevated turbidity seen in Figure 2-4. The

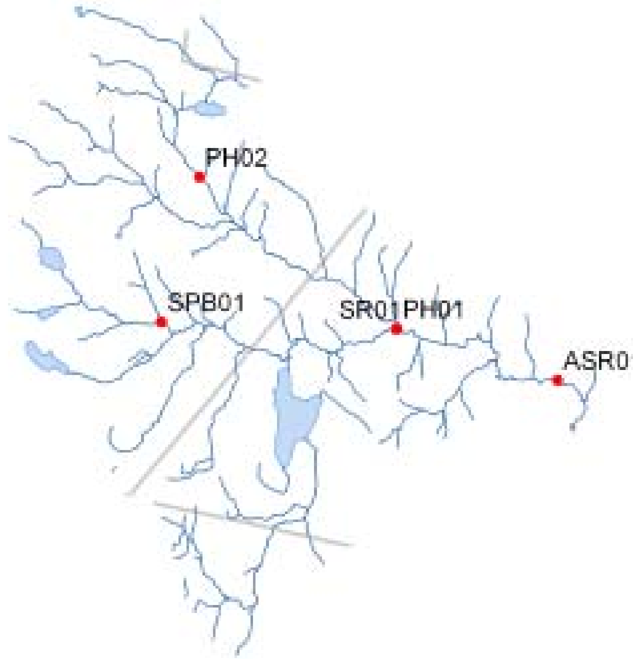


Figure 2-5. Stevens River water quality monitoring sample sites.

levels were as much as fifty times as high as those during the dry weather sampling. These sources of sediment entering the river during storm events should be a priority for restoration efforts in the Stevens River watershed. A follow up monitoring program was completed in 2007 capturing three storm events in the summer and fall. The storm events that were captured during 2007 were not as large as the event sampled in 2005 and consequently phosphorus and turbidity levels were not nearly as high. In spite of this, the phosphorus and turbidity levels measured still indicate an increase in sediment and phosphorus in the Stevens River during rainfall events.

GOAL: ESTABLISH BASELINE WATER QUALITY MEASUREMENTS OF THE STEVENS RIVER WATERSHED AND PRESENT THIS INFORMATION TO THE PUBLIC.

Objective: Identify reference reaches in the Stevens River watershed.

In the development of a watershed-wide picture of water quality, certain surface waters in their natural condition are identified as reference waters. The condition of all other surface waters can then be judged based on their deviation from the condition of these reference waters.

21. Use all available good quality data on the physical, chemical, and biological values of the waters, and collect any additional necessary data in the watershed to establish reference reaches.

Potential key players: Peacham Conservation Commission, DEC
Potential funding sources: LaRosa, CRJC PG
Time-frame: 2009

Objective: Expand and consolidate monitoring data in the watershed to provide a complete picture of the current water quality conditions.

22. Provide results of water quality testing and information about the water quality of the watershed to the public through schools, the web, and the local library.

Potential key players: Stevens River Watershed Council, school, libraries, local media
Potential funding sources: CRJC PG
Time-frame: 2009

23. Continue lay monitoring programs in the watershed. In 2012 follow up on 2005 and 2007 stream sampling to determine if success has been made in addressing sources of sediment and phosphorus, and to look into any new threats to water quality in the Stevens River watershed.

Potential key players: Peacham Conservation Commission, Stevens River Watershed Council
Potential funding sources: LaRosa, CRJC PG
Time-frame: 2012

Section 2-3 Nonpoint Source Pollution in the Stevens River Watershed

Nonpoint source pollution was the top rated concern in the Stevens River watershed including runoff from roads, developed lands, agricultural lands, and associated with logging operations. These topics are discussed in detail in Sections 1-3 and 1-5 of this plan on pages 4 and 10, but included in this section is a description of road projects and agriculture in the Stevens River watershed.

Road Projects, Bridge and Culvert Surveys and Capital Improvement Budgets for the Stevens River Watershed

A number of water quality related road projects have been completed or are in the works in the Stevens River watershed. The Caledonia County Natural Resources Conservation District (CCNRCD) met with road commissioners from Peacham and Barnet in 2006 as part of the Partners for Fish and Wildlife Program with funding provided by the Upper Connecticut River Mitigation and Enhancement Fund. During each visit, water quality priorities were reviewed and windshield surveys were conducted in each town to review the town's priorities for road work and water quality goals. In Barnet, several undersized culverts were selected as problem sites. In Peacham, road erosion and roadside ditching proved to be the greatest water quality priority. A priority site in Peacham was improved in 2006, which included extensive roadside ditching, seeding and mulching, the replacement of several key culverts, and the stabilization of a serious headcut that was causing sediment loading into the nearby stream (see Figure 2-6). The Town of Peacham received funding from the Better Backroads program to conduct a road erosion inventory and capital improvement budget. The CCNRCD was hired to conduct the inventory and analysis of 15 key sites. The inventory includes an assessment of the current conditions at the site such as culvert adequacy assessments, levels of erosion and sedimentation, and distance to nearby waterways. The report makes recommendations for improvements at each site and outlines estimates of costs.

In 2006 the Town of Peacham received a Clean and Clear watershed planning grant to address erosion and stormwater runoff issues at the town garage. This project reduced erosion from three locations of the town garage that drain into Peacham Hollow Brook.

A bridge and culvert survey of the Stevens River watershed was completed in 2004 by the Northeast Vermont Development Association in cooperation with Lyndon State College.

Agriculture in the Stevens River Watershed

Agriculture gives the Stevens River watershed much of its character. It also supports the economic base, cultural identity, and patchwork landscape of open and forested lands so highly valued in the watershed. In addition, as agricultural land is converted to suburban development, there is generally a net increase in nutrient production, so keeping well managed agricultural land in active production can sustain better water quality. Farm land makes up 17% of the Stevens River watershed and much of the farm land is located along streams and rivers. Farm productivity involves the spreading of nutrient rich fertilizers and manures, so good management practices on farms are an important part of reducing NPS pollution in the watershed. Appendix A3 has a complete description of agriculture in the Stevens River watershed.

Many farms in the Stevens River watershed have installed Best Management Practices or BMPs, which are voluntary practices to correct a current waste management problem on a specific farm. To date, 22 projects or Best Management Practices have been initiated in the Stevens River watershed (AAFM 2007a). Fifteen projects are for production area practices (*e.g.,* barnyard runoff, manure storage, leachate collection). The remaining seven projects are for field practices (*e.g.* stream bank stabilization, stream crossing). The total cost of these practices is $315, 916 with the Vermont Agency of Agriculture, USDA, EPA and landowners all contributing a share.

GOAL: REDUCE THE AMOUNT OF SEDIMENT AND NPS POLLUTION ENTERING THE STEVENS RIVER.

Objective: Reduce conflicts between road infrastructure and the Stevens River, reducing pollution and long term maintenance costs.

(See page 12 for basin-wide strategies)

24. Support the creation of an active conservation commission in Barnet to act as advocates for the watershed including such things as supporting driveway and private road ordinances, following up on bridge and culvert surveys and seeking funding.

Potential key players: selectmen, planning commissions, interested citizens
Potential funding sources: NA
Time-frame: 2012

25. Evaluate runoff from the Peacham and Barnet municipal sand piles and cover if needed.

Potential key players: selectmen, road foremen
Potential funding sources: town funds, Municipal Stormwater Mitigation Grant
Time-frame: 2009

Objective: Reduce nonpoint pollution from the agricultural, developed, and rural landscape.

(See page 6 for basin-wide strategies)

26. Participate in the Source to Sea clean up to clean up trash and historical dump sites along the river's edge. Work with local communities to reduce the number of abandoned cars along the Stevens River and in the Stevens River watershed.

Potential key players: Peacham Conservation Commission, community volunteers, CRWC
Potential funding sources: NEKWMD, CRWC
Time-frame: 2010

Section 2-4 River Corridor Management in the Stevens River Watershed

Figure 2-6. The Stevens River from Barnet School to Karme Choling where the river has degraded its bed and shows evidence of planform adjustment (rapid channel migration).

As described in Section 1-4 of this plan (on page 7) river corridor management is one of the top issues in Basin 14. This is also true in the Stevens River watershed where the Caledonia County Natural Resources Conservation District (CCNRCD) has completed a Phase 1 geomorphic assessment of the Stevens River watershed and has nearly finished the Phase 2 assessment for the entire main stem of the Stevens River, Peacham Hollow Brook up to East Peacham, and the South Peacham Brook up to the Peacham – Danville Road.

The assessments results still need to be updated, analyzed and written up, but initial results have shown that a number of stream reaches are going through the evolution process shown in Figure 1-3 on page 8. This includes the section of Stevens River above the Barnet Dam, which is currently aggrading or building up its bed probably caused by the backwater behind the dam, but could also be related to increased sediment entering this reach from upstream reaches.

The section of the Stevens River that runs from the Barnet School to Karme Choling (shown in Figure 2-6) shows signs of cutting down into its bed in addition to increased erosion and channel movement, called planform adjustment. The cause of these adjustments is unclear but may be related to the river working its way through sediments deposited when the Stevens River watershed was originally deforested over 200 years ago, causing large scale erosion and sediment deposition in this valley. This section of river is the focus of a corridor protection and restoration project and will likely continue to progress through the stream evolution process until it creates a new floodplain at a lower elevation. Allowing the river to complete this evolution process will eventually lead to the restoration of the river's equilibrium condition where the river will be able to store sediment and flood waters, and provide improved aquatic habitat.

Another stream in the watershed that shows signs of degradation is South Peacham Brook from the Harveys Lake Dam downstream about a mile to where the brook leaves the open farm fields and enters into the woods. This degradation may be related to the trapping of sediment behind the Harveys Lake Dam, creating an imbalance in sediment and flow in the river below (as shown in Figure 1-2). The banks of South Peacham Brook have also been armored as it passes through West Barnet and this could have contributed to the degradation by keeping floodwaters in the channel, increasing stream power and therefore erosion. South Peacham Brook could benefit from limiting future bank armoring and restoring the sediment regime on this reach of river.

River Corridor Planning and Fluvial Erosion Hazard Mapping

The results from the geomorphic assessments can be used to develop a river corridor plan for the Stevens River which will be important to restoring or maintaining the Stevens River's equilibrium condition by reducing current and future constraints on the river that cause instability. This plan would include a process for selecting and implementing river corridor management projects and provide a basis for corridor protection through various land use planning and incentives programs.

Riparian Restoration

A number of river corridor restoration projects in the Stevens River watershed have been initiated in recent years. The Barnet School on the upper end of the reach of river pictured in Figure 2-6 has planted a riparian buffer along the Stevens River on school property. In addition a buffer restoration project was completed at the confluence of the Peacham Hollow Brook and South Peacham Brook by the CCNRCD. Finally the NRCS completed an extensive CREP project including fencing and tree plantings along Cloud Brook.

GOAL: MAINTAIN AND WHERE NEEDED, RESTORE THE EQUILIBRIUM CONDITION OF THE STEVENS RIVER.

Objective: Identify and protect stable reaches.

27. Complete Phase 1 and Phase 2 geomorphic assessments of the Stevens River watershed including an analysis of the results and a final report.

Potential key players: CCNRCD, RMP,
Potential funding sources: UCM&E, RCG
Time-frame: 2009

28. Protect land along the Stevens River where there are existing riparian buffers, significant wetlands, or where land is important to maintaining the rivers stability as determined by the geomorphic assessments and future river corridor plan.

Potential key players: private landowners, UVLT, municipalities, CCNRCD, Peacham Conservation Commission
Potential funding sources: UCM&E, VHCB, USDA
Time-frame: 2012

Objective : Increase the participation of the public and towns in stream corridor protection.

In Vermont, the protection of riparian habitat is largely the responsibility of local landowners through the application of good management practices on riparian lands and town governments through town planning and zoning.

29. Present Phase 1 and 2 geomorphic assessment results to the general public and riparian landowners to expand public understanding of river dynamics including best practices to promote stable streams.

Potential key players: CCNRCD, RMP, towns
Potential funding sources: UCM&E
Time-frame: 2009

30. Develop a river corridor plan for Barnet and Peacham to develop conservation and restoration priorities.

Potential key players: CCNRCD, RMP, towns, DEC, selectboards, Peacham Conservation Commission
Potential funding sources: UCM&E, RCG
Time-frame: 2011

31. Create minimum consistent zoning that would protect rivers in the watershed through setbacks and riparian buffer ordinances, and flood hazard zones and overlay districts.

Potential key players: CCNRCD, RMP, Towns, DEC, selectboards, Peacham Conservation Commission, NVDA
Potential funding sources: UCM&E, RCG
Time-frame: 2012

Objective: Recognize reaches of the Stevens River where it is out of equilibrium and where needed, restore riparian vegetation.

32. Implement restoration or corridor protection projects at the Barnet School and on other reaches identified through the geomorphic assessments and river corridor planning process.

Potential key players: Local landowners, RMP, CCNRCD
Potential funding sources: 319, UCM&E, tree programs, CREP, RCG
Time-frame: 2012

Section 2-5 Lakes and Dams in the Stevens River Watershed

Residents of the Stevens River watershed are fortunate to have many lakes and ponds in the watershed including: Harveys Lake, Martins Pond, Fosters Pond, Ewell Pond, and Mud Pond. With the exception of Harveys Lake, these ponds still have large amounts of undeveloped shoreline, and all of the lakes provide unique recreational opportunities important aquatic habitat. The main concerns about lakes and ponds in the watershed include nutrient enrichment, exotic species, acidification and toxins, dams and water level fluctuations, and lakeshore protection and enhancement which are all described in detail in Section 1-6 of this basin plan on page 12. The impacts of dams on rivers are also discussed in this section.

Exotic Invasive Species

In the Stevens River watershed exotic invasive species education programs include the Harveys Lake greeter and boat wash program that staffs a monitor at peak use times to inspect boats and to provide information to boaters. Other important efforts at Harveys Lake include the lakeshore watch which also increases awareness and can catch invasive plants and animals before they become unmanageable. To keep these species out of the watershed it will be increasingly important that the lake and pond associations work together.

In addition to aquatic invasive species there are also a number of wetland and riverbank exotic invasive species, including purple loosestrife, phragmites, and Japanese knotweed which can reduce the quality of aquatic habitats and spread along river corridors. A project was completed at the Peacham Town Garage with the assistance of the Peacham Conservation Commission in 2005/2006 to eradicate the invasive species phragmites from the site due to the high potential of spread by town road equipment.

Shoreline Protection

While recreational uses abound in the vast majority of Vermont's lakes, Vermonters only have a handful of lakes in which they can experience the type of recreational opportunities that wilderness lakes can offer. In order to ensure that Vermonters of today and the future can have access to the wilderness lake experience, it is important to have a lake protection and conservation strategy. In addition, undeveloped lakeshores provide critical wildlife and aquatic life habitat.

As part of DEC's strategy to protect remaining wilderness lakes and ponds, lakes in Vermont have been rated based on their wilderness or wilderness-like characteristics. The only pond rated on this scale in the Stevens River watershed is

Mud Pond, which has an undeveloped shoreline owned by the State of Vermont and has a wilderness-like rating of 10 out of 10. Martins Pond has about 1/3 of its shoreline undeveloped, much of which is within Groton State Forest. Fosters Pond is largely undeveloped and Ewell Pond, near the headwaters of Peacham Hollow Brook, has only scattered development. For all four of these ponds protecting the natural shoreline will maintain the natural feel of these ponds and help to protect their natural integrity.

The largest body of water in the watershed is Harveys Lake at 351 acres. While much of the Harveys Lake shoreline is already developed, efforts can be made to encourage development in the future that will protect the water quality of the lake and maintain some of the remaining natural feel of the lake by leaving a protective buffer around the lake.

The Town of Peacham has a shoreland zoning district providing for setbacks and buffer vegetation to address septic, scenic, and runoff issues. Barnet has shoreland regulations for 12 bodies of water requiring setbacks and limiting some development near lakeshores but does not include any language for vegetative buffers.

GOAL: PROTECT AND RESTORE THE NATURAL ENVIRONMENTS OF LAKES AND PONDS IN THE STEVENS RIVER WATERSHED TO SUPPORT WATER QUALITY, RECREATION AND AESTHETICS.

(See page 15 for basin-wide strategies)

Objective: Protect areas of existing natural lakeshore and on developed lakeshores, increase riparian vegetation and reduce erosion and nutrient runoff.

33. Ensure the protection of portions of undeveloped shorelines on Fosters, Ewell, and Martins Ponds through voluntary conservation of at least one property on these lakes and ponds.

Potential key players: State of Vermont, VRC, Towns of Barnet and Peacham, Planning commissions.
Potential funding sources: VHCB
Time-frame: 2012

34. Maintain existing shoreline vegetation through the creation of shoreline zoning with vegetated buffers for all watershed towns.

Potential key players: State of Vermont, Towns of Barnet and Peacham, Planning commissions, VLCT.
Potential funding sources:
Time-frame: 2012

35. Hold a workshop or series of workshops on lakeshore management to cover such topics as buffer restoration and low impact lawn care and landscaping.

Potential key players: Lake Associations, Land Trusts, DEC, planning commissions
Potential funding sources: Watershed Grant, CRJC PG
Time-frame: 2009

Objective: Prevent the spread of aquatic and riparian invasive species to the Stevens River watershed.

36. Continue efforts of the Harveys Lake Association to prevent invasive species spread through use of the boat wash and boater education.

Potential key players: Harveys Lake Association, DEC - AIS
Potential funding sources: ANC
Time-frame: ongoing

37. Increase the level of communication between lake associations and residents to prevent spread of invasive species into the watershed. Send out a mailing to lake and pond residents about exotic species and other common lake and pond issues.

Potential key players: Lake Associations, DEC - AIS, DEC
Potential funding sources: ANC, local fundraising
Time-frame: 2009

Objective: Prevent, eliminate or reduce the negative impacts of dams and water withdrawals in the Stevens River watershed.

38. Address the issue of the back flow of water from South Peacham Brook into Harveys Lake.

Potential key players: Harveys Lake Association, DEC
Potential funding sources:
Time-frame: 2012

39. Continue ongoing discussions between the Ben's Mill Trust and state and federal regulators on alternatives for repowering the historical Ben Threshers Mill.

Potential key players: Ben's Mill Trust, DEC, F&W, US F&W
Potential funding sources: Local Fundraising, historic preservation grants, CLG
Time-frame: 2012

Section 2-6 Impaired and Altered Waters in the Stevens River Watershed

The Agency of Natural Resources is responsible for maintaining water quality in each waterbody in accordance with the Vermont Water Quality Standards. Water quality is determined using biological, physical, and chemical criteria for each water quality management class. The Department of Environmental Conservation monitors surface waters for conformance with numeric and narrative water quality criteria to document violations and determine use attainment. This process is outlined in the DEC publication *2006 Vermont Surface Water Assessment Methodology Including Vermont Listing Methodology* (DEC 2005). If DEC has sufficient evidence to conclude a water is not achieving water quality standards than the water is listed as impaired. There are no water bodies listed as impaired in the Stevens River watershed.

Altered Waters or Waters in Need of Further Assessment

There are other waters that fall outside the scope of impaired waters but have not met water quality standards or are of concern for other reasons. The waters listed in Table 2-1 are waters that fall outside the scope of the list of impaired waters but include concerns or problems identified by the Stevens River Watershed Council, DEC, the public or other entities. There are two bodies of water listed as waters of concern in the Stevens River watershed because they are in need of further assessment.

Table 2-1. Local waters of concern (Including waters in need of further assessment) in the Stevens River watershed (DEC 2007b).

Waterbody	Reason for Concern	Status	Current or Future proposed Actions	Strategy #
STEVENS RIVER (US RT 5 UP TO I-91)	SEDIMENT, MORPHOLOGICAL INSTABILITY	Phase 1 assessment complete, Phase 2 assessment in progress	• Assessment results will be analyzed in the future. • Upstream restoration and protection projects may reduce sediment entering this reach of river	25-30
HARVEYS LAKE (Barnet)	WATER LEVEL MGMT MAY IMPAIR AQUATIC HABITAT	TOWN IS EXPLORING DAM MODIFICATIONS		36

Chapter 3 – The Wells River Watershed

Section 3-1 Watershed Description

The Wells River watershed lies immediately south of the Stevens River watershed and its area is approximately 99 square miles or 63,400 acres. The headwaters of this drainage area arise in part on the slopes of Blake Hill, Owlshead Mountain, Spice Mountain, Kettle Mountain and Little Spruce Mountain all in Groton State Forest and flow either into Kettle and Osmore Ponds or form brooks that flow into Groton Lake or Ricker Pond. Drainage from the slopes of Devils Hill, Jennison Mountain, Jerry Lund Mountain and Wesson Hill form Red Brook and the North Branch Wells River, which are two of the three largest tributaries to the Wells.

The Wells River begins below Lake Groton and Ricker Pond and flows southeasterly through Groton, South Ryegate and the northern portion of Newbury before meeting the Connecticut River in the village of Wells River (DEC 1999).

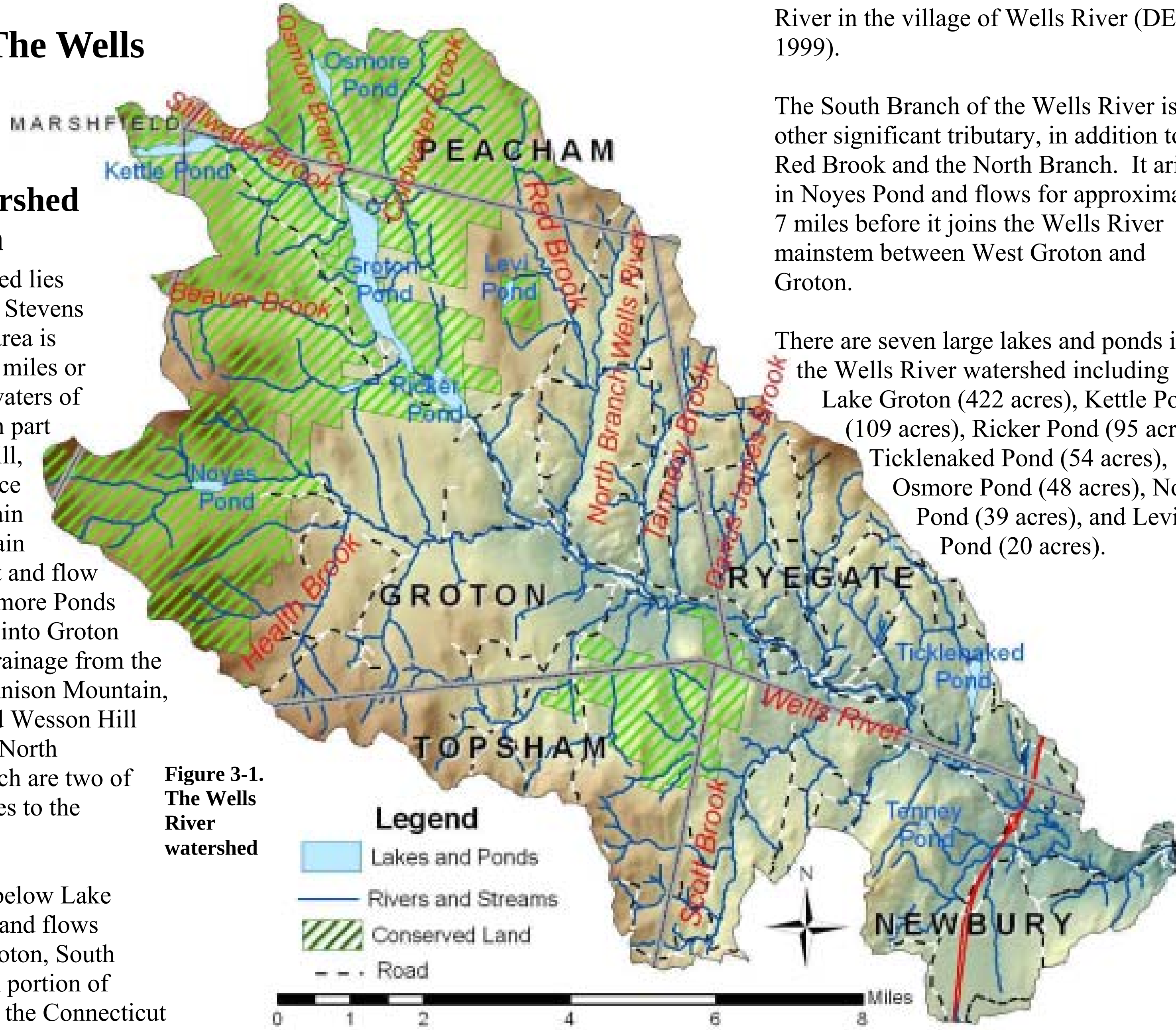


Figure 3-1. The Wells River watershed

The South Branch of the Wells River is the other significant tributary, in addition to Red Brook and the North Branch. It arises in Noyes Pond and flows for approximately 7 miles before it joins the Wells River mainstem between West Groton and Groton.

There are seven large lakes and ponds in the Wells River watershed including Lake Groton (422 acres), Kettle Pond (109 acres), Ricker Pond (95 acres), Ticklenaked Pond (54 acres), Osmore Pond (48 acres), Noyes Pond (39 acres), and Levi Pond (20 acres).

Groton State Forest and Levi Pond Wildlife Management Area

These two state lands make up 28% of the Wells River watershed including the majority of the Wells Rivers headwaters. The management of such a large part of the watershed has a large impact on the water quality in the rest of the Wells River as it flows to the Connecticut River. As stated in the draft Groton Management Unit Long Range Management Plan, land management in the state forest will protect water quality to the greatest extent possible. From a watershed standpoint, state lands function as forested buffer zones that play an important role in maintaining water quality, protecting riparian, lake, and wetland habitats, and protecting floodplain and wetland flood storage areas reducing flood potential downstream (ANR 2007).

In addition, Osmore, Kettle, Noyes, and Levi Ponds are all within the State Park or Wildlife Management Area (WMA) and the State forest makes up a vast majority of the watersheds of Groton and Ricker ponds. The Groton State Forest and Levi Pond WMA also provide for a wealth of recreational opportunities including fishing, boating, swimming, hiking, cross country skiing, birding and camping. There are also many unique habitats in the state forest including one of the largest bogs in Vermont, Peacham Bog.

The dominant land cover type in the Wells River watershed according to data from the Vermont Land Cover Classification Project (1997) is forest with 81.5% of the watershed or 49,995 acres as deciduous, coniferous or mixed forest. The agricultural component is much smaller in the Wells River watershed than the Stevens River watershed with only 7.6% or 4660 acres in agricultural uses. Surface water and wetlands together cover 6.7% or 4111 acres of the watershed.

There are numerous large and significant wetlands in the Wells River watershed. The largest wetland, Peacham Bog, is entirely with in the Groton State Forest and is protected, but there are many smaller wetlands on private property that also provide important functions and values.

Developed land (residential, commercial, industrial and transportation) covers 4.2% of the watershed or 2550 acres. Most of the developed land is transportation use (DEC 1999).

Dams in the Watershed

Like most of New England, dams played an important role in the development of the Wells River watershed providing power for a number of historic mills in the watershed. There are at least 13 dams in the watershed more than half of which are still operational. Many of these dams are at the outlets to lakes and ponds in the watershed. There are also two hydroelectric dams, the Boltonville Dam, and the Adams Paper Company Dam, both on the main stem of the Wells River. Both of these dams were privately redeveloped for hydropower generation in the 1980s. Unfortunately, the flows provided in the bypassed reach at Boltonville Dam (Wells River Hydroelectric Project) are insufficient to support aquatic biota, angling, and aesthetics in accordance with the levels set in Vermont Water Quality Standards.

Water-based Resources

The tributaries, and associated lakes, ponds and wetlands in the watershed support aquatic life and habitat and provide recreational opportunities through their fisheries, swimming beaches, boating runs, and aesthetics. In addition, the surface waters provide drinking water and irrigation supplies. The fundamental purpose of protecting water quality in Vermont is to protect these and any other beneficial uses and values of the water. Waters in the Wells River watershed are protected in order to support uses valued by the public including swimming, boating, and fishing. Some uses are protected specifically if the Agency of Natural Resources identifies them as existing uses under the anti-degradation policy of the Vermont Water Quality Standards (VWQS § 1-03). Existing uses in Basin 14 are listed in Chapter Six in tables 6-1 through 6-3 on page 83.

Swimming

Many of the lakes and ponds in the watershed are used for swimming including Lake Groton, Ricker Pond, Kettle Pond and the Ticklenaked Pond. In addition, there are a number of informal sites on the Wells River and tributary streams where swimming is common but these are not catalogued in this basin plan.

Boating

The majority of boating in the watershed occurs on lakes and ponds. In addition, some locations on the Wells River are used for whitewater kayaking including the stretch of river near the Fish and Wildlife access on the Wells River in Newbury.

Fish Habitat and Fisheries

The Wells River watershed provides a diversity of fishing opportunities ranging from warmwater fish species in some of the large lakes including Lake Groton, and Ricker and Ticklenaked ponds, to self sustaining brook trout fisheries in Noyes Pond and many headwater streams. As noted in the Draft Groton Management Unit Long Range Management Plan, Noyes Pond is a remarkable fishery resource not only within the Wells River watershed, but within the entire State of Vermont. Sizable ponds in Vermont that support, or have the capacity to support, an entirely wild population of brook trout that sustains a high quality fishery are a rarity. Noyes Pond is a *limited-entry* fishery. Angling is prohibited in the tributaries to Noyes Pond, for the purpose of maintaining them as a spawning and nursery refuge (ANR 2007). Streams in the Groton State Forest and many of the other upland streams in the Wells River watershed including Keenan and Tannery Brooks, provide wild self-sustaining populations of brook trout at an abundance level and growth rate high enough to attract angling interest. Other lakes in the watershed and the Wells River are stocked with trout species. Levi and Osmore ponds are stocked with brook trout while Kettle Pond is stocked with rainbow trout. The Wells River is stocked by the Vermont Department of Fish and Wildlife (DFW) with brown trout from the outlet of Ricker Pond to the confluence with the South Branch of the Wells River and again from South Ryegate Village almost to the confluence with the Connecticut River. Brown trout will be replaced with rainbow trout starting in 2009. Brook trout are stocked from the confluence of the South Branch of the Wells River to South Ryegate Village. The Wells River starts out warm because it flows from Ricker Pond, but tributaries like the South Branch of the Wells River help to cool it as it flows further down stream. The majority of the Wells River is too warm for trout during the summer months, but trout can survive in cold water refugia in the Wells River and its tributaries (Kratzer, 2007).

Lake Groton, and Ricker and Ticklenaked ponds are regularly fished for warm water species including smallmouth bass, largemouth bass, chain pickerel, yellow perch, brown bullheads, and sunfish. Excessive nutrient levels in Ticklenaked Pond have caused dissolved oxygen levels that are too low to support fish life in the depths.

The Wells River is stocked with Atlantic salmon fry as part of an effort to restore Atlantic salmon to the Connecticut River. The Wells River is used as a nursery stream, as compensation for the vast amounts of mainstem spawning and nursery habitat that have been destroyed. The idea of the nursery stream is to stock salmon fry, hoping that they will survive and grow into smolts and migrate out to the ocean. Returning adult salmon currently can ascend as far up the Connecticut River as the dam at Dodge Falls in East Ryegate, about 4 miles upstream of the mouths of the Wells and Ammonusooc rivers. Salmon will not be able to ascend into to the upper Wells River because of the dams close to its confluence with the Connecticut River. However, it is the intention that this nursery stream will boost the total numbers of salmon returning to the Connecticut River and ascending the accessible tributaries.

Fish species collected in the Wells River watershed include: Atlantic salmon, brook trout, brown trout, largemouth bass, smallmouth bass, yellow perch, slimy sculpin, common shiner, longnose dace, blacknose dace, lake chub, white sucker, blacknose shiner, longnose sucker, creek chub, pumpkinseed, fallfish, and bluntnose minnow (Kratzer, 2007).

Irrigation and Animal Watering
According to the AAFM approximately 34% of known surface water withdrawals and 45% of known ground water withdrawals in Caledonia County are used for irrigation of vegetables, orchards, and other crops. These statistics may be considerably different for the Wells River as this is only a small portion of the county, but are still a significant use of waters in the watershed.

Drinking Water Supplies
Drinking water in the Wells River watershed is primarily from private wells and public water supplies from groundwater sources such as the supply for the Village of Wells River. No surface waters are designated as public water supplies but surface waters may be used by an unknown number of private residencies and seasonal camps.

Section 3-2 Improving Water Quality Awareness in the Wells River Watershed

Understanding the existing conditions of surface waters is one of the first steps in any water quality protection program. The DEC monitoring strategy is described on page three but this section will include specific water quality information related to the Wells River watershed as well as efforts to provide this information to the wider community.

Biological Monitoring Sites in the Wells River Watershed

Biological monitoring has been done on six sites in the Wells River watershed including three sites on the mainstem and three sites on tributaries near the Pine Mountain Wildlife Management Area. All of these sites received ratings of between good and excellent exceeding the Vermont water quality standards for Class B waters. Samples were taken again in 2007 but have not been analyzed at the time of publication.

Lake Monitoring

Since 1979, the Department of Environmental Conservation has worked with volunteer monitors to sample the water quality in lakes and ponds. The Vermont Lay Monitoring Program equips and trains local lake users to measure the nutrient enrichment of lakes by collecting water samples according to the program's EPA-approved Quality Assurance Project Plan. Lake Groton and Ticklenaked Pond are sampled on a weekly basis during the summer months for water clarity, chlorophyll, and at Ticklenaked Pond for phosphorus as well. The citizen lake monitors share a strong interest in improving the lake's water quality and have worked to reduce nutrient runoff from roads and lands in the watershed. The citizen lake monitors have also assisted DEC in identifying aquatic nuisance species.

The State of Vermont also monitors lakes larger than 20 acres for phosphorus in the spring on a rotational basis. All of the lakes and ponds in the watershed are

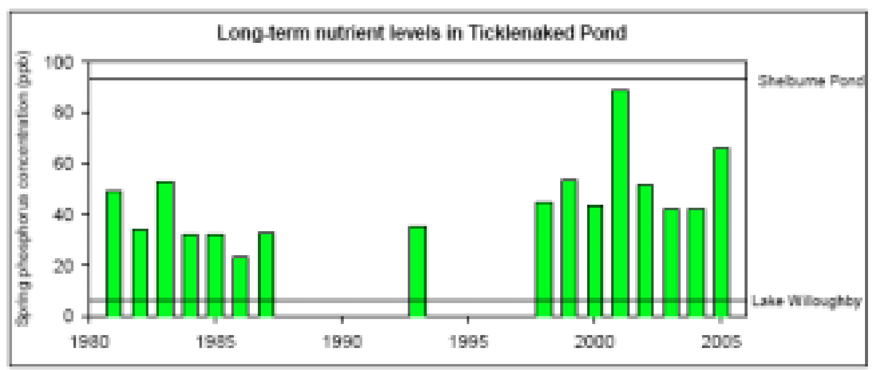


Figure 3-2. Spring Phosphorus Levels in Ticklenaked Pond since 1981.

classified as mesotrophic (having a moderate level of nutrients) except for Ticklenaked Pond, which is classified as eutrophic (having a high level of nutrients). These data establish a reference point from which to measure future changes in water quality. These sampling data as well as sampling data from the LMP program have been used to classify Ticklenaked Pond as impaired due to elevated phosphorus levels. Figure 3-2 shows high levels of phosphorus in Ticklenaked Pond since the early 1980s as relation to the very low phosphorus levels in Lake Willoughby and high phosphorus levels in Shelburne Pond. The Department of Environmental Conservation has also done intensive monitoring of Ticklenaked Pond and all its tributaries in 2005 and 2006 as part of an EPA funded study. The goal for this study is to produce a Total Maximum Daily Load (TMDL) for the waterbody. A TMDL allocates pollution from different sources in the watershed to ensure compliance with the water quality standards. One of the factors in developing the TMDL for Ticklenaked Pond is to identify whether the main source of phosphorus is from sources in the watershed or from internal loading from legacy phosphorus stored in sediments in the pond. The initial results from this study suggest that internal loading is one factor causing high phosphorus levels in the pond but that there are continuing sources of phosphorus in the watershed which must also be addressed to restore Ticklenaked Pond. A TMDL for Ticklenaked Pond phosphorus levels will be developed in the spring of 2008.

E. coli Monitoring

Sampling has also been done in the watershed through a number of programs to identify elevated levels of pathogens. High levels of pathogens, generally measured as *E. coli*, increase the risk of gastrointestinal sickness limiting recreational uses of waters. To protect public health, the State of Vermont has the strictest standard for *E. coli* in the country of 77 colonies per 100 milliliters of water in any single sample.

The Lake Groton Association sampled *E. coli* in Lake Groton in the summer of 2003. The highest level of *E. coli* measured was 44 colonies per 100 ml of water, well below the Vermont standard. The Department of Forests and Parks and Recreation also samples two beaches on Lake Groton and one site on Ricker Pond for *E. coli* levels weekly during the summer. Only one sample in 245 samples from 1997 to 2004 exceeded the Vermont *E. coli* standard suggesting excellent water quality for these two lakes. *E. coli* sampling on Ticklenaked Pond has not identified elevated levels but a very small tributary to the lake had levels in excess of the Vermont *E. coli* standard in 2006.

Boltonville Land Use Exploration (BLUE) Camp and Volunteer Monitoring

A local farmer in cooperation with local scientists and the White River Natural Resource Conservation District established the BLUE camp to teach local children about the impacts of various land uses on the Boltonville section of the Wells River. The land uses studied include farming, Interstate 91, the Newbury Dump, and the Boltonville Dam. The impacts of this program went beyond the campers through two presentations to the Newbury Conservation Commission and through publicity in local papers. A grant was received in 2007 to study how to make the camp sustainable. Recommendations included collaboration with local schools, summer camp programs, or an affiliation

Figure 3-3. Campers at the BLUE camp measuring flow of the Wells River.

with an existing environmental education non-profit.

Stream and Tributary Monitoring

Additional water sampling was done in the Wells River and tributaries in 2007 by local volunteers. This was done with the assistance of Tom Smith and equipment used by his environmental science class at Blue Mountain School. A number of sites were sampled for turbidity, phosphates, pH, conductivity, dissolved oxygen and temperature. In addition, the students from Blue Mountain School completed water quality sampling.

Water Quality Data Management

Not all of the data from the Vermont Lakes and Ponds Program, the Vermont Biological Monitoring and Assessment Lab, and studies done by local lake associations and watershed organizations is currently compiled and made available online for easy public use. DEC is currently working to make this data available through an online environmental mapping program. Making this data accessible to the general public would not only inform local residents but this information may also encourage landowners to take action to address any of the problems that are demonstrated by the water quality data.

GOAL: ESTABLISH BASELINE WATER QUALITY MEASUREMENTS IN THE WELLS RIVER WATERSHED AND PRESENT THIS INFORMATION TO THE PUBLIC.

Objective: Provide a complete picture of the current water quality conditions through expand monitoring.

40. Expand the volunteer monitoring program with a minimum of monthly sampling of turbidity, oxygen, conductivity, temperature and pH along the main stem of the Wells River.

Potential key players: volunteers, Newbury Conservation Commission, DEC, Wells River Watershed Council
Potential funding sources: Borrow equipment from neighboring watershed groups, LaRosa, EPA
Time-frame: 2008

Objective Make water quality testing results easily available to members of the watershed

41. Alert the public to any alarming water quality data or trends in the results by getting this information to lake associations, municipalities, newspapers and other interested parties.

Potential key players: DEC, Watershed Council, DFPR, BLUE camp, LMP, other volunteers
Potential funding sources: State funds, CRJC PG,
Time-frame: ongoing

42. Make annual water quality data easily accessible online and linked to lake association and town web sites.

Potential key players: DEC, Watershed Council, BLUE camp, LMP, lake associations
Potential funding sources: State funds, CRJC PG
Time-frame: 2009

Objective: Increase the involvement of students and volunteers in collecting water quality data.

43. Involve one class of students and volunteers in watershed sampling such as macroinvertribate sampling, chemical sampling, or fish surveys.

Potential key players: Wells River Watershed Council, Blue Mountain School, libraries
Potential funding sources: LaRosa
Time-frame: 2008

44. Continue the BLUE camp by establishing partnerships between local schools and summer programs. Continue its mission of informing local students and the local community of the relationship between land use and water quality.

Potential key players: Wells River Watershed Council, WRNRCD, UVM watershed Alliance
Potential funding sources: Sustainable future grants, CRJC PG, Ducks or Trout Unlimited, local funding
Time-frame: 2012

Section 3-3 Nonpoint Source Pollution in the Wells River Watershed

Nonpoint source pollution was the top rated concern in the Wells River watershed including runoff from developed lands, agricultural lands, and associated with logging operations. One specific concern which came up during the planning process was a number of old gravel pits in the watershed where gravel could easily wash into surface waters. There are also concerns with leachate from the Newbury Landfill along the banks of the Wells River and a small landfill on the northern banks of the Wells River where waste from a local paper mill has been dumped.

Common basin 14 NPS issues are discussed in detail along with common strategies for Basin 14, in Section 1-3 of this plan on page four. Included here is a description of agriculture in the Wells River watershed. A complete description of agriculture in the Wells River watershed is included in Appendix A4.

Agriculture in the Wells River Watershed

Agriculture gives the lower Wells River valley much of its character, although much of the headwaters of the watershed are forested. The proportion of the Wells River watershed that is in agricultural use (7.5% of the watershed) is smaller than that of the Stevens River watershed. Despite this, there is a strong agricultural community in the watershed which supports the local economy and community. Appendix A4 has a complete description of agriculture in the Wells River watershed.

Much of the agricultural land in this watershed is along the Wells River and a few smaller tributaries that flow in from the north including Tannery Brook, Darius James Brook and the Ticklenaked Pond outlet stream. As agricultural land is converted to suburban development, there is generally a net increase in nutrient production, so keeping well managed agricultural land in active production can sustain better water quality. The location of agricultural land along streams and rivers and the spreading of nutrient rich fertilizers and manures make good management practices on farms an important part of reducing NPS pollution in the watershed.

Many farms in the Wells River watershed have installed Best Management Practices (BMPs) which are voluntary practices installed to correct a current waste management problem on a specific farm. In the past 10 years, 19 BMPs have been initiated in the Wells River watershed. Twelve projects are for production area practices (*e.g.,* barnyard runoff, manure storage, leachate collection) covering 493 animals. The remaining seven projects are for field practices (*e.g.* stream bank stabilization, stream crossing) of which three have been completed. The total cost of these practices is $151,026 with the Vermont Agency of Agriculture, USDA, EPA and landowners all contributing a share to the total cost.

GOAL: REDUCE THE AMOUNT OF SEDIMENT AND NON POINT POLLUTION ENTERING THE WELLS RIVER.
(See page 6 for basin-wide strategies)

Objective: Reduce levels of NPS pollution from the agricultural, developed, and rural landscape.

45. Monitor the Newbury Landfill and paper mill disposal site for leachate into the Wells River and address any concerns as they are found. Provide information to landowners about proper handling of historical dump sites on their property.

Potential key players: Conservation commissions, selectboards, Vermont Waste Management Division
Potential funding sources:
Time-frame: ongoing

46. Identify gravel pits in the watershed and work with landowners to revegetate any gravel pits that are causing sedimentation in the Wells River.

Potential key players: DEC, conservation commissions

Potential funding sources: WHIP
Time-frame: 2008

47. Encourage low impact development standards to reduce stormwater runoff from commercial developments and local villages.

Potential key players: Conservation commissions, town selectboards, TRORC, NVDA, DHCA, DEC
Potential funding sources: 604b
Time-frame: ongoing

Section 3-4 Wells River Stream Channel Instability and Aquatic Habitat

As described in Section 1-4 on page seven of this plan, river corridor management is one of the top issues in Basin 14. This is also true in the Wells River watershed where residents in the Town of Newbury have expressed an interest in developing an FEH overlay district for the town. A meeting was held in 2006 to discuss this possibility and completing the Phase 2 geomorphic assessment on the Wells River in the town of Newbury will be a priority to capitalize on this interest. There are also reaches of the Wells River that have experienced high rates of erosion and this has been a concern for many members of the watershed council, particularly in locations where the river flows near gravel pits. Members of the watershed council have also been interested in improving the quality of aquatic habitat in the watershed and maintaining access to the Wells River.

The CCNRCD received a grant in 2007 to complete a Phase 1 geomorphic assessment of the entire Wells River watershed and a Phase 2 assessment of portions of the Wells River watershed.

GOAL: MAINTAIN AND, WHERE NEEDED, RESTORE THE EQUILIBRIUM CONDITION OF THE WELLS RIVER.

Objective: Protect stable reaches, intact floodplain, and forested river corridors.

48. Complete Phase 1 geomorphic assessments of the Wells River watershed and Phase 2 geomorphic assessments with a priority of the following Six locations:

- the S curves above West Groton where bank has been armored;
- around possible impacts from dams on Lake Groton and Ricker Ponds;
- in Groton Village;
- near South Ryegate on reaches where the Route 302 has been moved;
- above and below the interstate bridge; and
- in the Town of Newbury to provide the basis for FEH mapping.

Potential key players: CCNRCD, NVDA, RMP
Potential funding sources: UCM&E, RCG
Time-frame: 2009

49. Protect floodplains identified through the geomorphic assessments as important for maintaining the stability of the Wells River. Work with land trusts to include language in conservation easements that protect floodplains and buffers for maintaining or restoring stream stability.

Potential key players: UVLT, RMP, VRC, conservation commissions
Potential funding sources: UCM&E, VHCB
Time-frame: 2012

50. Protect and provide public access to unique features along the river. The Wells River has many waterfalls, historical mill sites, and beautiful areas where it is important to maintain public access to help keep people connected with the river. Some of these sites include:

- Boltonville Falls
- the chutes and historical foundations at the Fish and Wildlife Access
- Access to the Wells River from the Wells River Railroad

Potential key players. conservation commissions, VRC, UVLT, CVT, Historic preservation
Potential funding sources: VHCB, Town Conservation Funds
Time-frame: 2012

Objective: Encourage increased participation from the public and towns in stream corridor protection.

51. Develop a river corridor plan for the Wells River watershed to reduce human river conflicts and to protect buffers of an appropriate width for the river type.

Potential key players: NVDA, TRORC, selectboards, CNRCD
Potential funding sources: RCG, UCM&E
Time-frame: 2010

52. Encourage and advise towns on including minimum building setbacks and natural buffers along streams in town plans and zoning. Help to coordinate between towns to provide consistent protection for the Wells River for its entire length.

Potential key players: NVDA, TRORC, VLCT
Potential funding sources: 604b
Time-frame: As town plans and zoning are revised

53. Develop and implement an FEH overlay district for the Town of Newbury, and begin this process in other towns in the watershed.

Potential key players: NVDA, TRORC, Newbury, Groton and Ryegate selectboards, planning commissions, and conservation commissions
Potential funding sources: RCG, UCM&E
Time-frame: 2012

54. Provide information to the public about the importance of riparian buffers.

Potential key players: conservation commissions, SEWER, CCNRCD
Potential funding sources: CRJC PG, Watershed Grant
Time-frame: 2010

Objective: Restore the Wells River in unstable reaches and on reaches without sufficient buffers.

55. Restore the riverbank along the Longmore pit and adjacent historical gravel pits.

Potential key players: NVDA, WRNRCD, Town of Newbury, landowners
Potential funding sources: UCM&E, USACE
Time-frame: 2012

56. Identify, prioritize and restore unstable reaches as determined by Phase 1 and 2 geomorphic assessments.

Potential key players: NVDA, CCNRCD, towns, riparian landowners
Potential funding sources: UCM&E
Time-frame: 2012

Section 3-5 Transportation-Related Water Quality Issues in the Wells River Watershed

Transportation-related water quality issues were rated as one of the top concerns in the Wells River watershed. This issue and related strategies for all of Basin 14 are discussed in detail in Section 1-5 of this plan on Page 10.

Bridge and Culvert Surveys and Capital Improvement Budgets

An inventory of existing bridges and culverts can help to prioritize the replacement of structures that are most likely to fail, constrain the water way and exacerbate flooding problems or block fish passage. All of the towns in the Wells River watershed have mapped the location of culverts with help from the Lyndon State College. In addition culverts in a portion of the watershed were surveyed in 2006 using new in-depth survey protocols developed by the Agency. Using

Table 3-1. Priority Culverts for replacement in the surveyed portions of the Wells River Watershed in Groton and Ryegate. The percent bankfull width is the width of the culvert as compared to the bankfull width of the stream and is an indicator of the degree to which a culvert is undersized.

Priority	Road	Stream	Structure #	% of Bankfull
1 Groton	HARV ORR RD	North Branch Wells River	70000601660304X	50%
2 Groton	RED BROOK RD	Red Brook Trib	70000703680304X	38 %
3 Groton	HARV ORR RD	North Branch Wells River Trib	70000601640304X	38 %
4 Groton	HARV ORR RD	North Branch Wells River Trib	70000601620304X	50 %
5 Groton	GREAT RD	Tannery Brook Trib	70000401310304X	50 %
6 Groton	GREAT RD	North Branch Wells River Trib	70000401550304X	75 %
7 Groton	MINARD HILL RD	Tannery Brook Trib	70000202230304X	60 %
1 Ryegate	QUINT RD	Wells River Trib	70006301570310X	38 %
2 Ryegate	HALL RD	Wells River trib	70000603240310X	47 %
3 Ryegate	RENFREW DR	Wells River trib	70003702520310X	40 %
4 Ryegate	WITHERS POON RD	Wells River trib	70000502250310X	57 %
5 Ryegate	GILFILLAN RD	Wells River Trib	70004400920310X	75 %

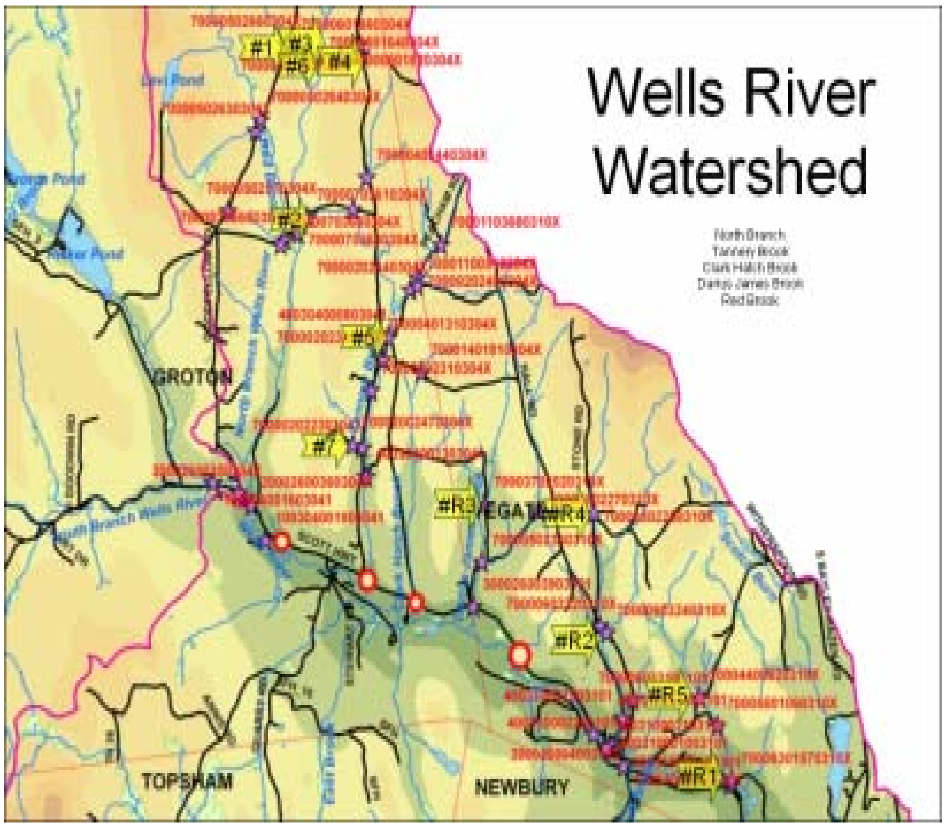


Figure 3-4. Bridges and culverts surveyed in 2006 with priorities for replacement

this protocol the size and configuration of 49 bridges and culverts in the Wells River watershed were surveyed to determine: if they were large enough to accommodate the flows of the stream, if they allowed for the passage of sediment that is necessary to maintain a stable stream, and if they provided for the passage of fish and wildlife. This survey was done in close collaboration with the road commissioners in Groton and Ryegate, and a prioritization of culverts for replacement was made, shown in Figure 3-4 and Table 3-1. Table 3-1 shows the culverts that were ranked as priorities for replacement based on the degree to which they were undersized, caused up and downstream erosion or deposition, had poor alignment, and were barriers to fish passage.

In the summer of 2007 a clean and clear grant was provided to the Town of Groton and the number one priority culvert was replaced. Funding through the Partners for Water Quality Program has been secured to replace an additional top priority culvert in Groton.

GOAL: MINIMIZE CONFLICTS BETWEEN STREAMS' NATURAL FUNCTIONS AND TRANSPORTATION INFRASTRUCTURE.
(See page 12 for basin-wide strategies)

Objective: Reduce conflicts between bridges and culverts and the Wells River.

57. Complete ANR bridge and culvert surveys of the watershed and compile this information for use by towns to prioritize bridge and culvert replacement. Work with town road commissioners and the district fisheries biologist during the survey to focus efforts on priority areas of the watershed.

Potential key players: NVDA, ANR, Town road commissioners
Potential funding sources: 604b, 319, RCG
Time-frame: 2010

Section 3-6 Lakes and Dams in the Wells River Watershed

Residents of the Wells River watershed are fortunate to have many lakes and ponds in the watershed including: Lake Groton, Ricker Pond, Osmore Pond, Kettle Pond, Noyes Pond, Levi Pond, Ticklenaked Pond and Tenney Pond. Many of these ponds still have large amounts of undeveloped shoreline, and all provide for unique recreational opportunities and host important aquatic habitat. The main concerns about lakes and ponds in the watershed include nutrient enrichment, exotic species, acidification and toxins, dams and water level fluctuations, and lakeshore protection and enhancement which are all described in detail in Section 1-6 of this basin plan on page 12. The impacts of dams on rivers are also discussed in this section..

Nutrient Enrichment

The issue of nutrient enrichment has been discussed in Sections 3-3 and 3-4 of this plan and is a concern in most developed lakes and ponds. As shown in Figure 3-5 nutrient levels are of particular concern in Ticklenaked Pond, which is currently listed as impaired because of elevated phosphorus levels which are described in Section 3-2. The Ticklenaked Pond Association has been working to clean up sources of phosphorus in the watershed using a watershed grant from the State of Vermont. Projects included buffer plantings, beaver baffle installation, agricultural Best Management Practice implementation, and road improvement projects. In addition, a number of agricultural projects have been completed in the watershed to reduce nutrient input from this source.

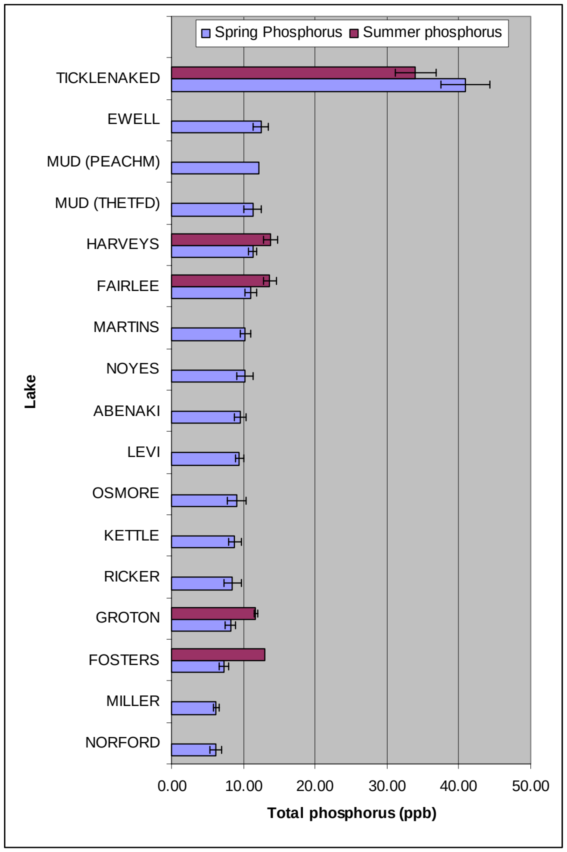


Figure 3-5. Total phosphorus in Basin 14 ponds from spring phosphorus and summer LMP data showing one standard error bars.

The draft TMDL (described on page 33) analysis of Ticklenaked Pond shows that the lake receives approximately 204 kg of phosphorus per year, of which: 111 kg are derived from nonpoint watershed sources; 86 kg from internal recycling of "legacy" phosphorus; four kg from direct rainfall contributions; and three kg from septic contributions. Current estimates indicate that alternatives aimed at reducing phosphorus loading between 39 and 126 kg/yr will yield water quality improvements and reduced in-lake phosphorus concentrations, as shown by Table 3-2. The alternative shown in Table 3-2 treating both the internal and watershed phosphorus loading is the most likely to result in attainment of water quality standards. Treating either the watershed loading or internal loading separately will show moderate improvements in water quality, but as they are complimentary actions, implementing both options together will produce the most sustainable improvements. Treating internal loading is commonly done by chemical inactivation of sediment-phosphorus release mechanisms, where the inactivation seals legacy phosphorus into the lake sediments. Such a treatment alone with out watershed loading reductions would be a temporary measure at best, as continued phosphorus accumulated on top of the treated surface would certainly overwhelm the capacity of the treatment to adsorb phosphorus in a short timeframe. Accordingly, it is important that meaningful watershed loading controls precede execution of an internal lake treatment.

Table 3-2. Phosphorus reduction scenarios for Ticklenaked Pond

Alternative	Resulting phosphorus concentration	Predicted water quality improvement
Treat watershed and internal load (final load 92 kg)	**~17 ppb**	**Major – Likely to meet standards**
Treat watershed load only (final load 178 kg)	**~33 ppb**	**Minor –not likely to meet standards**
Treat internal load only (final load 118 kg)	**~ 24 ppb**	**Moderate – may meet standards in certain years, will likely fail in few years**
Do nothing (current load 204 kg)	**up to 45 ppb**	**None**

Landuse phosphorus export modeling indicates that much of the phosphorus discharging from the watershed is attributable to agricultural land uses. Several issues are presently being addressed through a partnership between the Natural Resources Conservation Service and farm operators, which will significantly reduce phosphorus discharge to the Ticklenaked Pond watershed. Additional measures to address loading from developed lands in the watershed will be necessary to reduce watershed loading enough to meet water quality standards.

These efforts will be done in cooperation with the Ticklenaked Pond Association, the CCNRCD, the Town of Ryegate, and watershed residents.

Exotic Invasive Species

To prevent the introduction of invasive species, wash stations have been installed at Stillwater State Park (Lake Groton) and Ricker State Park (Ricker Pond). There are still concerns with the possible transport of Eurasian watermilfoil at Boulder Beach on Lake Groton , and at the informal access at the southern end of Ricker Pond. Both of these sites are used for car top boat access and do not have boat washes. In the case of the southern end of Ricker Pond, there is no signage.

The Lake Groton Association conducts searches within the lake to detect early infestations, and there are informational brochures and posters at the entrance to Stillwater State Park and the Groton Nature Center. In addition to this, sections of the Association's book *All About Lake Groton* and the Association's web site, grotonpond.com, include information about Eurasian watermilfoil and other exotic invasive species.

Low pH Ponds

Levi Pond is one lake particularly susceptible to low pH in the Wells River watershed. Levi Pond is impaired due to low Alkalinity and a pH measured at 5.8 in 2003. This pH level is low enough to likely impair the biotic community. This issue is discussed in detail in Section 1-6 on page 13.

Lakeshore Protection and Enhancement

The Wells River watershed has three ponds that are rated as wilderness like by the Vermont DEC including Osmore, Kettle and Levi ponds which are located in the Groton State Forest and Levi Pond Wildlife Management Area (DEC 1994). There are only 55 lakes with this status in the state. Ricker Pond, Lake Groton, and Ticklenaked Pond also have areas of undeveloped shoreline. To protect lakeshores, efforts can be made to encourage development in the future that will protect the water quality and maintain the natural feel of the lake by leaving a protective buffer around the lake.

GOAL: PROTECT AND RESTORE THE NATURAL ENVIRONMENTS OF LAKES AND PONDS IN THE WELLS RIVER WATERSHED TO PROTECT WATER QUALITY, RECREATION AND AESTHETICS.

(See page 15 for basin-wide strategies)

Objective: Protect areas of existing natural lakeshore and on developed lakeshores, increase riparian buffers and reduce erosion and nutrient runoff.

58. Ensure the protection of portions of undeveloped shorelines on Groton, Ricker, and Ticklenaked Ponds through voluntary conservation of at least one property along these lakes and ponds.

Potential key players: lake associations, land trusts, State of Vermont, planning commissions, VLCT
Potential funding sources: VHCB
Time-frame: ongoing

59. Maintain existing lakeshore vegetation through the creation of shoreline zoning in all watershed towns including language on vegetated lakeshore buffers.

Potential key players: State of Vermont, Towns of Groton, Ryegate and Newbury, planning commissions, VLCT
Potential funding sources:
Time-frame: 2012

60. Hold a workshop or workshop series on lakeshore management to cover such topics as buffer restoration and low impact lawn care and landscaping.

Potential key players: lake associations, DEC, conservation commissions
Potential funding sources: CRJC PG, Watershed Grant
Time-frame: 2009

Objective: Prevent the spread of invasive species to watershed lakes, ponds and rivers.

61. Continue efforts of the Lake Groton Association to prevent invasive species

spread through use of boat washes, inspections and boater education.

Potential key players: DFPR, DEC-AIS, lake associations
Potential funding sources: Watershed Grant, ANC
Time-frame: ongoing

62. Increase communication between the State Parks, the Lake Association, and the Town of Groton and develop new efforts such as a sticker program or boat launch "greeter" monitoring program for Lake Groton and Ricker Pond.

Potential key players: Lake Associations, DEC-AIS, DFPR, Town of Groton, CCNRCD
Potential funding sources: Watershed Grant, ANC
Time-frame: ongoing

Objective : Reduce phosphorus levels in Ticklenaked Pond to meet Vermont Water Quality Standards.

63. Finalize the TMDL for Ticklenaked Pond in cooperation with the Ticklenaked Pond Association, CCNRCD, NRCS, and Town of Ryegate. The TMDL will lay out necessary watershed phosphorus loading reductions needed to meet water quality standards as well as the potential need for internal treatment to address internal loading of phosphorus in Ticklenaked Pond.

Potential key players: TNPA, DEC, NRCS, CCNRCD, Ryegate Selectboard
Potential funding sources: EPA
Time-frame: 2008

64. Identify the primary watershed sources of phosphorus in the Ticklenaked Pond watershed through land-use modeling, stream and watershed surveys and through community outreach efforts and develop a plan to reduce annual watershed phosphorus loading by 26 kilograms (57 pounds) or the amount required in the final Ticklenaked Pond TMDL.

Potential key players: TNPA, DEC, NRCS, CCNRCD, Ryegate Selectboard and Road Commissioner
Potential funding sources: EPA, UCM&E, Watershed Grant, Better Backroads Grant, CRJC PG, 319, C&C
Time-frame: 2008

65. Work with the local community and partners to address each major source of phosphorus identified in the watershed study. Likely efforts will include working with watershed residents to improve shoreline management practices, improve roads and driveways to reduce erosion, reduce the use of fertilizer, and continued work with the agricultural community to reduce phosphorus loading.

Potential key players: TNPA, DEC, NRCS, CCNRCD, Ryegate Selectboard and Road Commissioner
Potential funding sources: EPA, UCM&E, Watershed Grant, Better Backroads Grant, CRJC PG, 319, C&C
Time-frame: 2009

66. Once commitments have been made to reduce phosphorus loading in the Ticklenaked Pond watershed and if, deemed necessary in the TMDL and supported by the local community, seek funding to complete an internal sediment-phosphorus inactivation treatment in Ticklenaked Pond to address the internal loading of phosphorus.

Potential key players: TNPA, DEC, CCNRCD, Ryegate Selectboard, local congressional and state legislative representatives
Potential funding sources: EPA, legislative appropriations at the State or National level
Time-frame: 2009

67. If necessary implement sediment-phosphorus treatment, including completion of necessary planning and permitting processes.

Potential key players: TNPA, DEC
Potential funding sources: EPA, legislative appropriations at the State or National level
Time-frame: 2011

Section 3-7 Impaired and Altered Waters in the Wells River Watershed

The Agency of Natural Resources is responsible for maintaining water quality in each waterbody in accordance with the Vermont Water Quality Standards. Water quality is determined using biological, physical, and chemical criteria for each water quality management class. The Department of Environmental Conservation monitors surface waters for conformance with numeric and narrative water quality criteria to document violations and determine use attainment. Waters that are determined to be below the biological, physical or chemical water quality criteria of the Vermont Water Quality Standards are listed as impaired. To be listed as "impaired" and included in the EPA- Approved *List of Impaired Surface Waters,* the violation of the Vermont Water Quality Standards must be substantiated by data collected through chemical, physical and/or biological monitoring and the cause or stressor most likely responsible for the impairment identified. This process is outlined in the DEC publication *2006 Vermont Surface Water Assessment Methodology Including Vermont Listing Methodology*.

Ticklenaked Pond is the only water on the 2006 303(d) list of impaired waters in the Wells River Watershed. Ticklenaked Pond is listed as impaired due to elevated phosphorus levels, as discussed in detail in section 3-6 of this plan. Levi Pond is impaired because of low alkalinity but has a TMDL which was approved in 2004. This is discussed in sections 1-6 and 3-6.

Altered Waters or Waters in Need of Further Assessment

There are other waters that fall outside the scope of impaired waters but have not met water quality standards or are of concern for other reasons. There is one body of water listed in need of further assessment in the watershed. The Wells River below the Newbury Landfill is listed as in need of further assessment because of leachate from the landfill.

Table 3-3. Impaired waters in the Wells River watershed (DEC 2007a)

WATER SEGMENT NAME/DESCRIPTION	POLLUTANT	USE(S) IMPAIRED	REASON FOR SURFACE WATER QUALITY PROBLEMS	ACTIONS TO RESTORE WATERS
TICKLENAKED POND (Ryegate)	PHOSPHORUS	AESTHETICS, AQUATIC LIFE SUPPORT, CONTACT RECREATION	ALGAE BLOOMS, HIGH PH, LOW D.O.	• TMDL study is in progress to determine the proportion of internal and external phosphorus loading (strategy 61&62) • BMP implementation at farms in the watershed through the EQIP Program has been started and will continue to be a priority (strategies 2 & 3) • BMP implementation on Developed lands (strategy 63) • If needed complete internal phosphorus treatment. (strategies 64&65))
LEVI POND (Groton)	ATMOSPHERIC DEPOSITION: EXTREMELY SENSITIVE TO ACIDIFICATION; EPISODIC	AQUATIC LIFE SUPPORT	ATMOSPHERIC DEPOSITION:	• This water was included in the Acid Lake TMDL submitted and subsequently approved by EPA in September 2004. Monitoring is ongoing to track this impairment.

Table 3-4 Local waters of concern (including waters in need of further assessment) in the Wells River watershed (DEC 2007b)

Waterbody	Reason for Concern	Status	Current or Future proposed Actions
WELLS RIVER (Newbury)	NEWBURY LANDFILL LEACHATE ENTERING SURFACE WATER VIA GROUNDWATER	TESTING FROM DAY CAMP STUDIED LEVELS	• Newbury Blue camp testing (strategy 41) • Continue DEC monitoring of groundwater
TICKLENAKED POND (Ryegate)	UNKNOWN SOURCE OF BACTERIA CONTAMINATION		• Sampling for *E. coli* levels during TMDL study of Ticklenaked Pond suggest removal of this from the 2008 list of priority waters • Survey small tributary to Ticklenaked Pond for sources of *E. coli*
WELLS RIVER (Newbury)	COMMUNITY CONCERNS RELATED TO EROSION FROM GRAVEL PIT OPERATIONS ADJACENT TO THE WELLS RIVER	ACT 250 RESTORATION PLAN HAS BEEN APPROVED	• Completion of the ACT 250 streambank restoration plan. • Phase 2 Geomorphic Assessment planed for this reach of river (strategy 46)
WELLS RIVER (BELOW BOLTONVILE DAM) (Newbury)	INADEQUATE FLOW AND STRUCTURAL ALTERATIONS IN DAM'S BYPASS	FERC EXEMPTION	• Address with exemptee or through FERC process (strategy 66)

Chapter 4 – The Waits River Watershed

Section 4-1 Watershed Description

The Waits River originates below the slopes of Signal, Burnt and Butterfield Mountains in the southern part of Groton State Forest. It is 23 miles long and flows southerly for about 8 or 9 miles before taking a turn and flowing southeasterly for 14 or 15 miles before entering the Connecticut River in Bradford. The total drainage area of the watershed is approximately 144.3 square miles or 92,400 acres.

The two largest tributaries to the Waits River are the South Branch and the Tabor Branch. The Tabor Branch is 10 miles long and drains 28.4 square miles or 18,180 acres. It flows from the base of the hills in northwestern Topsham south, southeast then south again converging with the Waits River just below East Corinth. The South Branch of the Waits River is 10 miles long and drains 44 square miles or approximately 28,160 acres. The South Branch is formed by the confluence of Cookville and Meadow Brooks in the southeastern part of Corinth and flows easterly then northeasterly meeting the Waits River on the eastern edge of Bradford.

The Waits River drainage is dominated by forested land covering 84.3% of the watershed or 84,348 acres. Agriculture is a distant second land use with only 8.2% of the watershed, or approximately 8,177 acres, used for agricultural purposes. Developed land, primarily transportation, accounts for 4.7% of the total watershed or

Figure 4-1. The Waits River watershed.

approximately 4689 acres. Surface water covers 1.4% of the watershed or 1439 acres and wetlands cover 1.3% of the watershed or 1334 acres.

About 4.2% of the Waits River watershed is permanently conserved as part of the Groton and Washington State Forests, the Bradford, Fairlee, and Orange Town Forests, and the Washington Wildlife Management Area. The Groton State Forest is the largest block of conserved land covering nearly 3% of the watershed in the headwaters of the mainstem of the Waits River. Additional lands have been conserved as part of the Orange County Headwaters project. These conserved areas provide a variety of watershed benefits including protection of water quality and upland and aquatic habitat as well as public access to water resources.

Dams in the Watershed

Like most of New England, dams played an important role in the development of the Waits River watershed providing power for a number of historic mills in the watershed. Most of these historic dams have been washed out over time and now the Waits River and its major tributaries are free flowing with the exception of the Bradford Dam, which is visible from Route 5 in the Town of Bradford and is the largest dam in the watershed. This dam is used to generate electricity and is managed as a run-of-the river dam (meaning that the dam does not store and release water) but there is a bypass reach which has low water levels impacting the habitat of this reach of river. The Bradford Dam was redeveloped by CVPS in 1981-82 and is regulated by the Federal Energy Regulatory Commission under an exemption.

Water-based resources

The tributaries, and associated lakes, ponds and wetlands in the watershed support aquatic life and habitat and provide recreational opportunities through their fisheries, swimming beaches, boating runs, and aesthetics. In addition, the surface waters provide drinking water and irrigation supplies. The fundamental purpose of protecting water quality in Vermont is to protect these and any other beneficial uses and values of the water. Waters in the Waits River watershed along with all surface waters in Vermont are protected in order to support uses valued by the public including swimming, boating, and fishing. Some uses are protected absolutely if the Agency of Natural Resources identifies them as existing uses under the anti-degradation policy of the Vermont Water Quality Standards (VWQS § 1-03). Existing uses in Basin 14 are listed in Chapter Six in tables 6-1 through 6-3 on page 83.

Swimming

There are a number of informal swimming holes in the Waits River watershed.

Boating

Canoeing and kayaking were identified as important uses during public forums in the Waits River watershed. The mainstem of the Waits River is used for white water kayaking during high water and is rated as highly important in a survey of whitewater rivers in Vermont (Jenkins and Zika 1992). The Waits River below the Bradford dam receives moderate usage for flat water boating and as an access point to the Connecticut River. Boaters also canoe in this location to view the abundant wildlife in the wetlands at the confluence with the Connecticut River. In addition, a Connecticut River Water Trail campsite is located adjacent to the Fish and Wildlife Access on the Waits River and draws boaters up from the Connecticut River into the Waits River.

Fish Habitat and Fisheries

Fisheries investigations conducted since the 1950s have shown that the Waits River supports dense populations of brook trout in smaller streams in the upper watershed with fewer brook and brown trout downstream. Survey results indicate a general increasing trend in the brook trout population in the upper watershed over the last 50 years. Naturally reproducing rainbow trout, common in many other Vermont rivers, have not been detected by surveys in recent years. Below the Bradford Dam, the Waits River enters the backwaters of the Connecticut River and supports a number of fish species including bass, pike, and perch present in the upper Connecticut River (Humling 2007). Creel surveys are an important tool used by fisheries managers to gather specific information from recreational fisheries. In creel surveys, anglers are interviewed about their fishing day. Information collected is used to estimate species caught, total angler participation, catch rate, and harvest. A creel survey conducted in 2000 by DFW indicated that angling pressure is low in the upper watershed and moderate throughout the remainder of the watershed. This information, related to fish inventory survey information, is used to support and guide management decisions.

Current fisheries management of the Waits River aims at protecting wild trout populations while providing recreational fisheries through the stocking of hatchery-raised trout where wild populations are insufficient to support them. No stocking of the upper watershed, where healthy populations of wild brook trout occur, has taken place since 2000, in accordance with *The Vermont Management Plan for Brook, Brown, and Rainbow Trout* (DFW 1993). Catchable sized rainbow trout are stocked each spring in the lower reaches to provide angling opportunities.

Temperature and habitat loss are thought to be limiting factors to coldwater fish populations in the Waits River below West Topsham as well as in the lower South and Tabor Branches. Temperatures above trout species' preferred range are regularly exceeded during the summer in the mainstem. Much of the Waits River mainstem is characterized by a wide, shallow stream channel with limited riparian trees and vegetation. Loss of streamside trees and vegetation leads to channel instability, erosion, sedimentation of spawning gravels, loss of instream cover, loss of shading and heightened water temperatures. Habitat fragmentation associated with improperly designed and installed stream-crossing structures may also be a limiting factor in trout populations.

Additional fisheries management focuses on protecting existing habitat through public outreach and participation in the regulatory process, and assessing aquatic organism passage through stream crossing structures. The Waits River watershed is identified as providing important habitat in the *Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River Basin* (Connecticut River Atlantic Salmon Commission 1998). The Waits River watershed supports approximately 5.1% of the available anadromous salmon nursery habitat within Vermont and approximately 2.4% of the available salmon nursery habitat within the entire Connecticut River Basin. Atlantic salmon fry are stocked annually and evaluated throughout the lower Waits River watershed (Humling 2007).

Irrigation and Animal Watering

According to the AAFM approximately 24% of known surface water withdrawals in Orange County are for irrigation while an almost insignificant amount of ground water is used for this purpose. These statistics may be considerably different for the Waits River watershed do to differences in characteristics of this watershed with other areas of the county. Vegetables, orchards, and other crops are all supported by limited irrigation.

Drinking Water Supplies

Drinking water in the Waits River watershed is primarily from private wells and the public Bradford Village water system supplied by groundwater. Mill Pond Brook covering portions of Fairlee, West Fairlee and Bradford is reserved as an emergency surface water supply for the Village of Bradford. Other surface waters may be used by an unknown number of private residences and seasonal camps.

Water Quality in the Watershed

Water quality data from the Waits River watershed comes from a number of different sources. This includes biological monitoring data from the Department of Environmental Conservation at ten different locations in the watershed (see Figure 4-2). Biological monitoring is done by characterizing the macroinvertebrate and/or fish communities and using the integrity of these communities to infer the water quality of the stream. As seen in Figure 4-2, most of the sites in the watershed are rated as very good to excellent. Pike Hill Brook has four sample sites listed as poor due to pollution from the abandoned Pike Hill mines. The monitoring site on a tributary to the Tabor Branch in Topsham is also listed as poor. These locations are discussed in detail in Section 4-6, Impaired and Altered Waters.

Other sources of water quality data in the watershed include fish surveys and temperature monitoring done by the Department of Fish and Wildlife as well as sampling done by local schools including the Waits River Valley School and River Bend Career and Technical Center. Sites sampled by the schools suggests *E. coli* contamination may be an issue in some locations along the Waits River, but this needs to be confirmed with more precise sampling techniques. Biological monitoring by the River Bend Career and Technical Center has shown healthy macroinvertebrate communities.

Issues related to fisheries in the Waits River watershed include elevated temperatures, erosion and sedimentation, limited riparian vegetation, and barriers to fish movement (DFW 2000). The DFW has monitored water temperatures on the main stem of the Waits River during the summers of 2000, 1981 and 1962 and found that temperatures often exceed 75° F, which is the temperature that can be lethal to trout over extended periods of time. During the summer of 2000, nine days were in excess of this temperature and this was considered a cool year. Based on these measurements, the temperature of the Waits River likely exceeds 80 degrees on a least a few occasions during warmer years and remains above

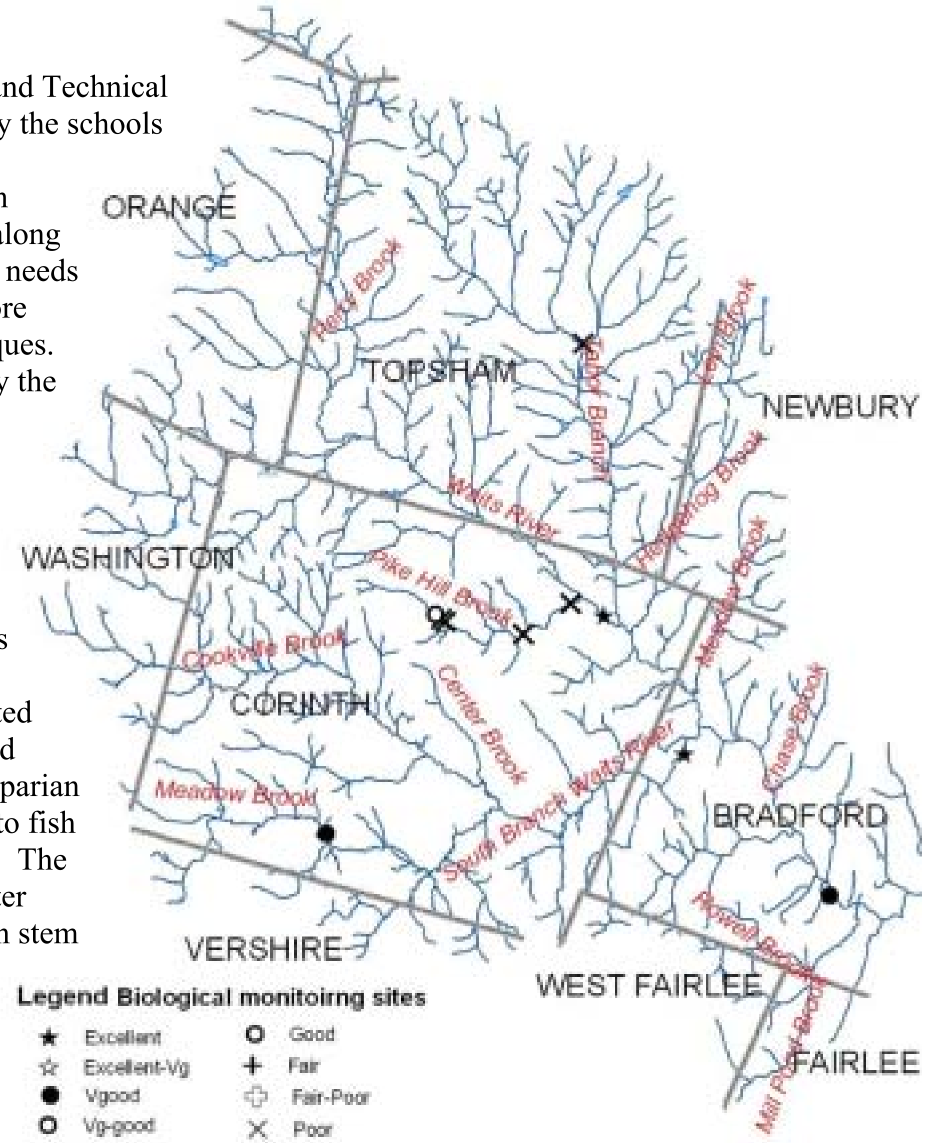


Figure 4-2. Biological Monitoring results on the Waits River

75 degrees for extended periods of time (DFW 2000).
One major factor that may be increasing temperatures on the Waits River is physical condition of the river and its banks. The Waits River is wide and shallow for a river of its size, which, along with limited riverbank vegetation, increases the amount of solar warming that the river receives. The poor physical condition of the river also can lead to erosion which threatens private property, and causes sedimentation and a reduction in the quality of the habitat in the river. These conditions have resulted in the listing of the Waits River from the South Branch to the Connecticut River as in need of further assessment due to sediment, temperature caused by habitat alteration, channel widening, erosion, and land runoff (DEC 2006). This is discussed further in Section 4-4.

Improper design or installation of culverts may present migration barriers to fish and other aquatic organisms in the watershed. Insufficient flows within culverts, excessive jump heights at culvert outlets, or excessive water velocities within culverts can each create migration barriers year-round or just during specific conditions.

Section 4-2 Water Quality Outreach in the Waits River Watershed

Understanding the existing conditions of surface waters is one of the first steps in any water quality protection program. This section includes specific information related to the Waits River watershed as well as efforts to provide this information to the wider watershed community. The State of Vermont monitors water quality through biological and chemical monitoring and working with outside groups and volunteers as explained in sections 1-2 and 4-1 of this plan on pages 3 & 51.

School Monitoring Programs

Both the Waits River Valley School and the River Bend Career and Technical Center have water sampling programs with local students. These programs present great educational opportunities for students and the community, but also provide additional information about the quality of waters in the Waits River watershed. The sampling done by these programs differs between the schools but together includes sampling for macroinvertrabrates, *E. coli*, turbidity, and nutrients including phosphorus and nitrogen. The sampling equipment and methods used by the schools are not the same as those used by the state, so results can't be used by the state to officially identify impaired waters, but are used to identify where state sampling should be done to follow up on areas that are potential issues in the watershed. Both schools have identified *E. coli* at levels which may be a concern and warrant further investigation, while biological sampling has generally indicated good water quality.

Public Field Trips and Events

Another approach to increasing awareness in the watershed around water quality issues and solutions is through hosting field trips and local events focused on watershed issues and solutions. In the summer of 2006, two field trips were organized by the Bradford and Corinth conservation commissions as part of the Go with the Flow series. These trips focused on wetlands at the mouth of the Waits River and land use and its relation to fisheries and the physical condition of the South Branch of the Waits River. These two trips were well attended and provided information on the functions and values of wetlands and the relationship between agricultural and forestry practices and stream geomorphology and fisheries. Additional field trips were held in 2007 in Bradford and Corinth to discuss stream geomorphology and the physical condition of the Waits River.

GOAL: DEVELOP A GOOD UNDERSTANDING OF THE WATER QUALITY IN THE WAITS RIVER WATERSHED AND INCREASE THE AWARENESS OF WATERSHED RESIDENTS ABOUT ANY WATER QUALITY CONCERNS AND BASIC ACTIONS THEY CAN TAKE TO ADDRESS THESE CONCERNS.

Objective: Increase the scope and reliability of water quality information collected in the Waits River watershed and provide this information to the public.

68. Work with the Biomonitoring and Aquatic Studies Section to locate biological monitoring sites in the Waits River watershed that will address community concerns. One site of concern is the Waits River near the Waits River Valley School because this site has ongoing testing by the local school which has suggested lower water quality.

Potential key players: BASS, interested community members, River Bend Career and Technical Center
Potential funding sources: State funds
Time-frame: 2007-2008

69. Continue and expand school and community based water quality testing in the watershed. Integrate local testing information in the watershed and make this available to the public. Work with new programs and groups to expand testing .

Potential key players: Waits River Valley School, Oxbow High School, River Bend Career and Technical Center, DEC
Potential funding sources: CRJC PG, WEF, UCM&E, Watershed Grant
Time-frame: ongoing

70. Identify areas of the Waits River watershed which may be at risk for specific types of pollution such as *E. coli*, nutrient enrichment, sedimentation, or metals due to local land uses to guide future water sampling efforts.

Potential key players: Waits River Valley School, Oxbow High school, River Bend Career and Technical Center, DEC, conservation commissions
Potential funding sources: CRJC PG, WEF, UCM&E, Watershed Grant
Time-frame: 2008

71. Begin a volunteer water quality testing program in the Waits River watershed to identify some of the water quality issues in the watershed including *E. coli* at the Waits River Valley School and at other swimming locations in the watershed. Publicize results to increase awareness in the community.

Potential key players: Waits River Valley School, Oxbow High School, River Bend Career and Technical Center, DEC, Bradford and Corinth conservation commissions
Potential funding sources: LaRosa, CRJC PG, WEF, UCM&E, Watershed grant
Time-frame: 2010

Objective: Increase the awareness in the watershed about good land stewardship to reduce water pollution in the Waits River watershed.

72. Conservation commissions will help distribute the booklet *A Place You Call Home* produced by Northern Woodlands in 2006. This publication discusses important land management principals for landowners many of which are related to water quality.

Potential key players: Northern Woodlands, conservation commissions
Potential funding sources:
Time-frame: 2007-2008

73. Provide opportunities for adults to learn about the Waits River. Continue field trips to sites along the Waits River, tributaries and other sites in the watershed to increase local knowledge of this great resource and current threats.

Potential key players: Bradford and Corinth conservation commissions, DEC
Potential funding sources: WEF, CRJC PG
Time-frame: Ongoing

Section 4-3 Nonpoint Source Pollution in the Waits River Watershed

Nonpoint source pollution was the top rated concern in the Waits River watershed including runoff from roads, developed lands, agricultural lands, and associated with logging operations. These topics and related strategies for all of Basin 14 are discussed in detail in Sections 1-3 and 1-5 of this plan on pages four and 10 respectively. Included in this section is a description of roads and agriculture in the Waits River watershed.

Road Assessments and Projects

A bridge and culvert survey was completed for the Waits River watershed in 2007. This was done through a survey of 218 structures completed by the DFW and 16 structures surveyed Redstart Consulting as part of the geomorphic assessment of the Waits River. Results from these assessments will be compiled and presented to local towns in 2008.

The Towns of Topsham and Washington have completed Better Backroads grants in the Waits River watershed to reduce runoff from town roads. In 2004, the town of Topsham completed a road inventory and budget plan funded through a Better Backroads grant.

Agriculture

Agriculture gives the Waits River watershed much of its character along with supporting the economic base of the watershed. In addition, as agricultural land is converted to suburban development, there is generally a net increase in nutrient production, so keeping well managed agricultural land in active production can sustain better water quality. Farm land makes up over 8% of the Waits River watershed and much of this land is located along streams and rivers. As farming involves the spreading of fertilizers and manures, good management practices on farms are important to reducing NPS pollution in the watershed.

One challenge with increasing the participation of farmers in the Waits River watershed in BMP programs that require taking land out of production, is that the Waits River valley is narrow and many of the farms along the river have a limited land base. Because of this, programs that might increase participation in this watershed such as the Vermont Agricultural Buffer Program that allows for the harvesting of the buffers along row crops and the development of new flexible approaches were supported by the watershed council. Appendix A5 has a complete description of agriculture in the Waits River watershed.

GOAL: REDUCE THE AMOUNT OF SEDIMENT AND NONPOINT SOURCE POLLUTION ENTERING THE WAITS RIVER.

Objective: Reduce road-related erosion and the impacts of undersized culverts on streams, fish and wildlife in the watershed.

(See page 12 for basin-wide strategies)

74. Present the results of the bridge and culvert survey of the Waits River watershed to selectboards and road commissioners in the watershed.

Potential key players: TRORC, conservation commissions, DFW
Potential funding sources: 319, 604b, UCM&E, RCG
Time-frame: 2009

75. Work with towns in the watershed to incorporate bridge and culvert survey data into plans for bridge and culvert replacement. Develop a plan to replace at a minimum those structures in each town which are at high risk for failure, or are barriers to significant fish or wildlife habitat.

Potential key players: Bradford and Corinth conservation commissions, town selectboards, ANR, TRORC

Potential funding sources: Better Backroads grants, UCM&E, VTrans, Municipal Stormwater Mitigation Grant
Time-frame: 2009 – 2011

Objective: Reduce NPS pollution from agricultural lands while maintaining an active agricultural community in the Waits River watershed.

(See page 6 for basin-wide strategies)

76. Develop and encourage participation in agricultural best management programs that work for farmers in the Waits River watershed where valleys are narrow and farms have limited land to give up for buffers.

Potential key players: WRNRCD, NRCS, AAFM
Potential funding sources: CREP, Vermont Agricultural Buffer Program
Time-frame: ongoing

77. Reevaluate the existing agricultural impairment in the Waits River watershed and address the impairment if this water is still not meeting water quality standards.

Potential key players: WRNRCD, NRCS, AAFM
Potential funding sources: EQIP, 319, BMP
Time-frame: 2009

Objective : Remove tires and garbage from streams in the watershed, and increase awareness of impacts from this garbage

78. Participate in the Source to Sea Clean up to clean up any sections of the Waits River and its tributaries with trash. Publicize this event to increase awareness of this problem.

Potential key players: CRWC, Bradford and Corinth conservation commissions
Potential funding sources:
Time-frame: ongoing

79. Support the passage of a tire deposit or other legislation that reduces the incentive to dispose of tires in streams and rivers. Work with other New England states to pass similar legislation so loss of sales from local tire dealers is limited.

Potential key players: Bradford and Corinth conservation commissions
Potential funding sources: NA
Time-frame: ongoing

Section 4-4 River Corridor Management in the Waits River Watershed

As described in Section 1-4 on page seven of this water quality management plan river corridor management is one of the top issues in Basin 14. This is also true in the Waits River watershed since of the Waits River appears to be currently going thorough the evolution process shown in Figure 1-3 on page 8. The Waits River below West Topsham is wide and shallow, and there is excessive streambank erosion in some areas. This is likely related to river corridor and watershed management over the past 200 years as well as large flood events in the 1973 and again in 1990 and channelizing, bulldozing and dredging after these events. These are visual observations but a more complete picture of the processes going on in the Waits River will be developed through a stream geomorphic assessment study that began in 2007. This assessment is lead by the Bradford and Corinth conservation commissions and the Waits River Watershed Council and funded through a River Corridor Grant.

In the summer of 2007, workshops were held in Corinth and Bradford on fluvial geomorphology and the basic concepts of the Phase 1 and 2 fluvial geomorphic assessments. These workshops were well attended by riverfront landowners and watershed residents.

GOAL: RETURN THE WAITS RIVER AND ITS TRIBUTARIES TO AN EQUILIBRIUM CONDITION.

Objective: Develop an understanding of the fluvial geomorphic processes acting in the Waits River and its tributaries and provide this information to the public.

80. Complete Phase 1 geomorphic assessments of the Waits River and its tributaries keeping communities informed about the results.

Potential key players: TRORC, Bradford and Corinth conservation commissions, RMP
Potential funding sources: WEF, RCG, UCM&E
Time-frame: 2007

81. Complete a Phase 2 geomorphic assessment of the Waits River and its tributaries that are identified as needing additional assessment during the Phase 1 geomorphic assessment or by community members.

Potential key players: TRORC, Bradford and Corinth conservation commissions, RMP
Potential funding sources: RCG, UCM&E
Time-frame: 2009

Figure 4-3. The Waits River below the confluence with the South Branch showing typical wide and shallow pattern which it maintains for much of its length below West Topsham

82. Present the results of the Phase 1 and 2 geomorphic assessments to members of the Waits River watershed.

Potential key players: Bradford and Corinth conservation commissions, RMP, Redstart Consulting
Potential funding sources: RCG, UCM&E
Time-frame: 2009

Objective: Increase the involvement of watershed towns in managing the Waits River based on fluvial geomorphic principles.

83. Complete a River Corridor Plan for the Waits River to identify riparian conservation priorities, river corridor protection strategies and restoration

projects to move the Waits River towards an equilibrium condition.

Potential key players: TRORC, RMP, Bradford and Corinth conservation commissions
Potential funding sources: RCG, UCM&E
Time-frame: 2009 - 2010

84. Develop fluvial erosion hazard overlay districts for towns in the Waits River watershed.

Potential key players: TRORC, RMP, Bradford Corinth and Topsham conservation and planning commissions and selectboards, DFW
Potential funding sources: UCM&E, RCG
Time-frame: 2012

Objective: Improve the aquatic habitat, stabilize streambanks, and reduce water temperatures in the Waits River and its tributaries.

85. Locate local tree stock appropriate for riparian buffer plantings and engage local volunteers to complete riparian buffer plantings along the Waits River and its tributaries.

Potential key players: NRCS, Bradford and Corinth conservation commissions
Potential funding sources: CREP funds, UCM&E, C&C
Time-frame: Ongoing

86. Complete restoration projects identified in the river corridor plan and compatible with information collected in the geomorphic assessments. Restoration projects should improve fish habitat as well as restore the equilibrium condition of the Waits River as suggested by Phase 2 geomorphic assessments.

Potential key players: RMP, Bradford and Corinth conservation commissions, DFW
Potential funding sources: UCM&E, RCG, CRJC PG
Time-frame: 2009

Section 4-5 Wetlands, Dams, Ponds and Invasive Species in the Waits River Watershed.

The Waits River does not have a large number of lakes and ponds in its watershed but there are large areas of wetlands and issues that pertain to dams and small ponds in the watershed. Background information on these topics and strategies for all of Basin 14 are included in Section 1-6 of this plan on page 12.

GOAL: PROTECT AND RESTORE WETLAND, AQUATIC AND RIPARIAN HABITATS IN THE WAITS RIVER WATERSHED.

Objective: Reduce the spread of exotic invasive aquatic and riparian species in the Waits River watershed

87. Host a workshop on invasive species in the watershed to educate the community about inadvertently planting or spreading these species.

Potential key players: Bradford and Corinth conservation commissions, WRNRCD
Potential funding sources: CRJC PG , WEF, Watershed Grant
Time-frame: 2010

88. Complete a demonstration project along the Waits River on control methods for Japanese knotweed,

including the proper disposal of Knotweed, to prevent its spread. Encourage landowners to mow or cut areas of knotweed on private property.

Potential key players: private landowners, conservation commissions
Potential funding sources: CRJC PG , UCM&E
Time-frame: 2011

89. Post signs about invasive species at all boat launches along the Connecticut River and the Waits River stating what aquatic invasive species are present at the location and what should be done to prevent their spread to or from the waterbody.

Potential key players: DEC, DFW
Potential funding sources:
Time-frame: 2009

Section 4-6 Impaired and Altered Waters in the Waits River Watershed

The Agency of Natural Resources is responsible for maintaining water quality in each waterbody in accordance with the Vermont Water Quality Standards. Water quality is determined using biological, physical, and chemical criteria for each water quality management class. The Department of Environmental Conservation monitors surface waters for conformance with numeric and narrative water quality criteria to document violations and determine use attainment. Waters that are determined to be below the biological, physical or chemical water quality criteria of the Vermont Water Quality Standards are listed as impaired. To be listed as "impaired", and included in the EPA- Approved *List of Impaired Surface Waters* the violation of the Vermont Water Quality Standards must be substantiated by data collected through chemical, physical and/or biological monitoring and the cause or stressor most likely responsible for the impairment identified. This process is outlined in the DEC publication *2006 Vermont Surface Water Assessment Methodology Including Vermont Listing Methodology* (DEC 2005). The DEC placed Pike Hill Brook on the "*Impaired Waters List"* dating back to 1998 for failure to meet ALS (Aquatic Life Support) water quality criteria due to metals drainage from Pike Hill Mine.

Acid Mine Drainage

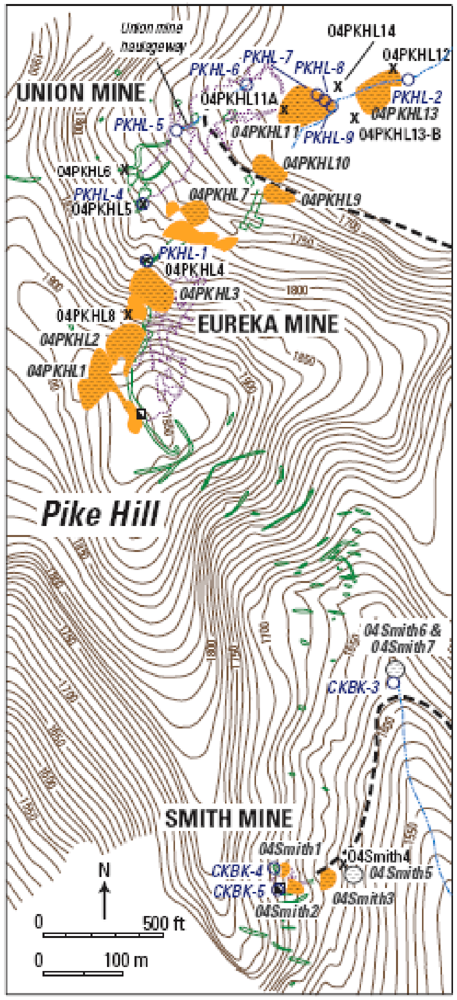
There is a long history of copper mining in the Waits River watershed at the Pike Hill Mines in Corinth, Vermont. Pike Hill is part of the Vermont copper belt which also includes the Ely Mine in Vershire and the Elizabeth Mine in Strafford. During the process of copper mining, piles of waste rock and tailings were created along with extensive underground workings. As water makes contact with the waste rock, sulfuric acid is produced which leaches metals into local surface and ground water. This process, called acid mine drainage, has resulted in the impairment of Pike Hill Brook. In addition, this process has resulted in elevated levels of metals detected in the unnamed tributary to Cookeville Brook (Kiah 2007), but this has not resulted in an ALS impairment of this stream. As a result of the ALS impairment of Pike Hill Brook, the DEC requested Pike Hill be added to the national priorities list under the Comprehensive Environmental Response, Compensation, and Liability Act (generally referred to as Superfund) and the site was listed in 2004. The EPA is now the lead agency heading up

Table 4-1. Impaired waters in the Waits River Watershed (DEC 2007a)

WATER SEGMENT NAME/DESCRIPTION	POLLUTANT	USE(S) IMPAIRED	REASON FOR SURFACE WATER QUALITY PROBLEMS	CURRENT AND FUTURE PROPOSED ACTION
PIKE HILL BROOK, FROM MOUTH TO THREE MILES UPSTREAM (Newbury)	METALS	AQUATIC LIFE SUPPORT	HIGH METALS IN DRAINAGE FROM ABANDONED PIKE HILL MINE & TAILINGS	EVALUATION OF THE MINE AND STREAM BY THE USGS IS CURRENTLY IN PROGRESS. (STRATEGY 88)
TRIBUTARY TO TABOR BRANCH, MOUTH UPSTREAM APPROX 0.1 MILE (Topsham)	UNDEFINED	AQUATIC LIFE SUPPORT	AGRICULTURAL & BARNYARD RUNOFF; MILKHOUSE EFFLUENT	A MACROINVERTEBRATE SAMPLE WAS TAKEN IN THE FALL OF 2007 AND FOLLOW UP WILL BE MADE BASED ON RESULTS. THERE ARE OTHER LAND USES IN THIS AREA THAT MAY BE EXACERBATING THE PROBLEM.

the evaluation of the Pike Hill site with the assistance of the Agency of Natural Resources and the United States Geological Survey (USGS). As of 2007, two studies of the site have already been completed by the USGS and are available on line at: http://infotrek.er.usgs.gov/pubs/

Three abandoned mines, Eureka, Smith and Union make up the Pike Hill Mines (see Figure 4-4). Runoff from the Eureka and Union mines drains into Pike Hill Brook, while runoff from the smaller Smith Mine drains into an unnamed tributary to Cookeville Brook. The drainage from the mines on Pike Hill includes waters with a low pH, and elevated levels of metals, which causes an impairment of the biotic community including both fish and macroinvertebrates in Pike Hill Brook (DEC 2005). In addition, a small tributary to Cookeville Brook has elevated levels of copper and other metals as a result of runoff from the Smith Mine (Kiah et al. 2007), but initial macroinvertebrate and fish sampling did not show an impairment of aquatic life in this stream (DEC 2005). Levels of metals and pH improve downstream along Pike Hill Brook, but do not meet water quality standards before entering the Waits River. Mean daily loading of iron, copper, aluminum, cadmium, and zinc at the uppermost sampling site was 52.5, 10.5, 9.8, .035, and 3.8 kilograms respectively (Kiah et al. 2007). Macroinvertebrate and fish communities in the Waits River below the confluence with Pike Hill Brook do not show any sign of impairment from the mine waste (DEC 2005).



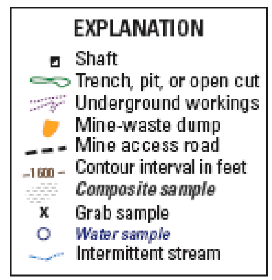


Figure 4-4. The locations of the mines on Pike Hill. (Taken from Piatak, 2006)

Further studies of the site are needed to develop a final clean up proposal for the site. There are many possibilities for how this remediation will take place. Restoration plans will likely include some diversion of clean water away from the tailings, stabilizing and/or moving of tailings piles to reduce erosion and contact with surface and ground water. In addition, some covering of the tailings or treatment of

Table 4-2. Local waters of concern (including waters in need of further assessment) in the Waits River watershed (DEC 2007b)

Waterbody	Reason for Concern	Status	Current or Future proposed Actions
WAITS RIVER, BELOW SOUTH BRANCH CONFLUENCE	SEDIMENT, TEMPERATURE CAUSED BY HABITAT ALTERATION, CHANNEL WIDENING, EROSION, LAND RUNOFF	GEOMORPHIC ASSESSMENT IN PROGRESS	PHASE 1 AND PHASE 2 GEOMORPHIC ASSESSMENT INITIATED AND WILL LEAD TO A RIVER CORRIDOR PLANNING EFFORT AND FEH MAPPING AND RESTORATION EFFORTS. (SECTION 4-4 STRATEGIES 80-84)
WAITS RIVER BELOW THE WAITS RIVER VALLEY SCHOOL	CONCERN RELATED TO ELEVATED *E. COLI* LEVELS IDENTIFIED THROUGH SCHOOL SAMPLING	MORE COMPREHENSIVE SAMPLING NEEDED TO CONFIRM	*E. COLI* SAMPLING AT THIS LOCATION (STRATEGIES 68 & 69)
WAITS RIVER (BELOW BRADFORD DAM)	ARTIFICIAL FLOW CONDITION, POOR FLOW REGIME IN DAM'S BYPASS SEGMENT	FERC EXEMPTION	ADDRESS WITH EXEMPTEE OR THROUGH FERC PROCESS

water may be required. The EPA will be soliciting community input as plans to address this site are developed.

Local Waters of Concern

There are other waters that fall outside the scope of impaired waters but have not met water quality standards or are of concern for other reasons. The Waits River from West Topsham to the Connecticut River is stressed and listed as in need of continued monitoring, and further assessment because of river sediment, temperature, habitat alteration, channel widening, erosion, and land runoff. A geomorphic assessment of the Waits River is planned for 2007- 2008 and should clarify the type and extent of instability and identify possible solutions to address these concerns (see Section 4-4 for a detailed description of this issue).

Sampling done by the Waits River Valley School has identified *E. coli* in the Waits River near the school. More robust sampling at this site through an approved lab would allow for a determination if *E. coli* levels at this location are above Vermont Water Quality Standards.

The Waits River in the bypass of the Bradford Dam is known to be altered due to low flow conditions. The dam has a FERC exemption.

GOAL: RESTORE IMPAIRED WATERS AND BETTER MANAGE WATERS OF CONCERN BEFORE THEY BECOME IMPAIRED FOR ALL WATERS IN THE WAITS RIVER WATERSHED.

Objective: Restore Pike Hill Brook

90. Develop and implement a plan with the USGS, EPA, State of Vermont and local community to remediate the Pike Hill Mine and restore Pike Hill Brook to meet Vermont Water Quality Standards as part of the Superfund process.

Potential key players: EPA, DEC, USGS, Corinth Conservation Commission and selectboard, local residents and landowners.
Potential funding sources: Superfund, private companies or responsible parties
Time-frame: 2012

Objective: Address sediment and temperature issues caused by habitat alteration on the Waits River the South Branch.

91. Complete strategies in Section 4-4 of this plan to restore the physical condition of the Waits River.

Chapter 5 – The Ompompanoosuc River Watershed

Section 5-1 Watershed Description

The headwaters of the Ompompanoosuc River begin above the town of Vershire in Vershire Heights and flow southeasterly for about six miles and then southerly for another 12 miles to its confluence with the West Branch of the Ompompanoosuc River just above the Union Village Dam. The portion of the mainstem of the Ompompanoosuc River above its confluence with the West Branch is also locally referred to as the East Branch of the Ompompanoosuc River.

The West Branch of the Ompompanoosuc River has a length of 16.5 miles and a watershed of about 60 square miles or 38,400 acres. It originates near Hawkins Mountain in the southwestern portion of Vershire. It flows south until South Strafford then flows generally easterly until its confluence with the Ompompanoosuc River just above Union Village Dam. After passing through the Union Village Dam the Ompompanoosuc River flows for another 6 miles before it enters the Connecticut River in a large marsh area near Pompanoosuc Village in the town of Norwich. The river drains a watershed of 136 square miles or 87,040 acres (DEC 1999).

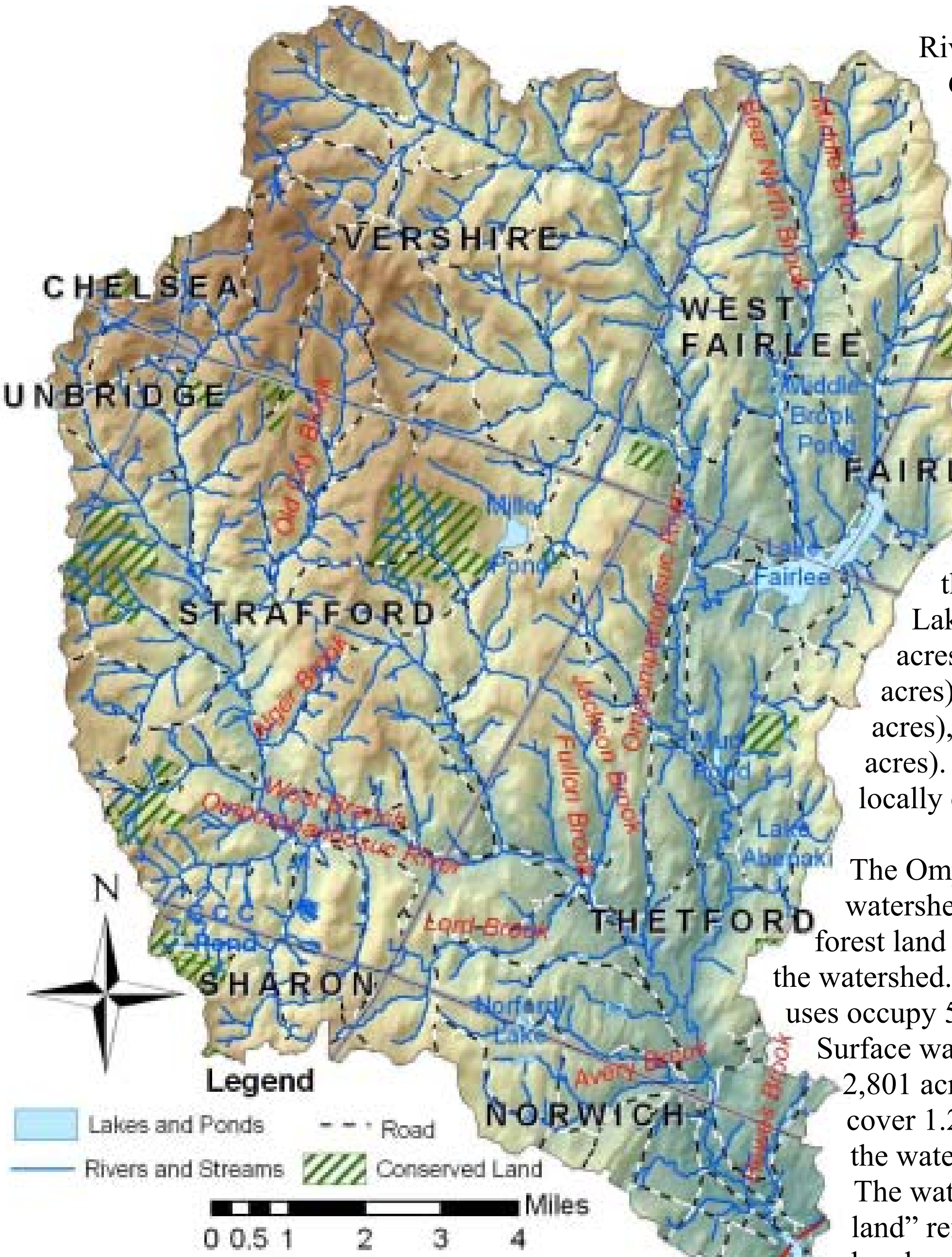


Figure 5-1. The Ompompanoosuc River watershed

The largest lakes in this watershed include Lake Fairlee (457 acres), Miller Pond (64 acres), Lake Abenaki (44 acres), and Mud Pond (20 acres). The latter is also locally called Forsyth Pond.

The Ompompanoosuc River watershed is dominated by forest land which covers 86% of the watershed. Agricultural land uses occupy 5.2% or 4,507 acres. Surface water covers 3.2% or 2,801 acres and wetlands cover 1.2% or 1,016 acres of the watershed (DEC 1999). The watershed has “barren land” referring to the abandoned Elizabeth and Ely copper mines covering about

0.3% of the watershed or 226 acres. Conserved lands in town or state forests, or Wildlife Management Areas cover 2.5 % of the land in the Ompompanoosuc River watershed.

Developed land, primarily related to roads, covers 4.1% or 3,596 acres of the watershed. The villages of Strafford, South Strafford, Thetford, West Fairlee and Vershire are all in the watershed, but these villages are all relatively small. For the most part the, watershed is rural.

There are a number of important historical sites along the Ompompanoosuc River and its tributaries. As stated in the 1996 findings of fact for the Outstanding Resource Waters designation for the 3.8 mile section of the Ompompanoosuc River, the floodplains of the Ompompanoosuc River likely contain historic and prehistoric archeological sites. In addition, there are a number of remnants from Vermont's industrial history along the river including mill sites, a wheel pit, the remains of several blacksmith shops, and the historically significant Sayre Covered Bridge (Vermont Water Resources Board 1996).

Dams in the Watershed

As in most of New England, dams played an important role in the development of the Ompompanoosuc River watershed, providing power for a number of historic mills in the watershed. The largest dam in the watershed is the Union Village Dam flood control structure which provides flood control for the lower Ompompanoosuc River and Connecticut River valleys and is operated by the United States Army Corps of Engineers (USACE). In summer, water flows freely through the Union Village Dam except when the dam is storing or releasing water during flood control events. Over the Union Village Dam's operating history, flood control events have occurred on average about once a year. During winter time, a pool is maintained behind the Union Village Dam, but the dam is managed as run-of-the-river during this time meaning that water flows into and out of the dam at the same rate. However, an exception to this is when the Union Village Dam reduces downstream flows for a time in the fall to fill up the winter pool, and increases downstream flows for a time in the spring as it releases water to drain the winter pool, and during similar changes in flows during flood control events. Improving operations at the USACE dams in Vermont, including the Union Village Dam, is the goal of an agreement between the Agency, USACE, and US F&W. One stated priority for the ANR in this document is winter flow regulation improvement at Union Village Dam (United States Army Corps of Engineers/ANR 2002).

Many of the other dams in the watershed are located at the outlet of lakes and ponds, while others are historical mill dams no longer in use. Many dams such as the dam at the outlet from Lake Fairlee, are privately owned, therefore shoreline owners are dependent on the dam owner with regards to water level management. Water level regulation can be established by rule through a petition to the Water Resources Panel.

Water-Based Resources

The tributaries and associated lakes, ponds and wetlands in the watershed support aquatic life and habitat and provide recreational opportunities through fisheries, swimming beaches, boating runs, and aesthetics. In addition, the surface waters in the watershed provide irrigation and limited drinking water supplies. The fundamental purpose of protecting water quality in Vermont is to protect these and any other beneficial uses and values of the water. Waters in the Ompompanoosuc River watershed along with all surface waters in Vermont are protected in order to support uses valued by the public including swimming, boating, and fishing. Some uses are protected absolutely if the Agency of Natural Resources identifies them as existing uses under the anti-degradation policy of the Vermont Water

Quality Standards(VWQS § 1-03). Existing uses in Basin 14 are listed in Chapter Six in tables 6-1 through 6-3 on page 83.

Swimming
Many of the lakes and ponds in the watershed are used for swimming and boating including Lake Fairlee, Miller Pond, and Lake Abenaki. In addition, there are a number of sites on streams in the watershed where swimming is common.

Boating
Boating and tubing were identified as important uses during public forums in the Ompompanoosuc River watershed. Boating is common on the largest lake in the watershed, Lake Fairlee, and to a lesser degree on a number of the smaller lakes in the watershed. At watershed forums, specific mention was made of the importance of boating on the West Branch of the Ompompanoosuc River and the West Branch has been rated as highly important for boating by Jerry Jenkins and Peter Zika (1992) in *The Whitewater Rivers of Vermont: The Biology, Geography and Recreational Use*. In addition, tubing on the West Branch in South Strafford was listed as an important activity by local residents. There is also a DFW boat launch on the Ompompanoosuc River near the confluence with the Connecticut River, and this lower section of the river is frequently used for boating.

Fish Habitat and Fisheries
Fisheries investigations conducted since 1980 have shown that the high elevation reaches of the Ompompanoosuc River and West Branch support moderate to high densities of wild brook trout. Moving downstream within the branches, the numbers of wild trout decrease. Limited wild brown trout in the lower Ompompanoosuc River and poor or absent populations of wild trout in parts of the West Branch, particularly below Copperas Brook, are likely attributed to well-documented copper pollution associated with several area mines. Wild rainbow trout are likely present in low densities. The lowest reaches of the main stem of the Ompompanoosuc River are backwatered by the Connecticut River at Wilder Dam. This area supports a number of fish species including bass, pike, and perch present in the upper Connecticut River.

Current fisheries management focuses on protecting existing habitat through public outreach and participation in the regulatory process, assessing aquatic organism passage through stream crossing structures, protecting wild brook trout populations in the upper river, and supplementing the lower river with catchable-sized rainbow and brook trout to provide additional recreational fishing opportunities. Stocked areas include the middle and lower reaches of the Ompompanoosuc River and West Branch. No trout are stocked in the mainstem below Union Village Dam.

Table 5-1. Fish species present in Ompompanoosuc River watershed lakes and ponds.

Common Name	Fish species present in waterbody			
	Miller Pond	Lake Fairlee	CCC Pond	Lake Abenaki
Brook trout	X[1]			
Brown trout		X[1]		
Rainbow trout	X[1]	X[1]		
Rainbow smelt		X		
Largemouth bass	X	X	X	X
Smallmouth bass		X		
Yellow perch		X	X	X
Rock bass		X		
Bluegill	X	X	X	
Pumpkinseed	X	X	X	
Redbreast sunfish	X[2]	X[2]	X[2]	
Brown bullhead	X	X	X	
Chain pickerel		X		
Blacknose dace			X	
Bluntnose minnow	X			
Golden shiner	X	X	X	X
Fallfish		X		
Longnose sucker		X		
White sucker		X	X	

[1]Currently stocked
[2]Needs verification

DFW manages fisheries on several public lakes and ponds in the Ompompanoosuc River watershed. These include Lake Fairlee, Miller Pond and the CCC Pond. Miller Pond has both a small warmwater fishery and rainbow and brook trout which are stocked annually. CCC Pond is the site of a youth summer camp and has a small fishery with largemouth bass, yellow perch and other species listed in Table 5-1. Lake Fairlee supports regionally important fisheries for both warmwater and coldwater fish species. It is stocked annually with catchable size rainbow and brown trout and supports popular fisheries for largemouth bass, smallmouth bass, and a variety of panfish. Ice fishing for yellow perch, rainbow smelt, bass, and trout takes place each winter on Lake Fairlee as well. Fish species present in Ompompanoosuc River watershed lakes and ponds with public access are presented in Table 5-1.

The Ompompanoosuc River watershed is identified as providing important habitat in the *Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River Basin* (1998). The Ompompanoosuc watershed contains approximately 1.5% of the available salmon nursery habitat within Vermont and approximately 0.7% of the available salmon rearing habitat within the entire Connecticut River Basin. Atlantic salmon fry are stocked annually and evaluated in the lower reaches of the Ompompanoosuc River above and below the Union Village Dam (Humling 2007). While strategies to improve fisheries are not broken out in a separate section of this plan, a number of strategies to improve riparian habitat and remove barriers to fish passage will benefit fisheries in this watershed (Humling 2007).

Irrigation and Animal Watering

According to AAFM approximately 24% of known surface water withdrawals in Orange County are for irrigation while an almost insignificant amount of ground water is used for this purpose. Between 1987 and 2002, the number of farms using irrigation in Orange County has more than quadrupled while the total acreage of irrigated land in the county has increased by nearly 70%.

Drinking Water Supplies

Drinking water in the Ompompanoosuc River watershed is primarily from private wells, and no surface waters are designated as public water supplies and only one ground water source protection area is designated for the West Fairlee Trailer Park. However, Lake Fairlee and other surface waters may be used by an unknown number of private residencies and seasonal camps. Protection of groundwater resources may become increasingly important as the regions population grows. This was not initially identified as one of the top issues in the watershed but emerged as a concern at the end of the planning process so should be addressed in future plans.

Riparian Flora and Fauna

There are a number of plant and animal species that make their home in and along the Ompompanoosuc River and its tributaries. A number of these are dependent on specific habitat types that the river and riparian lands provide. One rare species known to use the Ompompanoosuc River is the wood turtle, which has been reported from Interstate I-91 in Norwich to the Thetford -West Fairlee town line. Wood turtles *glyptemys insculpta* overwinter in the river, but need nearby upland, swampy, and sandy habitat throughout the year. Another location of particular note for fauna is an Important Birding Area at the confluence of the Ompompanoosuc River and the Connecticut River. This site is heavily used by migrating shorebirds.

Water Quality in the Ompompanoosuc River Watershed

The Ompompanoosuc River has more water quality information available than most watersheds in Vermont. Water quality information comes from a number of sources. The DEC has a number of biological monitoring sites across the watershed, and samples lakes on a regular basis. The Army Corps of Engineers and the United States Geological Society (USGS) have done extensive sampling in the watershed to determine the impacts of the two historical copper mines that are now superfund sites. Finally volunteer monitors have been sampling *E. coli* and metals in the watershed and lay monitors have been sampling Lake Fairlee for water clarity, phosphorus and chlorophyll levels since 1979. Figure 5-2 shows the results of biological monitoring highlighting the impacts from the Elizabeth and Ely copper mines on Copperas Brook and the West Branch in Strafford and Thetford, and School House Brook and the Ompompanoosuc River in Vershire and West Fairlee. The impacts to water quality from the mines include elevated metals levels and low pH due to acid mine drainage. This is discussed in more detail in Section 5-6. *E. coli* levels in excess of Vermont water quality standards were identified by the Army Corps of Engineers as part of their regular beach sampling program at the Union Village Dam. More extensive sampling has been done by the Army Corps of Engineers and the DEC in the last 10 years but the source of the coliforms has not been identified.

In the summer of 2006 and 2007, volunteer monitors including the Ompompanoosuc River Watershed Council (ORWC) and local conservation commissions completed an in depth study of *E. coli* levels on the river. This identified West Fairlee as one area of specific concern. Some of the results of this study can be seen in Figure 5-3 (ORWC 2007). In addition to studies of the water quality in the Ompompanoosuc River watershed, a study of the physical health of the West Branch of the Ompompanoosuc River was completed in 2006. The physical

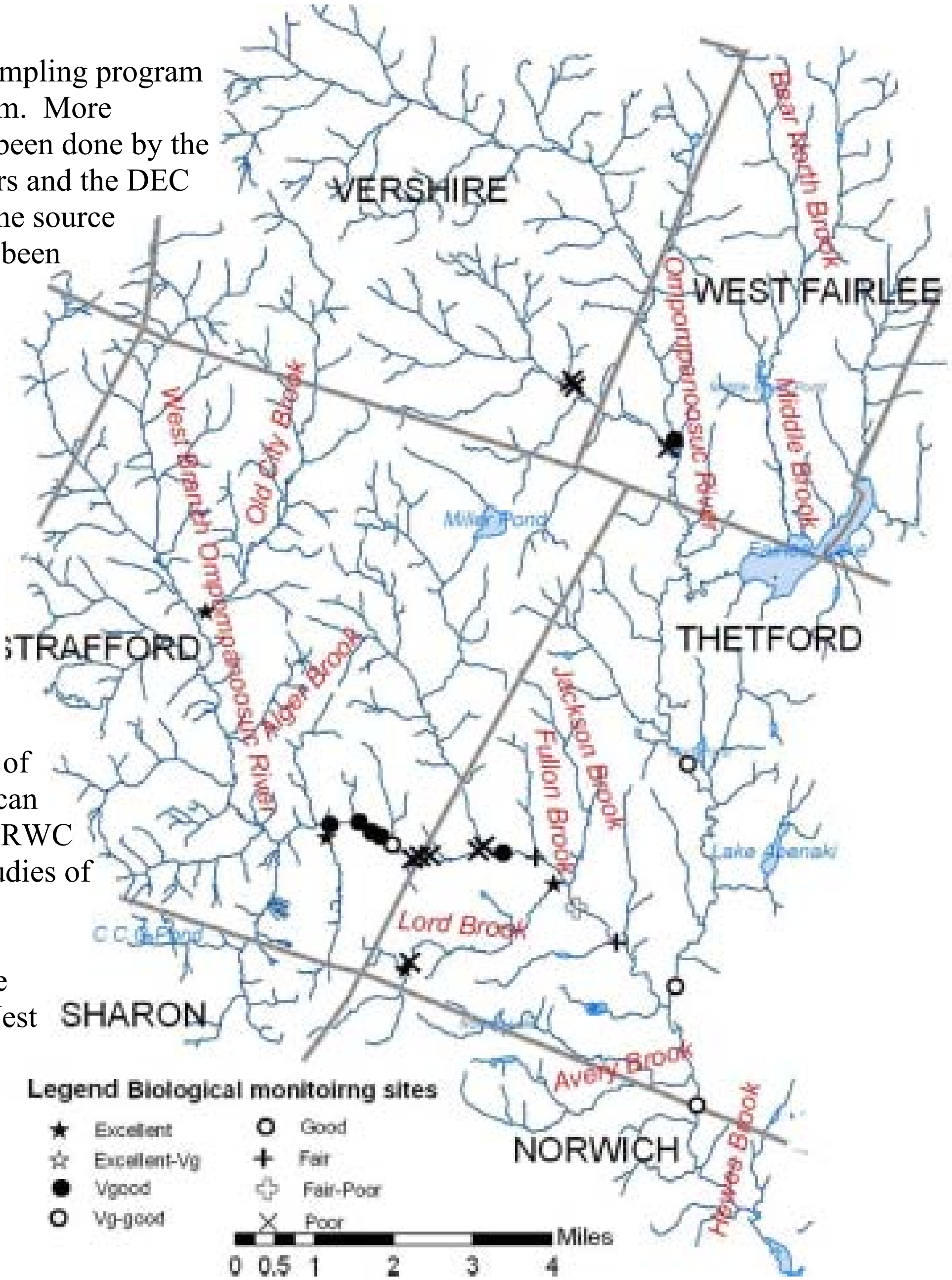
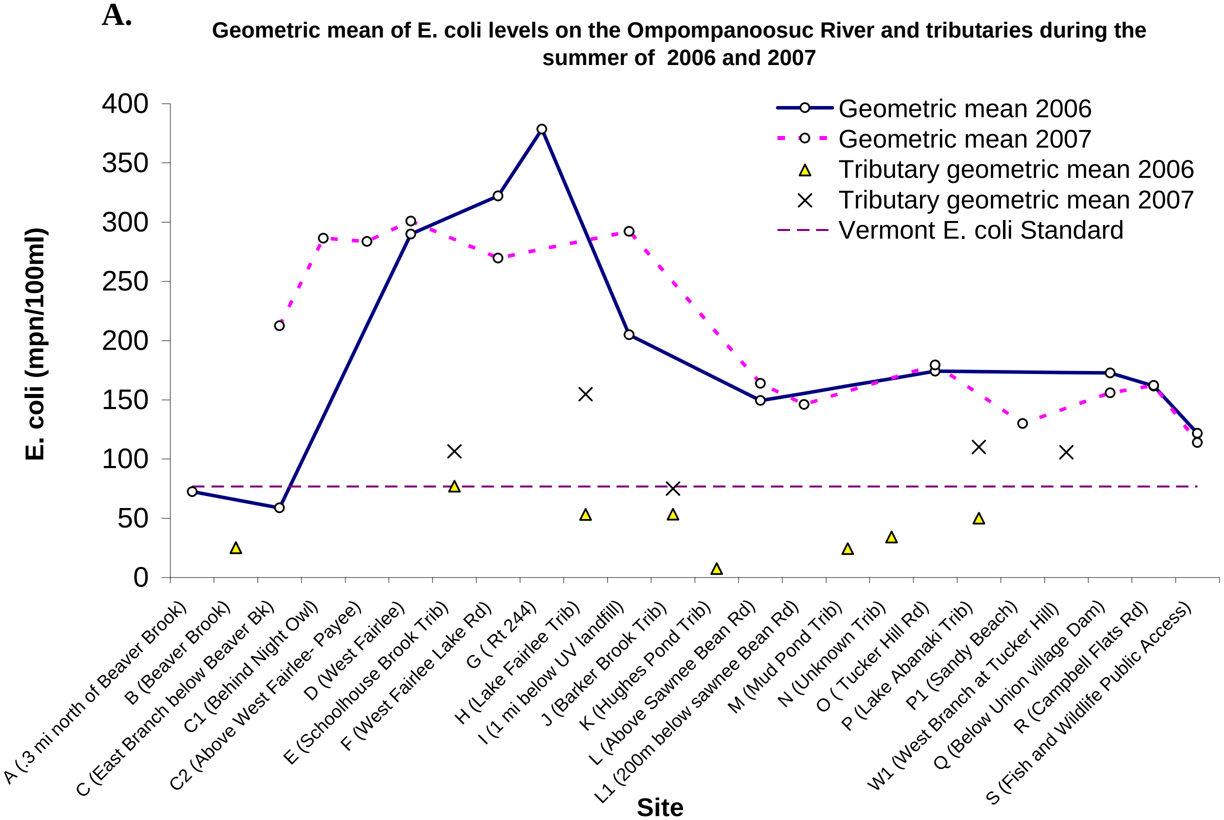


Figure 5-2. Biological monitoring sites on the Ompompanoosuc River showing the impacts from the Elizabeth and Ely Mines

condition of the river is closely related to water quality as streambank erosion is a major source of sediment and nutrients to the river. The physical condition of the river also has important implications for the quality of the aquatic habitat for aquatic species. This is discussed further in Section 5-3 of the basin plan. Improper design or installation of culverts may also impact the physical condition of the river and present migration barriers to fish and other aquatic organisms. Artificially shallow depths, excessive velocities in the culvert, or excessive jump heights at the outlet each create migration barriers year-round or just during specific flow conditions. This is discussed further in Section 5-4.

A.



B.

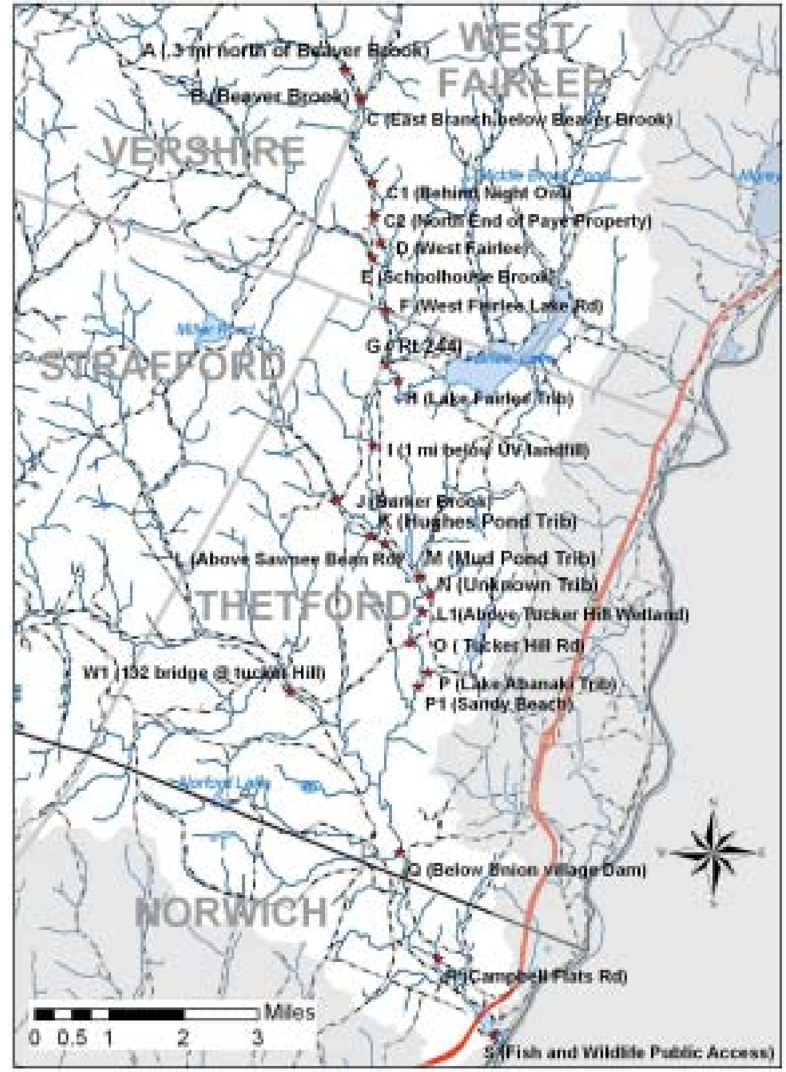


Figure 5-3. A. The geometric mean of *E. coli* levels on the Ompompanoosuc River and Tributaries in the summer of 2006 and 2007. The line represents the geometric mean of yearly E. coli levels on the Ompompanoosuc River while triangles and x's show levels on the tributaries in 2006 and 2007 respectively. B. The locations of sample sites marked by stars. Full reports of 2006 and 2007 results can be viewed on the web at: http://www.thetfordvermont.us/conscomm.htm

Section 5-2 Nonpoint Source Pollution in the Ompompanoosuc River Watershed

Nonpoint source pollution was the top rated concern in the Ompompanoosuc River watershed including runoff from developed lands, agricultural lands, and associated with logging operations. These topics including pollution from developed and forested lands are discussed in detail along with strategies common for all of Basin 14 in Section 1-3 of this plan on page 4. Included in this section is a description of agriculture in the Ompompanoosuc River watershed.

Agriculture

As with the rest of Basin 14 agriculture gives the Ompompanoosuc River watershed much of its character. In addition, as agricultural land is converted to suburban development, there is generally a net increase in nutrient production, so keeping well managed agricultural land in active production can support better water quality. The trend of increasing number of small farms in Orange County is particularly evident in the Ompompanoosuc River watershed which has seen increasing numbers of horse owners and small farms in recent years. Because of this trend the focus of outreach in this watershed will be on best management practices for smaller farms. Appendix A6 has a complete description of agriculture in the Ompompanoosuc River watershed.

GOAL: REDUCE THE AMOUNT OF SEDIMENT AND NONPOINT SOURCE POLLUTION ENTERING THE OMPOMPANOOSUC RIVER.
(see page 6 for basin-wide strategies)

Objective: Reduce *E. coli* levels in the Ompompanoosuc River to meet Vermont Water Quality Standards.

92. Continue the volunteer *E. coli* sampling program for Ompompanoosuc River until *E. coli* sources in the watershed have been identified and bracketed. Add sites or new techniques to better bracket potential *E. coli* sources as needed.

Potential key players: Thetford, West Fairlee and Norwich conservation commissions, USACE
Potential funding sources: LaRosa, CRJC PG , USACE, Watershed Grant
Time-frame: ongoing

93. Provide the results of *E. coli* testing to the public along with information on actions (such as cleaning up pet waste along the river and maintaining septic systems) that landowners can take to help reduce *E. coli* levels.

Potential key players: Thetford, West Fairlee and Norwich conservation commissions, DEC, USACE, Local Media outlets
Potential funding sources: NA
Time-frame: ongoing

94. Identify and correct failing septic systems and provide public education on proper septic system maintenance.

Potential key players: conservation commissions, DEC
Potential funding sources: C&C, Vermont Home Loan Fund
Time-frame: 2010

Objective: Reduce nonpoint source pollution from agricultural and developed lands in the watershed.

95. Establish buffers along the Ompompanoosuc River with the following priorities:

a. West Branch of the Ompompanoosuc River between Strafford and South. Strafford.
b. East Branch of the Ompompanoosuc River between Brimstone Corner and Crossroad.
c. Along Blood and Middle Brooks flowing into Lake Fairlee.

Potential key players: NRCS, AAFM, conservation commissions, Lake Fairlee Association
Potential funding sources: CREP, WHIP, C&C
Time-frame: 2012

96. Distribute brochures on AAPs, pasture management, barnyard areas and other topics relating to water quality to horse

and small farm owners through tack shops and veterinarians.

Potential key players: WRNRCD, NRCS, AAFM, tack shops, veterinarians
Potential funding sources: CRJC PG, WEF
Time-frame: 2009

97. Recommend the adoption of low impact development standards by local towns to address the issue of stormwater runoff.

Potential key players:, conservation commissions, planning commissions
Potential funding sources: NA
Time-frame: 2012

Section 5-3 River Corridor Management in the Ompompanoosuc River Watershed

River corridor issues are another top concern in the Ompompanoosuc River watershed as in other parts of Basin 14. Section 1-4 of this basin plan on page 7 describes this issue as it relates to all of Basin 14 but included here is a discussion of river corridor managment for the Ompompanoosuc River Watershed. Residents in the Town of Strafford have expressed particular concerns with erosion between the villages of Strafford and South Strafford. To address this issue the town sought and received funding from the Upper Connecticut River Mitigation and Enhancement Fund (UCM&E) over a series of years to conduct Phase 1 and 2 geomorphic assessments and to develop a River Corridor Management Plan for the West Branch of the Ompompanoosuc River. While this study only covers a portion of the Ompompanoosuc River watershed, a summary of the work is presented here because many of the issues are likely to be similar in other subwatersheds of the Ompompanoosuc River. This summary will also provide some background to assist other communities in the watershed that are currently pursuing assessments covering the remainder of the Ompompanoosuc River watershed.

River Corridor Planning

The goals set out by the Strafford Conservation Commission for the West Branch of the Ompompanoosuc River are to increase its value as a recreational resource, improve public access to the river and streams, improve aquatic habitat, reduce flood and erosion hazards and restore river corridor functions (Blazewicz and Nealon 2006a). Bear Creek Environmental was hired to complete Phase 1 and 2 geomorphic assessments as well as the River Corridor Management Plan for the West Branch of the Ompompanoosuc River. As stated in the River Corridor Management Plan

"These assessments showed that the West Branch of the Ompompanoosuc is undergoing active adjustment processes. On the majority of the West Branch, historic incision has lowered the elevation of the river bed leaving the floodplain inaccessible. As a result, high flows that would normally access the floodplain are contained within the channel; thereby causing extensive bank erosion, channel widening, lateral migration, loss of aquatic habitat, and general channel instability (pictured in Figure 5-4). The traditional approach of attempting to control erosion employs bank armoring (rip-rap), which is common on the West Branch, but has lead to further instability in the system.

Also, there are many encroachments upon the river corridor in the form of residential and commercial development, as well as roads. The result is a decreased amount of area that is capable of reestablishing equilibrium through lateral channel migration and the creation of a lower floodplain. It is important to protect the few areas that still have the space for the river to move; otherwise, management of the river will become increasingly difficult and expensive report considers the stage of channel evolution, sensitivity, condition, and major adjustment process for each section, or reach, of the West Branch in order to determine management strategies. The results are management approaches that are appropriate for each section rather than a uniform plan for the entire river. The four major project types identified for the West Branch of the Ompompanoosuc River are: conservation reaches, high recovery reaches, moderately unstable reaches, and highly unstable reaches" (Blazewicz and Nealon 2006a).

Figure 5-4. The West Branch of the Ompompanoosuc River just above the village of South Strafford. The river has historically incised and is now forming a new floodplain. (Taken from Blazewicz 2006b)

The project types are described and shown in Figure 5-5. Twenty-One of the priority projects from the West Branch River Corridor Management Plan have been highlighted in Table 5-2. While a river corridor plan only exists for the West Branch of the Ompompanoosuc River, this plan shows that similar types of projects may be applicable to the rest of the watershed such as working on protecting the river corridor and replacing undersized structures where they exist. The Thetford Conservation Commission, in cooperation with the Ompompanoosuc River Watershed Council and the conservation commissions of West Fairlee and Norwich, has received funding through a river corridor grant to complete a Phase 1 geomorphic assessment of the remainder of the Ompompanoosuc River watershed. When this is study is complete, similar projects for this portion of the watershed will be developed as well. Information for the buffer widths for the entire Ompompanoosuc River is not available but on the West Branch of the Ompompanoosuc River in Strafford, over half of the stream reaches were found to have over three quarters of the reach with little or no buffer on one or more banks (Nealon and Blazewicz 2004). Riparian buffers also play other roles in maintaining a healthy riverine ecosystem. Vegetated buffers provide shade to reduce surface

Figure 5-5. Project types for each reach (Blazewicz and Nealon 2006a)

Conservation reaches are generally in stable geomorphic condition and need little restoration work.
General strategies for restoration may include the following which are applicable to other reaches as well:

1. Implement FEH zones (see section 3.4)
2. Protect river corridor
3. Replace undersized structures (see section 4.1)

High recovery reaches (black and white dashed) are generally in good to fair geomorphic condition and exhibit expected channel dimensions, profile, and patterns. Restoration of these reaches is best approached with a passive or light active approach to restoration. General strategies for returning these river segments to health may include:

4. Attenuate stormwater if necessary
5. Plant riparian buffers
6. Treat streambank failure through minimally invasive approaches if there is a threat to property or infrastructure.
7. Conduce a Phase 3 assessment (if necessary)
8. Projects types 1 through 3 listed above

Moderately unstable reaches may not have expected channel dimensions, patterns, or profile. Moderately unstable reaches are best approached through conducting alternatives analysis in order to determine the best strategy for restoration. General strategies for implementation may include the following:

9. Conduct a Phase 3 assessment and alternatives analysis
10. Project types 1 through 5 listed above

Restoration of **highly unstable reaches** is best approached with caution. These reaches are often severely incised, aggrading, or exhibiting major planform or widening processes. Passive restoration techniques are preferred, as active geomorphic restoration of unstable reaches is often very expensive and could be unsuccessful. The very dynamic nature of these streams lends to the challenge of active restoration. The best technique may be to relieve the stream of obvious stressors such as undersized structures or other impairments to sediment transport and then to look for opportunities to develop a new floodplain. General strategies that are appropriate for these river segments are:

11. Plant riparian buffers (Set away from the top of bank)
12. Project types 1 through 4 listed above

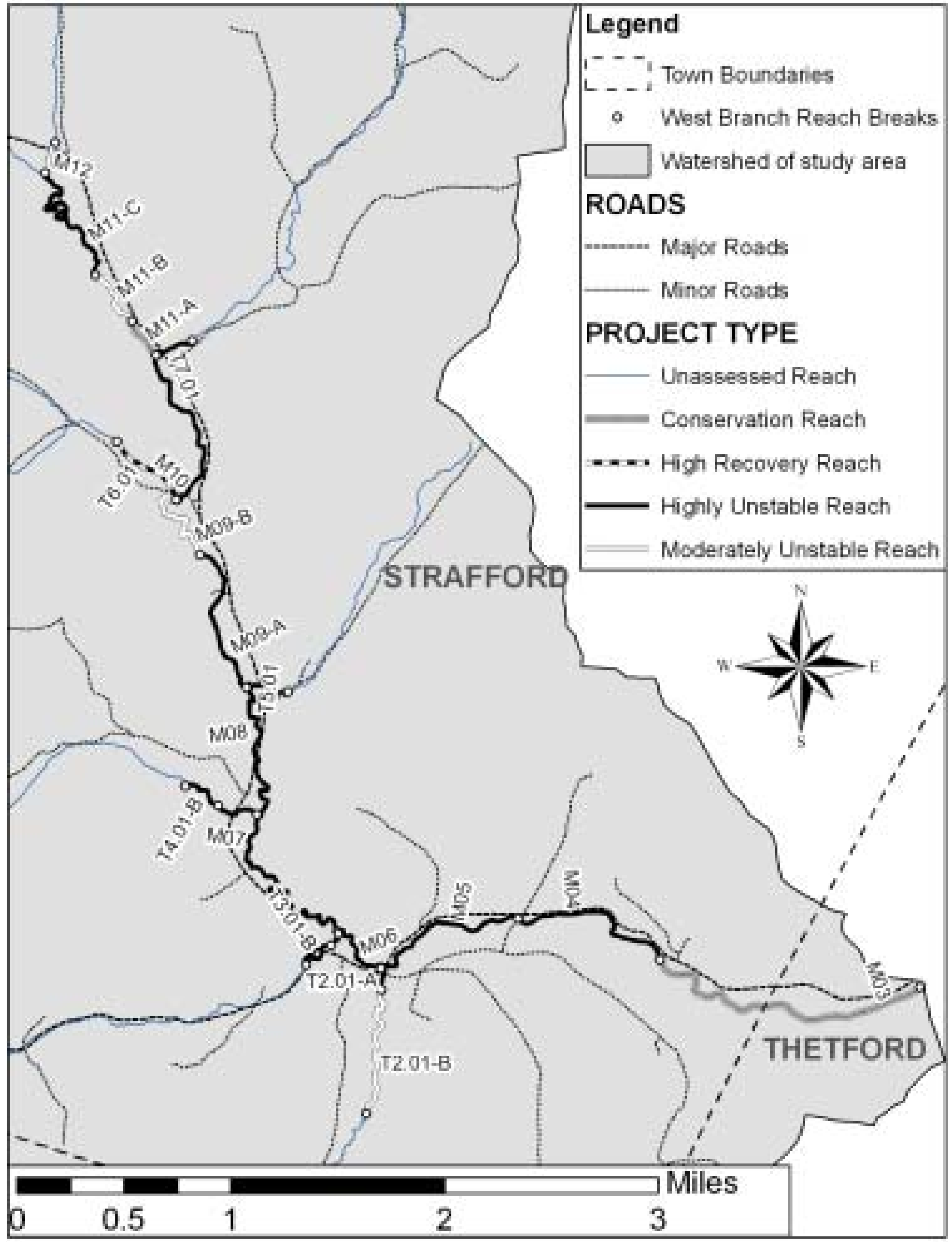


Table 5-2. River Corridor projects listed in the West Branch of the Ompompanoosuc River, River Corridor Management Plan (Taken from Blazewicz and Nealon 2006a)									
Project ID Number	**Segment Number**	**River Project Type**	**Specific Strategy**					**Project Description (including Potential Constraints and/or Opportunities)**	**Priority**
			River Corridor Protection	**Replace Undersized Structure(s)**	**Develop New Floodplain and Plant Buffer**	**Plant Riparian Buffer**	**Other**		
1	M12	MU	√			√		Maintain and expand existing buffer for long term stability	L
2	M11-C	HU	√					This reach is redeveloping floodplain; Recommend allowing river to adjust naturally. Protection of the river corridor through this reach would be beneficial to encourage long term stability.	L
3	M11-A	CR	√	√		√	Protect and enhance existing buffer	Although a few houses are within the river corridor, this reach has a fairly healthy buffer. An undersized bridge in this reach could be removed.	**M**
4	M10	HU	√	√	√			This reach suffers from historic straightening. Landowners may want to consider an alternatives analysis for floodplain redevelopment project. Attenuation of floodwaters and sediment in this reach may reduce pressure on the stream as it passes through the Upper Village.	**H**
5	M09-B	MU	√			√	Remove berm	A berm on the left bank downstream of the Brook Road bridge may prevent the stream from accessing its floodplain. This reach is also likely being impacted by increased sediment transport in reach M10 which is leading to excessive sediment deposition in this reach.	**H**
6	M09-A	HU	√					Historic photographs show this reach has been greatly straightened. Limited existing infrastructure to protect, therefore consider letting the channel adjust on its own.	L
7	M08	HU	√	√				Replace bridge over Justin Morrill Highway to remove channel and floodplain constriction.	**M**

Table 5-2. River Corridor projects listed in the West Branch of the Ompompanoosuc River, River Corridor Management Plan (Taken from Blazewicz and Nealon 2006a)									
Project ID Number	**Segment Number**	**River Project Type**	**Specific Strategy**					**Project Description (including Potential Constraints and/or Opportunities)**	**Priority**
			River Corridor Protection	**Replace Undersized Structure(s)**	**Develop New Floodplain and Plant Buffer**	**Plant Riparian Buffer**	**Other**		
8	M07	HU	√	√				Replace undersized private bridge to allow future access for private landowner. Landowner recognizes river's movement and has voluntarily planted floodway to help create roughness during high flows.	**M**
9	M06	HU	√		√			Landowners may consider determining the feasibility of a project in this area. Remove high spot at bend in river next to soccer field to create floodplain and help reduce flood hazard through village. Existing recreational use of this small area would need to be discontinued.	**H**
10	M05	HU	√		√			Relocate town sand storage. Landowners may consider a floodplain redevelopment project at this site. Also consider floodplain project at beginning of recreation path; existing land use, existing stream conditions, and public connection make this a good project.	**H**
11	M04	HU	√	√				Consider replacing undersized bridges on this reach in order to improve sediment transport and reduce potential flood hazard.	L
12	M03	CR	√				Preserve existing buffer	The entire reach is well forested, conservation of the corridor will provide for long-term benefits to the river.	**M**
13	T7.01	HU	√					This reach would best be maintained as a transport reach to protect existing infrastructure.	L
14	T6.01	HR	√	√		√	Remove berm at lower end; Livestock exclusion	This reach would benefit from a CREP project that would exclude livestock from the stream, locate an alternative watering source, and plant a riparian buffer. Also there are berms at the lower end that could be removed to improve floodplain access.	**H**

Table 5-2. River Corridor projects listed in the West Branch of the Ompompanoosuc River, River Corridor Management Plan (Taken from Blazewicz and Nealon 2006a)									
Project ID Number	**Segment Number**	**River Project Type**	**Specific Strategy**					**Project Description (including Potential Constraints and/or Opportunities)**	**Priority**
			River Corridor Protection	**Replace Undersized Structure(s)**	**Develop New Floodplain and Plant Buffer**	**Plant Riparian Buffer**	**Other**		
15	T5.01	HU	√					This reach is highly incised. Existing land use is pasture and field. Recommend allowing to adjust naturally.	L
16	T4.01-B	HU	√				Livestock exclusion	This reach would benefit from a CREP project that would exclude livestock from the stream, locate an alternative watering source, and plant a riparian buffer.	**H**
17	T4.01-A	HU	√					This reach is highly incised. Existing land use is field. Recommend allowing to adjust naturally.	L
18	T3.01-B	HU	√			√		This reach is best maintained as a transport reach in order to protect existing infrastructure through South Strafford Village. Voluntary buffer planting from local landowners could be encouraged.	L
19	T3.01-A	HR	√					This reach is highly incised. Existing land use is field. Recommend allowing to adjust naturally.	L
20	T2.01-B	MU	√					The corridor around this reach presents a good opportunity for protection. Land use in the surrounding subwatershed should avoid concentrating stormwater towards the very unstable valley walls of this reach.	L
21	T2.01-A	HU	√			√		This reach has been historically straightened and will likely be maintained in its current configuration to protect property in the Village of South Strafford. Voluntary buffer enhancement could be encouraged.	L

River Corridor Project Type:
CR = Conservation Reach **HR = High Recovery Reach** **MU = Moderately Unstable Reach** **HU = Highly Unstable Reach**
Priority Ranking:
H = Higher **M = Medium** L = Lower

water temperatures; filter sediments, nutrients, and other pollutants from runoff; provide shade and food for aquatic insects; provide cover and substrate for fish and aquatic insects; provide habitat to species whose life cycles include water and upland; offer cover for species traveling between habitats; slow floodwaters; and control ice damage.

Fluvial Erosion Hazard Mitigation

The federal government runs a program called the National Flood Insurance Program (NFIP) to reduce flood losses, allow residents to insure property from flood damage and provide assistance after floods. To participate in this program, towns must regulate development in flood prone areas and enforce minimum NFIP standards. All towns in the Ompompanoosuc River watershed participate in this program with the exception of the town of Vershire. These regulations are based on the chance that a property will be inundated in any given year. The current maps that this program is based upon do not evaluate the risk from erosion hazards which are areas at high risk for bank failure and erosion during flooding. In Vermont, erosion hazards cause more damage than inundation so regulating development in locations at high risk for erosion hazards similar to the NFIP programs regulation of development in areas at risk for inundation would greatly reduce flood damages, reduce the risk to human lives and property and reduce the future need for channel management. The development of FEH maps are based the channel width and stream sensitivity which are determined as part of Phase 2 geomorphic assessments. Once produced, an FEH map may be used to develop an overlay district by a town which can place limits on structures, land use activities, or even vegetative condition in the FEH zone to protect property from fluvial erosion hazards and to allow the river the space it needs to return to an equilibrium condition. Figure 5-6 shows the draft FEH map produced for the town of Strafford as part of the *West Branch of the Ompompanoosuc River Corridor Management Plan*. The FEH zone needs to be adopted as an overlay zone or incorporated into town zoning in some other fashion by the town of Strafford for it to take effect.

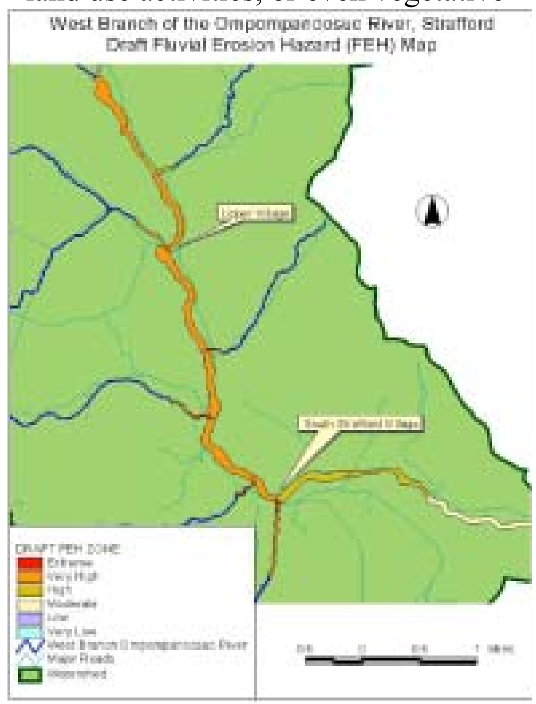


Figure 5-6. Draft FEH map of Strafford. (Taken from Blazewicz and Nealon 2006a)

GOAL: PROTECT AND RESTORE THE EQUILIBRIUM CONDITION OF THE OMPOMPANOOSUC RIVER.

Objective: Protect stable reaches, intact floodplain and forested river corridors.

98. Complete Phase 1 geomorphic assessments of the Ompompanoosuc River watershed and Phase 2 geomorphic assessments for the East Branch and any tributaries rated as fair or poor by the Phase 1 assessment.

Potential key players: TRORC, RMP, conservation commissions
Potential funding sources: UCM&E, CRJC PG, RCG, WEF
Time-frame: 2009

99. Protect floodplains identified through the geomorphic assessments as important for maintaining the stability of the

Ompompanoosuc River. Work with land trusts to include language in conservation easements that protect floodplains and buffers for maintaining or restoring stream stability.

Potential key players: UVLT, RMP, VRC, AAFM, NRCS, conservation commissions
Potential funding sources: UCM&E, VHCB, CREP, C&C
Time-frame: 2012

Objective: Increase the participation of the public and town government in stream corridor protection.

Most of the protection of riparian habitat is done at the local level through town zoning, and by private land owners who understand the importance of this habitat and manage their land to protect and enhance it.

100. Develop river corridor plans covering the Ompompanoosuc River watershed to reduce human/river conflicts. River Corridor plans will also prioritize the protection of the river corridor, including floodplains and buffers, and the completion of projects where this will provide the most benefit to the Ompompanoosuc River.

Potential key players: TRORC, RMP, DEC, conservation commissions
Potential funding sources: UCM&E, RCG
Time-frame: 2011

101. The watershed council recommends the inclusion of minimum building setbacks from rivers and natural buffers in accordance with the state Act 250 buffer recommendations in town plans and zoning, and the adoption of FEH overlay districts.

Potential key players: RMP, TRORC, Local Conservation and planning commissions. VLCT, selectboard members
Potential funding sources: Municipal Planning Grant, RCG
Time-frame: 2012

102. The watershed council recommends the development of state and federal incentives to encourage town adoption of FEH overlay districts by municipalities.

Potential key players: RMP, TRORC, FEMA
Potential funding sources: State funds, FEMA, RCG
Time-frame: 2012

Objective: Restore unstable reaches of the Ompompanoosuc River and reaches without sufficient buffers.

103. Implement restoration projects in areas identified through river corridor plans including the West Branch of the Ompompanoosuc River, River Corridor Management Plan (see Table 5-2) and future plans developed for the remainder of the Ompompanoosuc River watershed.

Potential key players: RMP, TRORC, DEC, conservation commissions
Potential funding sources: UCM&E, CRJC PG, RCG, WHIP, C&C
Time-frame: 2007-2012

Section 5-4 Transportation-Related Pollution in the Ompompanoosuc River Watershed

Transportation-related water quality issues were rated as one of the top concerns in the Ompompanoosuc River watershed. This issue and related strategies for all of Basin 14 are discussed in detail in Section 1-5 of this plan on Page 10.

Bridge and Culvert Surveys and Capital Improvement Budgets

The Strafford Conservation Commission has completed a bridge and culvert survey of the West Branch of the Ompompanoosuc River and its tributaries. This survey prioritized the replacement of 11 culverts in the Town of Strafford shown in Figure 5-7. Two Rivers Ottauquechee Regional Commission completed a survey of select bridges and culverts on the remainder of the Ompompanoosuc River watershed in 2006. This survey identified 15 culverts with widths less than 40% of the bankfull width, categorized as priority one culverts, and 12 culverts with widths of between 40 to 50% of bankfull width categorized as priority two culverts which are shown in Appendix A10. TRORC is working with towns in the watershed on capital budget planning for replacing priority one structures and recommends that towns regularly monitor and clean out priority two culverts (TRORC 2007).

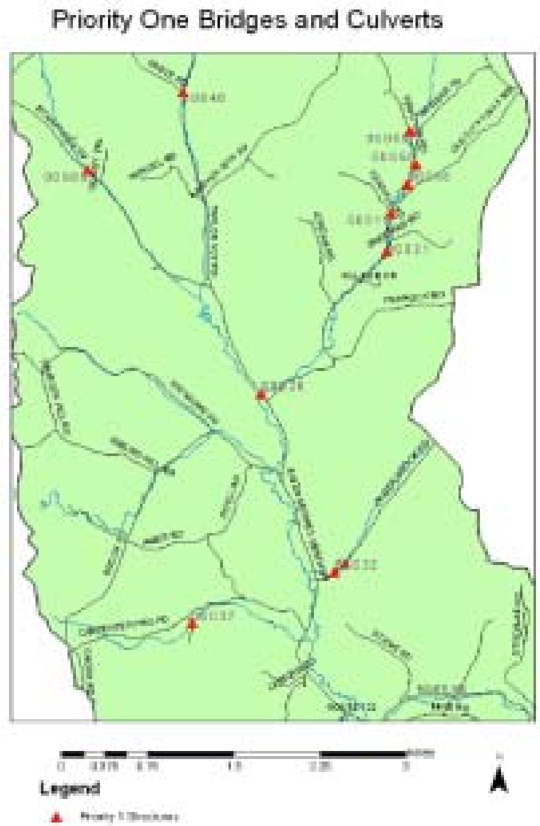


Figure 5-7. Priority culverts for replacement in Strafford (taken from Blazewicz and Nealon 2006a).

These culvert surveys were done using new survey protocols developed by the Agency to examine the size and configuration of bridges and culverts to determine: if they are large enough to accommodate the flows of the stream, if they allow for the passage of sediment that is necessary to maintain a stable stream and if they provide for the passage of fish and wildlife.

GOAL: MINIMIZE CONFLICTS BETWEEN STREAMS' NATURAL FUNCTIONS AND TRANSPORTATION INFRASTRUCTURE. **(see page 12 for basin-wide strategies)**

Objective: Reduce conflicts between bridges and culverts and the Ompompanoosuc River's natural functions.

104. Complete bridge and culvert surveys on all the tributaries to the Ompompanoosuc River and compile this information for use by towns to prioritize bridge and culvert replacement.

Potential key players: TRORC, ANR, Town road commissioners, VTrans
Potential funding sources: 319, 604b, HMGP
Time-frame: 2008

Objective: Reduce erosion from road surfaces, ditches and banks.

105. Provide information to local recreation organizations about erosion control techniques for trails, stream and river access points, and proper bridge and culvert construction. Develop a proposal to use a VYCC watershed crew to restore

impacted sites. Identify sensitive areas where access should be limited.

Potential key players: VYCC, VAST, VASA Root District Riding Club, Upper Valley Trails Alliance, Cross-Rivendell Trail Association, VMBA, Coyote Hill.
Potential funding sources: VYCC, 319
Time-frame: 2010

106. Review layouts of municipal garages in the watershed with each municipality to control runoff from salt and sand piles at municipal garages. Develop a set of cost effective management practices and municipal garage layouts that minimize erosion runoff and assist towns in completing these improvements.

Potential key players: road commissioners, selectboard members, Local Roads Program
Potential funding sources: Town funding, C&C, Stormwater Mitigation Grants.
Time-frame: 2011

Section 5-5 Lakes, Dams and Wetlands in the Ompompanoosuc River Watershed

Some of the larger lakes and ponds in the Ompompanoosuc River watershed include Lake Fairlee, Lake Abenaki, Miller Pond, Norford Lake, Bebe Pond and Mud Pond (locally called Forsyth Pond). The main concerns about lakes and ponds in the watershed include nutrient enrichment, exotic invasive species, acidification and toxins, dams and water level fluctuations, and lakeshore protection and enhancement. Also discussed in this chapter are dams and wetlands which may not be associated with lakes. Background information on these topics and strategies for all of Basin 14 are included in Section 1-6 of this plan on page 12.

Exotic Invasive Species

The Lake Fairlee Association has been running a Eurasian watermilfoil control program for the past 10 years to reduce the impacts of this invasive plant. This program began with hand pulling but has expanded to include diver operated suction harvesting, benthic barrier placement and a public access greeter component. The program also involves lakewide searching and extensive educational initiatives. The cost of this program in 2007 was over $117,000 from state, local and private sources. The Lake Fairlee Association has been developing innovative control methods to increase effectiveness, reduce costs, and lessen environmental impacts.

Invasive species watch programs like the state's VIPs or Vermont Invasive Patrollers can also help slow the spread of invasive species by catching infestations in their early stages when control is more feasible. To prevent the further spread of Eurasian watermilfoil and other aquatic invasives water body associations must work together to combat the spread of these species, and raise public awareness about the threats these species cause to Vermont waters.

Wetlands in the Watershed

There are numerous significant wetlands along the Ompompanoosuc River watershed and throughout the watershed. This includes a large wetland complex along Middle Brook draining into Lake Fairlee, remote wetlands along Bear Notch Brook, wetlands in the backwater of the Union Village Dam, and wetlands at the confluence with the Connecticut River. Wetlands absorb flood water and stormwater, filter pollutants and nutrients, provide habit for many species of plant and animals, provide open space, and opportunities for education and recreation. Because of these values wetlands in the watershed are protected thorough the Vermont Wetland Rules, and the identification, restoration and conservation of important wetlands is a strategy included in this plan.

Shoreline Protection

Much of the enjoyment of recreation on lakes and ponds is the beauty these environments provide. While none of the lakes or ponds in the Ompompanoosuc River watershed are rated as wilderness or wilderness like by the State of Vermont, there are areas of shoreline that are undeveloped and maintaining the natural shoreline preserves the natural feel of the ponds, filters pollution, and provides critical wildlife habitat.

Miller Pond and Lake Abenaki have large sections of undeveloped shoreline. Miller Pond is adjacent to the Podunk WMA and has limited development in its watershed. Mud Pond also has important sections of undeveloped shoreline.

Much of the shoreline of Lake Fairlee is developed with many year round houses and seasonal camps. To minimize the impacts current and future development, a protective buffer around the lake should be maintained and where needed restored. This can be encouraged through outreach to shoreline owners, by conservation of important properties, or regulated through the requirements of town zoning and planning. The impacts from existing development can be reduced by increasing riparian vegetation and reducing erosion and stormwater runoff from these lands. A large section of the southeast shoreline of Lake Fairlee was purchased by the Aloha foundation in 2005 which is likely to maintain the natural feel of this section of lake.

GOAL: PROTECT AND RESTORE THE NATURAL ENVIRONMENTS OF LAKES AND PONDS IN THE OMPOMPANOOSUC RIVER WATERSHED TO PROTECT WATER QUALITY, AQUATIC HABITAT, RECREATION AND AESTHETICS.

(see page 15 for basin-wide strategies)

Objective: Protect areas of existing natural lakeshore and on developed lakeshores, increase riparian buffers and reduce erosion and nutrient runoff.

107. Ensure the protection of the shoreline of Miller Pond, Lake Abenaki and Lake Fairlee through voluntary conservation of one shoreline property.

Potential key players: UVLT, conservation planning and zoning commissions, select boards, lake associations
Potential funding sources: VHCB, Watershed Grant
Time-frame: Ongoing

108. Maintain existing lakeshore vegetation through the creation of shoreline zoning in all watershed towns including language on vegetated lakeshore buffers.

Potential key players: conservation and planning commissions, select boards, lake associations, VLCT, TRORC
Potential funding sources: NA
Time-frame: Ongoing

109. Encourage the restoration of shoreline vegetation on lakes and ponds in the watershed working with existing groups to apply for grants to cover shoreline plantings and by holding educational workshops on good shoreline management.

Potential key players: lake associations, conservation commissions, DEC
Potential funding sources: Watershed Grant, 319
Time-frame: Ongoing

Objective: Prevent the spread of invasive aquatic and riparian species to watershed lakes and rivers.

110. Continue to increase the effectiveness and efficiency of Eurasian watermilfoil control in Lake Fairlee.

Potential key players: Lake Fairlee Association, DEC - AIS

Potential funding sources: ANC, Local fundraising, municipal grants
Time-frame: ongoing

111. Increase communication between lake associations, municipalities, and watershed residents and visitors on actions to prevent invasive aquatic and riparian species spread.

Potential key players: Lake Fairlee and Lake Morey Lake Association, DEC - AIS, Federation of Vermont Lakes and Ponds, selectboards and conservation commissions of Thetford, Fairlee, West Fairlee.
Potential funding sources: ANC, Watershed Grant
Time-frame:2010

Objective: Minimize the negative impacts of dams in the watershed.

112. Research the feasibility of eliminating the winter pool at the Union Village Dam to minimize the impacts of water level fluctuations on the Ompompanoosuc River. If this is feasible then update the management of the dam to eliminate the pool.

Potential key players: DEC Hydrology program, USACE
Potential funding sources: USACE
Time-frame: 2011

113. Review any large water withdrawal proposals in the watershed to ensure that they do not reduce fish passage, alter sediment regimes, or reduce flows or groundwater levels to significantly impact aquatic habitat.

Potential key players: DEC Hydrology program, Friends of the Ompompanoosuc River, Stream Alteration Engineer, F&W
Potential funding sources:
Time-frame: ongoing

114. Compile existing ecological information on the wetlands on the lower Ompompanoosuc River in the backwater of the Connecticut River from Wilder Dam. Research any impacts from water level fluctuations on this environment and to migrating birds that use this site.

Potential key players: Norwich Conservation Commission, DEC Hydrology program, DEC
Potential funding sources: CRJC PG, UCM&E
Time-frame: 2012

Section 5-6 Impaired and Altered Waters in the Ompompanoosuc River Watershed

The Agency of Natural Resources is responsible for maintaining water quality in each waterbody in accordance with the Vermont Water Quality Standards. Water quality is determined using biological, physical, and chemical criteria for each water quality management class. The Department of Environmental Conservation monitors surface waters for conformance with numeric and narrative water quality criteria to document violations and determine use attainment. Waters that are determined to be below the biological, physical or chemical water quality criteria of the Vermont Water Quality Standards are listed as impaired. To be listed as "impaired", and included in the EPA-Approved *List of Impaired Surface Waters* the violation of the Vermont Water Quality Standards must be substantiated by data collected through chemical, physical and/or biological monitoring and the cause or stressor most likely responsible for the impairment identified. This process is outlined in the DEC publication *2006 Vermont Surface Water Assessment Methodology Including Vermont Listing Methodology* (DEC 2005).

Table 5-3. Impaired waters in the Ompompanoosuc River watershed (DEC 2007a)

WATER SEGMENT NAME/DESCRIPTION	POLLUTANT	USE(S) IMPAIRED	REASON FOR SURFACE WATER QUALITY PROBLEMS	ACTION TO RESTORE WATER
COPPERAS BROOK (1 MILE) (Strafford)	METALS, ACID	AGRICULTURAL WATER SUPPLY, AESTHETICS, DRINKING WATER SUPPLY, AQUATIC LIFE SUPPORT	HIGH METALS IN DRAINAGE FROM ABANDONED ELIZABETH MINE & FROM TAILINGS	• STABILIZATION OF TAILINGS DAM AT TAILING PILE ONE COMPLETE. • PHASE 1 WILL INCLUDE SURFACE WATER DIVERSION, STABILIZATION OF THE WESTERN FACE OF TP-1, AND TAILINGS REMOVAL FROM COPPERAS BROOK. • PHASE 2 WILL INCLUDE SURFACE AND GROUNDWATER DIVERSION AND FINAL COVERINGS FOR TP-1 AND TP-2, THE TREATMENT OF REMAINING SEEPS FROM TP-1, AND MITIGATION OF TP-3 AS A SOURCE OF ACID MINE DRAINAGE**.** (STRATEGY 114)
WEST BRANCH OF OMPOMPANOOSUC RIVER (3.8 MILES) (Strafford)	METALS, ACID	AESTHETICS, AQUATIC LIFE SUPPORT		
LORDS BROOK (0.5 MILES ABOVE MOUTH UPSTREAM TO RM 3.3) (Strafford)	METALS, ACID	AQUATIC LIFE SUPPORT	ABANDONED MINE DRAINAGE, BELOW "SOUTH CUT"	• MEASURES TO ADDRESS THE ACID MINE DRAINAGE IMPAIRMENT IN LORDS BROOK ARE ADDRESSED IN THE FEASIBILITY STUDY. (STRATEGY 114)
ELY BROOK (aka SCHOOLHOUSE BROOK) BELOW ELY MINE (2.2 MILES) (Vershire, West Fairlee)	METALS, ACID	METALS, ACID	HIGH METALS IN DRAINAGE FROM ABANDONED ELY MINE	• THE FINAL CLEANUP PLAN TO RESTORE THIS SITE IS IN THE REMEDIAL INVESTIGATION PHASE AND WILL COMMENCE WHEN FUNDING THROUGH THE EPA SUPERFUND PROGRAM IS APPROPRIATED (STRATEGY 115)
OMPOMPANOOSUC RIVER BELOW ELY MINE (1.5 MILES) (West Fairlee)	METALS	AESTHETICS	HIGH METALS IN DRAINAGE FROM ABANDONED ELY MINE & FROM TAILINGS	
SAWNEE BEAN BR. TO USACE BEACH AREA LOWER OMPOMPANOOSUC (2.4 MILES) (Thetford)	*E. COLI*	CONTACT RECREATION	FREQUENT BEACH CLOSURES; HIGH BACTERIA LEVELS; SOURCE(S) UNKNOWN	• COMMUNITY BASED *E. COLI* TESTING AND COMMUNITY OUTREACH. (STRATEGY 90 & 91) • RIVER AND WATERSHED SURVEY • OUTREACH ON PROPER SEPTIC SYSTEM MAINTENANCE (STRATEGY 92)
BRIMSTON CRN TO BELOW W. FAIRLEE VILLAGE, LOWER OMPOMPANOOSUC (2.4 MI) (Vershire, West Fairlee)	*E. COLI*	CONTACT RECREATION	HIGH BACTERIA LEVELS; SOURCE(S) UNKNOWN	

Sections of the Ompompanoosuc River are listed as impaired due to elevated *E. coli* levels. The extent of the *E. coli* impairment on the Ompompanoosuc River will be revised based on water sampling discussed in Section 5-1 and will likely include the Ompompanoosuc River from West Fairlee to Brimstone Corners.

Acid Mine Drainage

The Ompompanoosuc River watershed has a long history of copper mining at both the Elizabeth and Ely mines in Strafford and Vershire, Vermont. While these sites provided copper and economic development, and continue to have historical significance, they are also the primary cause of water quality impairment in the Ompompanoosuc River watershed.

During the process of copper mining, piles of waste rock and tailings were created, which are now the primary sources of sediment, acid mine drainage and metals at the site. From the initial studies these sites do not pose serious health threats to the public with the exception to localized ground water contamination and lead contaminated soil near copperas factories on the site. However, runoff from the site does cause degradation of the biotic community including both fish and macroinvertebrates (EPA 2006a). Biological monitoring results have shown an absence of macroinvertebrates in Copperas Brook and a decrease in density and number of pollution intolerant species of macroinvertebrates in the West Branch of the Ompompanoosuc River below Copperas Brook. The biomass of fish is also reduced in the West Branch below the confluence of Copperas Brook (Langdon 2002). Ely Brook and the Schoolhouse Brook show similar impairments to the macroinvertebrate and fish communities and these impacts continue to a lesser degree in the East Branch of the Ompompanoosuc River.

The runoff from these sites has also reduced recreational opportunities by limiting swimming and fishing in these waters, along with discoloring the water and substrate of Copperas Brook and the West Branch below the Elizabeth Mine.

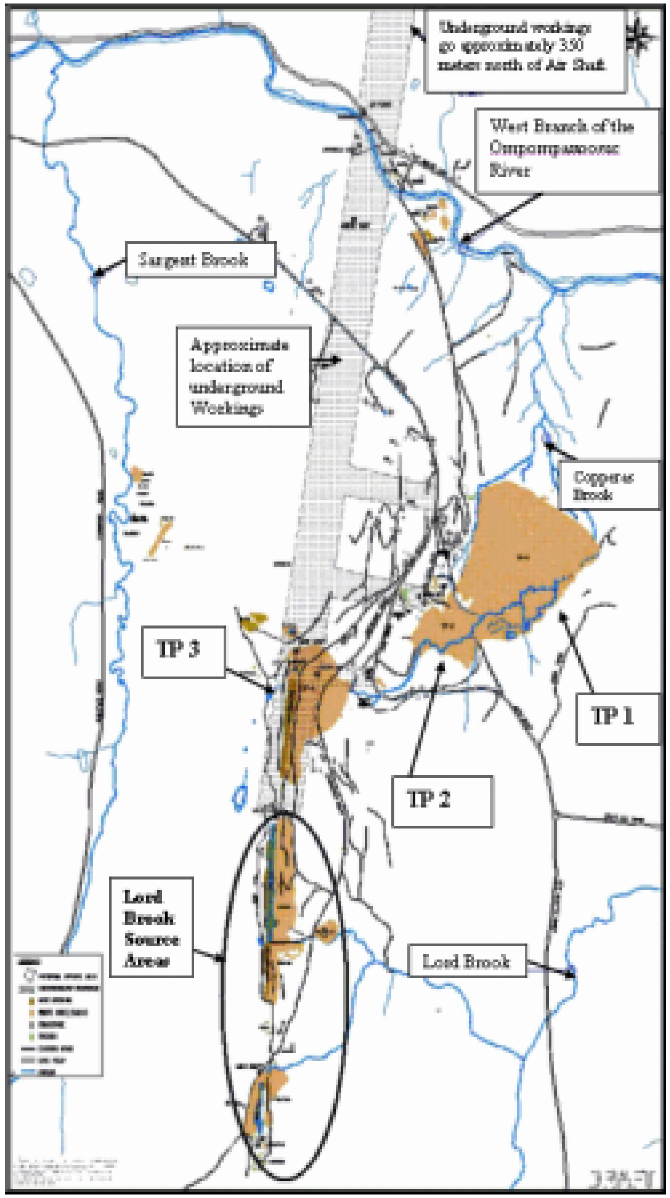


Figure 5-8. An overview of the Elizabeth Mine with major pollution source areas shaded.

Figure 5-9. Elizabeth Mine during the stabilization of tailings pile 1 in 2004

Superfund Site Cleanup

Both the Ely and Elizabeth mines are listed as superfund sites by the Environmental Protection Agency (EPA). The EPA has been coordinating with the State of Vermont and local communities to complete site investigations and develop final cleanup proposals which are well under way at the Ely Mine and almost complete at the Elizabeth Mine.

Investigations have identified four tailings piles at the Elizabeth mine as well as extensive mine workings and contaminated sediment which need to be addressed. During the initial site investigation at the Elizabeth Mine, the dam holding back tailings pile one (TP-1) was determined to be in danger of failure. This issue was addressed during the summer of 2004 and 2005 as a time- critical removal action (TCRA). This action consisted of constructing an earthen dam abutting the old dam to prevent a catastrophic failure of the TP-1. During 2006, the west side of the TP-1 tailing dam was graded and stabilized and a surface water diversion for the lower west side was also completed. In 2007 Phase 1 of the Non Time Critical Removal Action (NTCRA) was completed including remaining surface water diversion for TP-1 and tailings pile two (TP-2), tailing removal in Copperas Brook. Phase 2, will include surface water and groundwater diversion and the placing of a final covering on TP-1 and TP-2 and the collection and treatment of remaining seeps at the toe of TP-1. TP-3 will either be consolidated and capped in place or excavated and removed to TP-1. Any remaining run-off from TP-3 will be collected and treated. The EPA published a proposed plan for the site to include work in the Lords Brook watershed and removal of sediments in Copperas Brook (EPA 2006a)

EPA hopes to complete the major data collection activities for the Ely Mine during 2006 and 2007. This would allow for EPA to develop a cleanup plan for the Ely Mine during late 2007 that would be presented to the community for public comment during 2008 (EPA 2006b).

Altered Waters or Waters in Need of Further Assessment

There are other waters that fall outside the scope of impaired waters but have not met water quality standards or are of concern for other reasons. There are two bodies of water listed in need of further assessment in the watershed. This includes the West Branch of the Ompompanoosuc River from Strafford to South Strafford. This reach of river has received large amounts of sediment from streambank erosion, and has been evaluated by Phase 1 and 2 geomorphic assessments discussed in Section 3. About five miles of the East Branch is in need of further assessment from elevated *E. coli* levels. A community water sampling program has shown elevated *E. coli* levels over the last two years so this section of the Ompompanoosuc River will be listed as impaired in the next 303(d) report (See Section 5-1). Finally Lake Fairlee is listed

Table 5-4. Local waters of concern (including waters in need of further assessment) in the Ompompanoosuc River watershed (DEC 2007b)

Water body	Town	Reason for Concern	Status	Current or Future proposed Actions
WEST BRANCH, OMPOMPANOOSUC RIVER (SOUTH STRAFFORD UP TO STRAFFORD)	STRAFFORD	SEDIMENT	PHASE 2 GEOMORPHIC ASSESSMENT COMPLETE	• DEVELOP RESTORATION PLAN OR CORRIDOR MANAGEMENT PLAN TO RESTORE THE WEST BRANCH'S STABILITY. (STRATEGIES 96-101 SEE SECTION 5-3)
WEST FAIRLEE VILLAGE TO SAWNEE BRIDGE, LOWER OMPOMPANOOSUC (5 MI)	WEST FAIRLEE AND THETFORD	*E. COLI*, HABITAT ALTERATION, CHANNEL WIDENING, EROSION, LAND RUNOFF	USACE TESTING EVERY OTHER YEAR. VOLUNTEER SAMPLING SUGGESTS THIS SECTION MAY BE IMPAIRED	• CONTINUE COMMUNITY BASED *E. COLI* TESTING OF THE RIVER HAS RESULTED IN THIS REACH BEING INCLUDED ON THE 2008 303(D) LIST (SEE SECTION 5-1).
LAKE FAIRLEE	THETFORD, WEST FAIRLEE, AND NORWICH	LOCALLY ABUNDANT EURASIAN WATERMILFOIL GROWTH	WEEVIL PRESENT	• ACTIONS TO EDUCATE CITIZENS ABOUT EXOTIC SPECIES AND PREVENT THE SPREAD OF EURASIAN WATERMILFOIL TO OTHER WATER BODIES. (SEE SECTION 5-5) • CONTINUING MECHANICAL REMOVAL OF EURASIAN WATERMILFOIL. (SEE SECTION 5-5)

as altered due to invasive species because of Eurasian Milfoil which is discussed in detail in Section 5-5.

GOAL: RESTORE ALL IMPAIRED WATERS IN THE OMPOMPANOOSUC RIVER WATERSHED TO MEET VERMONT WATER QUALITY STANDARDS AND IMPROVE THE MANAGEMENT OF ALL WATERS OF CONCERN BEFORE THEY BECOME IMPAIRED.

Objective: Restore Copperas Brook, Lords Brook, Ely Brook, Schoolhouse Brook and the West Branch and main stem of the Ompompanoosuc River to meet Vermont Water Quality Standards.

115. Complete strategies 91 thorough 93 to reduce *E. coli* levels in the Ompompanoosuc River to meet Vermont Water Quality Standards.

Potential key players: DEC, conservation commissions, USACE
Potential funding sources: LaRosa, Watershed Grant, CRJC PG
Time-frame: 2012

116. Continue the work of the EPA and the State of Vermont to complete the superfund process to restore Lords Brook, the West Branch of the Ompompanoosuc River and Copperas Brook, to meet VWQS with community input from the Elizabeth Mine Citizen Advisory Group (EMCAG).

Potential key players: EPA, DEC, EMCAG
Potential funding sources: Superfund, state funds for ongoing site maintenance.
Time-frame: Ongoing

117. Complete the final cleanup proposal and begin the remediation of the Ely Mine minimizing environmental impacts and impacts to historical elements of the site. Restore Schoolhouse Brook to meet VQWS.

Potential key players: EPA, DEC, Local communities
Potential funding sources: Superfund, state funds for ongoing site maintenance
Time-frame: Ongoing

Chapter 6 – Management Goals and Plan Implementation

Section 6-1 Establishing Management Goals for Surface Waters in Basin 14

The protection or improvement of water quality and water-related uses can also occur by establishing specific management goals for particular bodies or stretches of water. The management goals describe the values and uses of the surface water that are to be protected or achieved through appropriate management. Management goals can be established through the following processes which are further described below:

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

The Agency of Natural Resources is responsible for determining the presence of existing uses on a case by case basis or through basin planning and the Vermont Water Resources Panel is responsible for adopting the other designations by rule. Once the Agency or the Panel establishes a management goal, the Agency manages state lands and issues permits to achieve all management goals established for the associated surface water. Before the Agency recommends, or the Panel establishes management goals through a classification or designation of surface waters as a rule, input from the public on any proposal is required and considered. The public is also able to present a proposal for establishing management goals for the Panel to consider at any time.

When the public develops proposals regarding management goals, the increased community awareness can lead to protection of uses and values by the community and individuals.

Water Management Typing and Classification

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

Presently, in all basins across Vermont waters above 2,500 feet in elevation are classified A(1) by Vermont statute. In addition the Water Resources Panel or members of the public can petition that high quality waters with significant ecological value below 2,500 feet be classified as A(1) based upon the public interest. In Basin 14 the only A(1) waters include those above 2,500 feet in elevation (which are only found in the headwaters of the Waits and Wells River watersheds). The management objective for A(1) waters is to maintain their natural condition.

Waters used as public water supplies are classified A(2). The only two class A(2) waters in Basin 14 are (a) the South Peacham Brook watershed from ½ mile east of Fosters Road which was historically used as water supply and (b) Mill Pond Brook and its watershed in the towns of Fairlee, Bradford and West Fairlee. Mill Pond Brook and its associated waters are reserved for emergency use as the Bradford water supply. All the remaining waters in the watershed below 2,500 feet in elevation are Class B waters.

As part of the Water Quality Standards revisions in 2000, the system was changed to allow Class B waters be divided into three management types: B1, B2 and B3. This change was made to furnish a greater level of protection to existing higher quality waters and to recognize attainable uses that could be supported by improvements to existing water quality. A simplification of the B1, B2 and B3 designations would be to say that the spectrum from B3 to B2 to B1 is described as representing "good," "better" and "best" aquatic conditions.

The revised Water Quality Standards require that all basin plans place Class B waters into one of the three water management types. However, the Vermont Legislature passed bill H154 in 2007 which allows for the adoption of the Basin 11 and Basin 14 water quality management plans without water management typing proposals; so long as they are adopted prior to July 1, 2008. These plans must be revised within two years of adoption with proposed water management types or an alternative method of protecting water quality in high quality waters.

Once the Vermont Water Resources Panel adopts the water management type designations for specific waters, it is the responsibility of the Agency, individuals and all levels of government to work to achieve or maintain the level of water quality specified by the designations.

Existing Uses

All surface waters in Vermont are managed to support uses valued by the public including swimming, boating, and fishing. The degree of protection afforded to these uses is based on the management type or class of the water. In particular surface waters, however, some uses are protected specifically if the Agency identifies them as existing uses under the anti-degradation policy of the Vermont Water Quality Standards (VWQS). The Agency uses a list of specific criteria to identify existing uses during basin planning and in the development of river basin water quality management plans. The list of specific criteria can be found in Appendix A11.

The Agency identifies and determines the presence of existing uses of particular waters either during the basin planning process or on a case by case basis during application reviews for state or federal permits. The Vermont Water Quality Standards define an existing use as *"a use which has actually occurred on or after November 28, 1975, in or on waters, whether or not the use is included in the standard for classification of the waters, and whether or not the use is presently occurring."* The following factors are considered by the Agency when identifying existing uses (VWQS § 1-03(b)).

- Aquatic biota and wildlife that use or are present in the waters;
- Habitat that supports existing aquatic biota, wildlife or plant life;
- The use of waters for recreation or fishing;
- The use of waters for water supply or commercial activity that depends directly on the preservation of an existing high level of water quality; and
- With regard to the factors considered under the first two bullets above, evidence of the use's ecological significance in the functioning of the ecosystem or evidence of the use's rarity.

During the Basin 14 planning process, DEC collected sufficient information to document and determine the presence of existing uses for swimming, boating, and fishing on flowing waters. Waters used as active or emergency public drinking surface water supplies were also identified. The Agency presumes that all lakes and ponds that exist within the basin have existing uses of fishing, contact recreation and boating. This simplifying assumption is being used because of the well known and extensive use of these types of waters for these activities based upon their intrinsic qualities and, to avoid the production and presentation of exhaustive lists of all of these waterbodies across Basin 14. This presumption may be rebutted on a case-by-case basis during the Agency's consideration of a permit application which might be deemed to affect these types of uses.

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

Table 6-1. Determination of existing uses of flowing waters for contact recreation (swimming) in Basin 14

Surface Water	Location of Use	Watershed	Town	Documentation of Existing Use
Ompompanoosuc River	Sandy Beach	Ompompanoosuc River	Thetford	Swimming hole at USACE land at Union Village Dam
Ompompanoosuc River	Ledges	Ompompanoosuc River	Thetford	Swimming hole at USACE land at Union Village Dam

Table 6-2. Determination of existing uses of flowing waters for boating in Basin 14 (RM is river mileage measured from the river terminus)

Surface Water	Location of Use	Watershed	Town	Documentation of Existing Use
Wells River	From the Wells River F&W access to above Adams Paper Company Dam. RM 1.8-2.4	Wells River	Newbury	Wells River F&W access and evidence of white water boating use including annual white water Kayak race. **Put in/Take out:** Wells River F&W Access
Waits River	From Pike Hill Road in Waits River to Route 25b. RM 1.7-13.8	Waits River	Topsham, Corinth, Bradford	Rated as highly important for boating (source: Jenkins and Zika 1992) **Put in:** Pike Hill Road Bridge **Take out:** Route 25b Bridge
Waits River	From the Bugbee landing boat launch to the Connecticut River. RM 0-0.9	Waits River	Bradford	Boating is a regular use from the public Waits River Boat Launch to the Connecticut River
Ompompanoosuc River	From F&W access to the Connecticut River. RM 0-0.3	Ompompanoosuc River	Norwich	Boating is a regular use from the Ompompanoosuc River F&W access to the Connecticut River

Table 6-3. Determination of existing uses of flowing waters for fishing in Basin 14 (RM is river mileage measured from the river terminus)

Surface Water	Location of Use	Watershed	Town	Documentation of Existing Use
Stevens River	From Patneaude Lane to Connecticut River excluding Barnet Falls. RM 0-2.2	Stevens River	Barnet	DFW identifies fishing as an existing use based on fish stocking criteria
Stevens River	From Peacham Hollow Brook to Barnet Center Road. RM 3.8-4.8	Stevens River	Barnet	DFW identifies fishing as an existing use based on fish stocking criteria
South Peacham Brook	From West Barnet to Stevens River. RM 0-2.2	Stevens River	Barnet	DFW identifies fishing as an existing use based on fish stocking criteria
South Peacham Brook	Within 0.5 miles downstream of Green Bay Loop. 4.6-5.1	Stevens River	Peacham	DFW identifies fishing as an existing use based on public access

Jewett Brook	Within Roy Mountain WMA. RM 0.1-1.7	Stevens River	Barnet	DFW identifies fishing as an existing use based on public access
Wells River	From Ricker Pond to Newbury/ Ryegate town line. RM 6.4-16.2	Wells River	Groton, Ryegate	DFW identifies fishing as an existing use based on fish stocking criteria
Wells River	From below the Boltonville Falls for 0.5 miles. RM 4.6 – 5.1	Wells River	Newbury	DFW identifies fishing as an existing use based on fish stocking criteria
Wells River	From .2 miles above the Tenney Pond tributary to above Adams Paper Company Dam. RM 1.7-2.6	Wells River	Newbury	DFW identifies fishing as an existing use based on fish stocking criteria and public lands
East Brook	Within Pine Mountain WMA. RM 0.9-1.8	Wells River	Topsham/Groton	DFW identifies fishing as an existing use based on public access
Keenan Brook	Within Pine Mountain WMA RM. 1.3-1.6 and 2.25-2.5	Wells River	Topsham/Groton	DFW identifies fishing as an existing use based on public access
South Branch Wells River	From Noyes Pond downstream to South Branch Road bridge. RM3.8-5.0	Wells River	Groton	DFW identifies fishing as an existing use based on public access
Depot Brook	From 0.5 miles upstream of US-232 downstream to Groton Pond. RM 0-0.9	Wells River	Groton	DFW identifies fishing as an existing use based on public access
Beaver Brook	From the west end of Beaver Brook Road downstream to Groton Pond. RM 0-1.7	Wells River	Groton	DFW identifies fishing as an existing use based on public access
Coldwater Brook	From 0.5 miles upstream of Boulder Beach Road downstream to Groton Pond. RM 0-0.75	Wells River	Groton	DFW identifies fishing as an existing use based on public access
Waits River	From VT 302 to Bradford Dam. RM 1.1-19.5	Waits River	Orange, Topsham, Corinth, Bradford	DFW identifies fishing as an existing use based on fish stocking criteria
Waits River	Below Route 5 to Connecticut River. RM 0-1.0	Waits River	Bradford	DFW identifies fishing as an existing use based on public access and fishing use
Ompompanoosuc River	From Mill Village to the Union Village Dam. RM 4.2-20.5	Ompompanoosuc River	Vershire, West Fairlee, Thetford	DFW identifies fishing as an existing use based on fish stocking criteria
Ompompanoosuc River	From just below the Union Village Dam to the Connecticut River. RM 0-3.9	Ompompanoosuc River	Thetford, Norwich	DFW identifies fishing as an existing use based on fish stocking criteria and public access
Ompompanoosuc River West Branch	From Strafford Village to South Strafford. RM 7.3-10.2	Ompompanoosuc River	Strafford	DFW identifies fishing as an existing use based on fish stocking criteria

Table 6-4. Determination of existing uses of waters for public surface water supplies in Basin 14

Surface Water	Watershed	Town	Basis for Determining the Presence of an Existing Use
Mill Pond Brook watershed above water intake dam	Waits River	West Fairlee, Fairlee, Bradford	Maintained as an emergency water supply for the town of Bradford

Outstanding Resource Waters

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

The only ORW designation in Basin 14 is the Ompompanoosuc River, from its confluence with an unnamed tributary draining Gillette Swamp and Mud Pond to the confluence with the West Branch, a distance of about 3.8 miles. This section of the river was designated as an Outstanding Resource Water in March 1996 due to exceptional natural, cultural, scenic and recreational values. There are a diversity of recreational opportunities on this stretch of river, including swimming, white water boating, fishing, picnicking, photography and hiking. This stretch of river also includes many unique historic sites, and an unusual length of river with stable vegetated banks, natural river bottoms and wooded land corridor. Although no other waters have been identified as ORW in this plan there may be additional waters in the basin which merit this designation and for which ORW status should be pursued.

Warm Water and Cold Water Designations

In addition to the foregoing classifications and designations, (a) Lake Abenaki and (b) Ticklenaked Pond, as well as (c) all wetlands in Basin 14 and (d) the Waits River from the CVPS dam in Bradford to the Connecticut River from June 1st to September 30th, are designated for management as warm water fish habitat by the Vermont Water Quality Standards. The remainder of surface waters in Basin 14 are designated as cold water fish habitat. Waters designated as warm water fish habitat have less stringent dissolved oxygen, temperature and turbidity criteria than waters designated as cold water fish habitat (Vermont Water Resources Board 2006).

Section 6-2 Implementation of the Basin 14 Water Quality Management Plan.

Many state and federal agencies, private organizations, community groups and individuals have been involved in developing the strategies in this basin plan. The next step is the implementation of the strategies by these groups and others.

The collaborative process of identifying concerns and strategies ensures that participating groups will continue to be engaged in implementing the Basin 14 Water Quality Management Plan. Since the basin planning initiative included extensive discussions with the community and resource agencies, the actions of some of the potential key players, such as local conservation commissions and natural resource conservation districts, are already aligned in that direction. For other potential partners, the plan will provide ideas, opportunities and the rationale to leverage funding for implementation projects. Implementation then needs only a small catalyst to start the process or a guiding hand to keep it progressing. For some strategies, the Vermont DEC will facilitate the implementation process by setting up meetings and providing technical support. Implementation of other strategies will require the resources and energy of other community groups using the plan as a guide.

The success of the Basin 14 Water Quality Management Plan is not to be limited to the implementation of the strategies in the plan. The basin planning process has also developed a vast network of groups working together to meet common goals. The strength of the network will help leverage existing funds and support from other organizations. If the process has been successful, the next basin planning process will begin with the existing partnerships intact. In addition, a number of projects were completed with community partners during the planning process.

Evaluation of the Planning Process

No planning process is complete without feedback on the elements of the plan. Periodically the Watershed Councils in Basin 14 and their partners and collaborators will review the process and examine accomplishments in planning and implementation. Topics to be considered include the adequacy of the process set forth by the State and its partners, the progress of the basin planning process, reactions of the public to the process, and the adequacy of resources to conduct planning and implementation.

Progress Reporting

The Watershed Councils and partners will annually address the accomplishments made toward achieving the basin plan goals and the goals of the VT ANR's *Watershed Planning Initiative*. This will include an analysis of the number of strategies successfully completed from the basin plan on a yearly basis. In addition, every year strategies scheduled to be completed will be reviewed by the watershed councils, DEC and key players to ensure efforts are moving forward and to identify and address any obstacles which may prevent implementation. Further, longer range strategies will be reviewed to make sure progress is being made and to identify intermediate actions which may be necessary. This review process will keep community partners engaged and allow for accountability in achieving the goals laid out in this basin plan.

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Acronyms

319	Federal section 319 grants for NPS pollution abatement
604b	Federal section 604b pass through funds for regional planning commissions
AAFM	Vermont Agency of Agriculture Food and Markets
AAP	Acceptable Agricultural Practices
ALS	Aquatic Life Support
AMP	Acceptable Management Practices
ANR	Vermont Agency of Natural Resources
ANS	Aquatic Nuisance Species Program
BASS	Biological Assessment Studies Section
BLUE	Bartonville Land Use Explorers
BMP	Best Management Practices
C&C	Clean and Clean watershed planning funds
CCC	Civilian Conservation Corps
CCNRCD	Caledonia County Natural Resources Conservation District
CLG	Certified Local Government Grants
CREP	Conservation Reserve Enhancement Program
CRJC	Connecticut River Joint Commissions
CRJC PG	Connecticut River Joint Commissions Partnership Grant
CRWC	Connecticut River Watershed Council
CVT	Cross Vermont Trail
DEC	Vermont Department of Environmental Conservation
DEC-AIS	Department of Environmental Conservation Aquatic Invasive Species Program
DFPR	Vermont Department of Forest Parks and Recreation
DFW	Vermont Department of Fish and Wildlife
DHCA	Vermont Department of Housing and Community Affairs
DOH	Vermont Department of Health
EMCAG	Elizabeth Mine Community Advisory Group
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FEH	Fluvial Erosion Hazard
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
HMGP	Hazard Mitigation Grant Program
LaRosa	LaRosa Analytical Partnership Program
LEAP	Logger Education to Advance Professionalism
LMP	Lay Monitoring Program
NEKISI	North East Kingdom Invasive Species Initiative
NEKWMD	– North East Kingdom Waste Management District
NFIP	National Flood Insurance Program
NMPIG	Nutrient Management Incentive Grant Program
NPS	Nonpoint Source Pollution
NRCS	Natural Resource Conservation Service
NTCRA	Non Time Critical Removal Action
NVDA	Northeastern Vermont Development Association
NVRCDC	Northern Vermont Resource Conservation and Development Council
OCHP	Orange County Headwaters Project
ORW	Outstanding Resource Water
RCG	River Corridor Grant
RM	River Mileage
RMP	River Management Program (Agency of Natural Resources)
SCC	Strafford Conservation Commission
SEWER	Save Everyone's Wells River
TCRA	Time Critical Removal Action
TMDL	Total Maximum Daily Load
TNPA	Ticklenaked Pond Association
TRORC	Two Rivers Ottauquechee Regional Commission
UCM&E	Upper Connecticut River Mitigation and Enhancement Fund
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
US F&W	United States Fish and Wildlife Service
UVLT	Upper Valley Land Trust
UVM Ext	University of Vermont Extension
VAST	Vermont Association of Snow Travelers
VHCB	Vermont Housing and Conservation Board
VHCB	Vermont Housing and Conservation Board
VIP	Vermont Invasive Patrollers
VLCT	Vermont League of Cities and Towns
VTrans	Vermont Agency of Transportation
VRC	Vermont River Conservancy
VWQS	Vermont Water Quality Standards
VYCC	Vermont Youth Conservation Corps
WEF	Wellborn Ecology Fund
WHIP	Wildlife Habitat Enhancement Program
WMA	Wildlife Management Area
WRNRCD	White River Natural Resources Conservation District

Glossary

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

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

Acceptable Management Practices (AMP) - methods of silvicultural activity generally approved by regulatory authorities and practitioners as acceptable and common to that type of operation. AMPs may not be the best methods, but are acceptable.

Aggradation – a progressive buildup or raising of the channel bed and floodplain due to sediment deposition. The geologic process by which streambeds are raised in elevation and floodplains are formed. Aggradation indicates that stream discharge and/or bed-load characteristics are changing. Opposite of degradation.

Anadromous – a fish species that feeds and grows to maturity in the ocean, then migrates into freshwater rivers and lakes to spawn.

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

Basin - one of seventeen planning units in Vermont. Some basins include only one major watershed after which it is named such as the White River Basin. Other Basins include two or major watersheds such as Basin 11 including the West, Williams and Saxtons Rivers.

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

Biological Monitoring - surveys of the macroinvertebrate and fish communities of lakes, wetlands, rivers, and streams in order to evaluate the biological health, or biological integrity, of the resource surveyed.

Biological Integrity – 1) "biological integrity may be defined as the maintenance of community structure and function characteristic of a particular locale or deemed satisfactory to society" Cairns (1977); 2) "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a composition and diversity comparable to that of the natural habitats of the region" Frey (1977).

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

Conductivity – a measure of the water's ability to conduct an electrical current, directly related to the total dissolved ions in the water.

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

Dissolved Oxygen – the concentration of free molecular oxygen dissolved in water.

Easement – a restriction placed on a piece of property to protect its ecological and open-space values. It is a voluntary, legally binding agreement that limits certain types of uses or prevents development from taking place now and in the future. In a conservation easement, a landowner voluntarily agrees to donate or sell certain rights associated with his or her property, such as the right to subdivide, and a private organization or public agency agrees to hold the landowner's promise not to exercise those rights.

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

Eutrophic – a high level of nutrient availability and biological productivity in an aquatic ecosystem.

Fluvial erosion hazard - refers to the endangerment of human investments and public safety resulting from land use choices and expectations that conflict with the dynamic and oftentimes catastrophic physical adjustments of stream channel and flood plain dimensions, elevations, locations and longitudinal slope, in response to rainfall/runoff events and sometimes ice jams. (contrast with flood inundation hazard)

Fluvial geomorphic equilibrium - the condition in which the physically dynamic nature of fluvial systems is freely expressed over time in response to the range of watershed inputs and climatologic conditions, and as influenced by topographic, geologic, and existing human imposed boundary conditions.

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

Groundwater – Water that is below the ground.

Impaired water - a water that has documentation and data to show: a violation of one or more criteria in the Vermont Water Quality Standards, or conditions that cause lack of full support for any given designated use for the water's class or management type.

Impervious – a surface that does not allow water or other liquids to penetrate through.

Low Impact Development - a set of innovative stormwater management techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source through small, cost-effective landscape features located at the lot level. These include practices such as raingardens, bioretention facilities, dry wells, filter/buffer strips, grassed swales, and rain barrels.

Macroinvertebrate – animals without backbones and large enough to see with the naked eye.

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

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

Oligotrophic – A low level of nutrient availability and biological productivity in an aquatic ecosystem.

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

Phosphorus – Phosphorus is a nutrient which is generally the limiting nutrient in aquatic systems in the northeast. Because of this the amount of phosphorus available in aquatic systems determines the extent of aquatic plant and algae growth.

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

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

Riparian – located on the banks of a stream or other body of water.

Riparian Buffer Zone - the width of land adjacent to lakes or streams between the top of the bank or top of slope or mean water level and the edge of other land uses. Riparian buffer zones are typically undisturbed areas, consisting of trees, shrubs, groundcover plants, duff layer, and a naturally vegetated uneven ground surface, that protect the waterbody and the adjacent riparian corridor ecosystem from the impact of these land uses.

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

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

Sources – the land uses, human activities, or occurrence of conditions that are the origin of the causes of impairments, impacts or stresses on river and stream in the basin.

Surface Waters – Surface waters are waters that flow above the level of the ground in streams and in lakes and ponds.

Total maximum daily load (TMDL) - the calculation of the maximum amount of a pollutant that a waterbody can receive on a daily basis and still meet Vermont Water Quality Standards.

Transparency – a depth measurement taken by lowering a white and black, 8-inch diameter, Secchi disk into the water to the point just before it cannot be seen.

Trophic – a relative level of productivity.

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

Type / Typing - a category of water management requirements based on both the existing water quality and reasonably attainable and desired water quality management goals. Through the basin planning process all Class B waters must be allocated into one or more Water Management Types (B1, B2, B3) pursuant to § 3-06 of the Vermont Water Quality Standards.

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

Water quality parameter – the physical, chemical or biological attribute measured to determine water quality.

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

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

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