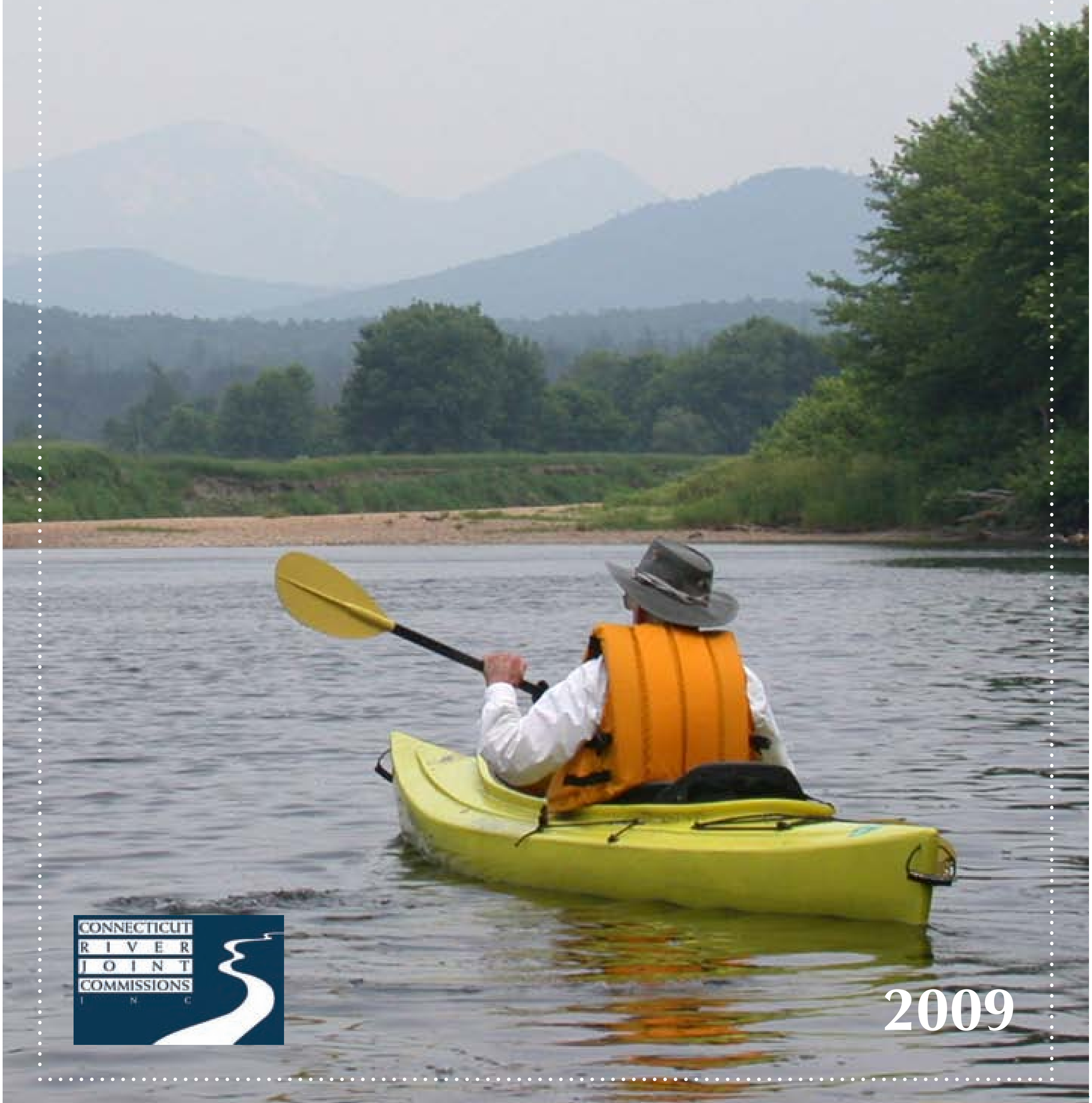
Water Resources

Connecticut River Management Plan

Headwaters Region



CONNECTICUT RIVER JOINT COMMISSIONS INC

2009

Water Resources

Headwaters Subcommittee of the Connecticut River Joint Commissions

Adopted September 5, 2007, updated July, 2009

Produced with support from the New Hampshire Department of Environmental Services, the National Oceanic and Atmospheric Administration, US Gen New England, the Vermont Department of Environmental Conservation, a Vermont Watershed Grant from the Vermont Agency of Natural Resources, and the Davis Foundation.

Drafted by the Headwaters Subcommittee with the assistance of Adair D. Mulligan

This report is also available at **www.crjc.org/waterresources.htm.**

Connecticut River Joint Commissions

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Cover photo: The Connecticut River, looking downstream from Stratford, N.H. and Brunswick, Vt.

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Key Recommendations

- **Follow the principles of sustainable forest management.** Forest landowners should follow guidelines in *Good Forestry in the Granite State*, develop management plans for their forests, minimize the visual and water quality impacts of clear-cutting, especially near the river, use integrated pest management to lessen the reliance on chemicals, protect and maintain a forested riparian buffer along waterways and dispose of slash away from streams, and consider conservation easements on their property to allow it to continue in active forest management and to contribute to the economic, scenic, and timber resource base of the region.

- **Install an early warning system for Murphy Dam.** The NH Bureau of Emergency Management and DES Dam Bureau should enlist the help of the federal Homeland Security Agency to install an early warning system that will reach all communities in New Hampshire, Vermont, and Quebec that could be affected by a catastrophic failure of Murphy Dam.

- **Eliminate bacterial discharges to surface waters.** Identify sources of bacteria in the river that are related to human activities, including failed or inadequate septic systems, and remedy them.

- **Evaluate possible contamination at a salvage yard.** NH DES should work with the owner of the equipment salvage yard in Colebrook to test surface and groundwater above and below this site, especially near the business's headquarters building. The site may be a good candidate for a brownfields study.

- **Keep development away from floodplains.** Towns should not permit building in the 100-year floodplain, to protect their citizens and businesses from damage, to avoid adding to flooding of their downstream neighbors, and to reduce the public cost of disaster relief. FEMA should provide accurate floodplain maps for Headwaters region towns.

- **Avoid river contamination from gravel processing operations.** Gravel mining operators should process gravel at a safe distance from the river, to avoid contaminating the water with fine rock powder particles, and take steps to keep such fine material from blowing around. State environmental agencies should monitor and enforce permit conditions for gravel pit construction.

- **Educate developers about the need for stormwater permits.** State agencies should inform developers and landowners about recent changes in stormwater permitting.

- **Inform the public about water quality.** State agencies should make water quality monitoring data easily accessible to the public, including to those who do not use computers, so the public understands the present condition of the river and its tributaries.

- **Update rules for disposal of unused medicines.** EPA and the states should develop better rules to dispose of unused medicines, so that these pollutants do not end up in wastewater that can eventually reach the river.

- **Retain and enhance riparian buffers.** Landowners along rivers and streams should retain and enhance buffers of native vegetation on their banks to help hold soil together. Town officials and landowners should be aware of the provisions of the updated New Hampshire Comprehensive Shoreland Protection Act. Towns should ensure that new landowners have access to CRJC's erosion maps and guidance.

I. Preface

A Citizen-based Plan for the Connecticut River

The Headwaters Subcommittee meets at the Columbia Town Hall.

The Headwaters region's plan is a blueprint for stewardship of the Connecticut River – for communities, landowners, businesses, and agencies on both shores. Gathering together to create this plan for the Headwaters segment of the river were representatives from the towns of Pittsburg, Stewartstown, Colebrook, Columbia, Stratford, and Northumberland, N.H. and Canaan, Bloomfield, Brunswick, and Maidstone, Vt.

The strength of the Headwaters Subcommittee's planning process lies in the diversity of its membership. These citizens, as directed by RSA 483, represent local business, local government, agriculture, recreation, conservation, and riverfront landowners. All of the recommendations of the Headwaters Subcommittee's plan represent the consensus of this diverse group of citizens. Subcommittee members are listed in Appendix A.

"A lot of the authenticity of the River Commissions comes from this participation at the grassroots level."

Cleve Kapala, past president, CRJC

Origin of the Connecticut River Management Plan

The Connecticut River Joint Commissions (CRJC) mobilized hundreds of valley residents and local officials to join them in nominating the Connecticut River into the New Hampshire Rivers Management and Protection Program in 1991-2. The New Hampshire Legislature subsequently designated the river for state protection under RSA 483, which authorized CRJC to develop a river corridor management plan. CRJC sought support from the Vermont Legislature as well, so citizens from both states could engage in planning for their shared river. With backing from both legislatures, CRJC then contacted select boards or city councils from the 53 New Hampshire and Vermont riverfront communities and asked them to nominate representatives to serve on five bi-state local river subcommittees. This partnership between local town representatives and the state commissions for the Connecticut River enabled CRJC to publish the first edition of the *Connecticut River Corridor Management Plan* in 1997, after five years of work by the Commissions and the five bi-state local river subcommittees. Since this planning process began in 1993, nearly 200 citizens have thus participated in the subcommittees' work.

Following its publication, communities on both sides of the Connecticut River examined its findings and used them as a basis for enacting new or enhanced protection for the river. State and federal agencies also pursued its recommendations, embarking on studies of sediment and water quality and fish tissue toxins. The *Connecticut River Corridor Management Plan* was cited as a basis for designation of the Connecticut River as an American Heritage River by the White House in 1998. A summary of progress on the plan's recommendations appears in Appendix B.

A New Water Resources Plan

At the request of the CRJC, a new assessment of water quality in the Connecticut River mainstem was conducted in 2004 by the New Hampshire Department of Environmental Services (NH DES) with the support of the U.S. Environmental Protection Agency (EPA). Following announcement of the results in January, 2005, CRJC asked the local river subcommittees to begin work on updating, revising, and expanding the 1997 Water Quality chapter, exploring new topics such as flow, flooding, drought, groundwater, and other areas, in an attempt to portray and address the full range of water resources in the region. Because tributaries are responsible in large part for the river's condition, the subcommittees included an examination of tributary issues. Several members conducted windshield assessments of smaller tributaries within their towns, previously unstudied.

"Used to be that when the river suddenly turned muddy or there was a washout, people would grumble about it over their breakfast, but kept on chewing. Nowadays, they get out there to see what's happened, and chase the sediment upriver to see where it's coming from. They really care."

Brendan Whittaker
CRJC Commissioner, Brunswick, Vt.

Plan Process

The Headwaters Subcommittee met at the Columbia and Colebrook Town Halls from January, 2005 until November, 2007 to develop the new water resources chapter of the Connecticut River Management Plan for this section of the river. CRJC's conservation director transcribed the subcommittee's discussions to construct drafts of the plan, which the members revised and approved. Clarksville and Lemington did not actively participate.

A first draft of the plan was circulated for public comment in May, 2007, and a public meeting held to answer questions about the plan. After considering comments from various agencies, organizations, individuals, and CRJC's Water Resources Committee, the Subcommittee adopted a final version in September, 2007.

Scope of the Plan

The Subcommittee has concentrated its planning upon the 80 miles of the Connecticut River from Fourth Connecticut Lake in Pittsburg through Maidstone and Northumberland. While the recommendations are directed toward this area, the Subcommittee members believe that their consideration beyond the riverfront towns could benefit the river, its tributaries, and the region as a whole. Recommendations are presented within each topic area, and are summarized in Appendix C, arranged by responsible party. Some are aimed beyond town boundaries, to guide state and federal agencies. The Subcommittee recognizes that proper care of the river is a big job and important public duty. Therefore, help from beyond the watershed is sometimes appropriate and needed from agencies that share responsibility for the river. A list of acronyms appears in Appendix K.

Local Adoption of Recommendations

New Hampshire RSA 483, the Rivers Management and Protection Act, encourages communities on protected rivers such as the Connecticut to adopt a locally-conceived means of conserving the river and its shoreline. The Legislature sought also that "the scenic beauty and recreational potential of [the Connecticut River] shall be restored and maintained, that riparian interests shall be respected" without preempting the land zoning authority already granted to the towns. The mechanism for adoption of this plan in both states is the conventional local planning process. Planning boards and commissions can review recommendations in the water resources chapter and integrate them into the local master plan, and select appropriate recommendations to bring to townspeople for adoption as specific additions to their zoning ordinances. The Subcommittee has also made many recommendations which are non-regulatory in nature, inviting landowners and others to put them into action.

The Connecticut River Joint Commissions

The New Hampshire Legislature created the Connecticut River Valley Resource Commission in 1987 to preserve and protect the resources of the valley, to guide growth and development, and to cooperate with Vermont for the benefit of the valley. The Vermont Legislature established the Connecticut River Watershed Advisory Commission in the following year. The two commissions banded together as the Connecticut River Joint Commissions in 1989, and are headquartered in Charlestown, N.H. The Commissions are advisory and have no regulatory powers, preferring instead to advocate and ensure public involvement in decisions that affect the river and its valley. CRJC's broad goal is to assure responsible economic development and economically sound environmental protection. The thirty volunteer river commissioners, 15 appointed by each state, represent the interests of business, agriculture, forestry, conservation, hydro power, recreation, and regional planning agencies on both sides of the river.

Acknowledgments

The strength of this plan lies largely within its creation by a cross-section of local citizenry. From time to time, however, the local subcommittee called upon the expertise of state agencies, regional planning commissions, and local watershed group leaders to educate them about issues of particular concern. We would like to express our gratitude to those who lent their time to share information with the Headwaters Subcommittee:

- Steve Couture, *NH Department of Environmental Services Rivers Coordinator*
- Tim Carney and David Chappell, *NH Department of Environmental Services Dam Bureau*
- Tamara Colton Stevens, *Essex County Conservation District Manager*
- Diane Bennett, *Coös County Conservation District Manager*
- Brendan Whittaker, Mary Sloat, and Nat Tripp, *Connecticut River Commissioners*

We are particularly grateful to the towns of Columbia and Colebrook for providing meeting space in their historic town halls.

Technical assistance - Mapping and other technical assistance were provided by the Upper Valley Lake Sunapee Regional Planning Commission.

Funding to support the work of the Headwaters Subcommittee came from:
NH Department of Environmental Services
National Oceanic and Atmospheric Administration
USGen New England
Davis Foundation

II. Introduction

It is here, in a spruce-fir forest, that the largest river in New England begins. Here, it changes and grows from an icy splash over jumbled boulders to a meandering river between loamy banks. Some of the finest trout water in the Northeast, it is loon water, canoe water, and working water. The Headwaters region is the root of the river, and reflects the roots of human history on the land. The forests and the soils of the river valley still shape the lives of people here. Residents enjoy a relationship with the land and the river that people from away don't always understand. The Connecticut River in its headwaters is a reminder of the river the way it once was throughout its length, and which the region's citizens hope will remain the same.

Fourth Connecticut Lake, source of New England's largest river, rests a few hundred feet from the Canadian border at 2,670 feet above sea level.

The Headwaters segment begins at the river's source at Fourth Connecticut Lake at the Canadian border, and runs 80 miles south, flowing between the New Hampshire towns and villages of Pittsburg, Clarksville, Stewartstown, Colebrook, Columbia, Stratford, Groveton, and Northumberland, and the Vermont towns and villages of Beecher Falls, Canaan, Lemington, Bloomfield, Brunswick, and Maidstone. In this run, it captures the drainage of approximately 1,200 square miles as it falls over 1,800 feet from Fourth Lake to the breached Wyoming Dam.

The Headwaters Subcommittee believes firmly in the right of all citizens to use and enjoy their own properties and the Connecticut River, and that the most effective protection of the river has come and will continue to come from private landowners. The Subcommittee also recognizes that the Connecticut River is a public resource that affects the quality of life for Headwaters region residents. The river also draws many visitors, and plays a powerful role in the economic well being of the region.

Because the actions of private landowners can affect the quality of both public waters and private property downstream, the Headwaters Subcommittee believes that it is appropriate for all landowners to participate as caretakers of the river for the benefit of themselves and their neighbors. Through private voluntary action, landowners can be a big part of both problems and solutions on the river. Communities, too, can and should take action to keep the Connecticut River as the valuable economic and environmental resource that it has long been to their citizens.

The quality of Connecticut River as a whole has improved vastly since the years when thousands of homes discharged raw sewage and many industries released untreated chemical wastes into the river. For the better part of a century before this, much of the river in this region, and some of its tributaries, were scoured, straightened, dammed, and flooded to move timber downstream to waiting mills during the legendary Connecticut River log drives.

While the quality of the Headwaters stretch had deteriorated less than in downstream reaches, it too has improved with the investment in modern septic systems and leach fields, wastewater treatment plants, manure storage facilities, and use of best management practices. Thanks to these investments and the Clean Water Act, today it is not only possible but enjoyable to swim in the river, where several decades ago, one might have looked the water over carefully before venturing in.

River water in the Headwaters region is used for agricultural and industrial water supplies, and a number of public and private wells are located near the river to draw upon groundwater that is associated with it. Free flowing, steeply dropping waters, such as the rapids at Lyman Falls, keep oxygen levels high and allow the river to support excellent fisheries and to assimilate the treated wastes it now receives.

Very good water quality, adequate dissolved oxygen, and an aquatic food chain community in excellent condition distinguish the Headwaters segment of the river. Still, the Headwaters reach of the river can carry nutrients, sediments, bacteria, debris, and other forms of pollution, and faces new challenges from increasing riverside development. Questions remain about bacteria in 50 miles of the Headwaters reach that can make swimming unsafe.

A number of small and large wetland areas are connected with the river, particularly around the Connecticut Lakes. Riparian buffers, or filter strips of natural shoreland vegetation, remain in many locations to help hold the banks and to catch pollutants in runoff before they can reach the river.

III. River Quality

A. Clean Water Has Clear Economic Value

Good water quality is of economic importance to the Headwaters region. The free-flowing nature of much of the river in this segment is especially valued, because it ensures that river water is well oxygenated, provides excellent fishing and boating, and is highly scenic. The three mile segment from Lyman Falls to Bloomfield is important for all of these reasons, as is the free passage of the river over the breached Wyoming dam site, where water is re-aerated after assimilating wastes that were, until recently, added by the Groveton paper mill. Existing impoundments are also appreciated by residents of the region and by visitors, for the variety they provide in boating and fishing experiences. A number of public and private wells are located near the river with the potential to draw upon associated groundwater. The quality of the river's waters is also important to visitors. The Connecticut River Byway, an economic development initiative that has built strong momentum, is centered on the river's appeal as a recreation asset.

The river offers good, clean fun that brings dollars into the region. Here, canoeists launch at the Stratford-Maidstone Bridge.

A 2007 study in New Hampshire found that about $379 million in total sales is generated by those who are fishing, boating or swimming in New Hampshire fresh waters, or about 26% of all summer spending in the state.[1] Fishing, boating and swimming have about the same economic impact as snowmobiling, downhill skiing, cross-country skiing, and ice-fishing combined. Interviews with users of eight public boat ramps in the Great North Woods found that 61% of anglers, boaters and swimmers say they would decrease their intended visits to the region if water clarity and purity declined. For the purpose of this study, "water clarity and purity" include milfoil or other invasives, mercury, and algae. Of those who would decrease their intended visits, 22% would leave the state and 11% would leave the region. Those recreationists leaving the state would create a loss of 7% – or about 73,000 visitor days.

The study found that overall, surface water recreation in the 14 towns in New Hampshire's Great North Woods tourism region generates over 400 jobs, over $9 million in personal income and more than $26 million in business sales, totaling about 7% of the recreational revenue generated by anglers, boaters and swimmers in New Hampshire. A perceived decline

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1. *The Economic Impact of Potential Decline in New Hampshire Water Quality: The Link Between Visitor Perceptions, Usage and Spending*. Prepared for the New Hampshire Lakes, Rivers, Streams and Ponds Partnership by Anne Nordstrom, May 2007.

in water clarity and purity in the Great North Woods region would lead to a loss of almost 30 jobs, a loss of about $650,000 in personal income and a loss of nearly $2 million in business sales.

Ten years ago, a survey prepared for the Headwaters Subcommittee by North Country Council found that the recreational opportunities offered by the Connecticut River which depend upon its water quality represent a $26-31 million dollar business in the river towns of Pittsburg to Haverhill, on the New Hampshire side alone.[1] Local water-dependent businesses were strongly interested in maintaining or improving water quality, with the help of area town governments. Habitat for fish and other aquatic life highly dependent upon excellent water quality is a notable feature of the Headwaters, which is home to a famous coldwater fishery that includes wild brook trout.

B. Connecticut River Water Quality

1. River Management Planning

New Hampshire and Vermont approach river planning differently in the Connecticut River watershed. New Hampshire designated the Connecticut River into its Rivers Management and Protection Program in 1992 with the support of local citizens and the Connecticut River Joint Commissions. As part of this designation, the state required CRJC to act as the local advisory committee for the river, and to develop a Connecticut River Corridor Management Plan with the help of five local river subcommittees set up under state law. CRJC published the six-volume first edition of the plan in 1997. This document is a revised and updated version of the water quality chapter of that plan.

Vermont embarked upon watershed planning in 2002, under a mandate from the legislature that originally gave the Department of Environmental Conservation until 2006 to complete basin plans for the state's 17 watersheds, although this will now not be complete for many more years. Basin planning has not yet begun for the Vermont Connecticut River tributaries in the Headwaters region (Basin 16 = Nulhegan River, Willard Stream, Paul Stream, and others). When it does, Headwaters Subcommittee members will be encouraged to participate. For the next few years, the Headwaters Subcommittee's Water Resources Plan must serve as the primary management plan for these Vermont tributaries. Under the guidance of state basin planners, citizen committees will develop basin plans in a process modeled partly on the grassroots approach used by CRJC. At the same time, the state agency is moving ahead with watershed assessment and restoration projects, such as geomorphology studies.

2. Water Quality Has Improved in the Last 50 Years

In 1951 the Connecticut River was "undamaged for the first 44 miles of its course," but quickly gathered untreated sewage from homes and communities along its banks.[2]

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1. National Wildlife Federation and North Country Council, *Rivers, Recreation, and the Regional Economy: A Report on the Economic Importance of Water-Based Recreation on the Upper Connecticut River.* 1996.
2. Federal Security Agency, Public Health Service, *Connecticut River Drainage Basin: A Cooperative State-Federal Report on Water Pollution.* 1951.

At this time, 219 miles of the Connecticut River between New Hampshire and Vermont were rated as Class C ("Damaged"), and 6 miles were rated Class D ("Damaged. Unsuitable for most legitimate water uses. Suitable only for the transportation of sewage and industrial wastes without nuisance and for power development and limited industrial uses. Aesthetic quality poor."). These two classifications, and the waters that portrayed them, are thankfully a thing of the past.

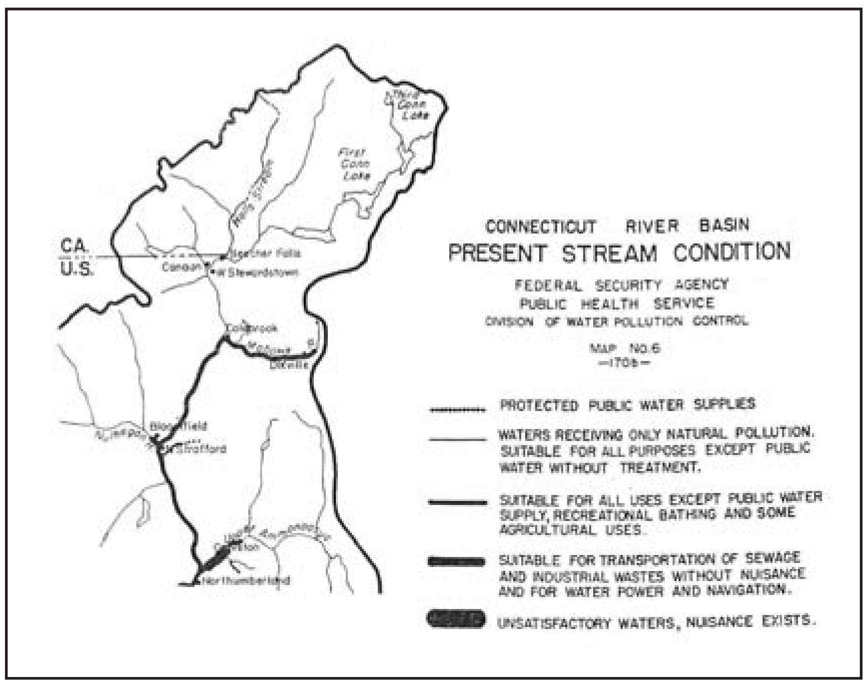
A mere half century ago, the river carried untreated domestic sewage from 3,000 people in the Headwaters region of New Hampshire and nearly 1,000 in nearby Vermont, plus untreated wastewater from two paper mills. The resort hotels and inns in the basin were a particularly noxious source of pollution in the 1950s. The hotel known today as The Balsams sent unsatisfactorily treated sewage from about 800 people into the Mohawk River, causing the entire length of that tributary to be rated C. The Mohawk and the Connecticut River from Colebrook to Northumberland were thus deemed unsafe for "recreational bathing" and some farm uses. The five mile section from Northumberland village down to Lancaster, below the two paper mills, was labeled "suitable for transportation of sewage and industrial wastes without nuisance and for water power and navigation."

"In the summertime, when it got hot and the river got down, it literally stunk."

Guildhall riverfront farmer, describing the Connecticut River in the 1950s.

3. Water Quality Management by the States

New Hampshire water quality standards apply to the Connecticut River. Water classifications defined by the states set management goals for a stretch of river. Water quality standards are used to protect the state's surface waters, and each state defines water quality in its own way, based on its statutes and administrative rules.



Water quality in the Headwaters region in 1951.

An interesting difference appears between the two states' water quality standards, such as their concepts for bacterial contamination. Vermont has the strictest standard for *E. coli* in the nation, although the Department of Environmental Conservation does not have the resources to enforce these standards consistently. Class B waters must not exceed 77 *E. coli* organisms per 100 milliliters of water, while New Hampshire tolerates 126 per 100 ml. State water quality standards may be compared at www.neiwpcc.org/neiwpcc_docs/i_wqs_matrix04.pdf.

New Hampshire - Today, the State of New Hampshire has two classifications: A and B, and has designated the entire Connecticut River as Class B, although back in 1951, only 44 miles of the river qualified as Class B.

New Hampshire Water Quality Standards

Tracking water quality is the responsibility of the Watershed Management Bureau of the New Hampshire Department of Environmental Services (NH DES). Standards in New Hampshire consist of three parts: designated uses, including swimming, fishing, boating, and aquatic habitat; numerical or narrative criteria to protect the designated uses; and an anti-degradation policy, which maintains existing high quality water that exceeds the criteria. New Hampshire measures physical and chemical aspects of water, and also has a relatively new biological monitoring program for assessing aquatic life.

Class A waters - *Escherichia coli* are not to exceed a geometric mean of 47 *E. coli*/100 ml (based on at least 3 samples obtained over a 60-day period) or more than 153 *E. coli*/100 ml in any one sample. There shall be no discharge of any sewage or wastes into these waters.

Class B waters - *Escherichia coli* are not to exceed a geometric mean of 126 *E. coli*/100 ml (based on at least 3 samples obtained over a 60-day period) or more than 406 *E. coli*/100 ml in any one sample, shall have no objectionable physical characteristics, and shall contain a dissolved oxygen content of at least 75 percent of saturation.

Vermont - Vermont considers most of the Connecticut River to be Class B, with the exception of 2.27 miles in Waste Management Zones, which are designated mixing zones for discharges from wastewater treatment plants. Waste Management Zones are a specific reach of Class B waters designated by a permit to accept the discharge of properly treated wastes that prior to treatment contained organisms pathogenic to human beings. Throughout the receiving waters, water quality criteria must be achieved, but increased health risks exist in a waste management zone due to the authorized discharge. In the Headwaters region, these zones surround four waste management discharges, totaling 1.24 miles.

Total Maximum Daily Load (TMDL)

Each state must identify those water bodies that are not meeting their water quality standards, and calculate the maximum amount of a pollutant that each can receive and still meet the state's water quality standards. It also develops a means to reduce these pollutants. TMDLs can be calculated for correcting water pollution from specific discharges or throughout a watershed and balance how much the pollutant needs to be reduced based on location.

Vermont TMDL list: Vermont lists no water bodies in the Headwaters region that do not meet water quality standards, although several streams have been identified for further assessment. These include Leach and Willard Streams in Canaan, where stream instability has led to sedimentation and erosion, and the East Branch of the Nulhegan River, where there is concern about sedimentation and erosion associated with logging. Basin planning will not begin on the Vermont side for several years, but when it does, water quality assessments

Vermont Water Quality Standards

The Water Quality Division of the Department of Environmental Conservation, in the Vermont Agency of Natural Resources, manages water quality information for this state. Standards in Vermont include designated uses, including swimming, fishing, boating, aquatic biota, wildlife and habitat, and aesthetics, numerical or narrative criteria to protect the designated uses including flow, and policies for flow, anti-degradation, and basin planning, among others. Vermont's water quality monitoring program emphasizes biomonitoring (an ambient monitoring program started in 1982) and also measures physical and chemical aspects of water bodies.

Class A waters - *Escherichia coli* are not to exceed a geometric mean based on at least 3 samples obtained over a 30 day period of 18 organisms/100 ml, no single sample above 33 organisms/100 ml. None attributable to the discharge of wastes.

Class B waters - *E. coli* are not to exceed 77 organisms/ 100ml. Vermont's water quality standards also include criteria for turbidity, dissolved oxygen and temperature based on whether the waters are designated for cold or warmwater fish habitat, and for aquatic biota, wildlife and aquatic habitat. Standards for phosphorus exist for the Lake Champlain basin, but not for the Connecticut River watershed. Nitrate standards exist for all waters, based on flow.

Vermont's Water Resources Board will eventually designate all Class B waters as either Water Management Type 1, 2, or 3, in order to more explicitly recognize their attainable uses and the existing level of water quality protection. Until waters are designated as a specific type, the criteria based on such designations do not apply. Vermont's Water Management Typing process has been before the Water Resources Panel for a long time and at this writing has not been resolved.

will take place. For many of the Headwaters tributaries, it will be the first such studies ever undertaken. www.vtwaterquality.org/planning.htm.

New Hampshire TMDL list: While there were no Headwaters streams or ponds listed in 2004, by 2008 much research had been done, and there are a number of water bodies that do not meet state water quality standards in the area. Much of the region suffers from low pH, partly because of the chemistry of the rocks and thin soils underlying much of the higher ground in the region and partly because of the effects of acid rain. Sources of other contamination are unknown.

EPA has approved a TMDL for addressing low pH in PIttsburg's Round Pond. Wrights Pond, also in Pittsburg, has naturally occurring low pH that has mobilized aluminum from the soil into the water of the pond.

New Hampshire considers that the following ponds, rivers and streams currently do not meet state standards:

Town	Impaired Waters *(source: 2008 NH 303(d) List of Impaired Surface Waters) - http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm*
Pittsburg	• Connecticut River behind Moose Falls Dam- low dissolved oxygen threatens aquatic life • 16.18 miles of the Connecticut River - low pH • Back Lake - cyanobacteria • 10 miles of Hall Stream- do not meet standards for E. coli and have elevated lead levels. (NOTE: Hall Stream also drains parts of East Hereford, Quebec)
Clarksville	• 4.17 miles of the Connecticut River have elevated lead and low pH
Stewartstown	• 6.61 miles of Bishop Brook are contaminated with E. coli from an unknown source. • 2.06 miles of the Connecticut River are contaminated with E. coli and have low pH
Columbia	• Connecticut River is contaminated with E. coli and has low pH • 9.57 miles of Simms Stream are contaminated with E. coli
Stratford	• Connecticut River is contaminated with E. coli and has low pH
Northumberland	• 3.7 miles of the Connecticut River has E. coli • 9.3 miles of the Connecticut River has high aluminum and low pH • Upper Ammonoosuc Rivers have low pH.

4. Water Quality Monitoring Activities

There is currently no regular, on-going water quality monitoring program on the Connecticut River or its tributaries in the Headwaters region. Although the Clean Water Act requires the states to report water quality conditions and problems to EPA every two years, surface waters are not sampled on a regular basis to see whether they meet water quality standards. New Hampshire currently monitors water quality only for dissolved oxygen, nitrates, and a limited number of other parameters, which do not include many pollutants which could come from industrial sources.

New Hampshire DES occasionally monitors the health of aquatic life in the Headwaters region, since it started a biomonitoring program that began sampling in 1997. The kinds and variety of aquatic life surviving in a stream give a good picture of the quality of the water and sediments in which they live. Vermont has used a similar approach for many years. DES visits wadeable streams to collect fish and macro invertebrates ("bugs") as well as basic physical and chemical water quality data and assess habitat. In the Headwaters region, 20 biomonitoring stations have been set up on the uppermost Connecticut River and its New Hampshire tributaries.

Both states now welcome the help of citizen volunteers in gathering data about their local waters, although there are presently no volunteer monitors in the Headwaters region. In 1998, NH DES started the New Hampshire Volunteer River Assessment Program (VRAP), providing training, water quality monitoring equipment, and technical support. VRAP supports over a dozen volunteer groups throughout the state who conduct water quality monitoring. VRAP data are available at http://des.nh.gov/organization/divisions/water/wmb/vrap/index.htm. Vermont also supports volunteer water quality monitoring.

5. Water Quality in the Connecticut River Today

In preparation for the update of this plan and at the request of CRJC, NH DES assisted by the EPA assessed the entire river mainstem in New Hampshire in 2004[1], Appendix D) The study looked at bacteria, to see if the water is safe for swimming, boating, and fishing, and also measured fish habitat quality by looking at dissolved oxygen, pH, specific conductance, and temperature. Samples were taken at:

- Fourth CT Lake
- Downstream of Fourth CT Lake
- Third CT Lake & boat ramp
- Downstream of Third CT Lake
- Upper Moose Falls Pond
- Route 3 Bridge, Pittsburg
- Second CT Lake & boat ramp
- Magalloway Road Bridge
- First CT Lake & boat ramp
- Carr Ridge Road Bridge
- Lake Francis State Park boat ramp
- Lake Francis
- Route 145 Bridge
- Mountain Valley Road, Pittsburg
- Route 3 Bridge, Pittsburg/Clarksville
- Bridge Street Bridge, Stewartstown
- Canaan Dam RR Bridge
- Main Street Bridge, W. Stewartstown
- Bridge Street Bridge, Colebrook
- Columbia Covered Bridge
- ½ mi. above Route 105 Bridge
- Route 105 Bridge, N. Stratford
- Stratford-Maidstone Bridge
- Guildhall Bridge, Northumberland

Bacteria - Bacteria can reach rivers through poorly working septic systems and through runoff, such as drainage from a pasture. Wetlands and other slow-moving waters that host moose and other wildlife can send bacteria-laden water into streams during heavy rains. Heavy rains following manure application on agricultural fields may wash bacteria into waterways, as may cows themselves if they have access to the river. Stormwater may be carrying pet waste into the river from village areas.

"We want to thank the groups from up north for sending us clean water."

Wantastiquet Subcommittee Chair, Hinsdale

Bacteria results indicate a need for further study. In the single 2004 season when a complete water quality monitoring effort took place, bacteria were found in amounts that violated New Hampshire water quality standards, although very limited sampling at a few stations in 2005 did not find bacteria above state standards. The 2004 results for bacteria are disturbing, given the popularity of these wild and rural northern waters for swimming, canoeing, and kayaking. Most water samples in the Pittsburg section of the river showed it safe for swimming, although a few samples had bacteria levels higher than state standards. Given that these samples came from areas that

1. *2004 Connecticut River Water Quality Assessment, Preliminary Assessment Status*. N.H. Department of Environmental Services.

drained wetlands with little or no human development, it is possible that much of the bacteria are related to wildlife and not to farming or other human activities. However, high bacteria counts appeared from Bishop Brook in Stewartstown all the way down to the Guildhall/ Northumberland bridge, a distance of 50 miles that includes the designated natural segment of the river. While results from the two years are different, it is clear that bacteria can be a problem at times.

A major improvement in septic waste treatment in the village of Stratford Hollow has recently eliminated septic discharges to Bog Brook, a tributary of the Connecticut River. While a number of systems in the Hollow were not upgraded, they pose little pollution threat. Only one discharges greywater near the brook.

Colebrook now has the capability to test *E. coli* specifically, and can be of use for volunteer river monitors. The current system, which requires that samples be driven to the Concord or Plymouth lab within six hours of collection, makes sampling and processing difficult so far from the lab, when there is a local plant able and willing to handle the work.

pH (acidity) - The 2004 study found mixed pH results, reflecting the strongly varied geology of the region and the possible influence of acid precipitation and agricultural use of lime. Some local landowners have recorded soil pH levels that have dropped significantly over the last five years.

Low pH affects the river in most of the Headwaters region, except between Indian Stream and Bishop Brook, and from the Canaan Dam impoundment to Cone Brook. For about half of the Connecticut Lakes region, more sampling needs to be done before final conclusions can be drawn. Soils in this region are naturally acidic, and also receive acid rain and snow carried on the wind from industrial areas of the Midwest and southern Canada. When weather comes predominantly from the southwest, precipitation tends to be much more acidic than when it comes from the less industrialized areas northwest of the Headwaters region. It would be useful to measure the acidity of rain and snow falling in the area.

Above the North Stratford Bridge, the study found unusually high pH levels, which may be related to drainage from Simms Stream just upstream, from limestone-influenced Lime Pond in Columbia. Applying agricultural lime on a windy day could also have an effect, as could drainage from a local farm field that is fertilized with sewage sludge after it has been stabilized with lime. The permit for use of this sludge does not permit spreading closer than 100 feet from the river in New Hampshire, although it is permitted up to 50 feet from the river in Vermont.

Water temperature - The 2004 study found that water temperatures were acceptable. However, Headwaters Subcommittee members have occasionally found high water temperatures during the summer, due partly to lack of shade where riverside trees have been removed, low flows, or water releases from Murphy Dam when water had been held under the sun for some time.

One report of 82 degree temperatures in the early 1990s was associated with a fish kill in North Stratford. Later, the N.H. Fish and Game Department worked with the U.S. Geological Survey to install a water temperature sensor at the North Stratford gage, providing essential real-time information for fisheries managers. The sensor was discontinued in the summer of 2006, but reinstalled by the N.H. Dam Bureau that fall.

Dissolved oxygen - The 2004 study found that oxygen levels in the water were within acceptable limits, which is predictable due to the river's lively flow through the region.

Turbidity and sedimentation - The 2004 study did not look at turbidity; however, turbidity and sedimentation are a serious water quality problem in the Connecticut River in the Headwaters region. More care is required to minimize sediment migrating into the river and its tributaries from land development. Turbidity should be included in the list of monitoring tests.

Recommendations for Water Quality Monitoring

- NH's VRAP program should arrange with local wastewater plants to process bacteria samples to encourage local volunteer water quality monitoring, and change its rules to allow reimbursement of local plants for this service.

- DES should make water quality monitoring data easily accessible to the public, including to those who do not use computers.

- NH's VRAP program should sponsor a regular water quality monitoring program to enable local citizen monitoring efforts that provides training and equipment and includes monitoring of bacteria, pH, and turbidity. Monitoring should also include measurement of the acidity of rain storms.

- NH DES should identify sources of contamination for waters listed on the Section 303(d) list as needing a TMDL and look at the area's geology to learn more about pH.

- NH DES should focus monitoring on Bog Brook to confirm that Stratford Hollow septic problems have been addressed.

C. Connecticut River Sediment Quality

Several studies of river sediments in recent years help paint a picture of what is in the silts and sands of the river bottom, and what might be making its way into the river's fish and other aquatic life. In response to the 1997 *Connecticut River Corridor Management Plan,* EPA conducted two studies of sediments that included the Headwaters region. Results are summarized in Appendix E.

In 1998, EPA studied 10 sites on the New Hampshire/Vermont portion of the river.[1] Three were located in the Headwaters region: downstream from Lake Francis, downstream from the Nulhegan River, and above the breached Wyoming Dam. In 2000, EPA returned for a more detailed study, and took 100 samples of sediment at 93 sites on 200 miles of the river.[2] In the Headwaters, the study looked at 21 sites on the mainstem, two at Halls Stream, and one each inside the mouths of the Mohawk, Nulhegan, Paul Stream, Potter Brook, and the Upper Ammonoosuc. They analyzed samples for 244 different kinds of volatile organic compounds, pesticides, PCBs, metals, and other pollutants.

screening level = threshold for effects on aquatic life

While residents and visitors to the Headwaters region tend to think of the area as relatively pristine, sediments in the river show the marks of man-made contaminants even here. In most cases, contaminant concentrations are not high enough to be a risk to aquatic life, although pesticides, pollutants associated with engines, and heavy metals can be found in the sediments in a number of places.

None of these contaminants was purposefully put into the river, but instead reached the water and sank into its sediments after being washed off the land, drifting through the air, or leaking from a container. The findings for Fourth Connecticut Lake and the Connecticut River just below Pittsburg Village and Halls Stream are especially surprising.

Fourth Lake - Tiny Fourth Lake, the river's isolated source, is a long distance from any road or human development, and sits within a few hundred yards of the highest point in the 11,000 square mile watershed. Yet sediment studies indicate that it has not escaped the cloud of human activity.

Found in this pond in very low concentrations, but the highest found in the 2000 study, were acetone, butenone, the pesticides 4,4'DDD, alpha-BHC, and methoxychlor, one PCB congener, and five kinds of dioxins. Many of these chemicals have been banned for a number of years, but they still linger in the sediments. Fourth Lake also showed the highest levels of calcium, selenium, and silver found anywhere in the study, and enough arsenic, cadmium, lead, and mercury to have an effect upon aquatic life.

While the source of these sediment pollutants is unknown, they may have drifted in to the region, carried by winds from the industrial agricultural areas of the Midwest or Canada, or may be a sign of nearby pesticide applications in the past. Some of these contaminants can build up in the bodies of plants and animals, and the effects may not appear for many years.

Pittsburg Village - More pollutants exceeded the screening level here than anywhere else on the 200 miles of river studied in 2000, except for a flooded industrial site in Wilder, Vt. Just below Pittsburg village, the river's sediments contain napthalene, fluorene, phenanthrene,

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1. *Upper Connecticut River Sediment/Water Quality Analysis*. U.S. Environmental Protection Agency, Region 1, October 1999.
2. *Upper Connecticut River Valley Project, New Hampshire and Vermont*. U.S. Environmental Protection Agency, Region 1, by Roy F. Weston, Inc., 2001.

anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, indeno (1,2,3-cd)pyrene, arsenic, nickel at concentrations that can be expected to affect aquatic life. Also found here in very low concentrations, but the highest found in the study, were acetophenone and acenaphthylene.

Storm drains may be a source of the petroleum-based contaminants found in the river sediments. There were several old service stations below the Route 145 bridge which once had leaky storage tanks that have since been replaced. Turbines in the old Baldwin Mill could also have been a source of some petroleum byproducts.

Beecher Falls and Halls Stream - Sediments in the Connecticut River just below the mouth of this tributary, which drains the only Canadian part of the watershed and enters the river near a furniture manufacturing complex, contained a significant number of petroleum hydrocarbons, pesticides, and arsenic. Found in Halls Stream in very low concentrations, but in the highest levels found anywhere in the 200-mile study, were the pesticides aldrin, endosulfan, mirex, and t-Permithren. Sediments here also had the highest arsenic level found anywhere in the study. While no other pollutants were found in the tributary above screening levels, those just downstream in the Connecticut River at Beecher Falls include naphthalene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a) pyrene, and indeno (1,2,3-cd)pyrene, below screening levels.

Automotive and heating oils - Petroleum hydrocarbons showed up in stream sediments in a number of places. These chemicals can get into streams when roads or motor vehicle trails closely follow waterways, from leaks and drips from automobiles, snowmobiles, boat engines, or other vehicles. They can also enter groundwater and nearby surface water from leaking underground storage tanks, or from an accidental spill. Pyrene, for example, was found at levels that could affect aquatic life at nearly half of the sites sampled.

Heavy metals and arsenic - Several elements found in nature appeared in notable concentrations in the Headwaters region, including arsenic and nickel. Nickel exceeded screening levels at 15 sites, arsenic at nine sites, cadmium at two sites, and lead at one site. The highest nickel levels found anywhere on the 200-mile study were found at Lake Francis. “Paris Green,” an arsenic compound, was once used on potato bugs on the farms which were later inundated by Lake Francis. The highest concentration of manganese was found in the Mohawk River near Nash Equipment.

Pesticides - Pesticides showed up more often in Headwaters sediments than in any other part of the Connecticut River examined in the 200-mile study area, although in low concentrations that do not present much risk to aquatic life. In addition to pesticides found below Hall Stream, the highest concentration of beta-BHC appeared below the mouth of the Nulhegan River. The highest concentration of heptachlor was found below Paul Stream, and of endrin a half mile below the breached Wyoming Dam. In 1998, EPA found low concentrations of the breakdown products of DDT at the Wyoming Dam as well.

D. Connecticut River Fish Tissue

In 2000, the U.S. Environmental Protection Agency worked with the four Connecticut River states to conduct a comprehensive fish tissue toxin study[1]. This landmark study, which may be the first river-wide study of fish tissue in the nation, represents significant cooperation among the four states, with each contributing substantial funding and staff. The concept for the study comes directly from the public, raised in the 1997 *Connecticut River Corridor Management Plan*.

Fish Consumption guidelines *(do not apply to stocked fish)*: Pregnant and nursing women, and women who may get pregnant can safely eat one 8-ounce meal per month of freshwater fish. Children under age 7 can safely eat one 4-ounce meal per month of freshwater fish. All other adults and children age 7 and older can safely eat four 8- ounce meals per month of freshwater fish. When eating bass, pickerel, white perch or yellow perch, limit consumption to fish 12 inches or less in length while following the above guidelines. Stocked trout contains relatively low levels of mercury. For rainbow and brown trout, women of childbearing age and children can safely eat one meal per week, others can eat 6 meals per week. Brook trout could be either stocked or from a reproducing population, therefore they should be consumed at the rate of the general statewide advisory.

Biologists sampled white sucker, yellow perch, and smallmouth bass from eight sections of the Connecticut River, choosing fish species that represent different levels of the food chain and are widely found in the 410-mile long river, although all are not common in the Headwaters Region. Smallmouth bass, yellow perch and white suckers were collected during 2000 from the mainstem of the Connecticut River and composite samples were analyzed for total mercury, coplanar (dioxin-like) PCBs and organochlorine pesticides, including DDT and its breakdown products.

In Reach 7 (Moore Reservoir to Canaan Dam), the study looked at white suckers, yellow perch, and smallmouth bass. In Reach 8 (above Canaan Dam), the study looked at only two specimens of white suckers, since perch and bass were absent in this coldwater fishery, allowing a very poor characterization of this more pristine stretch of the Connecticut River.

The study found that total mercury concentrations in all three species of fish were significantly higher upstream than downstream. Mercury poses a risk to recreational and subsistence fishers and to fish-eating wildlife. Risk from PCBs was generally lower in upstream areas than in downstream areas, although this varied by fish species and was different for the humans, mammals, birds or fish that eat them. Dioxin-like PCBs pose a risk to recreational and subsistence fishers and to fish-eating mammals and fish-eating birds. DDT and related breakdown products pose a risk to human subsistence fishers and to fish-eating birds, but not

1. Connecticut River Fish Tissue Contaminant Study: Ecological and Human Health Screening (2000). Prepared for the Connecticut River Fish Tissue Working Group by Greg Hellyer, Ecosystem Assessment Unity, USEPA - New England Regional Laboratory, N. Chelmsford, MA, May 2006.

to recreational fishers or fish-eating mammals.
Much of the mercury appearing in Connecticut River fish is believed to come from Midwest power plants and urbanized eastern seaboard emissions. Once in the river, mercury bio-accumulates to high levels in the food chain. EPA banned the use and manufacture of PCBs in the U.S. in 1977. DDT use was severely restricted by EPA in 1972, but over 1.3 billion pounds were applied during the previous 30 years. Dioxins and PCBs break down very slowly in the environment and bio-accumulate in food chains. There are no known current sources of PCBs or DDT to the Connecticut River, so contaminants found in the fish result from past contamination in the watershed. However, dioxins are produced in nature and also inadvertently by humans, often through combustion processes such as at waste incinerators or through burning trash in backyard barrels.

Recommendations for Fish Tissue

- EPA and the state fisheries agencies of New Hampshire and Vermont should revisit the fish tissue toxin study in the Headwaters region, and sample coldwater species.

E. Invasive Aquatic Species

The Headwaters Region has, until relatively recently, escaped the exotic aquatic plants and animals that have been a problem further south in New Hampshire and Vermont since the mid-1960s. However, the discovery of the invasive alga Didymo at Bloomfield in 2007 abruptly changed the picture.

Native plants have evolved together over thousands of years with animals such as beetles and other insects that have become specialized to feed on them. Exotic species, growing without such natural controls, can crowd out natives, disrupting the food chain and stunting fish growth. Exotic aquatic plants can interfere with boating and swimming and reduce the value of waterfront property. The zebra mussel could harm boating, swimming, fisheries, and even industry.

Didymo colonies can look like clumps of wet wool or like strands of wet toilet paper.

Once an invasive plant or animal is established in a water body, continuous management is the only way to control it. Therefore, it is important to prevent infestations in the first place and identify new ones early. State biologists conduct field searches each summer, but volunteer help is critical. Both states offer grants to local lake associations and towns for control and treatment of exotic aquatic weeds, and have programs and training for volunteer "weed watchers." A list of invasive aquatic species, including those present in the Headwaters region, appears in Appendix F.

Sources of invasive aquatics - Invasive plants and animals could reach the Headwaters Region in many ways. Plants such as milfoil can come in on the propellers and trailers of boats that have been in infested waters. Zebra mussel larvae can lurk in bait buckets, live wells, or engine cooling systems. Aquatic invasives could come from aquariums dumped into surface waters or from flooding of landscaped "water gardens" planted with exotic plants. Road crews can spread soil and fill contaminated with the seeds or root fragments of plants such as Japanese knotweed. Didymo apparently arrived in the Connecticut River on the soles of fishing waders belonging to a fisherman who had recently traveled to New Zealand.

Lake Francis and the First, Second, and Third Connecticut Lakes are perhaps the most vulnerable water bodies in the Headwaters Region for invasive aquatic species, since they receive many boaters visiting from infested water bodies. However, until 2007, there was no boat/trailer check program in place at the Lakes to ensure that these boats are not delivering hitch-hiking weeds from other lakes.

Didymo - *Didymosphenia geminata* ("rock snot") is an invasive freshwater diatom (microscopic algae). It was discovered by a fishing guide on the Connecticut River in the designated natural segment at Bloomfield in June, 2007. Biologists later confirmed finding Didymo from the confluence of Perry Stream in Pittsburg to Guildhall. This is the first known occurrence of this diatom in the entire eastern U.S. Biologists believe that Didymo can be spread by recreational equipment such as felt-soled waders, bait buckets, neoprene diving gear, water shoes, canoes, kayaks, and life jackets. Within days of learning of the infestation, local fishing lodges responded by creating wash stations for their guests and educating fishermen.

Didymo is generally a species of northern river systems with cobble or rocky bottoms. It can form extensive colonies smothering life such as aquatic insects that are a food source for other wildlife. Didymo's stalks attach to rocks and river vegetation, and it can form masses 10-12 inches thick on the river bottom, trailing for lengths of 2-3 feet in the current. Its appearance is very unattractive, making the water less appealing for recreation. Water is usually clear and cool (about 60 degrees F), with relatively low nutrient concentrations and generally moderate to moderately fast current. However, biologists are noticing a shift in the habitats where Didymo can survive to include streams in warmer climates, with more nutrients, and even some tannic (tea colored) waters.

There is currently no way to control or eliminate Didymo. The alga can remain viable for several weeks if kept moist. State agencies have concluded that closing the river is not practical, and that the best approach is to attempt to prevent further spread by humans, especially to tributaries.

Other Invasive Aquatic Plants - The 2006 Connecticut River Aquatic Invasive Plants Outreach & Survey Project, funded by CRJC's Partnership Program, surveyed for invasive plants at 21 mainstem sites in New Hampshire and Vermont from Hinsdale to Pittsburg. In 2006, no invasive plants were found in the three areas surveyed in the Headwaters portion of the Connecticut River:

- Back Lake at Bacon boat launch, Pittsburg
- Second Connecticut Lake at TransCanada boat launch
- Third Connecticut Lake, Route 3 boat launch.

A subsequent study in 2007 found purple loosestrife and true forget-me-not at an unofficial boat launch near the Groveton Speedway in Northumberland. Among invasive wetland plants, purple loosestrife is as yet uncommon in the Headwaters region, but is increasing, and appears in roadside ditches near First Lake.

Japanese knotweed is increasing very rapidly, and in the last five years has become a prominent plant in riparian areas south of the Headwaters region. There is a large infestation near the Bishop Brook bridge in Clarksville, and another on the riverbank in Maidstone. Yellow flag iris and common reed are seen occasionally in the region.

Invasive aquatic animals - The zebra mussel is fast becoming a scourge in Lake Champlain, but has not yet invaded the Connecticut River. Nonetheless, the river is considered one of the few New Hampshire water bodies susceptible to this invader because its comparatively less acidic waters are suitable for the mussel. Elsewhere in the watershed, exotic animals such as rusty crayfish are increasing after fishermen using them as bait may have released them into the water.

Recommendations for Invasive Aquatic Species

- State environmental and fisheries agencies should continue to cooperate to better understand and address the Didymo infestation.

- Fishermen and other recreational users must carefully clean their gear after visiting the Connecticut River and report sightings of invasive aquatic species to state agencies. Do not release unused bait into the water.

- The New Hampshire Lakes Association should set up a Lake Host program, with the help of TransCanada and NH DES, to check for invasive species at Connecticut Lakes boat launches on holiday weekends.

- Local outfitters, lodge owners, and guides should educate their customers about Didymo and other invasives, and encourage them to clean their gear.

- Boaters or divers traveling from waters infested with zebra mussel must wash and dry all equipment before reuse, hose off the boat, diving gear or trailer, and drain and flush the engine cooling system and live wells of the boat, bait buckets and the buoyancy control device from diving equipment.

- Aquarium owners should not dump aquarium plants or animals into any water body, but dispose of them by freezing or drying before putting them in the trash.

- Towns that do not have conservation commissions should establish them, and encourage them to become informed about invasive species.

IV. River Flow

A river is much more than just the runoff of rainfall. Rivers also draw their waters from underground springs of groundwater, slow seepage from wetlands, melting snow, and tributaries large and small. The amount of water in a river changes naturally during the year as the ground freezes and thaws, as trees leaf out and draw moisture from the soil, and as warm winds evaporate surface water.

The Connecticut River rushes down from its headwaters in the Connecticut Lakes.

Humans can affect the amount of water in a river by withdrawing water for irrigation or industrial use, or by building dams, clearing forests, filling wetlands, covering soil with hard surfaces like pavement and roofs, and by drilling wells to pump out groundwater that otherwise might reach the stream. Some of these actions, like withdrawals, simply reduce the amount of water flowing in the river. Others, such as clearing and development, send runoff to the river more quickly and erosively, rather than slowly and steadily. Dams can influence river flow by holding back water and allowing only a portion to flow, and by creating an impoundment where water can evaporate before it has a chance to flow downstream. Deregulation of public utilities has led to water level fluctuations that have effects on the river ecosystem that must be watched carefully to gage their long term impacts.

All rivers rise and fall through the year, and respond to changes in weather and watershed. A healthy river has enough water flow to keep fish and aquatic life alive year-round. Humans are also relieved when the river carries enough water to dilute and flush pollutants. While a healthy river may flood naturally, humans may affect the severity of floods with their choices of where to build and how they alter water's natural path to the river. Local regulations regarding protection of wetlands and shorelands are summarized in Appendix G.

A. Streamflow Gaging Stations

Gaging stations measure water level and flow rates, and are useful in helping to forecast flooding, set floodplain levels and regulations, and look at historical flooding trends in river systems. Gages tell river managers, state and local officials, and landowners about flow conditions on the river and its tributaries, essential during times of low and high water. Gages are also cited in water use permits and help define operations of hydro generating plants that affect flow. Good river management requires good knowledge of current river conditions, now possible due to satellite communication technology. Gage data are available at www.crjc.org/riverflow.htm.

Both the gages at Indian Stream and North Stratford now provide real-time data for flow, precipitation, and air temperature, allowing anyone with Internet access to check these conditions as they happen. For several years, the gage at North Stratford provided real-time data that allow fisheries managers to find out instantly the temperature of the water for cold-water fish species such as brook trout. These managers could request a release of cold water from Murphy Dam at Lake Francis should summer water temperatures rise into a dangerous range. However, the sensor was turned off in 2006, due to funding shortages at NH Fish and Game Department, eliminating a critical tool for managing fisheries in the 40 miles of river designated as eastern brook trout waters. Water temperature typically increases between Indian Stream and North Stratford. Fortunately, the N.H. Dam Bureau stepped in and installed a water temperature sensor at Murphy Dam.

The North Stratford gage is critical for management of the hydro dams downstream at Fifteen Mile Falls, because it provides advance notice of what to expect. Dam managers can check the flow at North Stratford and know how much water will arrive at Moore Dam 24 hours later. This information is used daily and downloaded into the dam's information systems. Because of the location of the North Stratford gage directly opposite the mouth of the Nulhegan River and behind a gravel bar, it is likely that the flow from the Nulhegan River is not measured by this gage except at high flow.

Table 1a. Active Gages in the Headwaters Region

Location	River	Gage number	Drainage area	Measurements available	Years of record	Funding source
Below Indian Stream	CT River	1129200	254 sq. mi.	discharge, gage height, air temperature, precipitation (real time) water temperature posted daily	since 1957	USGS & Public Service Company of New Hampshire. TransCanada personnel maintain and equip the weather station at the gage.
N. Stratford	CT River	1129500	799 sq. mi.	discharge, gage height, air temperature, precipitation (real time) water temperature posted daily	since 1930	USGS & NH DES
Groveton	Upper Ammonoosuc River	1130000	232	Real time gage height and air temperature	1940-2004 and since 2008	USGS & NH DES

There is no gage at Hall Stream, a major undammed tributary; in the recent past there have been heavy storms in this watershed and others nearby (Leach and Bolter Creeks in Vermont, Lyman Brook and Simms Stream in New Hampshire) that have had a significant effect downstream. There is a lot of low-lying land in this area that, while sparsely developed, is heavily used for farming and becomes polluted with eroded soil, manure, and sometimes automotive fluids when the river rises unexpectedly and farmers cannot move their animals or farming equipment in time. This area is also used for river recreation.

Table 1b. Discontinued Gages in the Headwaters Region				
Location	**River**	**Gage number**	**Drainage area (sq.mi.)**	**Years of Record**
First CT Lake	Connecticut River	1128500	83	1917- 1990
Colebrook	Mohawk River	1129440	37	1986-2004

A gage inside the mouth of Indian Stream would provide information about the flow not only of that major watershed, but also for Cedar Stream, whose flow presently cannot be separated from that of the mainstem when read at the gage located below Indian Stream. Cedar Stream's watershed is currently undergoing development that will result in runoff changes.

Funding for gage upkeep is shared by U.S. Geological Survey (USGS) with other agencies, and averages $12,500/year/gage for all costs associated with each gage. There have been threats to this funding in recent years, primarily as a result of efforts to cut state budgets. There were formerly five gaging stations in the Headwaters region. Three were abandoned due to budget cuts by New Hampshire. Although historic data will remain accessible, no new data will be collected unless new funding partners are found. Since the Mohawk River gage was discontinued in 2004, there have been at least three major flood events on this tributary. Information from the gage would have been useful to the town of Colebrook and to river managers.

"It is a great river and has big problems when it has them."

Vermont stream scientist

New Hampshire's Rivers Management Advisory Committee has recommended restoration of some gages, particularly in the watersheds of designated rivers such as the Connecticut. Since more extreme weather patterns seem to be emerging, and water is an increasingly valued commodity, it is important to be sure gages remain funded so that the data will continue to be available. Fortunately, the New Hampshire Legislature approved new funding for gages in 2007. The Upper Ammonoosuc River gage at Groveton was reinstated as part of this effort.

Recommendations for Gages

- USGS and DES should install a gage at Hall Stream, and reinstate the gage on the Mohawk River that was discontinued in 2004.

B. Flow & Flooding

1. Instream Flow

Instream flow refers to how much water is flowing in a river or stream, and incorporates how often, how long, when, and how fast it changes. Instream flow is affected by rainfall, snowmelt, and drought, and also by damming, diversion, withdrawals, and development. This can in turn affect water quality, erosion, temperature, recreation, nearby water supplies, and habitat.

As a river designated into New Hampshire's Rivers Management and Protection Program, the Connecticut River is to be governed by instream flow rules to ensure that there is adequate flow for "public uses including but not limited to navigation, recreation, fishing, storage, conservation, maintenance and enhancement of aquatic and fish life, fish and wildlife habitat, wildlife, the protection of water quality and public health, pollution abatement, aesthetic beauty, and hydroelectric energy production."

Instream flow rules for two New Hampshire rivers, the Souhegan and the Lamprey, have been drafted through a pilot process that will eventually be used on other rivers. At this time, there are no plans to attempt to create flow rules for the Connecticut River.

Vermont considers instream flow when issuing dam permits and water quality certificates, snow-making withdrawals, stream alteration permits, and Act 250 projects. The purpose is to "assure the passage of adequate water to maintain fisheries interests, aesthetic qualities, recreational and potable water supply uses appropriate to the water body in question." The state focuses on minimum flows adequate for fisheries-related interests, and uses the "7Q10" level, which means a drought flow equal to the lowest mean flow for seven consecutive days, adjusted to nullify any effects of artificial flow regulation, that has a 10% chance of occurring in any given year.

2. Connecticut Lakes

When there is a drought, levels in the four Connecticut Lakes retreat naturally, since they are located at the head of the watershed. Water level in the lakes depend upon local rainfall, the ability of surrounding wetlands to absorb and release it gradually to the lakes, and the amount of impervious surface in the lakes' watersheds, which at the present time is still low, but growing as homes and roads are built. The lakes are also home to long-time recreation and lodge businesses.

The levels at First and Second Lakes are controlled also by releases from their dams, which are managed by TransCanada. There are required minimum summer flows of 22.5 cubic feet per second (cfs) from Second Lake, 45 cfs from First Lake, and 85 cfs from Lake Francis. Winter minimum flows (November through May) are somewhat higher. (see Table 2A)

Second Connecticut Lake

The lakes are sometimes affected by operations at the three dams of the Fifteen Mile Falls Hydro project 75 miles downstream. The 2002 federal license for these dams relies on the Connecticut Lakes to store water to keep the hydro power dams, and the Connecticut River itself, running during summer months to sustain fish and aquatic life.

The license for Fifteen Mile Falls requires a minimum river flow from Comerford Dam. If there is not enough natural flow in the river to meet this, water is taken from Comerford and Moore reservoirs, Lake Francis, and up the chain to Second Lake. While the required minimum flow is lower (818 cfs) from June through September than for the rest of the year (1,145 cfs for October - March, and 1,635 cfs for April - May), the lakes may be lowered to provide water for the rest of the river in times when there is little or no summer rain.

However, the company is able to respond to extreme weather conditions, such as during the drought of 2002. With the approval of state and federal agencies, the company reduced the minimum flow from Comerford Dam to the level set by the previous license in order to avoid drawing too heavily from the Connecticut Lakes, although lake levels still retreated far beyond docks and other water-dependent structures.

3. River Flow South of the Connecticut Lakes

Connecticut River - Flow in the river below the lakes is strongly influenced by rain storms in the 170 square miles of high country around the lakes, and also by releases from Murphy Dam at Lake Francis. Below Lake Francis, and throughout the rest of the Headwaters segment, the river valley is composed of a large floodplain of varying width, bounded by steep sides. Heavy rain creates flooding here on a regular basis, especially when enough rain is received in the Lakes to force gates to open at Murphy Dam.

Tributaries - Tributaries also have a very strong influence on the mainstem in this uppermost part of its watershed. Weather patterns can be uneven, with isolated storms restricted to a single tributary watershed, resulting in uneven runoff. For example, a strong storm in 2006 dropped heavy rain in the Hall Stream watershed but had little effect in the Indian Stream watershed just over the ridge.

Flow from Murphy Dam - Rules for management of Lake Francis and Murphy Dam were created in the 1940s, at a time when clear-cuts in the surrounding industrial forest were larger and more common than they are today, and contributed to greater runoff into the river system. These rules call for shutting gates in times of high water. However, the rules do not distinguish between an isolated rainstorm and a general one, and in some circumstances may not be wise river management. The NH Dam Bureau, which oversees Murphy Dam, and the dam managers of TransCanada, which holds a water management agreement with the state at Murphy, are currently revising the rules for water management at this dam. The Dam Bureau recently began using a stepped release procedure at Murphy Dam so that flow increases and decreases gradually, reducing the disturbance of sudden changes to fish and to riverbanks.

At Second Connecticut Lake, TransCanada managers may need to pull the boards to protect the dam, releasing water that will flow to First Lake and then end up in Lake Francis. If there is room, the company will store water from a storm.

4. Flooding and Flood Control

The Headwaters region of the Connecticut River, occupying the steepest and highest part of the watershed, has more experience with flooding than any other region. The river uses its floodplains early and often in the spring, and at other times as the river carries runoff from heavy summer and fall storms.

Natural flood control - The river floodplains and wetlands, large and small, have long provided natural flood control by providing a place to store water and by absorbing it quickly and releasing it slowly. Wetlands also capture sediment and purify runoff. There is concern that small wetlands in the area are being damaged or lost to road construction and development, decreasing the sponge-like water storage capacity of these places and increasing the risk of flooding.

In 1994, the U.S. Army Corps of Engineers identified the river valley from West Stewartstown south into Lancaster and Lunenburg as one of the four most important natural valley flood control areas on the entire 410-mile long river.[1] Here, the river can spread out on 12,000 acres of floodplain and reduce its energy. Development of this "green infrastructure" would greatly increase future flood damage downstream.

"Floodplains are called floodplains for a reason. If we keep building in floodplains, we use up the sponge."

Vermont riverfront farmer

Artificial flood control - Lake Francis is the only dam in the Headwaters Region that was built for flood control. While many camps were built around the lake soon afterward, many of them leased from the state of New Hampshire, no construction is permitted on land where the state owns flowage rights. The state's flowage rights cover the area between 1,395 feet to 1,400 feet (the elevation of the top of Murphy Dam) surrounding the entire lake.

The dams at First and Second Connecticut Lakes today provide water for downstream hydro power, but were originally intended to manage and even create flooding, built by timberland owners who wanted water for log drives. Today, managers of the Connecticut Lakes dams allow enough water storage for a one-inch rainfall in each lake's basin, and hold water when possible to reduce spring flooding downstream.

Role of ice in flooding - Ice has a powerful role in flow and flooding on the uppermost Connecticut River. Ice jams can block the water's flow, sending it in a new path or causing sudden release and flooding as the jam breaks. Violent ice-out conditions on the Mohawk River, with water higher than the bridges, prompted the US Army Corps of Engineers to straighten its lower section. This has led to changes in sediment transport that have caused new erosion on the mainstem at the Colebrook Business Park.

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1. *Reconnaissance Study, Connecticut River Basin Natural Valley Storage, Connecticut, Massachusetts, New Hampshire and Vermont*. U.S. Army Corps of Engineers, 1994.

TransCanada manages water levels on First Lake and Lake Francis with an eye to preventing ice jams. During the winter, discharges are slowly reduced to prevent ice breakups later on which could cause ice jams on the river below.

Releases from Murphy Dam - Many local people believe that because camp owners around Lake Francis want the lake level held high, there are times when there is not enough storage room for the water that comes from upstream, forcing releases from Murphy Dam that can then pose potential major problems for landowners far below the dam.

Residents report that unexpected releases from Murphy Dam combined with high water from rain storms higher in the watershed, such as in October, 2005, can catch riverfront farmers unaware, stranding farm equipment and livestock in lower fields as far down river as Guildhall and beyond. Livestock were lost, expensive machinery damaged, the river polluted from fuels and oils, and riverfront structures threatened. An effective and reliable warning system is urgently needed, particularly to allow farmers to move equipment and livestock to higher ground. Farmers should move hay and equipment out of fields subject to such flooding as soon as they are done working, so they will not be caught off guard.

Murphy Dam at Lake Francis, left, and Pittsburgh Village

The downstream effect of a large release at Murphy Dam depends upon water conditions in the river valley. During a major flood, even a release of 3,600 cfs from Murphy would raise river water levels less than one foot at North Stratford, and much less downstream as the river valley widens. If the same flow were to be released during an extremely dry period, the effect would be much more noticeable, increasing water levels up to two feet far downstream at Dalton. The Dam Bureau considers this scenario to be highly unlikely, and the state notifies local authorities before such a release. The Essex and Coös County Conservation Districts are cooperating to arrange an effective notification system for riverfront landowners.

River dredging for flood control - Years ago, some rivers were dredged in the belief that this would create more storage room for flood water. This practice was encouraged by USDA and other natural resource management professionals at a time when sediment transport in streams and other stream mechanics were poorly understood. Contrary to expert advice and public opinion, extensive gravel mining actually worsened bank erosion and flood-related property damage as the streams began to readjust to their natural shape. The states no longer permit gravel dredging in rivers except under very limited circumstances. According to studies by Dr. John Field in the Headwaters region, a better way to prevent flood damage is to restore a stable stream form and protect the stream corridor from incompatible development.[1]

1. Field Geology Services, *Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire,* prepared for the Connecticut River Joint Commissions, October 2004.

5. Extreme Storms

The Headwaters region is experiencing more frequent extreme storms in recent years, creating local flooding and threatening riverbank stability as well as local roads, bridges, and buildings.

In 1995, a severe rainstorm hit Columbia, N.H., causing erosion in Cone and Lyman Brooks. In 2004, a powerful micro burst in Canaan, Vt., resulted in heavy erosion in the Leach Creek and Bolter Brook watersheds. On October 17, 2005, the Indian Stream gage recorded 5,430 cfs, the highest flow at that location since the gage was installed in 1957. In June, 2006, a storm focused on Colebrook and Columbia caused $1.3 million in damage, primarily on the Mohawk River, and was followed shortly after by another heavy storm. A month later, 2-3 inches of rain in several hours in Colebrook caused a beaver dam to wash out near the Diamond Ponds, undermining a road and sending sediment into the Mohawk River that muddied the Connecticut River for miles.

"I didn't put on my snowshoes until Feb. 14 this year."

Ed Mellett, Headwaters Subcommittee chair

Climate Change and water resources - Sudden, severe storms have been described as symptoms of climate change. According to the most recent research, climate change is already underway, and the Northeast can expect higher temperatures and shifting seasons, reduced snow cover, and more extreme weather.[1] These can all affect the flow and quality of rivers and streams. How large these changes will be depends on emissions choices we make now and in the near future, both here in the Headwaters Region, the Northeast, and globally.

By the end of the 21st century, the Headwaters region may be the only part of the Connecticut River Valley that retains snow cover for at least 30 days during the winter.[1] Winter snow accumulation strongly affects river flow. Precipitation that falls in early winter as rain rather than snow can run off frozen ground, rather than staying to melt in the spring. Here in the high country of the Connecticut River's headwaters, reduced snowpack could affect the flow of much if not most of the river.

More precipitation may come in short, intense bursts (more than 2 inches of rain in a day), which could lead to more flooding. More flooding could lead to greater erosion and increases in sediment, fertilizers, and other pollutants in runoff. Culverts and bridges must be sized properly in order to carry the water that might come their way. In other parts of the river valley, regional planning commissions are helping towns with surveys of their bridges and culverts, to identify those that may be too small and could be a public safety hazard in times of high water.

"The nature of storms is changing. That's what's disturbing."

Colebrook selectman

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1. Climate Change in the U.S. Northeast . A report of the Northeast Climate Impacts Assessment, Union of Concerned Scientists, Cambridge, Mass., 2006

The flow of many rivers and streams is typically low during the summer, putting stress on fish and other aquatic creatures. Fall rains usually bring streams back up, and conditions improve. Because evaporation is likely to increase with warmer temperatures, it could result in lower river flow and lake levels, especially in summer.

A longer growing season means trees will remove more soil moisture, and more irregular precipitation may mean more drought. Such droughts could lower groundwater levels and affect the drinking water supply of rural residents who depend on shallow aquifers and wells. Farmers may turn more toward irrigation at a time when river flow is already down, and flows are needed for healthy fisheries. In times of extended drought, the minimum flow requirements of the operating license for Fifteen Mile Falls could result in drastic drawdowns in the Connecticut Lakes, as seen in 2002.

Warmer water temperatures also reduce dissolved oxygen levels, stressing fish. Shading by trees along rivers and streams will be even more important in helping to keep water cool for trout. Less flow in summer streams could mean less dilution of pollutants and poorer water quality.

Both New Hampshire and Vermont have adopted state climate change action plans:

New Hampshire - http://des.nh.gov/organization/divisions/air/tsb/tps/climate/index.htm
Vermont - http://www.anr.state.vt.us/air/Planning/htm/ClimateChange.htm

Recommendations for Flow and Flood Control

- The N.H. Dam Bureau, Quebec, TransCanada, and emergency management officers from towns below Murphy Dam in New Hampshire and Vermont, should work together to develop a effective and reliable system for warning town officials about water releases that could result in flooding below the dam. The Essex and Coös County Conservation District managers can assist with contacts for riverfront landowners.

- Farmers should move hay and equipment out of fields subject to flooding as soon as they are done working.

- Landowners should check culverts on their land often to be sure they are not blocked. Avoid filling wetlands for new homes, camps, roads, and farm fields.

- Regional planning commissions should assist towns with surveys of their culverts and bridges to see if they are large enough. Homeland Security funds may be a source of support for such surveys.

- State and town road crews should ensure that culverts and bridges are sized properly in order to carry the water that might come their way during larger storms.

- Land conservation organizations, USDA Natural Resources Conservation Service, and the US Army Corps of Engineers should purchase development rights from willing owners of land in the natural valley flood storage area to help prevent flooding downstream.

- Landowners on the mainstem and tributaries should retain riparian buffers sufficient in size to control erosion and sedimentation and to provide shade to help keep waters cool.

- Towns should adopt a floodplain ordinance similar to Northumberland's prohibiting building in the 100-year floodplain and on flowage rights of way, to protect their citizens and businesses from damage and to reduce the public cost of disaster relief. Towns should ensure that buildings are set a safe distance back from the river even when outside of the floodplain, to reduce the risk of property loss in erosion-prone areas.

V. Working Rivers - Dams

There are five dams on the mainstem of the Connecticut River in the Headwaters. Moose Falls Dam and Murphy Dam at Lake Francis are owned by the state of New Hampshire. Murphy Dam and the dams at First and Second Lakes are operated for recreation, water storage, and flood control. They provide flow for the company's downstream hydroelectric facilities at Fifteen Mile Falls and beyond, and do not generate electricity themselves. TransCanada pays for the water from Murphy Dam through a contract with the New Hampshire Water Resources Council. All three dams have operated under their own rules since the 1930s, and are not covered by a Federal Energy Regulatory Commission (FERC) license, although their management is outlined in part in the Connecticut Lakes Settlement Agreement in the 2002 license for Fifteen Mile Falls.

Dams have both positive and negative effects on the local economy and the environment. They provide renewable electric energy and contribute to a town's tax base. Their impoundments provide different kinds of fishing and boating than might be possible on the river, although they force paddlers to portage. While dams create new habitat for some species of fish and wildlife, they block passage for other fish. Fish tend to congregate below discharge chutes at dams, which seem to play an important role in winter sustenance. Dams create impoundments that slow the movement of water, allowing it to warm up, evaporate, and lose oxygen, thus reducing the river's ability to clean its waters. The impoundments also trap nutrient-rich sediments, preventing enrichment of the river's floodplain. Dams that are operated in a peaking mode, where water is alternately stored and released, can affect the stability of riverbanks and impoundment shorelines, creating erosion.

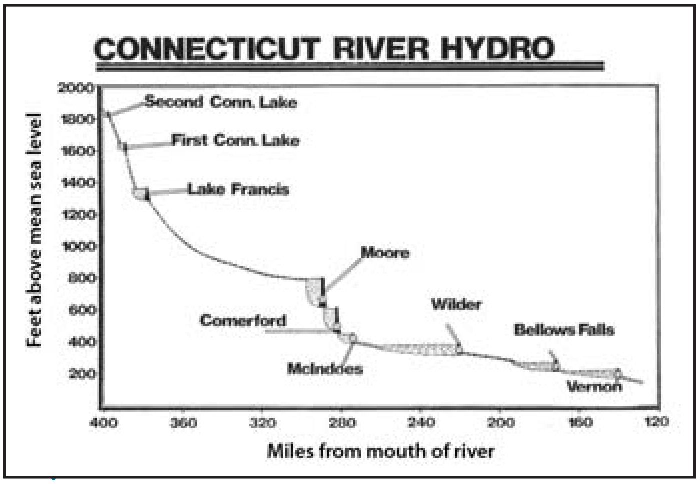
A. Connecticut Lakes Region Dams

1. Moose Falls Dam

This small earthen and timber crib dam on the river between Second and Third Connecticut Lakes is owned by the state of New Hampshire. It is operated in a run of river mode, and has little effect on the flow of the river.

2. Second Connecticut Lake Dam

Second Lake is a natural lake, whose water level was raised by construction of the dam at its outlet in 1935 by timberland owners to help float logs and pulpwood out of the region. Later, the dam came under the ownership of hydro generating interests to supply water for power generation downstream. The lake is drawn down to 1858 feet above sea level in elevation by mid-September and kept there until mid-October to allow lake trout to lay their eggs. This is done in coordination with NH Fish and Game Department. Fall rains usually return the lake to its normal elevation. Beginning in January, the lake is slowly drawn down to the minimum elevation to prepare for the spring runoff, which usually happens around the end of March and beginning of April. Company personnel check the lake's watershed every two weeks through the winter to take many kinds of snow measurements, and draw accordingly so that the lakes will fill. Water levels are kept two to three feet from the top of the dam during the summer for storage room for one-inch runoff from a rainstorm. They try to hold the water of Second Lake at elevation 1867.5 feet to provide storage space for a one-inch rain event, and will adjust the water level constantly depending on foliage and temperature conditions.



Location of the Connecticut Lakes dams on the upper river, showing the elevation change between the headwaters and the Massachusetts line. (Source: New England Power Company.)

3. First Connecticut Lake Dam

First Lake is also a natural lake, raised by a dam built here for log drives in 1915 and rebuilt in 1930, as at Second Lake. In early September, managers start a slow drawdown of the reservoir to make room for fall rains. Starting in mid-December the lake is drawn down in anticipation of spring runoff. The drawdown calculation is based on actual measured snow amounts, the snow water content, and historical precipitation averages gathered over the years. The target elevation is achieved by March 1. Discharges during the winter are kept as high as possible at the outset and slowly decrease over the winter, to prevent ice breakups later in the winter which can cause ice jams on the river below the dam. The goal is to have the lake low enough to capture all spring runoff and have a full reservoir when runoff ends. Water levels are kept two to five feet from the top of the dam during the summer, or approximately 1637.5 feet, in case of a large rainstorm. During the open water season, the company tries to keep the water level up as far as possible for the benefit of camp and dock owners.

Ever since TransCanada's predecessor, New England Power, acquired the dams at First and Second Lake and became involved in management of water from Murphy Dam, a power company representative has been on location, with good reason. A knowledgeable on-site person can respond quickly to local rain events and accidents, conduct regular measurements of snow and soil moisture conditions to better predict runoff, and develop a good knowledge of each lake's watershed. An on-site person has been invaluable for communicating with local officials and landowners for the benefit of the river, in addition to managing company property and addressing trespassing by loggers and others on company lands. Given the importance of these dams to the rest of the river downstream, it is essential that the company retain a staff presence in the Connecticut Lakes.

4. Murphy Dam

Murphy Dam, at the foot of Lake Francis, is a massive 2,200-foot long and 106-foot high earth embankment dam with a concrete spillway. It was built in 1940 at a cost of $2.3 million by the Connecticut River Electric Company. The goal was to create a water storage reservoir on the Connecticut River from what had once been a long, meandering stretch of river and its flat meadowland. The dam was also intended to serve as a flood control reservoir, following widespread damage downstream in the floods of March, 1936. Construction of the dam ended log drives on the uppermost river.

The surrounding property acquired by the state of New Hampshire includes 2,000 acres that are managed for public recreation and wildlife habitat. A state employed dam attendant lives on site. An agreement, formed when the dam was built, calls for a maintenance person to be within two hours' drive of the dam, around the clock. The dam is owned by the New Hampshire Water Resources Council, with whom TransCanada has a contract for the water. The state handles dam maintenance, and TransCanada directs gate changes to control water flow.

The hydro power company manages the dam in summer to keep water levels at an elevation of 17-19 feet from the top, or approximately 1,383 to 1,381 feet above sea level, to allow for a large rainstorm. In early September, as with the other two dams, the lake is drawn down slowly to capture fall rains. Starting in mid-December the lake is drawn down slowly over the winter months, beginning with discharges of 500-700 cfs and then slowly decreased over the winter for ice control. The drawdown is calculated as for First Lake, with the target elevation reached by March 1. The drawdown is intended to capture all the spring runoff and have a full reservoir at the end of this period. This allows for adequate electric power production at Fifteen Mile Falls over the winter and for flood control during the spring high water period. The 2002 Settlement Agreement increased minimum flow from Murphy Dam from 60 cfs to 85 cfs during the summer months when water temperatures can rise to levels that are dangerous for trout.

An application from a third party to install hydro generating equipment at Murphy Dam in 1999 was denied by the Federal Energy Regulatory Commission. There was concern that such a project could have interfered with the coordinated operations of the Connecticut Lakes dams and Fifteen Mile Falls. A similar project is currently being pursued. If a third party's hydro project at Murphy is approved, there would be no effect on flows until 2015, when TransCanada's current contract with New Hampshire expires. At that point, TransCanada and the state would renegotiate the contract, and either TransCanada would continue to control flow from the dam, the third party would win control, or NH DES would decide to retain control as it does on all other impoundments. In any event, the flow pattern should not change significantly, because of the federal flow requirements at the dams downstream at Fifteen Mile Falls, but it could result in new structures such as power lines in the Pittsburg village center, possibly near the town recreation fields.

Table 2a. Dams in the Connecticut Lakes region				
	Moose Falls Dam	**Second Connecticut Lake Dam**	**First Connecticut Lake Dam**	**Murphy Dam at Lake Francis**
Owner	State of NH	TransCanada Hydro Northeast	TransCanada Hydro Northeast	State of NH Water Resources Council
Date built	1950	1935 (Natural lake; dam raised water level)	1915, rebuilt 1930 (Natural lake; dam raised water level)	1940 (artificial impoundment)
Location	Pittsburg, NH river mile 398	Pittsburg, NH river mile 394	Pittsburg, NH river mile 386	Pittsburg, NH river mile 378
Dam type	earth/timber	earth, concrete, timber	earth, concrete	earth, concrete
Hazard to Life Code	A (low hazard potential; inspected every 6 years)	A (low hazard potential; inspected every 6 years)	B (significant hazard potential; inspected every 4 years)	C (high hazard potential; inspected every 2 years)
Elevation	(10 feet high)	Maximum 1869.5 feet Minimum 1858.0 feet	Maximum 1640.0 feet Minimum 1610.0 feet	Maximum 1385.0 feet Minimum 1305.0 feet
Required minimum flow	run of river	June 1- Sept. 30: 22.5 cfs Oct. 1 - May 31: 45 cfs	June 1 - Sept. 30: 45 cfs Oct. 1 - May 31: 83 cfs	June 1 - Sept. 30: 85 cfs Oct. 1 - May 31: 170 cfs
Spill capacity	522 cfs with 1′ freeboard	470 cfs through the gates	2800 cfs through the gates	2000 cfs through the gates
Generating capacity	none	none- used for water storage	none- used for water storage	none- used for water storage
Fish passage	not a barrier	no	no	no
Bypass length	none	none	none	800 feet
Watershed area	7.4 square miles	45.4 square miles	83 square miles	170.5 square miles
Impoundment	4 acres	1272 acres	3125 acres	1895 acres
Flow time to next impoundment	approx. 2 hours	2 hours to First Lake	1 hour to Lake Francis	44 hours to Moore Reservoir

cfs = cubic feet per second

Hazard potential at Murphy Dam - New Hampshire rates Murphy Dam as having high hazard potential to life should it fail, although state officials have stated that there is no danger of failure because the dam is extremely safe, well constructed, and well maintained. The state anticipates that the dam has a 100 year life, which means that it can be expected to last until 2040. Independent safety checks were performed in 1977, 1986, and 1998, and spillway stop logs on all four bays were replaced in 2003. As a high hazard dam, it is now scheduled for inspection every other year.

The dam has a center core of clay, which provides strength. The state estimates that it would take 12.2 inches of rain in six hours or 16.4 inches of rain in 72 hours to cause a flood at the dam, and water would have to reach one foot below the top of the dam to weaken the structure. An earthquake would have to measure 5.5-6.0 on the Richter scale to compromise the dam. An earthquake estimated to be 6.0 occurred in the Montreal area in 1732, and others have been much less significant, with earthquake activity centered in the Lakes Region and St. Lawrence River area.

The specter of a failure at this dam has haunted downstream communities for years. Should the dam fail suddenly and massively, the Connecticut River would rise 30 feet from Pittsburg to Stratford, and also into Quebec. Flooding would stop 85 miles downstream at Moore Reservoir, as long as water levels were low enough there to accept the extra water.

Despite the urging of local officials, there is no early warning system to alert these towns. DES plans to install a system to record discharge levels at real time, and in May, 2004, DES stated that there would also be an alarm system that would alert the dam attendant if there is an increase in flow downstream. A variety of other options have been discussed, but not put into effect. Area towns have emergency management plans in place. Area communities led by Colebrook are now looking at dam safety as a Homeland Security concern, especially with their location so close to the Canadian border.

NH DES has recently installed a real-time data collection system that provides information on lake level, discharge, air and water temperature, rainfall, and height of the stilling basin just below the dam. A spillway sensor was installed in early 2007. The system transmits by satellite, and the public can check on the information on the Internet or by telephone. DES is working with local officials to set up a reliable notification system.

B. Other Dams

1. Canaan Dam

First constructed in 1800, this dam between Canaan and West Stewartstown was the earliest on the mainstem in this region. Over the years it has been replaced many times and in at least two different places. Its flow created the very first commercial hydroelectric generating plant in the region, lighting up Beecher Falls to Colebrook. Public Service Company of N.H. pays the state of New Hampshire for headwater rights.

In preparation for relicensing of Canaan Dam, PSNH invited federal and state agencies and other interested organizations to participate in shaping the terms of the new license. The company has reviewed the Headwaters Region's 1997 *Connecticut River Corridor Management Plan* and 2008 *Connecticut River Recreation Management Plan*, and CRJC, advised by the Headwaters Subcommittee, has participated in this relicensing as a stakeholder. A new license was issued in 2009 by the Federal Energy Regulatory Commission.**2.**

Table 2b. Canaan Dam			
Owner	Public Service Company of NH	**Hazard Code**	low
Date constructed	1927	**Elevation**	1051.5 feet above msl
Location	Canaan VT / Stewartstown NH, river mile 367	**Required minimum flow**	136 cfs or inflow, whichever is less; 50 cfs into bypass reach for fish
Dam height	18 feet	**Spill capacity**	(Flash boards 3.5 feet high)
Dam type	concrete; 1360' foot long wood stave penstock	**Fish passage**	no
Impoundment	20 acres	**Generating capacity**	1100 kilowatts
Bypass length	2000 feet	**Watershed area**	381 square miles

Breached Dams and New Dam Construction

There are three breached dams on the mainstem which have not been redeveloped, and probably will never be: at the former Baldwin Mills site just below Pittsburg Village, at Lyman Falls in Bloomfield/Columbia, and the former Wyoming Dam at Northumberland/Guildhall.

Lyman Falls Dam brought electric power to the region. The land nearby is now conserved as Vermont's Lyman Falls State Park. CRJC removed spikes and rebar from the dam remains that had posed a danger to paddlers.

No new dams may be built on most of the Connecticut River mainstem in the Headwaters region under the New Hampshire Rivers Management and Protection Act (RSA 483). In river segments designated "natural," "rural," or "rural-community," the Act allows repair of a dam which was in place when the river was designated in 1992, at the same place and with the same impoundment level, but only within six years of the failure. Lyman Falls Dam failed many years ago, and therefore cannot be rebuilt.

The Rivers Act does, however, permit repair and maintenance of existing dams and construction of new dams on the five designated "community" segments, which include:

- 0.6 mile section around First Lake Dam
- 0.6 mile section around Second Lake Dam
- 2.3 mile section that includes Murphy Dam and 2.0 miles below it
- 3.8 mile section from Bishop Brook to Leach Creek, including Canaan Dam
- 2.0 mile section from one mile above the breached Wyoming Dam in Northumberland to one mile below.

In these selected areas, the river can be used for hydroelectric production and flood control. New dams are permitted here if they are consistent with protecting the resources for which the segment was designated, and only if they are run-of-the-river, have no significant diversions, and impoundment height is constant and not above the maximum historic level for the site.

Two breached dam sites are located in these community river segments. Plans for rebuilding the Wyoming Dam were abandoned in 1992 over concerns that creating an impoundment could result in violations of state water quality standards for dissolved oxygen. The permit for a wastewater discharge several miles upstream at Groveton requires oxygen mixed in at the breached dam site to allow the river to recover from this discharge. Similar plans for the Baldwin Dam were abandoned in the 1990s when the dam was denied a license by the Federal Energy Regulatory Commission.

While the Headwaters Subcommittee recommends no new dam construction on the mainstem of the Connecticut River, it acknowledges that the search for alternative energy sources may lead to interest in hydro power production on the tributaries. The benefits and drawbacks of such projects should be carefully weighed, in consultation with the fish and wildlife agencies of both states and the federal government, to be sure that all interests are considered.

3. Tributary Dams and Dam Failures

There are a number of dams on Connecticut River tributaries, including many in the Connecticut Lakes region that were likely built in the late 1800s and early 1900s to create ponds out of wetlands to manage the flow of water for log drives.

There have been several dam failures, with devastating results downstream, described in a 2005 geomorphology study of the Mohawk and Upper Ammonoosuc Rivers.[1] The catastrophic failure of the Lake Abenaki Dam in Dixville in 1929 caused the Mohawk River to "break out" with enough stream power to carve new meanders across the floodplain in several places. The dam at Maidstone Lake will soon be repaired as funds are being raised for the project. Big Brook Bog Dam in Pittsburg also needs repair.

Failure of the Nash Stream Dam in 1969 sent sediment downstream that, nearly 30 years later, still completely transforms the Upper Ammonoosuc River. Above the Nash Stream confluence, the Upper Ammonoosuc flows in a single deep and narrow channel that has remained unchanged since 1930, while downstream the multi-thread wide and shallow channel has shifted repeatedly as gravel bars fed by Nash Stream migrate down the river. Despite the presence of dams in Groveton, the influence of Nash Stream has extended all the way to the Connecticut River mainstem, where the growth of a sand bar is partially responsible for flow deflection and bank erosion at the Northumberland Cemetery.

Recommendations for Dams

- TransCanada should continue to have an on-site manager at First and Second Lake, and avoid automating these dams.

- The N.H. Bureau of Emergency Management and the N.H. Dam Bureau should enlist the help of the federal Homeland Security Agency to install an early warning system that will reach all communities in New Hampshire, Vermont, and Quebec that could be affected by a failure of Murphy Dam. Radio may be the easiest way to communicate with downstream towns.

- NH DES should revise rules for management of Murphy Dam in consultation with TransCanada.

- States should avoid further impoundment of the river mainstem to keep aeration at rapids

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1. *Fluvial Geomorphology Assessment of Northern Connecticut River Tributaries*. Prepared for the Connecticut River Joint Commissions by Field Geology Services, January 2006.

and drops. States should permit new hydro dams on tributaries only if they operate as run of river dams, not peaking dams, and only after weighing the benefits and drawbacks in careful consultation with state and federal fish and wildlife agencies.

• NH Dam Bureau and the party proposing hydro power development at Murphy Dam should seek assistance from North Country Council and the State Historic Preservation Office to ensure that any new structures be designed and placed to avoid adverse effects on the appearance and use of Pittsburg's village center and recreation fields.

VI. Using the Water

A. Water Withdrawals

As a designated river in New Hampshire's Rivers Management and Protection Program, the Connecticut River's water is protected from being diverted outside of New Hampshire's part of the watershed.

New Hampshire water withdrawals - New Hampshire requires registration of water withdrawals over a certain size, but does not require a permit unless there is a physical disturbance to the river. There is no charge for using the public's water. This registration program helps identify potential future problems of well interference, declining water tables and/or diminished streamflows, but does not actually limit withdrawals or provide a means of avoiding these problems.

In the Headwaters region, there are nine registered water withdrawals, including five water suppliers, one industrial plant (Wausau, now closed), one hydro plant (Weston Dam, Groveton), Columbia Sand and Gravel, and the Coös County Farm in West Stewartstown. Most withdrawals are groundwater received from wells, although industrial and mining sources such as Columbia Sand and Gravel in Columbia withdraw from surface waters. The Groveton village water system is also partly served by withdrawals from two brooks. A list of registered water withdrawals appears in Appendix H.

New Hampshire's policy on surface water withdrawals
New Hampshire requires registration of water withdrawals with the N.H. Geological Survey of DES that exceed 20,000 gallons per day averaged over any seven-day period from a single location or exceed a total of 600,000 gallons during any 30-day period. Once registered, monthly water use must be reported on a regular basis as long as the source is being used. No permit is required unless the withdrawal involves a physical disturbance to the bed or banks of the river. Examples of those affected uses include: water supply for domestic, commercial, industrial or institutional use, dilution of treated or untreated municipal or industrial discharges, including industrial process water, contact and non-contact cooling water, water for agricultural irrigation and snow making, and water used for power generation.

Vermont's Policy on surface water withdrawals
For most types of water withdrawals, ANR has adopted a procedure for determining the minimum streamflow necessary to meet Vermont Water Quality Standards. The proper management of water resources now and for the future requires careful consideration of the interruption of the natural flow regime and the fluctuation of water levels resulting from the construction of new, and the operation of existing, dams, diversions, and other control structures. These rules provide a means for determining conditions which preserve, to the extent practicable, the natural flow regime of waters. Act 250 and Stream Alteration permits may be needed, as well as a permit from the U.S. Army Corps of Engineers and a Section 401 Water Quality Certification.

Vermont water withdrawals - The state of Vermont requires permits for water withdrawals from in-state waters, limiting them to the "7Q10" level, which means a drought flow equal to the lowest mean flow for seven consecutive days, adjusted to nullify any effects of artificial flow regulation, that has a 10 percent chance of occurring in any given year. However, the state has no system for tracking withdrawals from the Vermont side of the Connecticut River. The amount of water that would otherwise have flowed in the Connecticut River from Vermont is unknown.

B. Groundwater and Drinking Water Supplies

Clean drinking water may be the region's most valuable but under-appreciated commodity. In the Connecticut River watershed, stratified drift aquifers, where large stores of groundwater are available, are closely associated with the river and its tributaries. Surface water and groundwater are closely linked. Groundwater feeds the river's flow, and the water beneath the river feeds groundwater. Pollution in groundwater can therefore pollute a nearby stream, and vice versa. No individual actually owns groundwater. Several Headwaters communities withdraw from wells near the river for their public drinking water supplies, including Colebrook, Groveton, Beecher Falls, and Canaan village. There is an aquifer in Colebrook that is very productive, with no "cone of depression" or area close to the well where the groundwater level sinks when water is pumped out.

1. Identifying and Monitoring Groundwater Supplies

Stratified drift aquifers have been mapped for New Hampshire. New Hampshire's state geologist is now pursing even more detailed mapping in the Connecticut River valley to give a more precise idea of where water supplies are located. Vermont's aquifers have not been mapped as comprehensively as New Hampshire's, although the state is now moving in this direction. An older set of "Groundwater Favorability maps" covering most of Vermont show rough aquifer delineations based on surficial geology. Source Protection Area maps are available for Vermont community water systems.

Groundwater regulation by the states - In New Hampshire, DES has regulated new groundwater withdrawals for public community water systems since 1991, to ensure that these wells have a sustainable yield and are sited in appropriate places. Since 1998, the state has regulated all groundwater withdrawals larger than 57,600 gallons/day. The legislature's intent is to prevent harm to existing water users and nearby ponds, streams, and rivers from large withdrawals at a new well, such as for a bottling plant.

Vermont requires that new public community water systems have delineated the areas from which the groundwater is drawn, with potential sources of contamination identified. However, without a statewide policy on groundwater withdrawal, and without adequate aquifer mapping, Vermont until very recently remained a target for commercial water bottling companies looking for private profit from a resource that belongs to the public.

2. Threats to Groundwater

Groundwater, which many residents pump into their homes for drinking, can be contaminated by a long list of pollutants that are difficult if not impossible to remove. Soil is nature's water filtering system. Septic systems located within the floodplain and inadequate or failed septic systems are a problem, because they can send disease-carrying pathogens, and whatever else homeowners put down the drain, to groundwater which may also reach the river. Leaking underground fuel storage tanks, chemical spills, pesticide and herbicide application areas, leaking sewer lines, junkyards, auto service centers, dry cleaners, industrial sites, sludge piles and lagoons, landfills, metal-working shops, improperly built manure storage, and even cemeteries can contaminate groundwater.

Some communities have taken steps to protect their drinking water supplies.

In the Headwaters region, there are a number of underground storage tanks located within 100 feet of the Connecticut River, especially in Stratford and Northumberland, most of them installed before the threat to groundwater – and drinking water – was understood. Canaan Village's municipal well was contaminated by a leaking gasoline tank 400 feet away. Fortunately, a site for a new well was available, but it cost $60,000. A major benefit of the reconstruction of DeBanville's Store in Bloomfield was the replacement of its fuel storage tanks. Home septic systems, which rely on leaching through soil to purify wastewater, can threaten wells when they are too close (for this reason, the states generally set a rule of 75′ as minimum between leach fields and wells). Some homes in the Headwaters region are located on lots too small to keep wells and leach fields properly separated.

Pittsburg's landfill on Back Lake Road has affected groundwater in an area where there is no other drinking water source available. Colebrook's unlined landfill has released a plume of hazardous waste into groundwater that was headed for Lime Pond, and the town has worked with the state to cap the landfill and reduce the threat. In 2005 the town built a treatment plant to remove contaminants from the groundwater, which is pumped around the clock. Both states have set up permitting programs to eliminate groundwater contamination by the improper disposal of waste.

Salt contamination is a growing concern. Salt above a certain level in groundwater makes the water unhealthy for drinking, since it can lead to high blood pressure and other diseases. Salt dissolves easily in water, and can reach groundwater through road salting, road salt storage areas, and places where snow is dumped, since there is often road salt mixed with the snow. For more on this issue, see Roads and Railroads.

3. Protecting Drinking Water Supplies

Recent studies demonstrate that conserving land to protect drinking water quality makes good economic sense. A study of 27 surface water supplies in watersheds with 10 to 60 percent forest cover found that the more forest cover in a watershed, the lower the treatment costs. For every 10 percent increase in forest cover, treatment and chemical costs decreased approximately 20 percent.[1]

While clean drinking water is essential, few towns have taken steps to protect it. A 2000 New Hampshire study showed that only 11 percent of lands through which water flows to sources of public drinking water are protected by ownership or conservation easement, and 39 percent of community water systems do not even own the sanitary protective radius around their wells (75-400 feet).[2] Local regulations regarding groundwater protection are summarized in Appendix G.

New Hampshire's Source Water Protection Program offers grants to help communities conserve land around their public water supplies to protect the quality of the water that reaches the wells. Colebrook withdraws from an aquifer that is connected to the Mohawk River, and has wisely purchased and protected a new parcel of land in this area to protect a new source of drinking water. Stratford is also moving to protect its water supply. Vermont currently offers low interest loans from the Drinking Water State Revolving Fund for public water supply protection, but not a specific grant program. However, each state's conservation license plate program offers grants that can be used to protect water supplies.

Recharging groundwater - The quantity of groundwater is as important as the quality. If groundwater supplies drop, there is less water to feed both wells and streams. Prolonged drought is one of the few causes of reduced groundwater levels that people cannot control. Changing the surface of the soil, such as through paving, development, or diversion through storm drains, prevents rain and melting snow from soaking into the soil to restore (or

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1. *Protecting the Source: Land Conservation and the Future of America's Drinking Water.* Trust for Public Land & American Water Works Association, 2004.
2. Research funded by NH DES and performed by the Society for Protection of New Hampshire Forests.

"recharge") groundwater. By building many small vegetated areas, such as "rain gardens" to capture water that might otherwise have run off, and keeping impervious surfaces and development on steep slopes to a minimum, careful developers can invite water to soak in and recharge groundwater as it might have naturally. Sometimes the groundwater is withdrawn and not replaced in the same watershed. Imagine water pumped from an aquifer in the Northeast Kingdom to be sold as bottled water in Burlington. The water will not return. For more information see http://www.epa.gov/owow/nps/ordinance/sourcewater.htm.

Recommendations for Groundwater

- States and towns should not permit landfills, salvage yards, and junkyards to be located on aquifers.

- States and towns should not permit new fuel tank farms to be located near the river.

- Towns should ensure that auto junkyards and facilities handling hazardous waste are located well back from the river.

- Vermont should improve its aquifer mapping.

- Towns should not allow development that puts both wells and septic systems close together on very small lots.

- Towns should take advantage of source water protection grant and loan programs.

- Towns should encourage people to handle automotive fluids, pesticides, and other chemicals properly so they don't contaminate their own wells.

- Homeowners should ensure that their septic systems are in good shape and operating well.

- Developers should design their projects to keep natural drainage patterns and use swales and depressions ("rain gardens") to reduce runoff.

VII. Land Use & Water Resources

A. Point Source Pollution-Wastewater Discharges

The Connecticut River has long served to take away wastewater from Headwaters area homes and businesses. Thanks to the federal Clean Water Act and major local investments, the wastewater the river is asked to carry today is much cleaner than it was 30 years ago. At that time, the federal government bore 80 percent of the burden of building wastewater treatment plants and the state contributed 10 percent. The government's participation has evaporated in the years since, leaving towns responsible for the heavy cost of building or upgrading their plants to meet new needs.

1. Town Wastewater Discharges

While Pittsburg Village relies on a septic system and leach field for waste disposal, larger towns have wastewater treatment plants that discharge to the Connecticut River. A number of these facilities have made improvements in recent years, improving management where needed and in some cases redirecting their discharges from smaller tributaries to the mainstem for better dilution. Problems with wastewater disposal may remain at Stratford Hollow.

The North Stratford wastewater treatment plant has had a difficult issue with iron clogging the infiltration beds, caused by very low pH groundwater in the area, which is precipitating iron out of the water. While Stratford's ultraviolet treatment appears to be working well to kill pathogens, the overall system was not operating well because of the clogged beds. The discharge to the Connecticut River was as acid as vinegar (5.7 to 5.8 pH), and could have affected fish and plant life. The town has acted effectively, and now has a capable operator in place and has fixed the pH problem.

"Water has a voice. It carries a message that tells those downstream who you are and how you care for the land."

River activist

Pharmaceutical and personal care product pollutants - Many substances, some harmful and some not, can pass through wastewater treatment systems and are not removed before the water is discharged into rivers and streams or when septic system leachate passes into groundwater. Scientists have only been able to detect these chemicals in streams since about 2000, and little is known about their effect upon groundwater. In 2002, 80 percent of streams sampled (139 rivers in 30 states) by the U.S. Geological Survey showed evidence of drugs, hormones, steroids, and personal care products such as soaps and perfumes.[1] While no studies have been done in the Connecticut River watershed to see whether this is a problem, disturbing evidence of the effects of these chemicals has been found in deformed fish in other rivers, including the Potomac and Shenandoah.

Painkillers, antibiotics, contraceptives and other hormones, chemotherapy drugs, and other medicines can pass through the body and through a wastewater treatment plant. Antibiotics flushed down the toilet can harm the beneficial bacteria that break down waste in septic systems and wastewater treatment plants. Hormones, fragrances, other substances have been detected in all urbanized and farm-intensive watersheds in the United States. Cosmetics, cleaners, insect repellant, and even nicotine and caffeine have been detected in some studies of waterways. Wastewater treatment plants are not required to upgrade to remove these

1. Kolpin, D. W.; et al. *Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999–2000: A National Reconnaissance*. Environ. Sci. Technol. 2002, 36, 1202–1211.

chemicals. Most tend to be largely removed or broken down but remain in sludge, where they usually do not mix with water but could become a problem if biosolids erode into streams or if pH changes. Biosolids aged more than 15 days are safer than fresher sludge.

Recent studies indicate that half of antibiotics produced are given to farm animals, which metabolize only 10-30 percent. The antibiotic level in manure slurry is thousands of times higher than municipal wastewater, landfill leachate, or sludge. Research suggests that soils rich in clay and iron oxides will be good at holding antibiotics in land-applied manure, although adding lime or phosphorus to cropland could prompt release into waters.

Exisiting laws and practices helped create the medical pollution problem. For years, patients have been told to discard unused or expired medications by flushing them down the toilet, where they go directly into the wastewater stream. Federal rules for disposal of controlled medications have not changed since the 1970s, and require the presence of a law enforcement officer. The conventional method of disposal in many hospitals, hospices, and nursing homes is to flush unused narcotics and other medications after the death of a patient, even when they are enclosed in sterile packaging and could be reclaimed for use by other patients.

A better way to dispose of these materials is urgently needed. In February, 2007, EPA advised that individuals wishing to dispose of medicines could add a small amount of water to solid drugs and flour, kitty litter, or sawdust to liquid medicines before capping, double sealing, and placing in the trash. To protect its surface waters and drinking water supplies, Maine began to experiment with collections of unused drugs in 2005, and in 2006, began allowing residents to mail unused drugs to the state. However, more direction is needed for area residents. The Upper Connecticut Valley Hospital and Coös County nursing home are now landfilling unused medications instead of flushing them. Education on how to dispose of pharmaceuticals is a better use of funds than attempting to test river water for a large number of these complex pollutants.

See http://des.nh.gov/organization/divisions/water/dwgb/dwspp/pharmaceuticals.htm for more information on disposal of pharmeceutical and personal care products.

2. Industrial Discharges

Several industries discharge wastewater to the river and its tributaries. Until it suspended operations, Ethan Allen Operations, Inc., in Beecher Falls, discharged a monthly average of 12,000 gallons per day of cooling water and other miscellaneous wastewater into Hall Stream. Local people have reported that Columbia Sand and Gravel's discharge of washing water into settling ponds very close to the river occasionally results in discharge to the river itself when these ponds are flooded by high water. Until it closed, Wausau had a wastewater treatment system to treat paper mill waste and effluent before it returned to the Upper Ammonoosuc River.

Table 3. Wastewater discharges in the Headwaters region		
Discharge	**Receiving water**	**comments**
Ethan Allen	Hall Stream	monthly average of 12,000 gallons per day of cooling water and other miscellaneous wastewater
Canaan WWTF	Connecticut River	1981
Colebrook WWTF	Connecticut River	1964, updates 1988, 2001. Added lagoon baffling, aeration system upgrade, lagoon sludge removal, increased capacity. Discharge improved after upgrade
Columbia Sand & Gravel	settling ponds next to Connecticut River	flooding on the river occasionally flushes fine sediments out of these riverside ponds on a frequent basis
Stratford Village	Connecticut River	Plant built 1986. Recently eliminated pH violations. Discharge generally good.
Stratford Mill House	Connecticut River	Plant built 1980s, upgrade 2003. Extended outfall to CT River for greater dilution, installed outfall diffuser, replacing effluent pumps.
Groveton	Connecticut River	Plant built 1968, update 1992. Need to clean out the second lagoon to improve effluent quality - one cleaned already (which somewhat improved effluent) - need to keep aerators running to provide adequate treatment.
Wausau Paper	Upper Ammonoosuc River	Groveton paper mill (currently inactive)
Northumberland	Connecticut River	Plant built 1985. Infiltration/inflow issues making plant exceed hydraulic capacity. This needs to be addressed.

Recommendations for Wastewater Discharges

- NH DES should focus water quality monitoring efforts on Bog Brook and Stratford Hollow and assist the town in seeking funding from Tri County CAP, the Tillotson Fund, or the Upper Connecticut River Mitigation and Enhancement Fund if further pollution problems remain. Consider buying out and removing houses that are on lots too small to support septic systems.

- Town conservation commissions and regional planning commissions should teach people to wrap and discard their unused and out-dated medicines in regular household trash rather than flushing.

- The U.S. Fish and Wildlife Service, EPA and the states should work together to establish updated rules for disposal or return of unused medicines and work with medical providers for more responsible disposal.

B. Non point Source Pollution

These sources of pollution are sometimes difficult to identify because they do not come from an easily observed point, but can include home landscapes, road runoff, storm drains, farms, logging sites, failed or inadequate septic systems, and eroding riverbanks. Tributaries can also deliver such pollution to the mainstem.

1. Landfills, Junkyards, & Transfer Stations

In years gone by, people simply dumped their refuse out the back door, and if there was a stream gully handy, all the better for dumping trash out of sight. More often, people brought their refuse to bridges and riverbanks, and the Connecticut River and its tributaries are still home to these old dumps. Most public dumps have been identified and capped. Most older landfills are not lined, and their contents can still seep into groundwater. Some, such as the old town dump near the Stratford-Maidstone Bridge at the confluence of Bog Brook, are now forested and have not been capped. Illegal dumping still continues here from time to time.

Modern landfills are built with liners and internal collection systems that gather the liquid leachate so it can be sent to the nearest wastewater treatment plant. The leachate, however, reflects the materials in the landfill, which can include heavy metals, poisons, and all kinds of hazardous materials that were dumped there, such as products containing mercury, rather than collected for safer disposal.

State rules about solid waste locations - On the New Hampshire side, new solid waste landfills are not permitted within a quarter mile of a designated natural or rural river segment, and at least 100 feet from the landward extent of the 500-year floodplain. They must be screened from the river with a vegetative or other natural barrier to minimize visual impact. Existing solid waste landfills may not be expanded within the 500-year floodplain. New solid waste storage or treatment facilities shall be set back a minimum of 250 feet from the normal high water mark of a designated natural or rural river segment and shall be screened with a natural barrier. On segments of the river designated rural-community and community, new landfills can be built within 1/4 mile of the river as long as they are 100 feet from the landward extent of the 500-year floodplain. An existing solid waste facility located within 250 feet of the normal high water mark may continue to operate under an existing permit, provided it does not cause degradation to an area in excess of that area under permit. A resource recovery operation can occur at such a landfill.

Vermont's regulations require a 300-foot setback from surface waters. The Canaan dump on Route 102 has been closed and is being monitored long-term by EPA. The town hopes to open a transfer station near the wastewater treatment plant, having decided not to pursue a site on a small, two-acre riverfront parcel with an eroding riverbank, next to a conserved organic dairy farm.

Colebrook landfill - The Colebrook landfill has been a source of pollutants and concern. The unlined 12-acre landfill was sending a plume of contaminated groundwater toward Lime Pond in Columbia, a conserved pond whose shores feature rare plants. The town worked with NH DES and New England Waste Services to reach an innovative agreement in 2005 that allowed capping and closing the landfill, and dealing with the contaminated groundwater. The groundwater is being pumped at the rate of 20,000 gallons/day, of which 15,000 gallons are sent to the wastewater treatment plant, and 5,000 are injected. The landfill has an infiltrated chamber system which treats the leachate before it is discharged to groundwater. As of early 2007, the plume had been reduced by pumping so that it had withdrawn within the Colebrook town line, and the town hopes that the plume will eventually be eliminated.

Equipment yard, Colebrook - A long-established junkyard on Route 26 in Colebrook is appreciated by many area people as a good source of parts, but it is also located on the banks of the Mohawk River and does not have a permit. The middle yard is on top of an old dump. Some of the metal and equipment stored on this site has been cleaned up and moved away from the stream in recent years, but much remains. Nearby in the sediments of the Mohawk River, scientists working for EPA found the highest level of manganese anywhere in their 200+ mile study in 2000.[1] They also found phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, indeno (1,2,3-cd)pyrene, and nickel. Because of these findings, it would be wise to check whether there has been an effect on surface and groundwater in the area.

Riverbank littering - Most large groups using the Connecticut River for recreation tend to pick up after themselves, but littering remains a problem at some fishing access points and at some riverfront properties. Illegal dumping of tires and appliances has increased since towns have started charging to take them at transfer stations. The amount of litter in the river has declined due to new efforts by the Connecticut River Watershed Council. The Council holds an annual source to sea cleanup, and Headwaters region citizens and scout groups have participated for several years.

Recycling - Communities are working to reduce the tonnage of solid waste they bring to landfills, by recycling.

Table 4. Municipal Solid Waste and Recycling - reported by NH towns in 2007 (source: NH DES)

Town	Combined municipal solid waste (tons)	Commercial/ Industrial Waste (tons)	Construction/ Demolition Waste (tons)	Compost (tons)	Recycling (tons)	Recycling rate
Pittsburg	382	0	141	0	368	49%
Clarksville	to Pittsburg	to Pittsburg	to Pittsburg	to Pittsburg	to Pittsburg	not available
Stewartstown	608	0	113	0	162	25%
Colebrook	715	0	271	9	634	47%
Columbia	to Stewartstown	0	10	0	120	48
Stratford	165	0	144	0	141	46%
Northumberland	851	0	449	8	272	26%

Construction and demolition debris - A recent question is how to dispose of debris from construction and demolition sites, which can include woodwork painted with lead paint, heavy metals, insulation, and other materials that, if incinerated, could put dangerous pollutants in the air. Currently, these materials are landfilled in the Headwaters region, which members believe is the best way to handle them. In years past, people dumped the remains of entire camps onto the Brunswick Springs property and over the edge of the high riverbank here. Recently, after conserving the land, the Abenaki owners removed this debris with the help of a selectman.

1. *Upper Connecticut River Valley Project, New Hampshire and Vermont*. U.S. Environmental Protection Agency, Region 1, by Roy F. Weston, Inc., 2001.

Household hazardous waste collections - North Country Council organizes hazardous waste collections for its member towns, although the nearest collection locations (Littleton and Lincoln) are often over an hour's drive for Headwaters region residents. Some New Hampshire towns have paid to hold their own local collections with the help of North Country Council. In the past these collections have brought in much hazardous material, but in recent years been less successful. Special arrangements can be made to take the waste to Littleton or Lyndonville at any time.

In Vermont, household hazardous waste collections rotate among the towns, and are held every month during the summer, so it is possible to find a convenient drop-off point for hazardous waste.

Recommendations for Landfills, Junkyards, and Transfer Stations

- Towns should organize carpooling to distant household hazardous waste collections and consider holding a local collection with wide publicity to ensure that citizens will participate. Towns should help their citizens become aware of new recycling rules for items containing mercury that went into effect in 2007.

- Towns should continue to landfill construction and demolition debris.

- States and towns should not permit landfills to be located on top of aquifers or on varves (see below).

- NH DES should work with the owner of the equipment salvage yard in Colebrook to test surface and groundwater above and below this site, especially near the business's headquarters building. The site may be a good candidate for a brownfields study.

- States should consider ways to reduce the growing tire litter problem, either through a deposit and return program, or by helping towns to accept waste tires at no cost.

- Citizens should avoid illegal dumping and participate in river clean-up events.

2. Shoreline & Floodplain Development

The value of shorefront property throughout the Connecticut River valley has risen sharply, and development along the Connecticut River, and particularly the Connecticut Lakes, has increased markedly. New shorefront owners are not always aware of the hazards involved in being neighbors to New England's largest river. The 1997 edition of this plan warned of the possible sale of New England Power Company lands around the Connecticut Lakes and development of vacation homes there. Fortunately, these lands are being conserved through the Sidebar Agreement that is part of the 2002 federal operating license for Fifteen Mile Falls, protecting this shoreline forever. The major project to conserve 171,500 acres of surrounding land, put up for sale by International Paper Company, built upon this effort. Yet, the threat of second-home development on other shorelines remains, especially in nearby parts of the

Connecticut Lakes region. There is presently no means to guide shoreline development in most Headwaters towns, other than the Comprehensive Shoreland Protection Act on the New Hampshire side.

New Hampshire Shoreland Protection

This photo shows one of many good reasons not to build too close to a river or stream.

The entire New Hampshire shore of the Connecticut River, within 250 feet, is covered by the Comprehensive Shoreland Protection Act (RSA 483A). In the Headwaters region, the law also applies to Indian Stream, Bishop Brook, the Mohawk River, Upper Ammonoosuc River, and a number of other rivers and streams listed in Appendix I. The law is summarized in this appendix. Its goal is to protect the river for the public, and avoid "uncoordinated, unplanned and piecemeal development along the state's shorelines, which could result in significant negative impacts on the public waters." The law also protects property owners by preventing investments dangerously close to the river. Towns must not issue permits for projects that violate state law.

This law calls for buildings to be set back at least 50 feet from the river. All new riverfront lots are subject to subdivision approval by DES. Minimum lot size is determined by soil type in places dependent on septic systems, and new lots must have at least 150 feet of shoreland frontage. No fertilizer, except limestone, shall be used within 25 feet of the reference line. Twenty-five feet beyond the reference line, low phosphate, slow release nitrogen fertilizer may be used on lawns or areas with grass. No other chemicals, pesticides or fertilizers of any kind shall be applied within 50 feet.

In 2007, New Hampshire enacted new, easier to understand riparian buffer protection. In the Waterfront Buffer (within 50 feet of the reference line), no natural ground cover shall be removed except as necessary for a six foot wide path to the water. Limited pruning may be done to improve a view, and a minimum amount of tree cover must be maintained. Stumps and root systems within 50 feet of the river cannot be removed because they keep riverbank soil in place. Owners of lots legally developed before July 1, 2008 may maintain but not enlarge cleared areas, including existing lawns and beaches, within the waterfront buffer.

Between 50 and 150 feet from the reference line, in the Natural Woodland Buffer, at least 50 percent of the area outside of impervious surfaces shall remain undisturbed. Owners of lots legally developed before July 1, 2008 that do not comply with the law are encouraged to, but shall not be required to, increase the percentage of area maintained in an undisturbed state. The updated law also limits impervious surfaces within 250 feet of the river to 20 percent of the lot, with some exceptions based on buffer and stormwater management. Property owners and developers are encouraged to seek creative solutions that utilize low impact development techniques. If impervious surface limitations are increased to 30 percent within the protected shoreland, a DES-approved stormwater management plan is required.

Until recently, the state has been largely unable to monitor or enforce this law, and violations have occurred. The Subcommittee has been concerned about this lack of enforcement, and about development of lands along the river which could threaten water quality through changes in stormwater movement, erosion during construction, and new septic systems. Homeowners may apply too much fertilizer or pesticide, so that the excess can get into the water. Homeowner may underestimate the importance of riparian buffers in protecting their property against erosion, capturing sediment and other pollutants washing off the land, and keeping the water shaded and cool for trout. Fortunately, the New Hampshire Legislature voted to provide DES with the ability to set up a permitting program and increase enforcement of the provisions of the law. This permit does not apply to timber harvesting that is not part of shoreland development, which is covered by a separate regulation.

"You best not be building in those floodplains. Mother Nature doesn't like it. Now, money talks more than common sense."

Guildhall riverfront farmer

Vermont shoreland protection - Vermont is the only state in the Northeast without a statewide shoreland protection law. However, Lemington, Brunswick, and Maidstone have their own shoreland protection through their local zoning ordinances for the Connecticut River and other streams. These local laws are comparable to or more effective than the New Hampshire law.

Vermont's Agency of Natural Resources has issued riparian buffer guidance for Act 250-regulated projects. The guidance recommends 100 feet from lakes and ponds, and depending on the situation, either 50 or 100 feet from rivers and streams. This is only guidance, however, and does not protect rivers or streams in the case of smaller projects.

Building in floodplains - Because building in floodplains takes over valuable farmland, transfers flooding problems downstream, and costs taxpayers money when flooding occurs, some towns, including Northumberland, have passed ordinances banning construction within the 100-year floodplain. Following a series of devastating floods, Stratford moved some of its buildings out of the floodplain and away from harm. Local regulations regarding shoreland and floodplain protection are summarized in Appendix G.

The National Flood Insurance Program, administered by the Federal Emergency Management Agency, requires special construction standards for buildings that are built in floodplains, but still permits buildings to be built on this dangerous land, and a building (or the mound on which it is placed) is allowed to take up space that floodwaters could otherwise have occupied. While this might reduce the amount of flood damage to the individual property, it does nothing to prevent pollution or stop increased flooding downstream. One building may not make much difference, but the effects of allowing many buildings to take up space in a floodplain can be a different story. Agricultural buildings are exempt from permit requirements in Vermont, even though they take up floodplain space as any other building would.

"The floodplain - that's the river's habitat."

River guide, Columbia

Floodplain maps - It is essential for landowners, town officials, and banks issuing mortgages and loans to have correct information on floodplain locations. Unfortunately, this region's floodplain maps (Flood Insurance Rate Maps, issued by FEMA) are often grossly inaccurate, and do not include contour lines that would show elevation. Colebrook's floodplain maps have major errors. The 1997 edition of this plan recommended that FEMA provide more accurate floodplain maps to the towns. This request was answered by FEMA for the southernmost 16 towns in New Hampshire and Vermont in 2001, based on a new study of the river from its headwaters down to the Massachusetts border. However, the agency declined to provide new maps for upstream towns, including the Headwaters region, citing low growth. However, the Headwaters region is ready to make the best use of good maps as growth pressures have recently increased.

"The floodplain as designated by the federal government is something out of Disney...a mythical floodplain."

Colebrook selectman

In 1994, when the U.S. Army Corps of Engineers identified the 12,000 acres of floodplain from West Stewartstown south into Lancaster and Lunenburg as one of the four most important natural valley flood control areas on the entire river, the Corps decided that it was not worth the cost to purchase conservation easements on this land. Development in this region would greatly affect future flood damage downstream. Property values have since risen sharply, and the answer might be different today.

Varves - Thousands of years ago, some of the river valley was a lakebed, with soil deposits that could pose problems for anything built upon them. Glacial Lake Colebrook (Columbia to Hall Stream area) and glacial Lake Coös (in the Stratford to Lancaster area) left behind layers of lake-bottom sediments that in some places sort themselves into varves, layers that have differing physical properties that can create unstable drainage. Varves are important for land use planning, because they behave differently from other kinds of soils. If a town planning board knows where the varves are and can ask applicants to deal with the challenges posed by varves, then the board can then decide on whether a proposed project is safe. Situating landfills, bridges, large buildings, and other important structures on varved deposits is risky. State geological survey offices can provide surficial geology mapping on a 50/50 cost share basis.

Recommendations for Shoreland and Floodplain Development

- FEMA should provide accurate floodplain maps for Headwaters region towns, based on 2002 research in which it has already invested public funds.

- Towns should encourage developers and landowners to establish and/or maintain buffers of native vegetation along rivers and streams for privacy and pollution control.

- States and towns should ensure that industrial development near the river, such as a gravel pit, has a good buffer of vegetation between operations and the river, to block dust and noise.

- Towns should adopt ordinances prohibiting building in the 100-year floodplain and on flowage rights of way, to protect their citizens and businesses from damage, to avoid adding to flooding of their downstream neighbors, and to reduce the public cost of disaster relief. Ensure that buildings are set a safe distance back from the river even when outside of the floodplain, to reduce the risk of property loss in erosion-prone areas.

- Towns should ask for sedimentation and erosion controls during and after construction.

- Towns should consider working with state geologists to map varves in their towns, to be sure major construction does not take place on unsafe soils.

- Landowners with river or stream frontage should keep the woody vegetation that protects their streambanks, and consider selling development rights to place easements on these areas.

- New Hampshire towns should not issue permits for projects that violate the state Shoreland Protection Law.

- Vermont should enact shoreland protection legislation.

- New Hampshire and Vermont should hold a public outreach program for realtors and for those who live along rivers and streams to remind them of the rules and best management practices that protect water quality.

- Citizens should be aware of state and federal laws that protect rivers and streams.

3. Roads, Gravel Pits, and Railroads

In the Headwaters region, roads and railroads must often follow streams closely to move through the often steep-sided valleys. Routes 3 in New Hampshire and 102 in Vermont follow the Connecticut River on courses little changed in the last two centuries, except that the river has attempted to claim parts of both roads. People have responded by widening, straightening, and armoring the road, rarely by moving it a safer distance from the river. Perhaps the roads with even greater impact upon the river are the unpaved roads on higher ground, many of them running through steep, difficult terrain such as through a logging job or a housing development. Most roads and culverts in the Headwaters region were built at a time when the surrounding land was forested, and culverts were not sized to handle the runoff that can result from heavily logged or developed land.

A sudden heavy storm can cause problems with blocked culverts and send sediment from such a road into a stream, affecting the Connecticut River mainstem far below. Better riparian buffers might help hold streambanks in place and help capture road-related pollutants escaping into the stream. The tradition and practice of town road bans during mud season are extremely valuable and should be continued.

Sometimes the roads themselves may not be a problem, but their closeness to streams can make them become a problem. In August, 2006, 2-3″ rain led to failure of a beaver dam near the Diamond Ponds in Colebrook, washing out the road to Coleman State Park and sending sediment into the Mohawk River and Connecticut River, where it was seen downriver as far as Columbia.

Road construction practices may not always consider what is best for nearby streams. When the Maidstone Bridge road was rebuilt, the Vermont Agency of Transportation put down lime, fertilizer, and mulch on the roadside, then gravel, even where the road passes along the very top of the riverbank. This is not only a waste of nutrients, but it is against New Hampshire law to use fertilizers so close to the Connecticut River. Other highway projects near the river have not used erosion control techniques or restored the riverbank.

When Hix Brook, a small tributary of the Mohawk River, washed out Diamond Pond Road in Colebrook in 2006, sediment muddied the Connecticut River more than 30 miles downstream.

The largest road in the Headwaters region is currently Route 3, which follows the general route of the river in New Hampshire. Over the last decade, much of this road has been widened with additions to shoulders, resulting in increased traffic speed in many places. There is a proposal for a new east-west highway across Coös County following Route 26 to Colebrook, then north on Route 3 to Canaan, then on to Canada. This road, as proposed, would have four foot shoulders and include truck passing lanes. The Subcommittee believes this highway is unnecessary and would result in increased speed, which is already a problem, and more road-related contamination of the Mohawk and Connecticut Rivers where they run close to Routes 26 and 3.

Logging roads - There are many miles of roads in the Connecticut Lakes Headwaters Working Forest which must be adequately maintained. Faulty construction or lack of regular maintenance of woods roads is a problem. There are roads, bridges and field access crossings that need repair. Temporary logging roads used to be a significant problem for local streams and the fish that live there, but most woods operators are more careful these days to follow best management practices, especially for forest properties that are applying for or have achieved certification. The streams carried silt from improperly built stream crossings, skidder trails, or harvesting at times when soils are prone to erosion. At The Nature Conservancy's Vickie Bunnell Preserve in Stratford, some very steep logging roads are actually being "retired" and removed.

"A well-set culvert equals good fish portage."

Culverts and bridges - Town road agents deserve the respect of all for their long hours of work to keep roads passable and safe during long winters and in tough terrain. Careless or uninformed activities by road agents have sometimes, however, led to siltation and other pollution in streams. Among these are inadequate drainage ditch construction and under-sized or poorly located culverts. An under-sized culvert or bridge can block with debris in a sudden storm and cause a stream to cut through a road, as happened in Canaan in 2004. A similar problem in Alstead, N.H., led to a major disaster on the Cold River in October, 2005. A blocked culvert on Route 3 in West Stewartstown led to several severe riverbank slumps above the pool behind the Canaan Dam. In other parts of the river valley, regional planning commissions are helping towns with surveys of their bridges and culverts, to identify those that may be too small and could be a public safety hazard in times of high water. As a result of the August, 2006 flooding, the town of Colebrook has examined its culverts. While logs and other woody debris create healthy fish habitat, culverts need to be kept clear to allow water to move through.

Funding is available for culvert replacement from several sources, especially for hanging culverts that create obstacles for fish passage. The USDA Natural Resources Conservation Service's Wildlife Habitat Improvement Program and Environmental Quality Incentives Program are among these sources. New Hampshire's Aquatic Resource Mitigation Fund, started in 2006, will soon be another. New Hampshire has developed Stream Crossing Guidelines which take fish habitat needs into account.

Snow dumping - Roads can affect nearby streams in many ways. The sand and salt used to keep roads clear in winter ends up in the stream. Plowed snow, which can also end up in the water, contains salt, sand, broken glass, oil, trash, and cigarette butts. Historically, many towns have not bothered to follow state regulations on snow dumping and storage, and there are fewer places to dispose of snow. Long-time snow dumping sites may also show signs of lead accumulation in the soil from the days of leaded gasoline.

Road salt - Hundreds of tons of salt are used on roads very near the river each winter, where it can easily reach the water. An exception may be the northernmost 11 miles of Route 3 in Pittsburg, where relatively little salt is used. Salt and salted sand used for road de-icing can pollute ground and surface waters. Salt in surface waters is toxic to fish and other aquatic life. Salt in drinking water can threaten public health.

A recent study of three rivers, including one in rural northern New Hampshire just east of the Connecticut River watershed, found that salt concentrations have been increasing for the past 30 years.[1] Research shows that sodium and chlorine, the elements that make up salt, are increasing and staying at elevated levels even when salt is not in use on the roads. In spring, summer and fall the levels of chloride concentrations at study sites were 10 to 100 times higher in the waters near salt use areas than in more isolated waters, and in the winter, concentrations were up to 1,000 times higher in the exposed waters. The study suggested that salt from a half century of use on winter roads has been accumulating in soils, groundwater and rivers themselves.

Salt storage - Improper salt storage and loading procedures can easily lead to trouble, since salt dissolves so easily in water. New Hampshire does not permit establishment or expansion of salt storage yards within 250 feet of the Connecticut or any other river covered by its Shoreland Protection Act. Vermont has no similar protection for its waters, beyond requiring that the Agency of Transportation (VTrans) store salt under cover and on an impervious

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1. "Increased salinization of fresh water in the northeastern United States", Kaushal, Sujay S., et al, Proceedings of the National Academy of Sciences of the United States of America, September, 2005.

material so it does not leach into the ground. Vermont has guidelines that recommend that towns avoid storing salt on floodplains, over aquifer recharge areas, or where salt could run off into streams or wetlands, but these are only guidelines. The Vermont Local Roads Program assists town highway departments on the full range of road issues, including storage building designs. VTrans must report weekly to the Agency of Natural Resources about the amount of de-icing material applied during the winter.

A major concern in this area has been the Vermont state highway shed in Bloomfield, where salt was stored some 30 feet from the river. A new storage shed was built in 2006, slightly farther from the water, and providing better protection from salt pollution. VTrans is now offering grants to towns that require only a 20 percent match, for projects like moving sand and salt storage.

Gravel pits - There are several gravel mining operations close to the river in the Headwaters region, where material delivered 10,000 years ago by glaciers is removed today for construction purposes. There have been instances in which gravel operations were not built in accordance with their approved design.

Columbia Sand and Gravel, which has several settling lagoons located close to the river's edge, has recently fixed a leaking berm. These lagoons, which are occasionally inundated by the flooding of the river, allow very fine sediments to enter the river and stay in suspension, sometimes as far as twenty miles downstream in Maidstone, where they settle on floodplains and affect agricultural use. Downstream farmers report that these fine particles of rock powder are a problem nearly every year. Wind can also lift this fine dust from piles stored near gravel pits.

A new gravel mining operation has opened farther south in Columbia near Lyman Falls. Excavations are to be separated from the river by a buffer and by the railroad tracks.

Rail related issues - The railroad follows the mainstem on the New Hampshire side for many miles in the Headwaters region. Old railroad ties are not being picked up and removed when they are replaced and some have fallen into the river. At the North Stratford railroad bridge over the river, creosote has been dripping from new ties for several years. Following up on a local complaint, DES worked with the railroad company to capture the leaking material before it could reach the water.

A rail car rehabilitation business is located between Route 3 and the river in Stratford, and rusting rail cars are stored on tracks near the river. While many of these cars have been moved out of sight and are no longer the visual blight they once were, some residents have expressed concern to the state about them depositing rust and flakes of lead-contaminated paint on the tracks or near the water. NH DES visited the area in 2007 and maintains that lead is not an issue.

Recommendations for Roads, Railroads, and Gravel Pits

- Towns should ensure that roads are built to standards that include slope limits. Discourage construction of new roads near rivers and streams.

- State and town highway crews should reduce the amount of salt used on winter roads. Avoid using fertilizer and lime during road reconstruction projects close to rivers.

- Those working in the woods should follow best management practices (BMPs) for stream crossings, culverts, and erosion control.

- Towns should follow snow disposal BMPs. Snow should be stored on flat, pervious surfaces, such as grass, and at least 25-100 feet from the edge of a stream or river, with a silt fence between the snow and the stream. There are larger setbacks for snow disposal near public wells. Once snow melts, debris should be quickly cleared from the site and brought to the landfill.

- Towns should ask for help from regional planning commissions to survey culverts and bridges to identify those that are undersized; also note if they block fish passage and seek grants for replacing them where necessary. Require culvert permits to be issued by the road agent for new development.

- State transportation agencies and towns should include riparian buffer restoration in road projects near streams and rivers, and keep culverts clear of woody debris.

- NH DES should look at potential contamination from suspension agents and cyclone operation at gravel pits.

- Gravel mining operators should process gravel at a safe distance from the river, to avoid contaminating the water with fine rock powder particles. Steps should be taken to keep such fine material from blowing around.

- Applicants planning to build gravel pits should adhere to permit conditions. State environmental agencies should monitor and enforce permit conditions for gravel pit construction.

- State and federal highway agencies should not support a new east-west highway across the Headwaters region.

- The rail car rehabilitation company should avoid storing deteriorated rail cars near water.

- The railroad company should pick up and remove discarded railroad ties.

4. Stormwater Runoff

What happens to rain falling on a spruce-fir forest is considerably different than what happens on a recently cleared hillside, the family yard, or a paved parking lot. Each one sheds water differently – faster or slower, with more or less chance to gather speed, cause erosion, and pick up pollutants such as automotive fluids and beer cans to fish-killing heat. Stormwater runoff may be the simplest but least understood means of water pollution. As a result, EPA and the states are phasing in stronger stormwater controls.

Impervious surfaces - Cleared, compacted, or paved land sends water downhill faster than when it is captured by thick vegetation and transpired by trees. Studies in Vermont show that when more than 10 percent of a stream's watershed is impervious (pavement, rooftops, compacted soil), the stream and its fish suffer from water quality problems.[1] The Headwaters region is in a good position to avoid such problems, because few if any tributary watersheds have yet been developed with this much impervious surface. Good decisions now can keep development from increasing water temperature and adding pollution, ruining the fine fishing for which the region is so well known.

Roads and parking lots account for as much as 70 percent of the total impervious surface in urban areas. Towns should view commercial parking lots and downtowns as hot spots for petroleum hydrocarbons, metals, nutrients, or solids, and especially for salt and warming of water. Elevated salt and temperature typical of parking lot runoff can be lethal to fish and other aquatic life. Sediment studies tend to show more pollutants in the river where the roads are close.

The typically urban problem of pollution from dog droppings may be moving north into the Headwaters region. Many people walk their dogs near the river in Colebrook and in North Stratford. Stormwater may be washing pet waste into the river and contributing to the higher bacteria levels that have been found here. The Lancaster Rotary Club and the town of Lancaster have installed pet waste stations that provide pet owners with bags.

Land clearing - The effect upon the Connecticut River mainstem from activities in a tributary watershed became very clear on a rainy day in 2004. Heavy land clearing in the watersheds of Leach Creek and Bolter Brook in Canaan, followed by four inches of rain on a day in July, resulted in streams changing course and thousands of dollars of damage to homes, roads, and farms. The runoff also sent silt, sand, and gravel into the Connecticut River, burying 18 miles of aquatic habitat. Studying the river here, Dr. John Field found that delta bars formed by tributary sediment deposits can actually reroute the mainstem toward the opposite bank, leading to erosion. He also found that tributaries with a lot of land clearance in their watersheds created such delta bars in the Connecticut, while nearby tributaries with more heavily forested watersheds have no significant delta bars or erosion on the opposite bank.[2]

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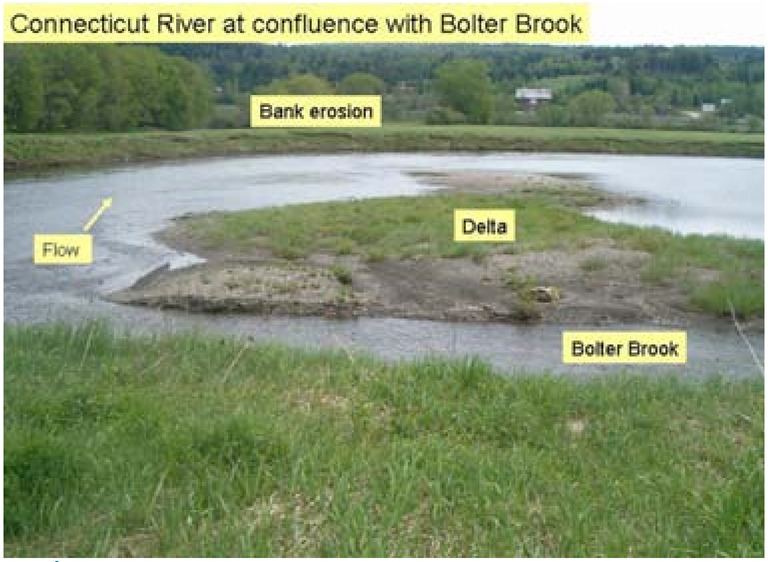
1. Pease, James. *Urban Nonpoint Pollution Source Assessment of the Greater Burlington Urban Stormwater Characterization Project*. Vermont Department of Environmental Conservation, 1997, in *Champlain Initiative, The Case for a Healthy Community: The History of Sprawl in Chittenden County*, March 1999.
2. *Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire*. Field Geology Services for the Connecticut River Joint Commissions, October, 2004.



Heavy clearing in Vermont's Bolter Brook watershed has caused erosion on the New Hampshire side of the Connecticut River.

Improper forestry and extensive clear-cutting adjacent to tributaries can drastically increase flow when the trees are no longer there to take up the water. In the first few years after a clear-cut, runoff greatly increases until the area can revegetate, and the runoff can do extensive damage, as has happened on Cone Brook in Columbia. Intermittent streams are just as vulnerable as year-round streams, and can cause just as much trouble with four inches of rain. Use of best management practices, especially retaining a riparian buffer, can make a big difference. Stormwater permits are now needed for dozing out stumps for development on more than one acre.

Heavy clearing, whether for forestry or for development, can therefore change stormwater runoff, how a tributary flows, and ultimately the Connecticut River itself and even property in another state. Towns may become concerned how such clearing can affect the roads and culverts they are responsible for maintaining.

Controlling stormwater - There are a number of common sense ways to keep runoff from causing trouble downhill. The main idea is to mimic the natural pattern of runoff when a property is developed, with "low impact development" techniques that slow it down and soak it up. Rather than channeling runoff into larger drainage ditches, the design calls for spreading runoff around and detaining it in many small vegetated catch areas and swales where it can soak into the ground and recharge groundwater rather than run off the land. Low impact design also recommends narrower or shared driveways, porous paving materials, smaller parking lots, directing runoff to places with porous soils, directing building to soils that are less porous, flattening slopes on cleared areas, keeping as many trees as possible or planting more, and avoiding construction close to streams. The water that eventually arrives at the stream tends to be cleaner, and more moves through the ground, keeping water levels up in wells and in waterways.

Recommendations for Stormwater Management

- Developers should include infiltration methods such as many small swales and runoff basins to capture runoff for groundwater recharge. Ensure that culverts are sized in anticipation of runoff from future cleared slopes.

- State agencies and regional planning commissions should educate developers about the need for stormwater permits.

- Towns should consider discouraging roads and development on steep slopes to control stormwater runoff. Ask regional planning commissions for advice in how to avoid runoff problems related to large scale clearing. Look at ways to include "low impact development" ideas as they review projects, and at how to change existing development to reduce runoff and promote stormwater infiltration. Require additional treatment to remove oil for new discharges to surface waters and dry wells, and treatment to remove metals should be required for redevelopment projects with discharges to surface waters.

- Loggers should use best forestry management practices when working near intermittent streams as well as year-round streams.

- Landowners on the mainstem and tributaries should retain riparian buffers sufficient in size to control erosion and sedimentation.

- Towns should explore ways to eliminate pet waste problems.

- Pet owners should pick up after their pets on public areas.

- Trail maintainers should check trails to see if water bars are needed to keep stormwater from eroding compacted soils.

5. Home Landscapes

Residential development in the Headwaters region has increased noticeably in the last decade, especially as second-home buyers come to the area. Rivers and streams provide a beautiful backdrop to a home landscape, but what a homeowner does on his or her land can have an important effect on that water.

Many people building on a waterfront parcel are tempted to cut down the vegetation along the stream in order to get a view of the water, not realizing that they are removing the protective barrier that keeps runoff from their lawns and gardens from reaching the water and keeps the riverbank from eroding. Farmers are professionally trained and certified to apply fertilizers and pesticides in the proper amount and at the proper time in the growing season. In contrast, homeowners have no such training and are likely to use much more of these potential pollutants, such as Round-Up and Miracle-Gro, than is necessary or advised. Runoff from driveways, roofs, and lawns can carry away these pollutants, delivering them to streams. Sometimes it's what a homeowner doesn't do that can cause trouble, such as neglecting to maintain a septic system, so that it fails and pollutes a nearby stream. Homeowners living near water have a responsibility to be sure they are good caretakers of those waters.

Recommendations for Home Landscapes

- Homeowners should not use fertilizer near rivers or streams. State law in New Hampshire prohibits use of fertilizer within 25 feet of the high water mark of the Connecticut River and other fourth order streams.

- Homeowners living near waterways should retain buffers of native woody vegetation along the banks, and consider planting some of the many ornamental native plants listed in CRJC's riparian buffer guidance.

• States should offer an information packet to owners of shoreland to educate them about the best ways to manage their property.

6. Farms and Rivers

Prime agricultural soils distinguish much of the floodplain in the Headwaters region. Land use along both sides of the river still speaks loudly of their value in the long-time lively agricultural economy and way of life in the river valley. Much of the quality of life on the river has been affected by agriculture, and mostly in a positive way. Most farms in this region are well-prepared to help maintain water quality. Farmers deserve public help to achieve the public benefit from water quality improvements.

Agriculture and the Connecticut River have a long and treasured history together.

Water quality concerns for farming
Farmers working near the river and its tributaries are aware of the need to manage manure and other fertilizers well so that they serve the farm and are not lost to the river, where they could cause algal growth downstream. The risk of pollution increases when more animals are crowded onto a smaller piece of land, which may happen at mega-dairies. Field applications of sewage sludge may lead to potassium deficiency, and the high pH required to kill pathogens may make other nutrients unavailable. A few farms in region still do not have adequate manure storage facilities.

Unregulated use of manure and farm chemicals on the Canadian side of Hall Stream is a concern for the river. Ten miles of Hall Stream do not meet standards for *E. coli* and have elevated lead levels.

Cows still have limited access to the river in this region at a few locations. Cows can trample the riverbank and cause erosion, just as human recreational users can. Livestock access to the water can result in much erosion. Two cows allowed access to a stream for 24 hours may contaminate as much water as the city of Keene, N.H., (pop. 22,500) uses in one day. However, fencing on flood-prone land to restrict cattle access can be problematic because the fencing must be replaced every year and will catch ice and debris.

Erosion - Some farmers grow corn on river bottomlands more continuously than is good for either the soil or for water quality. Corn land is highly exposed to erosion during flooding. Agricultural operations on the Canadian side of Hall Stream result in a noticeable amount of sediment in the Connecticut River mainstem.

The 2004 geomorphology assessment of the river shows that a riparian buffer of trees is absent along 20 percent of the northern river, especially downstream of Canaan, Vt., where more intensive agriculture occurs.[1] According to the study, "While the absence of trees, in and of itself, does not cause increased bank erosion, the lack of roots to stabilize the soil does increase the sensitivity of the banks to erosion. Eroding banks are 67 percent more likely to be found where the riparian buffer is absent." Vermont requires farms to have minimal riparian buffers of at least ten feet in depth, although New Hampshire treats this area as a best management practice, not a requirement.

Cost-sharing programs - Cost-sharing programs are often difficult to understand and have changing conditions attached to them. The state of Vermont has voted in extra dollars to make the Conservation Reserve Program more helpful to farmers, and funds are available on this side of the Connecticut River valley, but not in New Hampshire. At least one Headwaters dairy farm in Vermont has used these funds to install a substantial riparian buffer along the river. Funding for livestock fencing and alternative water sources is also available. Solar powered pumps for livestock watering can be had at no cost.

Farm sustainability - It is more desirable to see river bottomland used for agriculture than developed into house lots. This land offers prime agricultural soils of national significance, and, from a homeland security point of view, is essential to supply a local source of food. However, consumers do not appreciate or pay for the cost of food production, putting farm economics at risk and these valuable lands at risk of sale and development. All forms of agriculture must survive in the region.

Dairying, which for a century has been the primary form of farming in the Headwaters region, has recently diversified to include organic dairy farming. Under this system, which offers many water quality benefits, more cows are fed on pasture, and farms maintain fewer cows in total. Corn is not grown on the same piece of land continuously by organic farms, because this cannot be done without spraying. Many believe that if the farms were smaller, more numerous, and more prosperous, everyone would gain, and the river would run cleaner than ever.

Recommendations for farming

- U. S. Department of Agriculture should: recognize that New England should have its fair share of federal assistance, and that the needs of its agriculture are distinct from those of other regions; maintain funding levels for NRCS cost-share programs for conservation practices and adopt consistent, simple terms for cost-sharing programs; continue to offer cost-sharing for construction of manure storage pits; increase awareness of nutrient management planning as a potential cost-saving measure for farmers as well as a pollution-reducing technique, through county Cooperative Extension Service and conservation districts; adjust the time land is left in grass based on individual farm conditions;

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1. Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire, Field Geology Services for the Connecticut River Joint Commissions, October, 2004.

• Towns should investigate how conservation easements can help keep town service and school costs down if the land is not developed into house lots or into second homes which could later become year-round residences; develop the means to guide development that occurs on prime agricultural soils, such as

-discouraging building in the floodplain;
-allowing use of cluster development as a way of keeping farmland available;
-encouraging commercial development in areas that are not prime agricultural soils.

Heavy cutting on steep slopes in the riparian buffer can lead to erosion and water pollution.

"We can't always be finding the problem - we've got to be part of the solution."

Stewartstown select board member

• Farmers should voluntarily adopt best agricultural management practices; learn how conservation easements help keep the farm in the family and the land working; keep good records of yields, fertilizing, and soil/plant tissue analysis; decide on their own to establish/retain filter strips between fields and water courses; rotate corn frequently with other crops, particularly on flood-prone land.

• Dairy farmers should consider the option of organic farming.

• Vermont farmers should make use of the Conservation Reserve Enhancement Program to plant riparian buffers or provide livestock water sources.

• Vermont should continue to fund the Conservation Reserve Enhancement Program, and New Hampshire should follow Vermont's example.

• New Hampshire should require a minimum riparian buffer on farmland, and enforce the requirement.

• NH Dam Bureau, Emergency Management Officers from towns below Murphy Dam in New Hampshire, Vermont, and Quebec, and TransCanada should work together to develop a effective and reliable system for warning riverfront farmers about water releases that could result in flooding, so they can move livestock and equipment to higher ground before high water arrives.

• NH DES should investigate sources of contamination in Hall Stream, and if necessary, speak with Quebec authorities.

7. Forests and Rivers

The northern forest is likely the single most important factor in the water quality, fisheries, wildlife, recreational, scenic, and economic values of the river in the Headwaters Region. Forest management is a more significant land use in the Headwaters than in any other subcommittee region. This was a major area of focus for the Northern Forest Lands Council's work in the early 1990s.

The industry based upon this forest was once a major landowner, major employer, and major contributor to local taxes. However, no industrial forest landowners are now left in the region, and the land is now largely owned by timberland investment companies. There is a trend for these companies to buy industrial forestland and place it under conservation easements, in some cases depriving local towns of some tax revenue. In many cases, land management companies are hired to manage the forestland.

A forest is well known as the best guardian of the quality of water for drinking and for trout. Those who manage Headwaters forests also, indirectly, manage the water quality of the Connecticut River and its tributaries. Forest landowners who are aware of the many values of stream side forests use forested riparian buffers to control flooding and erosion, trap pollutants, shelter coldwater fisheries, and provide an attractive streambank and recreational opportunities. Landowners should maintain a forested riparian buffer along waterways. An undisturbed strip immediately adjacent to the banks is surrounded by a zone of selective management that allows new growth to effectively remove and utilize nutrients that might otherwise enter the stream.

The 2100 acre Washburn Family Forest in Pittsburg and Clarksville, conserved by the Society for Protection of New Hampshire Forests in 2008, includes over six miles of river frontage. It will continue to be managed as a working forest, with water quality protection in mind.

In New Hampshire, those planning to make a timber cut can cut up to 10,000 board feet, or 20 cords, for personal use, without the need to file an "Intent to Cut" form with the town. This translates to two fully loaded logging trucks. In Vermont, a landowner must submit an Intent to Cut Notification to the VT Department of Forests, Parks and Recreation only if he or she plans to conduct a heavy cut of 40 acres or more.

Current and potential problems include siltation from improperly built stream crossings or skidder trails, harvesting when soils are prone to erosion, and faulty construction or lack of regular maintenance of woods roads. Bank erosion and sedimentation can result from removal of a forested riparian buffer or from an inadequate buffer. Flash flooding and siltation can result from increased surface runoff when large areas of forest cover are removed. Siltation can result in impacts to fisheries, water quality, and aesthetics, and pose problems at downstream industrial water intake pipes.

Forest herbicides, once used more widely, are now used only by Christmas tree farms and in the Phillips Brook area of the Upper Ammonoosuc River watershed. Utility companies attempting to control vegetation under transmission lines are now relying more upon mechanical rather than chemical control.

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1. Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire. New Hampshire Division of Forests & Lands (DRED) and the Society for the Protection of New Hampshire Forests. 1997

The conservation easement for the Connecticut Lakes Headwaters Working Forest provides a model for forest stewardship that will benefit water quality in the region. Among the stated purposes of the easement, which was purchased by the State of New Hampshire in 2002, is "to conserve waterfront, streams, riparian areas and the quality of groundwater and surface water resources." Special management areas include wetlands and riparian zones. By signing the easement, the landowner, Lyme Timber Company, agreed to develop a stewardship plan for the 145,000 acres of forest it purchased from International Paper Company, and to manage them according to New Hampshire's best management practices for erosion control and "Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire." The conservation easement runs with the land and will apply to future owners as well.

Recommendations for Forests

- Water quality agencies should maintain effective communication and cooperation with timber management companies and other forest landowners.

- Forest landowners should: adopt the principles of sustainable forest management; develop management plans for their forests and conduct logging with the help of professional foresters; follow guidelines in *Good Forestry in the Granite State*; minimize the visual and water quality impacts of clear-cutting, especially near the river; promote and use integrated pest management to lessen the reliance on chemicals; protect and maintain a forested riparian buffer along waterways; smooth and seed skidder ruts after harvest; dispose of slash away from streams; consider conservation easements on their property to allow it to continue in active forest management and to contribute to the economic, scenic, and timber resource base of the region, but also allow it to remain unfragmented by development.

8. Airborne Pollutants

The Connecticut River and its tributaries are not secure from contaminants that arrive on the wind. Both New Hampshire and Vermont have issued fish consumption advisories for the Connecticut and other rivers, based on mercury levels. EPA's 2000 study of Connecticut River fish tissue toxins found that mercury concentrations were significantly higher in the Headwaters and Riverbend reaches of the river than downstream, although this may reflect the fact that results from much of the Headwaters region were combined with those from Moore and Comerford reservoirs, parts of the river where fish are already known to have significantly higher mercury.[1]

Much of this mercury originates from Midwest power plant and urbanized eastern seaboard emissions. Dioxins are produced unintentionally by humans as byproducts of chlorine bleaching in pulp and paper mills, as contaminants in certain chlorinated organic chemicals, and through incineration and combustion, such as by burning of trash in backyard barrels or private outdoor furnaces. Once in the river, all of

1. The Connecticut River Fish Tissue Contaminant Study, U.S. Environmental Protection Agency Region I, 2000.

these contaminants bio-accumulate in the food chain. Fortunately, backyard barrel trash burning is much less common than it was in past years, and is illegal in both New Hampshire and Vermont.

The states are doing a good job at addressing the mercury problem. In April, 2007, the New England Interstate Water Pollution Control Commission worked with New Hampshire, Vermont, and the other New England states and New York to form a draft mercury reduction plan using the federal Clean Water Act to establish the maximum levels of mercury that local lakes and rivers can absorb. The federal government has not set national standards.

Acid rain and snow continue to fall on the high terrain of the Headwaters region, where soils in most places have little capacity to neutralize it. Many, if not most rivers and streams in this highest part of the watershed are more acid than the Class B Water Quality standard of pH 6.5-8.0. Acid water creates poor habitat for fish and other aquatic life. Dust from the piles of fine particles removed during gravel washing also presents a localized source of airborne pollutants.

Recommendations for Airborne Pollutants

- Congress and the states should continue to reduce sources of mercury contamination and acid precipitation.

- Citizens should obey the ban on burning of household trash.

- Gravel pit operators should ensure dust control of material dredged from gravel washing lagoons.

9. Brownfields

There are no current brownfields sites in the Headwaters Region on either side of the river. "Brownfields" is a term for land that cannot be easily redeveloped or reused due to the potential or perceived presence of hazardous substances or other pollutants. There have been some successes in turning this disaster around and making productive use of such sites, putting them back on the tax rolls. Both states have revolving loan programs to help. The Vermont Agency of Natural Resources identified a few sites in the Headwaters region where all the investigation and clean-up work has been completed (Ethan Allen in Beecher Falls, Canaan Public School, Canaan Main Post Office), or contamination was investigated and determined to be below allowable levels of contamination or just needed minor work to stop contamination (such as at DeBanville's Store, removing underground storage tanks).

On the New Hampshire side, North Country Council has an EPA grant to assess petroleum-related brownfields sites in its 51-town region, including the Connecticut River area. NCC is applying for grant funds to explore non-petroleum related brownfields. Contaminated soil at the Beecher Property on Colby Street in Colebrook was removed. At the 1910 Garage on Titus Hill Road in Colebrook, an underground storage tank was removed, and no further testing is called for at this time.

VIII. Riverbank Erosion

Erosion is a natural process, caused primarily by shear stress of water forced against the bank and pressure on outside bends as the river moves naturally back and forth across its floodplain. Humans also cause erosion through such actions as creating boat wakes, allowing livestock to trample riverbanks, sending sudden water releases from dams, and especially through removing riverside vegetation that naturally holds the bank together. In the Headwaters region, erosion has also resulted from major alterations of the river over a century ago to benefit log drives.

Sedimentation and turbidity may be the most important problem threatening water quality in the Headwaters region. The river can run light brown after storms. While only a few Coös County riverfront farms have surface erosion, unnatural riverbank erosion continues to be a problem. While erosion creates habitat for bank swallows and other kinds of wildlife, it also adds sediment to the river that can smother fish spawning areas and nutrients that can cause growth of algae. Siltation also poses problems at industrial water intake pipes. Brown, silt-laden water is not inviting for swimming or boating, and ruins a fisherman's day.

"People think the Connecticut River doesn't need any help because it flows all by itself."
Hank Swan, Connecticut River Commissioner

A. 1995 County Erosion Inventory

Erosion on this part of the Connecticut River was inventoried by the Essex and Coös County Conservation Districts in 1995 on both sides.[1] Data were collected on bank heights, slopes, soils, vegetation, river dynamics, and existing erosion controls. The inventory was conducted by canoe from Pittsburg to Moore Dam, and found 70 sites of active erosion in the New Hampshire towns included in this segment, and 58 in the Vermont towns. It should be noted that an erosion inventory is a snapshot in time, and that erosion sites can change from one year to the next.

The report concluded that the most common erosive force is the river current, especially on concave banks where the current is forced against the shoreline. Seasonal flooding is also clearly an erosive force. Silty and sandy soils tended to have less vegetation and a higher erosion trend than loamy soils. Areas with no vegetative buffer at all tended to have a higher rate of erosion, especially when combined with damage from unrestricted livestock grazing along streambanks. The erosion study showed that most of the moderate and severe erosion sites occurred on farm land, especially where there was little or no riparian buffer. Various methods of erosion control have been used, from stone riprap, tires, junk cars, and "biotechnology," and some have produced relatively stable banks.

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1. Coös County Conservation District and Essex County Natural Resources Conservation District, Connecticut River Erosion Inventory of Coös County NH and Essex County VT, 1995

B. 2004 Geomorphology Assessment

The Connecticut River Joint Commissions sponsored an intensive assessment of the 85 miles of the river from Murphy Dam to Gilman by fluvial geomorphologist John Field, to look further into causes of erosion related to natural river movement.[1]

Effect of channel straightening - Dr. Field's research revealed that one third of the river had been straightened by humans before 1925, probably to remove obstructions for log drives, and that the river is likely still adjusting to this major change. The New Hampshire General Court gave permission in 1863 and 1867 to the Upper Connecticut River and Lake Improvement Company to remove rocks and other obstructions, and to enlarge the channel of the river from First Connecticut Lake to Fifteen Mile Falls. In 1864, the first log drive went through the region. The long, straight stretches of river created by this work are not natural, and the river is now reshaping the resulting sharp corners back into smoother, more natural curves. Straightening the channel has also caused the river to cut down three to four feet within its bed. The river is now trying to widen and slow as it recovers from these dramatic changes. For this reason, it is dangerous to build levees and berms close to the river, because they will not stand up to the river forces at work. A better approach would be to ensure that human development is kept far enough from the river to allow it to continue readjusting without threatening homes or businesses.

"If you get in there and try to put the river where you think it ought to go, it may not necessarily agree with you."

Vermont basin planner

Effect of tributaries - Tributaries are also changing the mainstem of the Connecticut. Sediment dropped in the mainstem from tributaries such as Bolter Brook in Vermont has shifted the current to erode the opposite bank in New Hampshire. Heavy land clearing in a tributary watershed may cause too much sediment to enter these tributaries. Sand spread on roads close to streams may also contribute to the problem. Sediment from Leach Creek has affected erosion at the Coös County Farm in Stewartstown, and sediment deposited by the Mohawk River in the mainstem is causing erosion downstream at the Colebrook Business Park. In Stark, sediment deposited by Mill Brook in the Upper Ammonoosuc River is causing erosion that affects a road built very close to the river's edge.

Dredging the sand and gravel bars that appear at the tributaries' mouths is not a solution because the tributaries will continue to make these deposits. A better solution is to prevent excess sediment from entering the streams in the first place.

Studies sponsored by CRJC in 2006-7 resulted in an innovative design to trap sediment in the lower reach of the Mohawk River in Colebrook. Since the US Army Corps of Engineers altered the lower Mohawk River in the 1960s, in an attempt to control ice jams in the downtown

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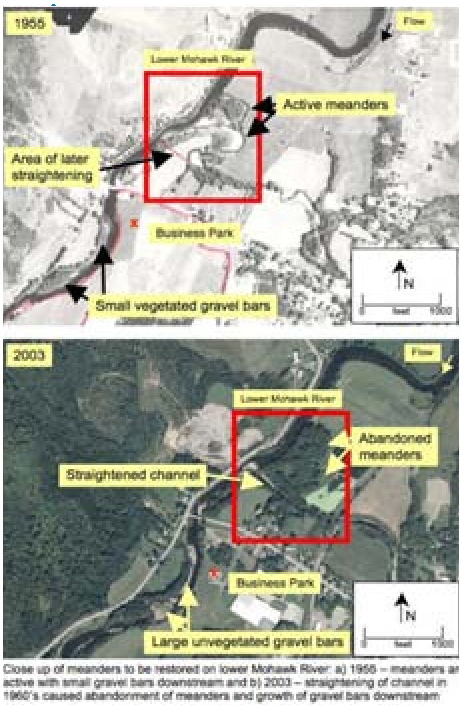
1. Field Geology Services, Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire, prepared for the Connecticut River Joint Commissions, October 2004.

area, forcing the river to abandon its natural meandering path to the Connecticut, the Mohawk has delivered its load of gravel and other sediment directly to the mainstem. This has caused a gravel bar to build up in the Connecticut River that has altered the river's flow and forced it against the bank at the Colebrook Business Park. CRJC has raised funds to restore the natural delta of the Mohawk to capture this sediment, by installing engineered logjams to slow the flow in the artificial channel. Studies undertaken in 2007 indicate that this will have no effect upon ice jams or flooding in the downtown area. Construction should take place in 2009.



The lower Mohawk River in 1955 and 2003.

Effect of high banks - High eroding banks of glacial outwash have a major role in erosion. When sand and gravel slide down these bare, unvegetated slopes, they fall into the river and are deposited in bars that deflect the river current onto nearby riverbanks. The high bank at Brunswick Springs, Vt., easily visible from New Hampshire's Route 3, is a prime example of such a source of sediment. Material from the high bank has created gravel bars that have in turn caused erosion on nearby prime farmland on both sides of the river. The high bank at the Northumberland Cemetery is another example.

Northumberland Cemetery - Erosion at the base of this 40-foot high bank has been a source of deep concern for many years, and now threatens burials at the top of the bank. CRJC sponsored a geomorphic study of this site in 2005, which found that the breaching of the Wyoming Dam between Guildhall, Vt. and Northumberland, N.H. in the 1980s has caused the river water level to drop at least three feet, resulting in higher stream velocity.[1] This is likely a primary cause for the extensive erosion and bank slumping along the high banks in the 3.3-mile reach between the dam site and the Upper Ammonoosuc River confluence. Erosion at the Northumberland Cemetery just a half mile downstream from this confluence is further affected by flow deflection around a sand bar just upstream of the cemetery property.

These conditions have destabilized the high riverbanks that are naturally susceptible to erosion given the glacial outwash sediments exposed in the banks, which are composed of thick sand deposits overlying a fine silt and clay layer near the base of the bank. Water percolating through the sand is stopped at the silt layer and seeps out of the bank, undermining the loose sand above and causing large slumps to form. John Field reported that slumping and erosion of the banks will likely continue as the river keeps adjusting to the removal of the Wyoming Dam. He advised that removing the sand bar would alleviate only some erosive pressures while leaving unaddressed a primary cause for the erosion (i.e., removal of dam) and potentially cause harm to aquatic habitat. Doing nothing, or only planting riparian vegetation, will not resolve the erosion problems. The bank will continue to be undermined at the base until the channel completely adjusts to increased flow velocities resulting from the removal of the dam. Riprap could be undermined by continued channel

1. Field Geology Services, *Fluvial Geomorphology Assessment of the Northern Connecticut River, Vermont and New Hampshire,* prepared for the Connecticut River Joint Commissions, October 2004.

adjustments unless keyed in well below the bank, which would be extremely expensive. The approach recommended for this site was an engineered, intentionally constructed "log jam" at the base of the bank because its construction would mimic natural processes occurring on the northern Connecticut River, improve cover habitat, and buttress the bank in the event of continued undermining of the bank. CRJC attempted to raise funds for an engineering design for this project, but was unsuccessful in finding the funds needed.

Rock riprap - The 2004 study also showed that stone riprap is not foolproof on the upper Connecticut River, and that in some places, the river has eroded behind the stone as it attempts to widen and slow down in recovery from straightening. Stone armoring can also move the river's energy and erosive power directly downstream, usually on the same side of the river. Many examples exist in the Headwaters region. A recent example is new erosion downstream of riprap added to the riverbank near the Colebrook Rest Area a few miles north of town.

Erosion maps for towns - Understanding the natural tendencies of a stream, its current condition, and what changes may occur in the future is important for making good decisions about protection, management, and restoration. In 2005, CRJC and Dr. Field met with leaders of each of the 16 towns covered by his studies, and presented them with maps showing erosion sites, bank composition, and riparian buffer condition in their towns, along with guidance about how to approach riverbank projects. This information is also posted on the CRJC Web site at www.crjc.org/erosion.htm.

Fluvial Erosion hazard mapping - Vermont's River Management Program has developed a fluvial erosion hazard mapping method to better define high-hazard streams. The maps can be used to delineate river corridors that should be protected from encroachments to preserve channel stability and avoid flood hazards.

C. Riparian Buffers

Riparian buffers are the single most effective protection for water resources in Vermont and New Hampshire. These strips of grass, shrubs, and/or trees along the banks of rivers and streams filter polluted runoff, capture sediment and nutrients, and provide a transition zone between water and human land use. Vegetated buffers are relatively inexpensive and have the added advantage of providing habitat for both land based and aquatic animal species and privacy for landowners. Shading streams with vegetation helps to optimize light and temperature conditions critical to the survival of certain species, such as trout.

Both the 1995 erosion inventory and the 2004 geomorphology assessment confirmed the value of riparian buffers. In this area, Dr. Field observed a 67 percent greater chance of finding erosion where there is no riparian buffer, and that a forested buffer at least 25 feet wide is associated with greater bank stability. The 2004 study found a lack of riparian buffer along a full 20 percent of the riverbank, and concluded that bank stability generally increases as buffer width increases, as long as a buffer is at least 25 feet wide. Vermont requires a minimum buffer of 10 feet on farms. New Hampshire has no such requirement.

To encourage better and more effective riparian buffers, the state of Vermont has voted in extra dollars for the Conservation Reserve Enhancement Program, and funds are available in the Connecticut River valley. A riverfront landowner in Canaan used the CREP Program to plant 6000 trees in a major riparian buffer project.

In contrast, a long-standing policy of the U.S. Army Corps of Engineers has required removal of woody vegetation growing in the berms of wastewater treatment facilities, including that at the Coös County Farm. In the same week, perplexed landowners watched as one federal program sponsored the planting of riverbank trees in Canaan, while another federal agency mandated their removal right across the river in Stewartstown.

The two states have differing policies regarding riparian buffers, although river experts in both states agree that buffers are very important for protecting water quality and reducing erosion. New Hampshire's Comprehensive Shoreland Protection Act requires that the area within 50 feet of a fourth order stream (and larger) must remain undisturbed. The act also protects the natural woodland buffer within 150 feet of such waters. Vermont has no statewide buffer protection. Of the Vermont towns in the Headwaters region, only Maidstone protects riparian buffers. Local regulations regarding riparian buffer protection are summarized in Appendix G.

D. Riverbank Restoration Projects

Several innovative landmark riverbank restoration projects have taken place in the Headwaters region. Among them is a project to plant a woody riparian buffer in a flood chute and restore the riverbank at the Hook Farm's 850-foot-long riverbank in Brunswick in 2001, sponsored by the USDA Natural Resources Conservation Service for Essex and Caledonia Counties and the Connecticut River Joint Commissions. Following the 2004 geomorphology assessment by John Field, CRJC identified an eroding bank at the Colebrook Business Park as a promising area for restoration. Alterations in the lower Mohawk River's channel had led to gravel deposits in the mainstem, creating new erosion pressures on the business park property. In 2006, CRJC installed a bio-engineering stabilization project at the park and planted a riparian buffer of native woody plants, and the property owners gave a conservation easement on the buffer area to the town of Colebrook to allow the riverbank restoration project to mature. A second, major project is planned at this site for 2009 on the adjacent riverbank upstream.

NH DES funded a project at Bog Brook in Stratford to control sediment deposits in the Connecticut River, which should in turn help to reduce erosion on a nearby Vermont farm. Bog Brook has been eroding south in high water times between Route 3 and the railroad tracks.

Recommendations for erosion and riparian buffers

- Landowners along rivers and streams should retain and enhance buffers of native vegetation on their banks to help hold soil together.
- Towns should discourage construction of roads close to rivers and streams that might later become susceptible to erosion.

- Town officials and landowners should be aware of the provisions of the New Hampshire Comprehensive Shoreland Protection Act, and avoid building close to the river or removing the riparian buffer growing along the river.

- Vermont should enact shoreland protection.

- Towns should adopt ordinances prohibiting building in the 100-year floodplain and on flowage rights of way, to protect their citizens and businesses from erosion and flood damage. Ensure that buildings are set a safe distance back from the river even when outside of the floodplain, to reduce the risk of property loss in erodible areas.

- Towns and landowners should consider conservation easements to prevent development in places where the river is actively eroding, to give the river room to move.

- Vermont farmers should make use of the Conservation Reserve Enhancement Program to plant riparian buffers.

- The U.S. Army Corps of Engineers should revisit its policy of removing riparian buffers.

- Boaters should abide by state boating law, which requires travel at headway speed only throughout the Headwaters region of the Connecticut River (except for the lakes), and avoid creating a wake.

- Towns should ensure that their riverfront landowners have access to CRJC's erosion maps and guidance.

IX. Current Protection for the River

A. State Tools for Protecting Riverfront Lands and Water Quality

1. New Hampshire

NH's Comprehensive Shoreland Protection Act (RSA 483-B) sets minimum shoreland protection standards for shore lands along New Hampshire's great ponds, fourth-order rivers, artificial impoundments and coastal waters. These standards are designed to minimize shoreland disturbance in order to protect the public waters, while still accommodating reasonable levels of development in the protected shoreland. Although the act sets minimum standards, section 483-B:8 gives municipalities the authority to adopt land use control ordinances which are more stringent. The legislature updated the Act in 2007.

2. Vermont

The State of Vermont is the only state in New England that still has no statewide protection for shore lands. Section 1422 of Title 10 of the Vermont Statutes gives towns the authority to regulate shore lands to prevent and control water pollution; preserve and protect wetlands and other terrestrial and aquatic wildlife habitat; conserve the scenic beauty of shore lands; minimize shoreland erosion; reserve public access to public waters; and achieve other municipal, regional or state shoreland conservation and development objectives. Other state regulations set standards for management of agricultural land, silvicultural practices, and sediment and erosion control. In-stream water quality continues to be directly regulated at the state level, including withdrawals and discharges from and into surface waters.

B. Local Tools for Protecting Riverfront Lands and Water Quality

Besides the state statutes, many tools are available to communities and individuals to protect water quality; some are of a regulatory nature, some are non-regulatory. Local tools can include adopting a master plan (town plan) and/or water resources management plan with strong recommendations for protecting water quality, scenic views, agricultural soils, riparian buffers, prime wetlands, floodplains, open space, and wildlife habitat. These recommendations can be carried through to regulatory documents such as zoning, subdivision and site plan review.

1. Local Regulatory Measures

Floodplain Ordinances - Floodplains provide flood storage, wildlife habitat and essentially act as buffers to protect water quality. Construction, development, or filling in of floodplains removes flood storage and displaces floodwater to locations further downstream. Floodplain ordinances can prohibit construction in the floodplain. There is the added benefit of protecting buildings from flood damage, which costs taxpayers millions of dollars each year. Towns should update their floodplain ordinances, incorporating them into town zoning bylaws where possible.

Shoreland Overlays - A community can adopt a shoreland protection ordinance or a buffer overlay to the zoning ordinance in which protection measures for surface waters can be more closely defined than for the rest of the town. In both states the requirements of the shoreland ordinance supersede that of the underlying zoning ordinance.

Fluvial Erosion Hazard Area Zone or Overlay District - Communities can help account for river erosion hazards and help maintain the stability of a stream system by establishing an overlay district based on fluvial erosion hazard mapping. There are several ways that towns can implement fluvial erosion hazard overlay zones. Education of property owners is a less intensive way to implement these zones, and incorporating the zones into town zoning bylaws is ideal.

Others - Towns may also adopt measures to limit the amount of impervious surface created by new development to reduce the transportation of sediments and nutrients, require sediment and erosion control measures during and after construction, and minimize development on valuable agricultural soils.

Model Ordinances - North Country Council developed a model ordinance for riparian buffers in 2002. In 1993, the Upper Valley Lake Sunapee Regional Planning Commission prepared a River Protection Overlay District Model Zoning Amendment as part of the Grafton County Nonpoint Pollution Project, which can be used as a model for riverfront communities. The Southern Windsor Regional Planning Commission in Vermont has developed "Suggested Criteria for Protection of Surface Water Quality." All of these could be used to develop local shoreland protection ordinances.

2. Local Non-regulatory Methods

Vegetated Buffers - The use of riparian buffers can be either regulatory or voluntary, and is one of the best and most commonly used methods of protecting surface water. This strip of natural or planted vegetation along the riverbank can intercept harmful nutrients, toxic chemicals and sediments before they enter the surface waters, and control bank erosion.

Conservation Purchase or Easements - Towns and conservation groups can use these tools to provide a buffer on land adjacent to surface waters and wetlands, to protect water quality and to provide public access without creating new regulations. Prime agricultural soils, water supply recharge areas, floodplains, sites for rare and endangered species, and historic and archaeological sites can be protected in the same manner.

Incentives - Current use tax assessment programs in both states encourage landowners to keep their land undeveloped. A variety of incentive programs offered by the USDA Natural Resources Conservation Service encourage landowners, especially farmers and forest landowners, to implement best management practices that benefit water resources, such as buffer planting, fencing of livestock, roof drainage improvements, and much more.

Indian Stream Farm in Pittsburg pioneered farmland conservation in the Headwaters Region, and today remains the northernmost farm in New Hampshire.

Education programs - Education programs through schools and non-profit education and land use organizations can increase the awareness of the general public regarding private property rights and ways to control nonpoint pollution on private land. Programs should emphasize the locations and use of existing public access and asking permission before stepping on private property.

X. Tributaries

Many small brooks and large rivers enter the Connecticut River in the Headwaters segment, draining the northern-most portions of Vermont and New Hampshire and a small portion of Quebec. The states have little information about most of them, and these North Country and Northeast Kingdom streams and rivers appear to be among the states' most pristine waterways. There are currently no watershed plans or organized groups for any of the New Hampshire tributaries in this region, and basin planning for the Vermont Headwaters tributaries has not yet begun. Limited sediment sampling occurred in a few of the tributaries in conjunction with the 2000 EPA study.

These tributaries are described, to the extent possible, in Appendix J. Given the lack of knowledge about most of them, several Headwaters Subcommittee members volunteered to conduct a windshield survey during the summer of 2006. Using maps prepared by NH DES for this purpose, members used a simple field recording sheet to assess the condition of small tributaries in their towns. Summaries of their reports are included in Appendix J.

Major headwater tributaries to the uppermost Connecticut River include Indian and Hall Streams, rivers with a deep history that once were the contested international borders of the young republic. Indeed, for a number of years, the region was known as the Indian Stream Republic. These and smaller tributaries to the Connecticut River and Lakes should benefit from new road management policies for the Connecticut Lakes Headwaters Working Forest.

Indian Stream - A significant part of the Indian Stream watershed is conserved. Near its confluence with the Connecticut, Indian Stream Farm is New Hampshire's northernmost farm and an early example of conservation in the region. It has has transitioned to organic dairy farming practices. Upstream, former International Paper Company industrial timberland is conserved Indian Stream flows through a spectacular rocky gorge before entering its broad, fertile floodplain closer to the mainstem.

Hall Stream - This large tributary forms the modern border with Canada, and the western part of its watershed is in Hereford, Quebec. There is concern about intensive agricultural use on the Canadian side of this stream, including loss of riparian buffer vegetation and severe erosion that sends sediment into the Connecticut River mainstem.

Leach and Bolter Creeks - Heavy clearing in the steep watersheds of these smaller Vermont tributaries resulted in soil erosion and sediment deposits in the mainstem of the Connecticut River that are large enough to affect the current of the river and to begin new erosion on the New Hampshire side. This has demonstrated that land management near a small tributary can indeed have an effect on a large river.

Mohawk River - Rising in Lake Gloriette in Dixville Notch, the Mohawk River is a major tributary to the Connecticut, draining 56 square miles and entering at Colebrook opposite Monadnock Mountain. While some dams remain on the river, the impact of dams on flow was greater in the past when more (now breached) dams were present. The river is free flowing in its lower ten miles. Alerted by a 2004 study of the Connecticut River that the Mohawk is contributing a heavy sediment load to the mainstem, CRJC conducted a geomorphic assessment of the lower ten miles of the Mohawk in 2005. Dr. John Field described the river in this way:

> *"The Mohawk is constrained by bedrock and glacial outwash terraces along much of its length, but several human factors have increased the river's sediment transport capacity above natural levels. Rock riprap is found along 13 percent of the river's banks, particularly through Colebrook, N.H. where the river is confined between concrete walls. In addition, over 50 percent of the channel's length has been artificially straightened with the lowest 0.5 miles straightened in the 1960's. The excess sediment transported to the mainstem as a result of these natural and artificial constraints has led to the deposition of large gravel bars at and downstream of the Mohawk River confluence; flow deflection around the bars is, in turn, causing severe bank erosion at the Colebrook Business Park. While the straightened channel segments remain relatively unchanged during low to moderate discharges, a dam break flood in 1929 resulted in multiple "break outs" where debris blocked the main channel and flow escaped over the banks with sufficient force to scour new meander bends into the floodplain surface."*[1]

After detailed study, CRJC launched a project to re-establish side channels near the mouth of the Mohawk River on land owned by the town, to help capture sediment before it can enter the mainstem. Heavy flooding in the summer of 2006 resulted in undermining of the channelized section of the river through downtown Colebrook.

The river is considered safe for swimming and fishing. However, in addition to erosion and sedimentation, water quality concerns on this tributary include road runoff from Route 26, a heavily traveled state highway, and possible contamination from an equipment yard. Sediment sampling at this location in 2000 revealed the highest manganese levels recorded anywhere in the 100 sites sampled between Pittsburg and White River Junction. The landowner has done considerable cleanup of the site, and a leaking underground storage tank has been addressed.

Nulhegan River - Possibly the wildest and most beautiful of Vermont's Connecticut River tributaries, the Nulhegan River drains a 65-square mile largely undeveloped watershed in the Northeast Kingdom. The river's several branches unite and meet the Connecticut near the Bloomfield/Brunswick town line. The complex of bogs, freshwater wetlands, and spruce fir forest includes over 20,000 acres conserved by the Silvio O. Conte National Fish and Wildlife Refuge, Vermont's West Mountain and Wenlock Wildlife Management Areas, and conserved industrial timberland. The Nulhegan's watershed shelters the largest deer wintering area in Vermont, a 15,000-acre softwood forest. The basin provides nesting habitat for loons, hooded mergansers, black, ring-necked, and wood ducks. At least 13 rare plant and animal species have been recorded here, including the only viable population of spruce grouse in the Connecticut River watershed. It also provides extensive contiguous forest for breeding migrant birds.

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1. *Fluvial Geomorphology Assessment of Northern Connecticut River Tributaries*. Final Report prepared for the Connecticut River Joint Commissions by Field Geology Services, January 2006.

Vermont considers parts of the Nulhegan River to be partially impaired by sediment and siltation from timber harvesting, and some habitat alterations. The river has a long history in the logging industry, and once hosted log drives, as did the Connecticut. This river, which is part of the route of the Northern Forest Canoe Trail, is in some parts rapid, and in others deep and sluggish.

Water quality is considered very good. This is the largest of the Northeast Kingdom tributaries that are part of Basin 16, for which Vermont has not yet begun a basin planning process.

Upper Ammonoosuc River - This major New Hampshire tributary drains 210 square miles, and flows from the northwest slopes of the White Mountain National Forest to the Connecticut River at Groveton. It has a long history of powering paper production in this busy town. There are three dams on the Upper Ammonoosuc River in Groveton, impounding a total of two miles of river. CRJC conducted a geomorphic assessment of the lower 22 miles of this river in 2005.[1] John Field described the river in this way:

The Upper Ammonoosuc River has an intriguing human history.

"Although bank erosion is observed immediately downstream of the dams, point bar development, channel migration, and continued floodplain access near the confluence with the Connecticut River mainstem indicate that the dams have not resulted in discernible channel incision. Upstream of the dams' influence, tributary inputs and channel straightening are the primary factors controlling channel morphology and bank stability.

Sediment inputs from Nash Stream, a tributary that suffered a large dam break flood in 1969, completely transforms the morphology of the Upper Ammonoosuc River. Upstream of the Nash Stream confluence the river is in a single deep and narrow channel that has remained unchanged since 1930 while downstream the multi-thread wide and shallow channel has shifted repeatedly as gravel bars fed by Nash Stream form and migrate down the river. Despite the presence of the dams, the influence of Nash Stream has extended to the Connecticut River mainstem where the growth of a sand bar is partially responsible for flow deflection and bank erosion at the Northumberland Cemetery.

Tributary inputs elsewhere on the Upper Ammonoosuc are helping to recreate meanders along portions of the 33 percent of channel artificially straightened by humans. Growth of a gravel bar and alluvial fan at the mouth of Mill Brook in Stark,

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1. *Fluvial Geomorphology Assessment of Northern Connecticut River Tributaries*. Final Report prepared for the Connecticut River Joint Commissions by Field Geology Services, January 2006.

NH has caused the Upper Ammonoosuc River to shift up to 250 feet in more than 70 years as flow is diverted around the accumulating sediment. The resulting erosion on the bank opposite the Mill Brook confluence is currently threatening the North Side Road along which emergency repairs were required twice during 2005. Although erosion is found along only seven percent of the river's banks, bank instabilities also occur immediately downstream of straightened segments. Increased sediment transport capacity resulting from the straightening causes increased deposition and flow deflection in the meander bends downstream where the sediment transport capacity is reduced."

Trout Unlimited and the N.H. Fish and Game Department are undertaking a major project to restore badly damaged aquatic habitat in the Nash Stream watershed.

XI. Conclusion

The Headwaters Region of the Connecticut River remains, in many ways, the purest and perhaps the most beautiful in the largest watershed in New England. Protected by deep forests and residents with a close relationship to the land, the river and its tributaries here offer a standard against which downstream reaches will always be measured.

All is not completely well, however -- there are signs both in the waters and sediments and on the riverbanks that human activity is affecting this fine trout water, and the river is facing new challenges from increased development.

Leadership in ensuring a healthy future for the river must come from private landowners and decisions at town meeting. The Headwaters Subcommittee looks for all to participate in safeguarding this, the life blood of the North Country.

Appendix A. Headwaters Subcommittee Members

These Local River Subcommittee members participated in development of this updated water resources chapter of the *Connecticut River Management Plan*:

David Begin, *Canaan, VT*
Tom Caron, *Canaan, VT*
Allen Coats, *Stewartstown, NH*
Kenneth Hastings, *Columbia, NH*
April Hyde, *Colebrook, NH*
Louis Lamoureux, *Maidstone, VT*
Kevin McKinnon, *Colebrook, NH*
Edwin Mellett*, *Northumberland, NH*
Gary Paquette, *Stratford, NH*
Robert Postier, *Bloomfield, VT*
Larry Rappaport, *Colebrook, NH*
Denault Routhier, *Bloomfield, VT*
Lisa Savard, *Pittsburg, NH*
Bill Schomburg,* *Columbia, NH*
Robert Ward, *Pittsburg, NH*

** elected officers of the subcommittee*

The following Local River Subcommittee members participated in development of the 1997 Connecticut River Corridor Management Plan which formed the basis for the current plan.

John Amey, *Pittsburg, NH*
Paul Amey, *Pittsburg, NH*
Sherry Belknap, *Bloomfield, VT*
Earl Bunnell, *Colebrook, NH*
Stanley Bunnell, *Clarksville, NH*
Lawrence Clough, *Canaan, VT*
Allen Coats, *Stewartstown, NH*
Odette Crawford, *Canaan, VT*
Joe Daley, *Lemington, VT*
James Fay, *Lemington, VT*
Alan Fogg, *Northumberland, NH*
Gordon Gray, *Northumberland, NH*
Lindsey Gray, *Pittsburg, NH*
Ken Hastings, *Columbia, NH*
Louis Lamoureux, *Maidstone, VT*
Richard Lapoint, *Pittsburg, NH*
Kevin McKinnon, *Colebrook, NH*
Ed Mellett, *Northumberland, NH*
Gary Paquette, *Stratford, NH*
Chuck Patterson, *Lemington, VT*
Mary Plumley, *Brunswick, VT*
Bill Schomburg, *Columbia, NH*
Barbara Tetreault, *Northumberland, NH*
Bob Ward, *Pittsburg, NH*
Timothy White, *Maidstone, VT*
Robert Young, *Lemington, VT*

Appendix B. Progress since 1997

Since publication of the first *Connecticut River Corridor Management Plan* in 1997, much progress has been made. Colebrook has worked with the state of New Hampshire to cap its landfill and is in the process of eliminating a plume of groundwater pollution that was headed for Lime Pond in Columbia. Many landowners are improving pollution control on their property by planting riparian buffers and reducing use of fertilizers and pesticides near waterways. New Hampshire has applied the Comprehensive Shoreland Protection Act to its side of the Connecticut River, and towns such as Northumberland have enacted even stronger protection for their shorelines.

Vermont has dedicated funding to assist landowners with water quality improvements through the Conservation Reserve Enhancement Program, and offered this funding to those in the Connecticut River valley. A Canaan riverfront landowner has used this program to plant the largest riparian buffer project undertaken along the entire Connecticut River. A growing number of landowners have decided to conserve their land, especially along the river, and have found conservation organizations willing and able to help them. The largest such conservation project in New Hampshire history occurred here, with the conservation of 171,500 acres of industrial timberland surrounding the headwaters of the Connecticut River.

The Connecticut River Joint Commissions have conducted a detailed geomorphic assessment of the entire Connecticut River in this region to learn more about the causes of erosion. These studies were extended also to the Mohawk and Upper Ammonoosuc Rivers when it became clear that they were affecting erosion on the mainstem. Results were shared with the select boards of each riverfront town in the region. CRJC began a multi-year project to curb erosion at the Colebrook Business Park that had been caused by artificial straightening of the lower Mohawk River. Results of these studies confirmed what local residents had long suspected – that heavy clearing in the watershed of even a small tributary, such as Bolter Brook, can lead directly to erosion on the mainstem of the Connecticut River.

In 1997, this Plan reported that the state of New Hampshire described the Connecticut River in the Headwaters region as offering excellent swimming, perhaps the best anywhere along the Connecticut River, and in addition to very good water quality, adequate dissolved oxygen, and an aquatic food chain community in excellent condition. The Plan cautioned that safe swimming and other water contact uses depend upon absence of harmful bacteria. It appears now that safe swimming without bacteria present is not a guarantee, especially in the section between Clarksville and Stratford.

Town investments in wastewater treatment and discharges will surely help improve this situation. Colebrook and Canaan have recently upgraded their wastewater treatment plants, and many direct septic discharges to Bog Brook have been eliminated in the village of Stratford Hollow. North Stratford has improved its wastewater treatment plant management and discharge, delivering it to the mainstem rather than to smaller tributaries. Vermont's transportation agency has also reduced a threat to the river by building a new salt storage shed at its Bloomfield yard. Both states have improved public access to water quality information in the last several years through their web sites. The Connecticut River has been the focus of energetic assessment of its waters, sediments, and fish in recent years, in response to the 1997 *Connecticut River Corridor Management Plan*. In preparation for the update of this plan, NH DES, with support from the EPA, conducted an assessment of water quality on the entire 275 miles of the river during the summer of 2004. The extensive study provided greatly improved information over what had previously existed. Two studies of sediment quality by EPA and a study of toxins in fish tissue by EPA and all four states brought new information that will be useful in many ways.

Appendix C. Summary of Recommendations by Responsible Party

Federal	
Congress	• Recognize that New England should have its fair share of federal assistance for agriculture, and that the needs of its agriculture are distinct from those of other regions; maintain funding levels for NRCS cost-share programs for conservation practices • Continue to reduce sources of mercury contamination and acid precipitation.
USGS	• Reinstate the gage on the Mohawk River that was discontinued in 2004 and install a gage at Hall Stream.
US Army Corps of Engineers	• Purchase development rights from willing owners of land in the natural valley flood storage area to help prevent flooding downstream. • Revisit its policy of removing riparian buffers.
FEMA	• Provide accurate, up to date floodplain maps for Headwaters region towns.
EPA	• Establish updated rules for disposal or return of unused medicines and work with medical providers for more responsible disposal. • Revisit the fish tissue toxin study in the Headwaters region, and sample coldwater species.
US Fish & Wildlife Service	• Establish updated rules for disposal or return of unused medicines and work with medical providers for more responsible disposal.
NRCS & county conservation districts	• Assist with contacts for riverfront landowners as part of a warning system for flooding below Murphy Dam. • Purchase development rights from willing owners of land in the natural valley flood storage area. • Continue to offer cost-sharing for construction of manure storage pits; adopt consistent, simple terms for cost-sharing programs; increase awareness of nutrient management planning as a potential cost-saving measure for farmers as well as a pollution-reducing technique, through county Cooperative Extension Service and conservation districts; adjust the time land is left in grass based on individual farm conditions.
States	
NH legislature	• Continue to reduce sources of mercury contamination and acid precipitation. • Do not support a new east-west highway across the Headwaters region. • Fund a Conservation Reserve Enhancement Program similar to Vermont's.
VT legislature	• Enact shoreland protection. • Continue to reduce sources of mercury contamination and acid precipitation. • Continue to fund the Conservation Reserve Enhancement Program.

Appendix C. Continued

environmental agencies (NH DES and VT DEC)	• Make water quality monitoring data easily accessible to the public, including those who do not use computers. • Avoid further impoundment of the river mainstem to keep aeration at rapids and drops. Permit new hydro dams on tributaries only if they operate as run of river dams, not peaking dams, and only after weighing the benefits and drawbacks in careful consultation with state and federal fish and wildlife agencies. • Do not permit landfills, salvage yards, and junkyards to be located on aquifers or varved soils. • Do not permit new fuel tank farms to be located near the river. • Consider ways to reduce the growing tire litter problem, either through a deposit and return program, or by helping towns to accept waste tires at no cost. • Ensure that industrial development near the river, such as a gravel pit, has a good buffer of vegetation between operations and the river, to block dust and noise. • Hold a public outreach program for realtors and for those who live along rivers and streams to remind them of the rules and best management practices that protect water quality. • Look at potential contamination from suspension agents and cyclone operation at gravel pits. Monitor and enforce permit conditions for gravel pit construction. • Educate developers about the need for stormwater permits. • Offer an information packet to owners of shoreland about the best ways to manage their property. • Maintain effective communication and cooperation with timber management companies and other forest landowners. • Continue to cooperate with fisheries agencies to better understand and address the Didymo infestation.
Vermont Department of Environmental Conservation	• Map the state's aquifers.
New Hampshire Department of Environmental Services	• Sponsor a regular water quality monitoring program that includes bacteria, pH, and turbidity, and encourage measurement of the acidity of rain storms. NH's VRAP program should arrange with local wastewater plants to process bacteria samples to encourage local water quality monitoring, and change its rules to allow reimbursement of local plants for this service. • Identify sources of contamination for waters listed on the Section 303(d) list as needing a TMDL and look at the area's geology to learn more about pH. • Install a gage at Hall Stream, and reinstate the gage on the Mohawk River that was discontinued in 2004. • Help develop a effective and reliable system for warning town officials about water releases that could result in flooding below Murphy Dam. • Revise rules for management of Murphy Dam in consultation with TransCanada. • NH Dam Bureau and the party proposing hydro power development at Murphy Dam should seek assistance from North Country Council and the State Historic Preservation Office to ensure that any new structures be designed and placed to avoid adverse effects on the appearance and use of Pittsburg's village center and recreation fields. • Focus water quality monitoring efforts on Bog Brook in Stratford. • Work with the owner of the equipment salvage yard in Colebrook to test surface and groundwater above and below this site, especially near the business's headquarters building. The site may be a good candidate for a brownfields study. • Not support a new east-west highway across the Headwaters region. • Investigate sources of contamination in Hall Stream, and if necessary, speak with Quebec authorities. • Require a minimum riparian buffer on farmland, and enforce the requirement. • Assist the New Hampshire Lakes Association to set up a Lake Host program to check for invasive species at Connecticut Lakes boat launches on holiday weekends.
fisheries agencies	• Revisit the fish tissue toxin study in the Headwaters region, and sample coldwater species.
transportation agencies	• Ensure that culverts and bridges are sized properly in order to carry the water that might come their way during larger storms. • Reduce the amount of salt used on winter roads. Avoid using fertilizer and lime during road reconstruction projects close to rivers. • Include riparian buffer restoration in road projects near streams and rivers, and keep culverts clear of woody debris.

Appendix C. Continued

Towns	
town management	• Help develop an effective and reliable system for warning town officials about water releases that could result in flooding below Murphy Dam. • Continue to landfill construction and demolition debris. • Ask for help from regional planning commissions to survey culverts and bridges to identify those that are undersized; also note if they block fish passage and seek grants for replacing them where necessary. Require culvert permits to be issued by the road agent for new development. • Ensure that their riverfront landowners have access to CRJC's erosion maps and guidance. • Establish a town conservation commission, if one does not already exist, and encourage it to become informed about invasive species.
planning boards & commissions	• Adopt a floodplain ordinance similar to Northumberland's, prohibiting building in the 100-year floodplain and on flowage rights of way, to protect their citizens and businesses from damage and to reduce the public cost of disaster relief. Towns should ensure that buildings are set a safe distance back from the river even when outside of the floodplain, to reduce the risk of property loss in erodible areas. • Do not permit landfills, salvage yards, and junkyards to be located on aquifers or varved soils. • Do not permit new fuel tank farms to be located near the river. • Ensure that auto junkyards and facilities handling hazardous waste are located well back from the river. • Do not allow development that puts both wells and septic systems close together on very small lots. • Take advantage of source water protection grant and loan programs. • Encourage developers and landowners to establish and/or maintain buffers of native vegetation along rivers and streams for privacy and pollution control. • Ensure that industrial development near the river, such as a gravel pit, has a good buffer of vegetation between operations and the river, to block dust and noise. • Ask for sedimentation and erosion controls during and after construction. • Consider working with state geologists to map varves in their towns, to be sure major construction does not take place on unsafe soils. • Do not issue permits for projects that violate the NH Shoreland Protection Law. • Ensure that roads are built to standards that include slope limits. Discourage construction of new roads near rivers and streams. • Consider discouraging roads and development on steep slopes to control stormwater runoff. Ask regional planning commissions for advice in how to avoid runoff problems related to large scale clearing. Look at ways to include "low impact development" ideas as they review projects, and at how to change existing development to reduce runoff and promote stormwater infiltration. Require additional treatment to remove oil for new discharges to surface waters and dry wells, and treatment to remove metals should be required for redevelopment projects with discharges to surface waters. • Investigate how conservation easements can help keep town service and school costs down if the land is not developed into house lots or into second homes which could later become year-round residences; develop the means to guide development that occurs on prime agricultural soils, such as discouraging building in the floodplain, allowing use of cluster development as a way of keeping farmland available, and encouraging commercial development in areas that are not prime agricultural soils. • Become informed about invasive species.
Road crews	• Ensure that culverts and bridges are sized to carry water during larger storms. Keep culverts clear. • Reduce the amount of salt used on winter roads. • Avoid using fertilizer and lime during road reconstruction projects close to rivers. • Follow snow disposal BMPs. Snow should be stored on flat, pervious surfaces, such as grass, and at least 25-100 feet from the edge of a stream or river, with a silt fence between the snow and the stream. Use larger setbacks for snow disposal near public wells. Once snow melts, clear debris quickly and deliver to the landfill. • Restore riparian buffers during road projects near streams and rivers.
conservation commissions	• encourage people to handle automotive fluids, pesticides, and other chemicals properly so they don't contaminate their own wells. • teach people to wrap and discard their unused and out-dated medicines in regular household trash rather than flushing. • organize car pooling to distant household hazardous waste collections and consider holding a local collection with wide publicity to ensure that citizens will participate. Towns should help their citizens become aware of recycling rules for items containing mercury. • encourage developers and landowners to establish and/or maintain buffers of native vegetation along rivers and streams for privacy and pollution control. • explore ways to eliminate pet waste problems.

Appendix C. Continued

Regional Organizations	
Regional Planning Commissions	• Assist towns with surveys of their culverts and bridges to see if they are properly sized. • Teach people to wrap and discard their unused and out-dated medicines in regular household trash rather than flushing. • Educate developers about the need for stormwater permits.
Land conservation organizations	• Purchase development rights from willing owners of land in the natural valley flood storage area to help prevent flooding downstream. • The New Hampshire Lakes Association should set up a Lake Host program, with the help of TransCanada and NH DES, to check for invasive species at Connecticut Lakes boat launches on holiday weekends.
Utilities	
Trans Canada	• Help develop a effective and reliable system for warning town officials about water releases that could result in flooding below Murphy Dam. • Continue to have an on-site manager at First and Second Lake, and avoid automating these dams. • Assist the New Hampshire Lakes Association to set up a Lake Host program, with the help of NH DES, to check for invasive species at Connecticut Lakes boat launches.
Railroad	• Rail car rehabilitation company should avoid storing deteriorated rail cars near water. • Pick up and remove discarded railroad ties. • Ensure that new rail ties will not contaminate rivers and streams with creosote.
Recreation Groups	
	• Check trails to see if water bars are needed to keep stormwater from eroding compacted soils. • Abide by state boating law, which requires travel at headway speed only throughout the Headwaters region of the Connecticut River (except for the lakes), and avoid creating a wake. • Boaters or divers traveling from waters infested with zebra mussel must wash and dry all equipment before reuse, hose off the boat, diving gear or trailer, and drain and flush the engine cooling system and live wells of the boat, bait buckets and the buoyancy control device from diving equipment. • Local outfitters, lodge owners, and guides should educate their customers about Didymo and other invasives, and encourage them to clean their gear. • Fishermen and other recreationists must carefully clean their gear after visiting the Connecticut River and report sightings of invasive aquatic species to state agencies. Do not release unused bait into the water.
Private Landowners	
Developers	• Design projects to keep natural drainage patterns and use infiltration methods such as many small swales and runoff basins to capture runoff for groundwater recharge. • Ensure that culverts are sized in anticipation of runoff from slopes that may be cleared in the future.
Gravel mining operators	• Process gravel at a safe distance from the river, to avoid contaminating the water with fine rock powder particles. Steps should be taken to keep such fine material from blowing around. • Adhere to permit conditions. • Ensure dust control of material dredged from gravel washing lagoons.
Farmers	• Move hay and equipment out of fields that are subject to flooding as soon as work is done. • Adopt best agricultural management practices; learn how conservation easements help keep the farm in the family and the land working; keep good records of yields, fertilizing, and soil/plant tissue analysis; decide on their own to establish/retain filter strips between fields and water courses; rotate corn frequently with other crops, particularly on flood-prone land. • Consider the option of organic dairy farming. • Make use of Vermont's Conservation Reserve Enhancement Program to plant riparian buffers or provide livestock water sources.
Forest landowners & loggers	• Follow best management practices for stream crossings, culverts, and erosion control. • Use best forestry management practices when working near intermittent as well as year-round streams. • Adopt the principles of sustainable forest management; develop management plans for their forests and conduct logging with the help of professional foresters; follow guidelines in Good Forestry in the Granite State; minimize the visual and water quality impacts of clear-cutting, especially near the river; promote and use integrated pest management to lessen the reliance on chemicals; protect and maintain a forested riparian buffer along waterways; dispose of slash away from streams; consider conservation easements on their property to allow it to continue in active forest management and to contribute to the economic, scenic, and timber resource base of the region, but also allow it to remain unfragmented by development.

Appendix C. Continued

Waterfront landowners	• Retain riparian buffers sufficient in size to control erosion and sedimentation. Consider planting some of the many ornamental native plants listed in CRJC's riparian buffer guidance. • Be aware of the provisions of the New Hampshire Comprehensive Shoreland Protection Act, and avoid building close to the river or removing the riparian buffer growing along the river. • Consider conservation easements to prevent development in places where the river is actively eroding, to give the river room to move. • Consider selling development rights to place easements on riverfront land. • Avoid using fertilizer near rivers or streams.
All landowners	• Check culverts on their land often to be sure they are not blocked. • Avoid filling wetlands for new homes, camps, roads, and farm fields. • Ensure that their septic systems are in good shape and operating well. • Avoid illegal dumping and participate in river clean-up events. • Be aware of state and federal laws that protect rivers and streams. • Pick up after pets near streams and in public areas. • Obey the ban on burning of household trash. • Avoid dumping aquarium plants or animals into any water body, but dispose of them by freezing or drying before putting them in the trash.

Appendix D. Connecticut River Mainstem Water Quality

Results of 2004 water quality assessment by the New Hampshire Department of Environmental Services, with support from CRJC and US EPA Region I. Fish consumption information is based upon New Hampshire state health advisories.
Swimming, fishing, and boating - determined by measurements of bacteria *(E. coli)*
Aquatic habitat - determined by measurements of dissolved oxygen, pH, specific conductance, and temperature
Fish consumption advisories: Information is available at:
www.wildlife.state.nh.us/Fishing/fish_consumption.htm.

Connecticut River Mainstem Segment	Sampling Location	Towns	Miles	Assessment - 2004
Fourth Connecticut Lake	4th Lake	Pittsburg	2.5 acres	safe for swimming and other recreation **insufficient information on aquatic habitat** **fish consumption unsafe - mercury**
Fourth Connecticut Lake to Third Connecticut Lake	downstream of 4th Lake	Pittsburg	1.9 miles	**insufficient information about safety of swimming** safe for other recreation **fish consumption unsafe - mercury**
Third Connecticut Lake	3d Lake; E. coli station at boat ramp	Pittsburg	298 acres	safe for swimming and other recreation **insufficient information on aquatic habitat** **fish consumption unsafe - mercury**
Third Connecticut Lake to Upper Moose Falls Pond	downstream of 3d Lake	Pittsburg	2.8 miles	**insufficient information on safety of swimming;** safe for other recreation **does not meet standards for aquatic habitat due to low pH** **fish consumption unsafe - mercury**
Upper Moose Falls Pond	Upper Moose Falls Pond boat ramp	Pittsburg	20 acres	**insufficient information on safety of swimming;** safe for other recreation **does not meet standards for aquatic habitat due to low pH** **fish consumption unsafe - mercury**
Moose Falls Dam to Scott Brook and Second Connecticut Lake	Route 3 bridge, Pittsburg	Pittsburg	0.8 miles	**insufficient information on safety of swimming;** safe for other recreation **does not meet standards for aquatic habitat due to low pH** **fish consumption unsafe - mercury**
Second Connecticut Lake	2d Lake; E. coli station at boat ramp	Pittsburg	1286 acres	safe for swimming and other recreation **insufficient information on aquatic habitat** **fish consumption unsafe - mercury**
Second Connecticut Lake Dam to First Connecticut Lake	Magalloway Road Bridge	Pittsburg	3 miles	**insufficient information on safety of swimming;** safe for other recreation **does not meet standards for aquatic habitat due to low pH** **fish consumption unsafe - mercury**
First Connecticut Lake	1st Lake	Pittsburg	2807 acres	safe for swimming and other recreation **insufficient information on aquatic habitat** **fish consumption unsafe - mercury**

Appendix D. Continued

Connecticut River Mainstem Segment	Sampling Location	Towns	Miles	Assessment - 2004
First Connecticut Lake Dam to Lake Francis	Carr Ridge Road Bridge	Pittsburg	2.5 miles	safe for swimming and other recreation **insufficient information on aquatic habitat** **fish consumption unsafe - mercury**
Lake Francis	Lake Francis State Park boat ramp	Pittsburg	2081 acres	safe for swimming and other recreation **insufficient information on aquatic habitat** **fish consumption unsafe - mercury**
CT River from Lake Francis to confluence of Indian Stream	Route 145 Bridge and Mountain Valley Road	Pittsburg	4.5 miles	safe for swimming and other recreation **does not meet standards for aquatic habitat due to low pH** **fish consumption unsafe - mercury**
CT River from confluence of Indian Stream to confluence of Bishop Brook	Route 3 Bridge, Clarksville/ Pittsburg line	Clarksville Pittsburg	4.2 miles	**insufficient information on safety of swimming;** safe for other recreation meets standards for aquatic habitat **fish consumption unsafe - mercury**
CT River from confluence of Bishop Brook to upper end of Canaan Dam impoundment	Bridge Street Bridge, Stewartstown	Clarksville Canaan Stewartstown	2.1 miles	**unsafe for swimming due to bacteria;** safe for other recreation **does not meet standards for aquatic habitat due to low pH** **fish consumption unsafe - mercury**
Canaan Dam impoundment	Canaan Dam Railroad Bridge	Canaan Stewartstown	20 acres	**unsafe for swimming due to bacteria;** safe for other recreation meets standards for aquatic habitat **fish consumption unsafe - mercury**
CT River from Canaan Dam to confluence with Mohawk River	Main Street Bridge, W. Stewartstown	Canaan Stewartstown	10 miles	**insufficient information on safety of swimming;** safe for other recreation meets standards for aquatic habitat **fish consumption unsafe - mercury**
CT River from confluence with Mohawk River to confluence with Cone Brook	Bridge Street Bridge, Colebrook. Columbia Covered Bridge	Colebrook Lemington Columbia	8.6 miles	**unsafe for swimming due to bacteria;** safe for other recreation meets standards for aquatic habitat **fish consumption unsafe - mercury**
CT River from confluence with Cone Brook to confluence with Nulhegan River	Hydrolab station, ½ mile above Route 105 Bridge, N. Stratford; Route 105 Bridge	Columbia Bloomfield Stratford Brunswick	6 miles	**insufficient information on safety of swimming;** safe for other recreation **does not meet standards for aquatic habitat due to HIGH pH** **fish consumption unsafe - mercury**
CT River from confluence with Nulhegan River to confluence with Upper Ammonoosuc River	Stratford-Maidstone Bridge	Stratford Brunswick Northumberland Maidstone	19 miles	**unsafe for swimming due to bacteria;** safe for other recreation meets standards for aquatic habitat **fish consumption unsafe - mercury**
CT River from confluence with Upper Ammonoosuc River to ½ mile below Guildhall Bridge	Guildhall Bridge	Northumberland Maidstone Guildhall	3.7 miles	**unsafe for swimming due to bacteria;** safe for other recreation meets standards for aquatic habitat **fish consumption unsafe - mercury**

Appendix E. Connecticut River Sediment Quality

Data from:

1) *2000 Upper Connecticut River Valley Sediment Study*, US EPA Region 1. Study of 100 sites on 200 miles of mainstem and tributaries, Pittsburg, N.H. to Hartland, Vt.
2) *1998 Upper Connecticut River Sediment/Water Quality Analysis*, US EPA, Region 1. Study of 10 locations on the mainstem from Stewartstown to Hinsdale, N.H.

Sampling Location	Towns	Site	Contaminants that exceeded screening level	Source
Fourth Connecticut Lake	Pittsburg	SD201E	arsenic, cadmium, lead, mercury, above screening level value. Highest levels of calcium, selenium, and silver found anywhere in study. Also found in very low concentrations, but the highest found in the 200-mile study, were acetone, butenone, the pesticides 4,4'DDD, alpha-BHC, and methoxychlor, one PCB congener, and 5 kinds of dioxins.	2000 EPA study
Second Connecticut Lake	Pittsburg	SD200L	arsenic, nickel above screening level value.	
Lake Francis	Pittsburg	SD001L	arsenic, nickel above screening level value. Highest level of nickel in 200-mile study.	
Lake Francis	Pittsburg	SD095L	arsenic, nickel above screening level value.	
Connecticut River below Pittsburg Village	Pittsburg	SD002L	more pollutants exceeded the screening level here than anywhere on the mainstem except Wilder VT. Napthalene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, indeno (1,2,3-cd)pyrene, arsenic, nickel above screening level value. Also found in very low concentrations, but the highest found in the 200-mile study, were acetophenone and acenaphthylene.	
Connecticut River below confluence of Indian Stream	Clarksville	SD003L	phenanthrene, fluoranthene, pyrene, benzo(a) anthracene, chrysene, benzo(a)pyrene, arsenic	
Connecticut River below Lake Francis	Stewartstown	UCTR01	nickel, chrysene	1998 EPA study

Appendix E. Continued

Sampling Location	Towns	Site	Contaminants that exceeded screening level	Source
Connecticut River below confluence of Bishop Brook	Canaan	SD004L	pyrene, nickel	2000 EPA study
Connecticut River below confluence of Hall Stream	Canaan	SD005E	phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, indeno (1,2,3-cd) pyrene, arsenic. Also found in very low concentrations, but the highest found in the 200-mile study, were the pesticides aldrin, endosulfan, mirex, and t-Permithren.	
Connecticut River below Canaan Dam	Canaan	SDOO8E	phenanthrene, fluoranthene, pyrene, benzo(a) anthracene, chrysene, benzo(a)pyrene arsenic, nickel	
Connecticut River near Coös County Farm	Stewartstown	SD009L	nickel	
Connecticut River above Colebrook	Colebrook	SD010L	nickel	
Connecticut River above Colebrook Bridge	Colebrook	SD011L	phenanthrene, fluoranthene, pyrene, benzo(a) anthracene, chrysene, benzo(a)pyrene, indeno (1,2,3-cd)pyrene, nickel	2000 EPA study
Connecticut River at Columbia Bridge	Columbia	SD013L	phenanthrene, pyrene, benzo(a)anthracene, nickel	
Connecticut River at Lyman Brook	Columbia	SD014L	*no pollutants found above screening levels*	
Connecticut River below the Nulhegan River and Route 105 bridge	Bloomfield	SD016E	phenanthrene, pyrene, benzo(a)anthracene, benzo(a)pyrene Also found in very low concentrations, but the highest found in the 200-mile study, was pesticide beta-BHC.	
Connecticut River below the Nulhegan River	Brunswick	UCTR02	nickel, chromium	1998 EPA study
Connecticut River at Paul Stream	Bloomfield	SD017L	phenanthrene, pyrene, benzo(a)anthracene, benzo(a)pyrene, nickel. Also found in very low concentrations, but the highest found in the 200-mile study anywhere, was the pesticide heptachlor.	2000 EPA study
Connecticut River at Stratford-Maidstone Bridge	Stratford	SD019L	Bridge)phenanthrene, pyrene, benzo(a) anthracene, benzo(a)pyrene; Also found in very low concentrations, but the highest found in the 200-mile study, were the semi-volatile organic compounds benzaldehyde and phenol .	
Connecticut River above Groveton	Northumberland	SD020L	*no pollutants found above screening levels*	
Connecticut River above Groveton	Northumberland	SD096L	nickel	
Connecticut River above breached Wyoming Dam	Guildhall	UCTR03	nickel; low concentrations of the breakdown products of the pesticide DDT	1998 EPA study
Connecticut River above breached Wyoming Dam	Northumberland	SD023L	*no pollutants found above screening levels.* Also found in very low concentrations, but the highest found in the 200-mile study, was the pesticide endrin.	2000 EPA study
Connecticut River at Neal Brook, 1.7 miles below Wyoming Dam	Northumberland	SD023L	*no pollutants found above screening levels.*	

Appendix F. - Invasive Aquatic Species

Invasive Aquatic Species (may not be a complete list)		New Hampshire present	New Hampshire prohibited*	Vermont present	Vermont prohibited*	Present in CT River mainstem	Present in Headwaters Region
Floating Plants	European Naiad *Najas minor*	X	X	X		X	
	Water Chestnut *Trapa natans*	X	X	X			
	Yellow Floating Heart *Nymphoides peltata*		X	X			
Submerged Plants	Rock Snot *Didymosphenia geminata*	X		X		X	X
	Variable Milfoil *Myriophyllum heterophyllum*	X	X				
	Fanwort *Cabomba caroliniana*	X	X		X		
	Eurasian Water-Milfoil *Myriophyllum spicatum*	X	X	X		X	
	Brazilian Elodea *Egeria densa*	X	X		X		
	Curly-leaf Pondweed *Potamogeton crispus*	X	X	X		X	
	Parrot Feather *Myriophyllum aquaticum*		X				
	Hydrilla *Hydrilla verticillata*		X		X		
	European Frogbit *Hydrocharis morsus-ranae*		X	X	X		
	Indian Water Star *Hygrophila polysperma*				X		
	Giant Salvinia *Salvinia auriculata*				X		
	Giant Salvinia *Salvinia herzogii*				X		
	Giant Salvinia *Salvinia molesta*				X		
	Giant Salvinia *Salvinia biloba*				X		
	Great Water Cress *Rorippa amphibia*			X			

*prohibited species are those whose sale, transport, or propagation is not permitted by state law.

Appendix F. Continued

Invasive Aquatic Species (may not be a complete list)		New Hampshire present	New Hampshire prohibited*	Vermont present	Vermont prohibited*	Present in CT River mainstem	Present in Headwaters Region
Emergent Plants	Purple Loosestrife *Lythrum salicaria*	X	X	X		X	X
	Common Reed *Phragmites australis*	X	X	X		X	X
	Flowering Rush *Butomus umbellatus*		X	X			
	Japanese Knotweed *Fallopia japonica*	X		X		X	X
	Yellow Flag Iris *Iris pseudoacorus*	X		X		X	X
	True forget-me-not *Myosotis scorpioides*	X		X		X	X
Animals	Zebra Mussel *Dreissena polymorpha*			X			
	Faucet Snail *Bithynia tentaculata*			X			
	Chinese mystery snail *Cipangopaludina chinensis*			X			
	Common Carp *Cyprinus carpio*			X			
	Gizzard Shad *Dorosoma cepedianum*			X			
	White Perch *Morone americana*			X			
	Rusty Crayfish *Orconectes rusticus*		X	X			
	European Rudd *Scardinius erythrophthalmus*		X	X			
	Walking Catfish *Clarias batrachus*		X				
	Grass Carp *Ctenopharyngodon idella*		X				
	Round Goby *Neogobius monachus*		X				

*prohibited species are those whose sale, transport, or propagation is not permitted by state law.

Appendix G. Local Shoreland and Water Quality Protection

New Hampshire Towns

Town Tools	Pittsburg	Clarksville	Stewartstown	Colebrook	Columbia	Stratford	North-umberland
1. Master Plan is in effect	No	No	No	Yes (1993)	Yes (1985)	Yes (1992)	Yes (2003)
2. River is mentioned in master plan	No	No	No	Yes	Yes	Yes	Yes
3. Scenic/historic resources mentioned in master plan/ zoning	No	No	No	Yes	Yes	No	Yes
4. Zoning is in effect	No	No	No	Yes (2004)	Yes (1987)	Yes (1994)	Yes (2004)
5. Subdivision Regulations in effect	No	1981	Yes (1988)	Yes (2001)	Yes (1988)	Yes (2000)	Yes (2005)
6. Site Plan Review is in effect	No	No	No	Yes (2004)	No	No	Yes (1994)
7. Excavation Regulations in effect	No	No	No	Yes	No	No	Yes
8. Shoreland Protection Regulations	No	No	No	No	No	No	Yes
a. Building setback required from waterways? (50′ setback on CT River - state law)	No	No	No	Yes	No	No	No
b. Development prohibited in flood hazard area? *(100 year floodplain)*	No	No	No	Yes	No	No	Yes
c. Riparian buffer protected? *(150′ buffer on CT River where buffer exists- per state law)*	No	No	No	No	No	No	Yes
d. Overlay district for rivers &streams?	No	No	No	No	No	No	Yes - 125′
e. Minimum frontage required for shore lots? *(150′ min. on CT River if no sewer-state law)*	No	No	No	No	No	No	No

Appendix G. Continued

f. Local regulation of docks?	No	No	Stewartstown No	No	No	No	No
Town Tools	**Pittsburg**	**Clarksville**		**Colebrook**	**Columbia**	**Stratford**	**North-umberland**
9. Wetlands Regulations	No	No	No	Yes	No	No	Yes
a. Uses regulated in wetlands?	No	No	No	Yes	No	No	Yes
10. Groundwater Protection Regulations	No	No	No	No	No	No	Yes
a. Uses regulated over aquifers?	No	No	No	No	No	No	No
b. Well-head protection area defined?	No	No	No	No	No	No	No
c. On-site sewage disposal buffer for water supplies?	No	No	No	No	No	No	No
11. Agricultural Soils Protection Regulations	No	No	No	No	No	No	Yes
12. Steep Slopes Regulations	No	No	No	No	No	No	No
13. Town has a conservation commission	No	No	No	Yes	Yes	No	Yes

Source: North Country Council provided base information in June, 2005; updates provided by Headwaters Subcommittee representatives.

Vermont Towns

Town Tools	Canaan	Lemington	Bloomfield	Brunswick	Maidstone
1. Town Plan is in effect (most recent)	Expired	Expired	No	Expired	Expired
2. River mentioned in master plan	Yes - prime ag	Yes	n/a	Yes	Yes
3. Scenic or historic resources mentioned in master plan and/or zoning	Yes	Yes	n/a	No	Yes
4. Zoning is in effect	Yes	Yes	No - flood regs only	Yes	Yes
5. Subdivision Regulations in effect	No	No	No	No	Yes
6. Site Plan Review in effect	Yes	Yes	No	Yes	Yes
7. Excavation Regulations in effect	Yes	Yes	No	No	No
8. Shoreland Protection Regulations	Wallace Pd. only	Yes	No	Yes	Yes
a. Building setback required from waterways? *(No state protection)*	Wallace Pd. only	Yes - 50'	No	Yes	Yes - depends on slope

Appendix G. Continued

Town Tools	Canaan	Lemington	Bloomfield	Brunswick	Maidstone
b. Development prohibited in flood hazard area? *(100 year floodplain)*	No	No	No	No	No
c. Riparian buffer protected?	Wallace Pd. only	No	No	No	Yes
d. Overlay district for rivers & streams?	Wallace Pd. only	No - but 50′ setback	No	Yes - 100′ all lakes/ streams	Yes - 500′ lakes & ponds over 10a. ex. Maidstone Lake
e. Minimum frontage for shore lots?	No	No	No	Yes	Yes
f. Local regulation of docks?	No	No	No	No	No
9. Wetlands Regulations	No	No	No	No	No
a. Uses regulated in wetlands?	No	No	No	No	No
b. Activities regulated in a buffer zone around wetlands?	No	No	No	No	No
10. Groundwater Protection Regulations	No	No	No	No	No
a. Uses regulated over aquifers ?	No	No	No	No	No
b. Well-head protection area defined?	No	No	No	No	No
c. On-site sewage disposal buffer around water supplies?	No	No	No	No	No
11. Agricultural Soils Protection Regulations	Ag district - 10 acre	Ag district - 5 acre min	No	No	Ag district
12. Steep Slopes Regulations	No	No	No	No	No
13. Conservation commission	No	No	No	No	No

Source: Northeastern Vermont Development Association, June 2005

*Vermont town plans expire after five years.

Appendix H. Registered Water withdrawals in New Hampshire

Type	Name	Facility	Town	Source	Source Type
water supplier	Pittsburg Water Dept.	Pittsburg Water Department	Clarksville	Clarksville wells	groundwater
institutional	Coos County Farm	Coos County Farm	Stewartstown	wells	groundwater
water supplier	Colebrook Town	Colebrook Water Works	Colebrook	wells	groundwater
mining	Columbia Sand & Gravel	Columbia Sand & Gravel	Columbia	Connecticut River	surface water
water supplier	Stratford Water Works	No Stratford Water Works	Stratford	wells	groundwater
water supplier	Northumberland Town	Groveton Village Precinct	Northumberland	Hughes & Moore Brook	surface water
water supplier	Northumberland Town	Groveton Village Precinct	Northumberland	wells	groundwater
water supplier	Northumberland Town	Northumberland Water Prec	Northumberland	Lost Nation wells	groundwater
industrial	Wausau Papers of NH Inc*	Groveton Division	Northumberland	Upper Ammonoosuc R.	surface water
hydroelectric power	Power House Systems	Weston Dam	Northumberland	Upper Ammonoosuc R.	surface water

* While this withdrawal remains registered, Wausau Papers of NH Inc. has closed its doors as of this writing.

Appendix I. New Hampshire Comprehensive Shoreland Protection Act NH RSA 483-B

The New Hampshire shore of the Connecticut River, from the river's source at Fourth Connecticut Lake, is covered by this law. The law also applies to lakes and ponds of 10 acres or more, and to other rivers and streams in New Hampshire's Headwaters Region that are fourth order and larger:

City/ Town	River/ Stream	Stream Order	Upstream limit of section covered by law (beginning of fourth order or designated segment)
Pittsburg	Connecticut River	4 & 5	(all; becomes 4th order at juncture of Scott Brook)
	Halls Stream	4	Juncture of 3rd order stream from Connecticut
	Indian Stream	4	Juncture of Middle and East Branch Indian Stream
	Roby Brook	4	Outflow of Shehan Pond in Clarksville
	Middle Branch Indian Stream	4	Juncture of unnamed 3rd order stream
	West Br. Dead Diamond R.	4	Juncture of Roby Brook
	East Inlet	4	Juncture with unnamed 3rd order stream
Clarksville	Connecticut River	5	(all)
	Bishop Brook	4	Juncture of Pond Brook in Stewartstown
	Cedar Stream	4	Juncture of Bog Branch
	Roby Brook	4	Outflow of Shehan Pond
Stewartstown	Connecticut River	5	(all)
	Bishop Brook	4	Juncture of Pond Brook
	Halls Stream	4	Junction of 3rd order stream from Vermont
Colebrook	Connecticut River	5 & 6	(all)
	Mohawk River	5	Juncture of unnamed 3rd order stream
	East Branch Mohawk River	4	Juncture of unnamed 3rd order stream
	West Branch Mohawk River	5	Juncture of East Branch Mohawk River
Columbia	Connecticut River	6	(all)
	Simms Stream	4	Juncture of East Branch Simms Stream
Stratford	Connecticut River	6	(all)
	Bog Brook	4	Juncture of unnamed 3rd order stream
	Nash Stream	4	Juncture of Pond Brook
Northumberland	Connecticut River	6	(all)
	Upper Ammonoosuc River	5	Juncture of Stony Brook in Berlin

New Hampshire's shoreland law was originally enacted in 1991, setting minimum standards for the subdivision, use, and development of shorelands of the state's larger water bodies. In 2005 the Legislature established a commission to study the effectiveness of the act. The Commission was comprised of 24 members representing a variety of stakeholders including the General Court, the conservation community, the regulatory community, natural resource scientists, agricultural interests, business and economic interests, and members of the general public. Its final report contained 17 recommendations for changes to the law, 16 of which were enacted and became effective April 1, 2008. The changes include impervious surface allowances, ways of measuring riparian buffer vegetation that are easier for landowners to understand and use, a provision for a waterfront buffer in which vegetation removal is restricted, shoreland protection along rivers designated under RSA 483 (Designated Rivers), and the establishment of a permit requirement for many construction, excavation or filling activities within the 250 foot protected shoreland area. For more information about the NH Shoreland Program, contact NH DES at 603-271-3503 or http://des.nh.gov/organization/divisions/water/wetlands/cspa/index.htm.

Appendix I. Continued

RSA 483-B
Comprehensive Shoreland Protection Act (CSPA)
A Summary of the Standards

Effective July 1, 2008**, A STATE SHORELAND PERMIT is required for many construction, excavation or filling activities within the Protected Shoreland**. Forest management not associated with shoreland development or land conversion and conducted in compliance with RSA 227-J:9 or under the direction of a water supplier for the purpose of managing a water supply watershed, and agriculture conducted in accordance with best management practices as required by RSA 483-B, III is exempted from the provisions of the CSPA. Projects that receive a permit under RSA 482-A, e.g., beaches, do not require a shoreland permit. A complete list of activities that do not require a shoreland permit can be found in the Shoreland Administrative Rules, Env-Wq 1406.

250 feet from Reference Line—THE PROTECTED SHORELAND:

Impervious Surface Area Allowance. Twenty percent of the area within the protected shoreland may be impervious surface. This may be increased up to 30 percent if there are 50 points of tree coverage in each 50 foot x 50 foot grid segment in the waterfront buffer (WB), and a storm water management plan is submitted and approved by DES.

Other Restrictions:

- No establishment/expansion of salt storage yards, auto junk yards, solid waste and hazardous waste facilities.
- All new lots, including those in excess of 5 acres are subject to subdivision approval by DES.
- Setback requirements for all new septic systems are determined by soil characteristics.
  - 75 feet for rivers and areas where the there is no restrictive layer within 18 inches and where the soil down gradient is not porous sand and gravel (perc>2 min.).
  - 100 feet for soils with a restrictive layer within 18 inches of the natural soil surface.
  - 125 feet where the soil down gradient of the leachfield is porous sand and gravel (perc rate equal to or faster than 2min/in.).
- Minimum lot size in areas dependent on septic systems determined by soil type.
- Alteration of Terrain Permit standards reduced from 100,000 square feet to 50,000 square feet.
- For *new* lots with on-site septic, the number of dwelling units per lot shall not exceed 1 unit per 150 feet of shoreland frontage.

150 feet from Reference Line—NATURAL WOODLAND BUFFER (NWB) RESTRICTIONS:

- For lots that contain ½ acre or more within the NWB, between 50 feet and 150 feet of the reference line, the vegetation within at least 50 percent of the area, exclusive of impervious surfaces, shall be maintained in an unaltered state.
- For lots that contain less than ½ acre within the NWB, between 50 feet and 150 feet of the reference line, the vegetation within at least 25 percent of the area shall be maintained in an unaltered state.

50 feet from Reference Line—WATERFRONT BUFFER and PRIMARY BUILDING SETBACK:

- Effective April 1, 2008, all primary structures must be set back at least 50 feet from the reference line. Towns may maintain or enact their own setback only if it is greater than 50 feet.
- Within 50 feet, a waterfront buffer must be maintained. Within the waterfront buffer, tree coverage is managed with a 50-foot x 50-foot grid and points system. Tree coverage must total 50 points in each grid. Trees and saplings may be cut as long as the sum of the scores for the remaining trees and saplings in the grid segment is at least 50 points.
- No natural ground cover shall be removed except for a footpath to the water that does not exceed 6 feet in width and does not concentrate stormwater or contribute to erosion.
- Natural ground cover, including the duff layer, shall remain intact. No cutting or removal of vegetation below 3 feet in height (excluding lawns) except for the allowable footpath. Stumps, roots, and rocks must remain intact in and on the ground.
- Pesticide or herbicide applications must be by a licensed applicator only.
- Low phosphorus, slow release nitrogen fertilizer may be used for the area that is beyond 25 feet from the reference line. No fertilizer, except limestone, shall be used between the reference line and 25 feet.

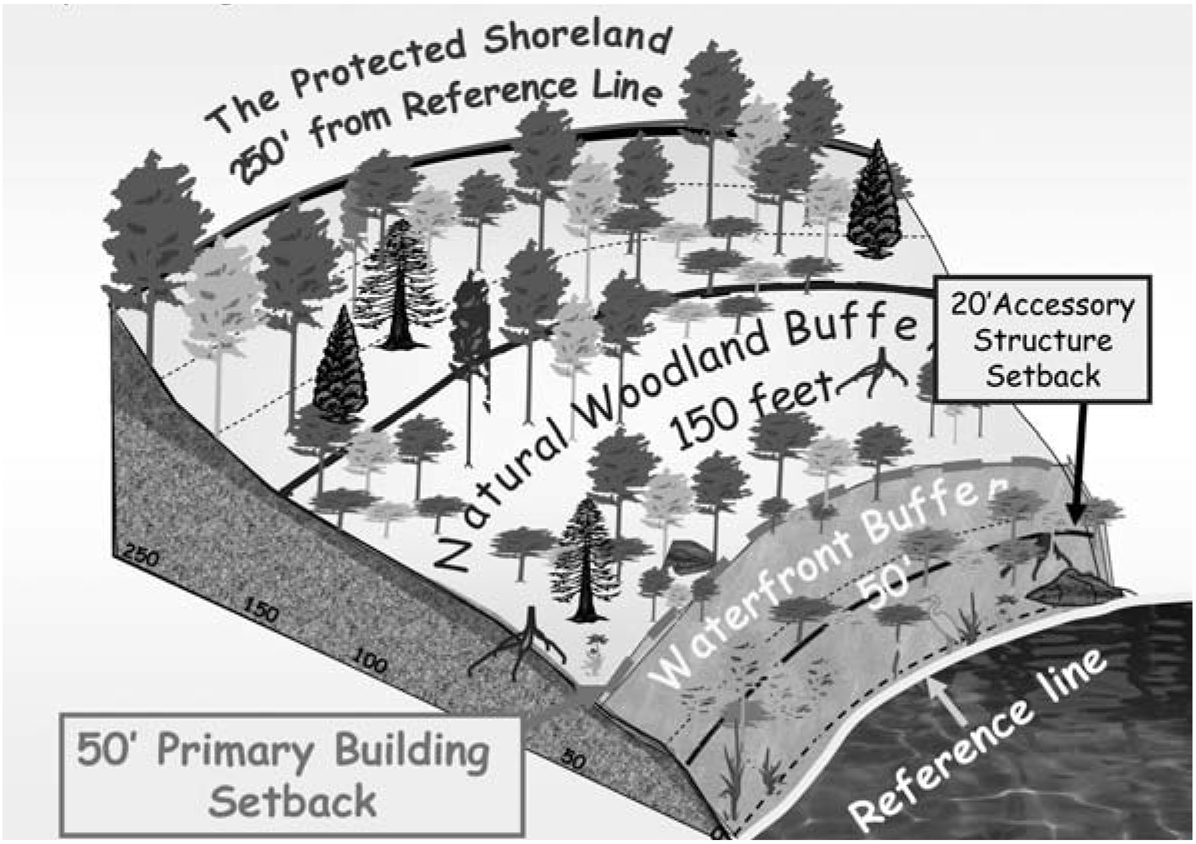
REFERENCE LINE: For ***coastal waters*** it is the highest observable tide line; for ***rivers*** it is the ordinary high water mark; for ***natural fresh waterbodies*** it is the natural mean high water level; and for ***artificially impounded fresh waterbodies*** it is the elevation at the spillway crest or, if there are flowage rights, the elevation of the flowage rights.

NON-CONFORMING STRUCTURES Are structures that, either individually or when viewed in combination with other structures on the property, do not conform to the provisions of the CSPA, including but not limited to the impervious surface limits of RSA 483-B:9V(g). They may be repaired, renovated, or replaced in kind using modern technologies, provided the result is a functionally equivalent use. Such repair or replacement may alter the interior design or existing foundation, but shall result in no expansion of the existing footprint except as authorized by the department pursuant to paragraph II of RSA 483-B.

A SITE ASSESSMENT is required prior to executing a purchase and sale agreement for any "developed waterfront property" using a septic disposal system and which is contiguous to or within 200 feet of a great pond (a public water of more than 10 acres) as defined in RSA 4:40-a and upon which stands a structure suitable for either seasonal or year-round human occupancy.

For more information, please visit the DES Shoreland Website at www.des.nh.gov/cspa

Appendix I. Continued



The protected shoreland in New Hampshire with setbacks and areas of restricted use. Source: N.H. Department of Environmental Servieces, 2009.

Appendix J. Tributaries to the Connecticut River

New Hampshire

Tributary	State Assessment*	Sediment Quality** contaminants found above level at which ecological effects might be expected	Local Observations
Town where tributary enters Connecticut River: Pittsburg			
Brooks feeding CT Lakes	safety of swimming, fishing – most not assessed health of aquatic life - insufficient information	not assessed	
Scotts Bog	Safe for swimming and boating; health of aquatic life not assessed***	not assessed	
Big Brook Bog	safety of swimming, fishing, health of aquatic life - insufficient information	not assessed	
Perry Stream	safety of swimming, fishing - not assessed health of aquatic life - insufficient information	not assessed	
Indian Stream	health of aquatic life - insufficient information safety of swimming, fishing - not assessed; likely not supporting in lowest reach***	not assessed	
Back Lake Brook	not assessed; Back Lake has cyanobacteria	not assessed	
Halls Stream	lower 10 miles unsafe for swimming - E. coli, unknown source. Elevated lead. Safe for fishing. Insufficient information on health of aquatic life.	SD 006L &, SD007L both showed arsenic & nickel; highest arsenic level at lower Halls Stream found in the study.	
Town where tributary enters Connecticut River: Stewartstown			
Bishop Brook	6.61 miles contaminated with E. coli from an unknown source. Safe for fishing. Health of aquatic life - insufficient information	not assessed	
Town where tributary enters Connecticut River: Colebrook			
Mohawk River	safe for swimming, fishing health of aquatic life - insufficient information	SD012L (near Nash Equipment on Carlton Hill Rd. Bridge) phenanthrene, fluorathene, pyrene, benzo(a)anthracene, chrysene, benzo(a)pyrene, indeno (1,2,3-cd)pyrene, nickel. Highest manganese level found anywhere in this study.	Subject of CRJC geomorphic assessment, 2005.
Town where tributary enters Connecticut River: Columbia			
Simms Stream	9.57 miles contaminated with E. coli Insufficient info on fishing, health of aquatic life	not assessed	Forested watershed with good riparian buffer; stream passes both dispersed and concentrated development. Watershed includes tributaries in Bunnell Preserve. Lime Pond (conserved) and Fish Pond are sources. Road along waterway for short distance; 3.5 miles logging road follow stream. No invasives observed. Bottom type varies from small boulders to silt. 1 well near Rt. 3. No evident WQ problems, flow tends to be consistent. Snowmachine trail crossing on bridge. Some fishing, coldwater fishery. No swimming.

Appendix J. Continued

Tributary	State Assessment*	Sediment Quality** contaminants found above level at which ecological effects might be expected	Local Observations
Harvey Brook	not assessed	not assessed	Forested watershed with good riparian buffer; passes through Xmas tree plantation where chemicals are used. Japanese knotweed, trash close to CT River confluence. Bottom type small cobbles to gravel. 1 well nearby. No evident WQ problems. Flow observed to disappear into ground before reaching CT River (9/06 obs.) Large sand/gravel bar in brook just above confluence.
Sweatt Brook	not assessed	not assessed	Forested watershed with good riparian buffer, passes 2 houses and 1 camp. Route 3 and RR trestle cross brook. Rt. 3culvert pad is above water level. Bottom type largely small boulders to gravel. No evident WQ problems, flow tends to be relatively consistent. Private ATV trail may be near or cross this brook.
Beaver Brook	not assessed	not assessed	Forested watershed with minor dispersed development. Ledge pack mining and gravel operation close to riparian buffer. Route 3, minor road, and RR cross brook. Perched culvert on Route 3 blocks fish passage. Some erosion. Bottom type varies from small boulders and cobbles to silt. Some road runoff. No recreational use. Good riparian buffer.
Cone Brook	Bio-assessments have been done, and the stream appears on the state's impaired list for aquatic life.	not assessed	Forested watershed with good riparian vegetation; drains Bunnell Preserve. Some Japanese knotweed at nearby residence, not down stream yet. RR trestle has large granite block apron, may block fish movement at low water. Bottom type varies from small boulders to gravel. Coldwater fishery, little fishing use. No evident WQ problems, flow consistent. Roadside trash at Rt. 3. Snowmachine trail close in some places. Sand/gravel bar at confluence.
Lyman Brook	not assessed	not assessed	Forested watershed with good riparian vegetation; 95% in conserved land in Bunnell Preserve. Passes 3 houses and 3 camps. Some erosion. Road and RR cross. Some tributaries have waterfalls and beaver activity. Bottom type largely small boulders to gravel. Nearby wells. Some turbidity with heavy rain. Flow relatively consistent. Trash near bridge. Popular swimming holes, at 2d bridge and at old mill site below. Coldwater fishery, used for fishing. Established snowmachine trail and trespassing ATV use. Gated road follows brook .
Town where tributary enters Connecticut River: Stratford			
Bog Brook	insufficient info on safety of swimming, fishing, health of aquatic life	not assessed	
Kimball Brook	1.63 miles not healthy for aquatic life - pH from unknown source. Safe for swimming and fishing	not assessed	water quality has improved since wastewater treatment plant discharge moved from this brook to the CT River.
Bissell Brook	not assessed	not assessed	

Appendix J. Continued

Tributary	State Assessment*	Sediment Quality** contaminants found above level at which ecological effects might be expected	Local Observations
Nash Stream	bio-assessments done;5.896 miles impaired for aquatic life.		Subject of habitat assessment and restoration effort by Trout Unlimited.
Connary Brook	not assessed	not assessed	
Town where tributary enters Connecticut River: Northumberland			
Potter Brook	not assessed	not assessed	
Upper Ammonoosuc River	not healthy in some areas for aquatic life - pH from unknown source safe in some areas for swimming, fishing, boating	SD021L (below WWTF and Wausau) - phenanthrene, pyrene, fluorathene, benzo(a) anthracene, chrysene, benzo(a) pyrene SD022L (Potter Brook above Groveton) - pyrene	Subject of CRJC geomorphic assessment, 2005. Upper watershed partly located in White Mountain National Forest. Lower river significantly altered by failure of Nash Stream Dam in 1969. Wausau Paper withdraws processing water from the river and has its own wastewater treatment plant.
Burnside Brook	5.85 miles impaired by low pH and E. coli		

* 2008 draft NH 303(d) list of Impaired Surface Waters
**2000 *Upper Connecticut River Valley Sediment Study*, US EPA, Region 1. Study of 100 sites on 200 miles of mainstem and inside mouths of tributaries, Pittsburg NH to Hartland VT
***For more information on the condition of NH water bodies, see NH DES Water Division - Surface Water Quality Assessments and "report cards" for each water body at http://www2.des.nh.gov/SWQA/SWQAList.aspx

Vermont

Tributary	State Assessment*	Sediment Quality**	Local Observations
Town where tributary enters Connecticut River: Canaan			
Halls Stream	2002 VT Surface Water Quality Assessment Report: The unlined industrial waste lagoon at Ethan Allen, located 200' from Hall Stream in Beecher Falls, VT, contains process wastewater and sludge from furniture finishing. Monitoring by the states has found that while no toxicants were found in the surface water of Hall Stream, semi-volatile organics are present in its sediments up and downstream from site, and threatens the use of this water for agricultural irrigation.	not assessed	Heavy agricultural use and cropping close to riverbank on Canadian side. Little to no riparian buffer on Canadian side.
Leach Creek	sedimentation from stream instability from Route 102 up to Wallace Pond; needs further assessment	not assessed	Severe erosion after micro burst in 2004; heavy clearing in this watershed has led to sediment deposits in the CT River. Subject of NRCS study.
Bolter Brook (also known as Capon Bk)	not assessed	not assessed	Severe erosion after micro burst in 2004; heavy clearing in this watershed has led to sediment deposits in the CT River. Subject of NRCS study.
Willard Stream	sedimentation from stream instability from mouth up to Route 102; needs further assessment	not assessed	
Town where tributary enters Connecticut River: Lemington			
Mill Brook	not assessed	not assessed	
Blodgett Brook	not assessed	not assessed	

Appendix J. Continued

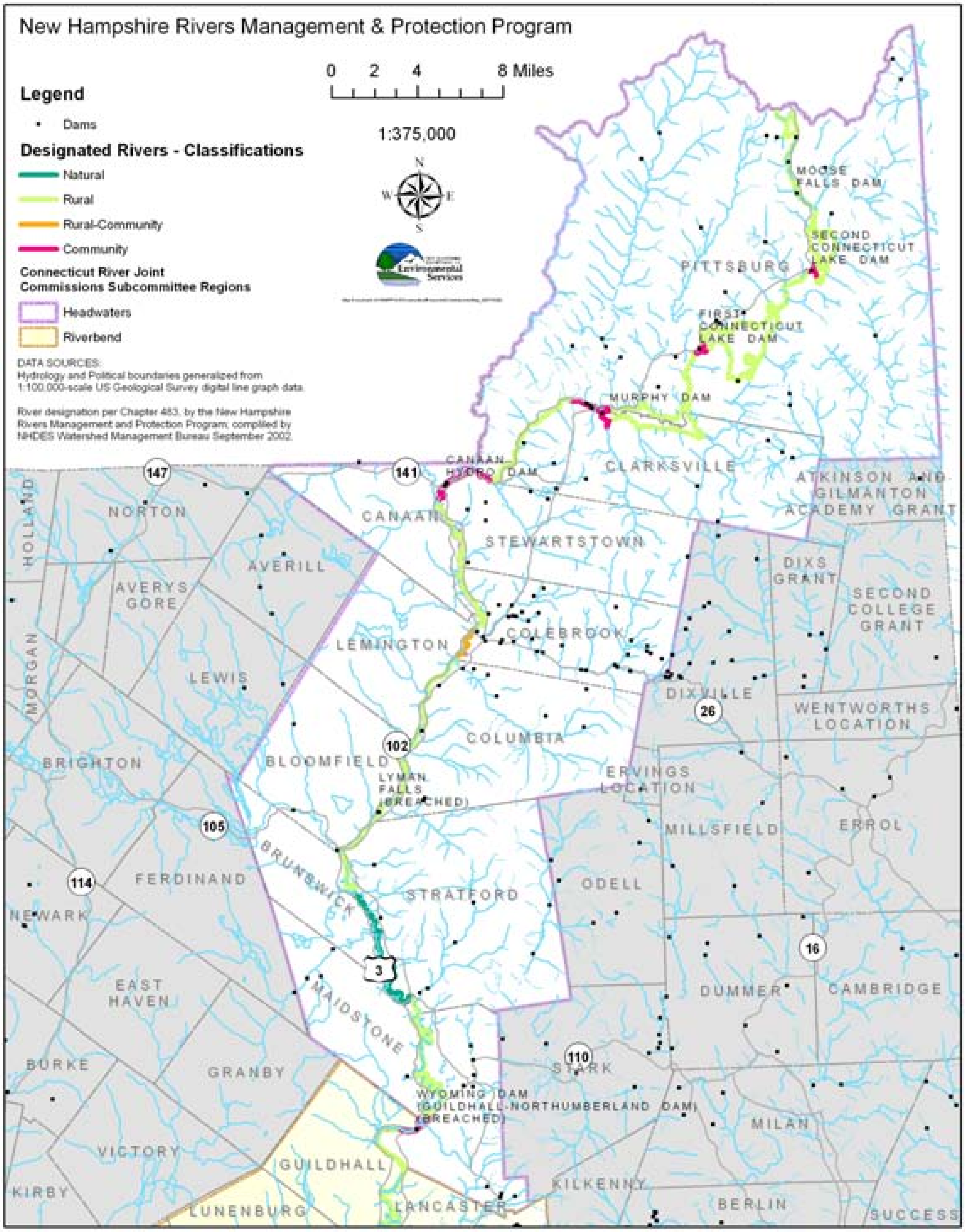
Tributary	State Assessment*	Sediment Quality**	Local Observations
Town where tributary enters Connecticut River: Bloomfield			
Clough Brook	low pH, medium to low buffering; needs further assessment	not assessed	2d order stream; most of watershed in Lemington, largely forested, some agriculture & dispersed residential development. Little road runoff. Bottom type large boulders to gravel, some sand. No evident WQ problems; flow tends to be consistent. Public access.
Daley Brook	not assessed	not assessed	2d order stream Watershed completely forested. Bottom type varies from ledge to small boulders, cobbles, and gravel; some sand. No evident WQ problems; flow tends to be consistent. Not a source of drinking water.
Mill Brook	not assessed	not assessed	2d order stream Forested watershed with minor dispersed development and road along waterway. Some road runoff. Bottom type ledge to cobbles and gravel. Waterfall. Minor erosion. No evident WQ problems. Flow tends to be relatively consistent. Public access. Scenic
Nulhegan River	East Branch: sedimentation resulting from erosion associated with logging; needs further assessment	SD015L - no pollutants found above screening levels	3-4th order. Watershed largely forested with some dispersed development, road and railroad along waterway, Conte Refuge and state conserved land. Some road runoff; minor lawn runoff. Bottom type varies from large to small boulders to gravel, sand and silt. Not a source of drinking water. No evident WQ problems. Flow tends to be relatively consistent. Used for swimming, fishing, canoeing/ kayaking. Public access. Very scenic.
Town where tributary enters Connecticut River: Brunswick			
Wheeler Stream	not assessed	not assessed	Tree revetment project installed by NRCS near confluence with Connecticut River.
Paul Stream	not assessed	SD018L - no pollutants found above screening levels	

* 2008 VT draft 303(d) List of Impaired Surface Waters and 2008 draft VT List of Priority Surface Waters Outside the Scope of Clean Water Act Section 303(d)
***2000 Upper Connecticut River Valley Sediment Study*, US EPA, Region 1. Study of 100 sites on mainstem and inside mouths of tributaries, Pittsburg NH to Hartland VT

Appendix K. List of Acronyms

BMP = best management practices
CFS = cubic feet per second
CREP = Conservation Reserve Enhancement Program (Vermont)
CRJC = Connecticut River Joint Commissions
CRWC = Connecticut River Watershed Council
EPA = United States Environmental Protection Agency
FEMA = Federal Emergency Management Administration
FERC = Federal Energy Regulatory Commission
NH DES = New Hampshire Department of Environmental Services
NRCS = Natural Resources Conservation Service of USDA
TMDL = total maximum daily load
USDA = United States Department of Agriculture
USGS = United States Geological Survey
UST= underground storage tank
VRAP = Volunteer River Assessment Program
VT DEC = Vermont Department of Environmental Conservation
VT ANR = Vermont Agency of Natural Resources
WWTF = wastewater treatment facility

Appendix L. Headwaters Region Map and River Classifications



ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

R&L-14 2009

River Classifications and State Regulated Protection Measures As They Apply To Each Classification

	RIVER CLASSIFICATIONS			
	Natural	**Rural**	**Rural-Community**	**Community**
Activities Allowed				
Dams & Encroachments				
Construction of New Dams	No	No	No	Yes
Reconstruction of Breached Dams	No	Yes (within six years)	Yes (within six years)	Yes
Channel Alterations	No (excluding repair)	Yes (with conditions)	Yes (with conditions)	Yes (with conditions)
Water Quality/ Water Quantity				
Water Quality	Class A or B	Class B	Class B	Class B
Interbasin Transfers	No	No	No	No
Protected Instream Flow	Yes	Yes	Yes	Yes
Waste Disposal				
New Landfills	No (within 250 ft.)	No (within 250 ft.)	No (within 250 ft.)	No (within 250 ft.)
New Hazardous Waste Facilities	No (within 250 ft.)	No (within 250 ft.)	No (within 250 ft.)	No (within 250 ft.)
Other New Solid Waste Facilities	No (within 250 ft.)	No (within 250 ft.)	No (within 250 ft.)	No (within 250 ft.)
New Septic Systems	No (within 75 ft.)	No (within 75 ft.)	No (within 75 ft.)	No (within 75 ft.)
New Auto Junk Yards	No (within 250 ft.)	No (within 250 ft.)	No (within 250 ft.)	No (within 250 ft.)
Fertilizer				
Limestone	Yes	Yes	Yes	Yes
Sludge and Septage	No (within 250 ft.) Conditions apply	No (within 250 ft.) Conditions apply	No (within 250 ft.) Conditions apply	No (within 250 ft.) Conditions apply
Low Phosphorus, Slow Release Nitrogen	No (within 25 ft.)	No (within 25 ft.)	No (within 25 ft.)	No (within 25 ft.)

All Other Fertilizers	No (within 25 ft.)	No (within 25 ft.)	No (within 25 ft.)	No (within 25 ft.)
Pesticides and Herbicides				
All pesticides and herbicides	Yes (with conditions)	Yes (with conditions)	Yes (with conditions)	Yes (with conditions)
Recreation Use				
Motorized Watercraft	No	Yes (within 150 ft. of shoreline, only "headway" speed)	Yes (within 150 ft. of shoreline, only "headway" speed)	Yes (within 150 ft. of shoreline, only "headway" speed)
New Building				
Primary Structure	No (within 50 ft.)	No (within 50 ft.)	No (within 50 ft.)	No (within 50 ft.)
Multiple Dwellings	Yes (with conditions)	Yes (with conditions)	Yes (with conditions)	Yes (with conditions)
Impervious Surface Cover	Yes (with conditions)	Yes (with conditions)	Yes (with conditions)	Yes (with conditions)
Subdivision	Yes (with approval)	Yes (with approval)	Yes (with approval)	Yes (with approval)l
Buffer Removal				
Natural Ground Cover	No (within 50 ft., except for 6 ft. path)	No (within 50 ft., except for 6 ft. path)	No (within 50 ft., except for 6 ft. path)	No (within 50 ft., except for 6 ft. path)
Stumps, Roots and Rocks	No (within 50 ft.)	No (within 50 ft.)	No (within 50 ft.)	No (within 50 ft.)

For further information about the N.H. Rivers Management and Protection Program visit the DES website at www.des.nh.gov/organization/divisions/water/wmb/rivers/index.htm or contact Steve Couture, Rivers Coordinator, 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095; (603) 271-8801; steven.couture@des.nh.gov.

Appendix M. Water Resources Maps

Maps created for CRJC by Upper Valley Lake Sunapee Regional Planning Commission, by Rachel Ruppel, GIS analyst, December, 2007.

Data Sources:
NH base map features, including roads and railways, from 1:24,000 Digital Line Graph (DLG) data supplied by Complex Systems Research Center, UNH (CSRC). VT base map features from 1:5,000 orthophotos distributed by VT Center for Geographic Information (VCGI). VT roads from Enhanced 911 Board, distributed by VCGI. VT railway from USGS 1:100,000 DLG data, distributed by VCGI, 1987.

NH watershed boundaries by US Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) and NH Department of Environmental Services (NHDES), 1:24,000 scale, distributed by CSRC, 1983. VT watershed boundaries by USDA NRCS, 1:24,000 scale, from USGS DLG's and Digital Raster Graphics (DRG), distributed by VCGI.

Wetlands data provided by the US Fish & Wildlife Service, National Wetlands Inventory (NWI). NH wetlands distributed by CSRC, 1:24,000 scale. VT wetlands distributed by VCGI, 1:80,000 scale.

Aquifers mapped by US Geological Survey (USGS) in cooperation with NHDES, 1:24,000 scale, distributed by CSRC, 2000. For detailed information, see Geohydrology and Water Quality of Stratified-Drift Aquifers in the Middle Connecticut River Basin, West-Central NH, USGS Water-Resources Investigations Report 94-4181 or Geohydrology and Water Quality of Stratified-Drift Aquifers in the Upper Connecticut and Androscoggin River Basins, northern New Hampshire: USGS Water-Resources Investigations Report 96-4318. No digitized aquifers available in the state of VT.

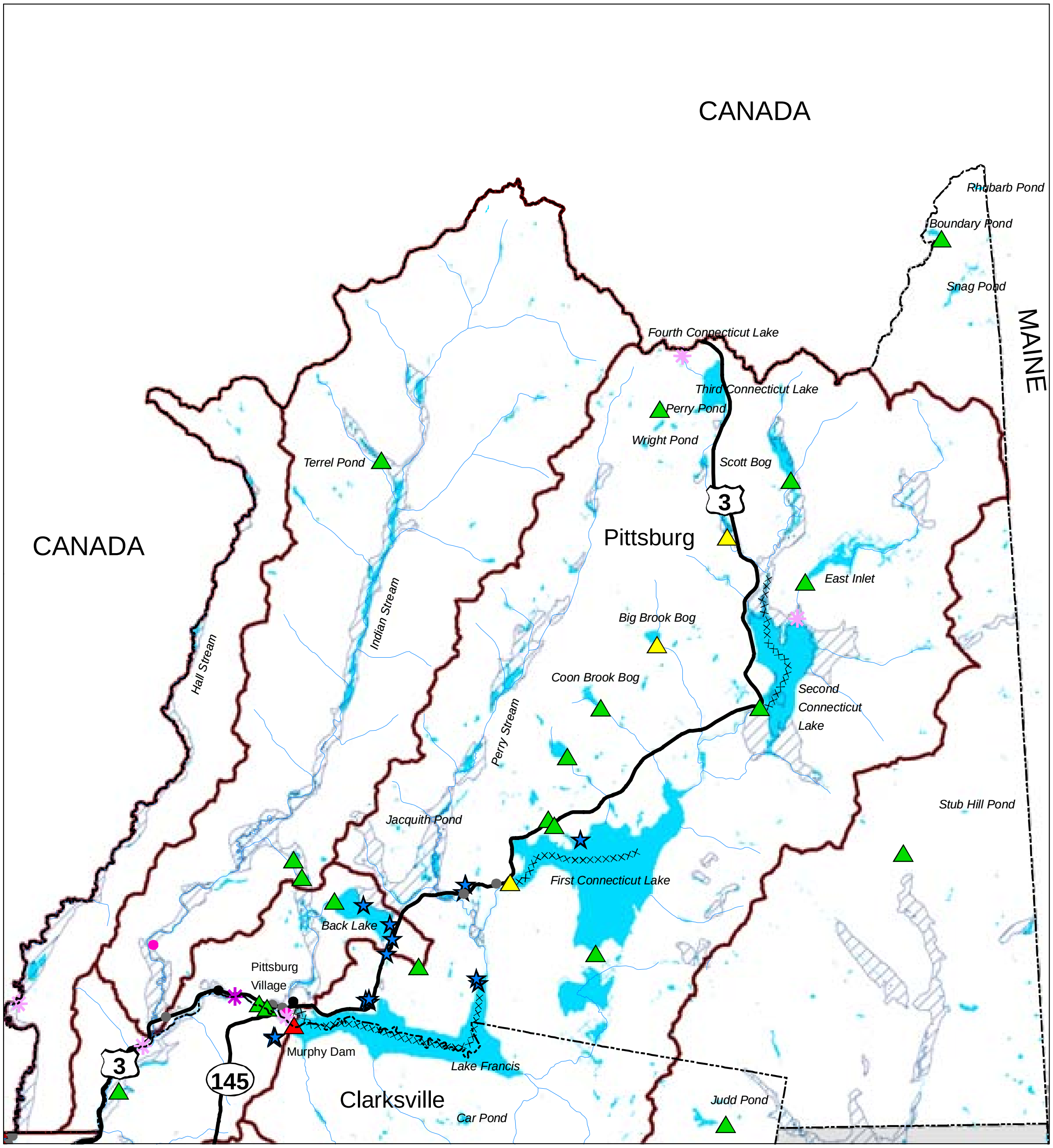
NH public drinking water supply sources from NHDES, 1:24,000 scale, distributed by NHDES, 1997. VT public drinking water sources by Halliburton NUS Corporation, funded by US Environmental Protection Agency (EPA), distributed by Vermont Agency of Natural Resources (VTANR), 1994.

Sediment locations from Weston Solutions, Inc., 2000, distributed by US Environmental Protection Agency--New England, funded in cooperation with NHDES and VTANR. See Upper Connecticut River Valley Sediment Study from Weston Solutions, Inc. for detailed information on sediment samples. This study sampled river sediments in 100 locations along the mainstem and inside the mouths of tributaries between Fourth Connecticut Lake in Pittsburg, NH and the confluence of the Ottauquechee River in Hartland, VT. Sediments were analyzed for the presence of 159 possible contaminants. "High risk priority" means that the concentration of the pollutant(s) found in the sediment suggests a strong likelihood of impacts to aquatic life. "Moderate risk priority" means that the concentration of the pollutant(s) found in the sediment suggests a moderate likelihood of impacts to aquatic life.

Potential water quality threats in NH distributed by NHDES include the following:
  Underground Storage Tank Facilities, 2004.
  Automobile Salvage Yards, 1991.
  Point/Non-point Potential Pollution Sources**
  Groundwater Hazard Inventory, 2003 **
**Refer to written report for more detailed information on each potential water quality threat categories.

Potential Water Quality Threats in VT from VTANR distributed by VCGI include Underground Storage Tank Facilities and the Pollution Source Inventory of 1980.

The impoundment zone, or upstream extent of impoundments, generated by MicroData, 1994, based on source data provided by Connecticut River Joint Commissions.



Water Resources - Pittsburg, NH

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
xxxxx Impoundment Zone

Public Water Supply

Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

N W E S

Water Quality Threats

VT Pollution Source Inventory of 1980
- C Petrochemicals
- F Agricultural Wastes
- K Liquid Waste to Land Surface/Subsurface
- L Landfilll/Dump
- P Lagoon-Municipal
- U Salt/Salted Sand

Underground Storage Tank Facilities

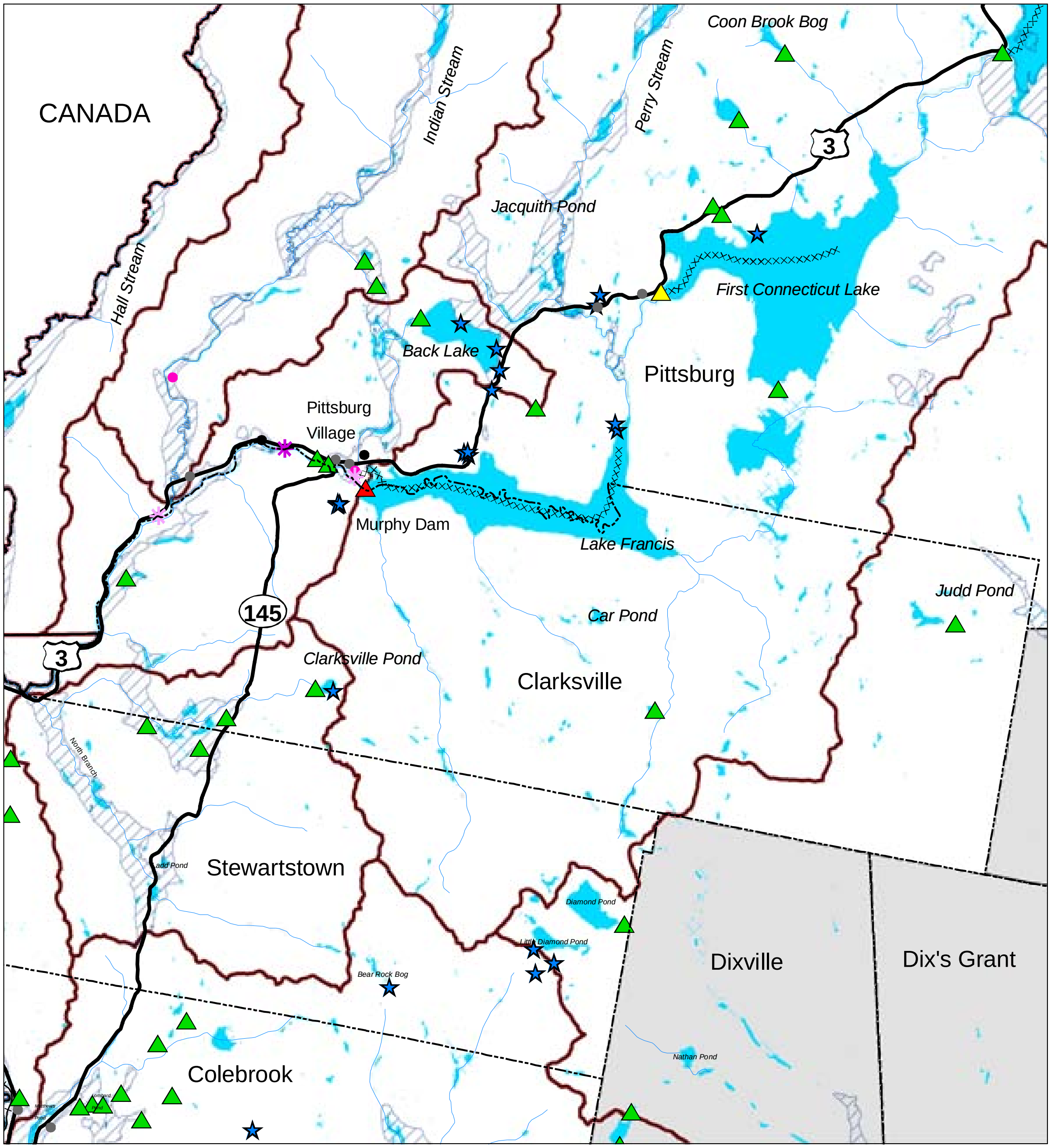
NH Water Quality Threat Inventories
- Snow Dump/Salt Storage
- Large Septic System
- Lagoon
- Landfill/Dump

2 0 2 4 Miles

1:185,000

Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, December 2007.

Funding provided by CRJC and US Gen New England.



Water Resources - Clarksville, NH

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
xxxxx Impoundment Zone

Public Water Supply

Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

N W E S

Water Quality Threats

VT Pollution Source Inventory of 1980
- C Petrochemicals
- F Agricultural Wastes
- K Liquid Waste to Land Surface/Subsurface
- L Landfilll/Dump
- P Lagoon-Municipal
- U Salt/Salted Sand

Underground Storage Tank Facilities

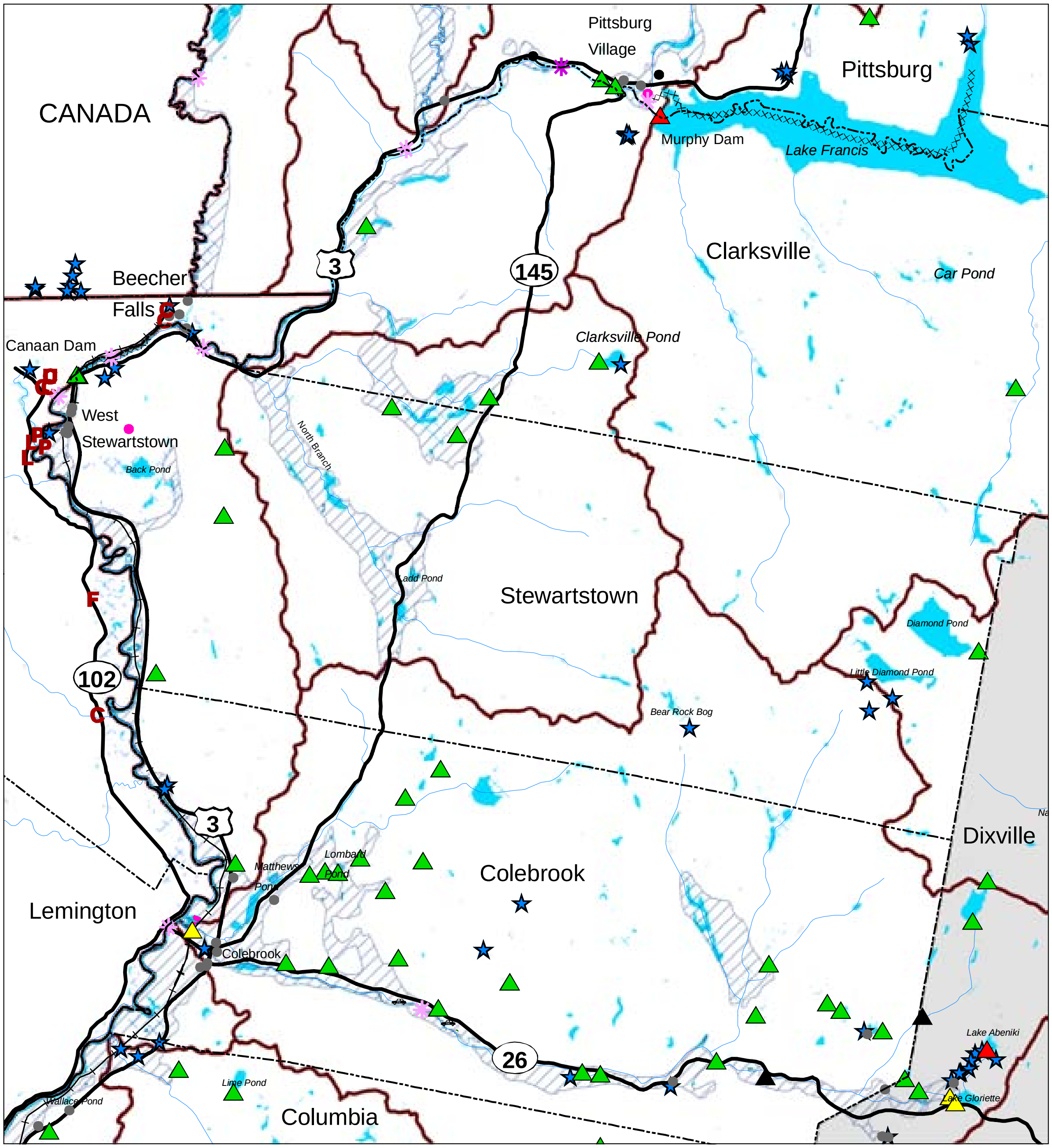
NH Water Quality Threat Inventories
- Snow Dump/Salt Storage
- Large Septic System
- Lagoon
- Landfill/Dump

1 0 1 2 Miles

1:135,000

Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, December 2007.

Funding provided by CRJC and US Gen New England.



Water Resources - Stewartstown, NH

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
xxxxx Impoundment Zone

Public Water Supply

Sediment Locations

High Risk Priority
Moderate Risk Priority

Dams

Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

N
W E
S

Water Quality Threats

VT Pollution Source Inventory of 1980

- C Petrochemicals
- F Agricultural Wastes
- K Liquid Waste to Land Surface/Subsurface
- L Landfilll/Dump
- P Lagoon-Municipal
- U Salt/Salted Sand

Underground Storage Tank Facilities

NH Water Quality Threat Inventories

- Automobile Salvage Yard
- Snow Dump/Salt Storage
- Large Septic System
- Lagoon
- Landfill/Dump

1 0 1 2 Miles

1:110,000

Map created by
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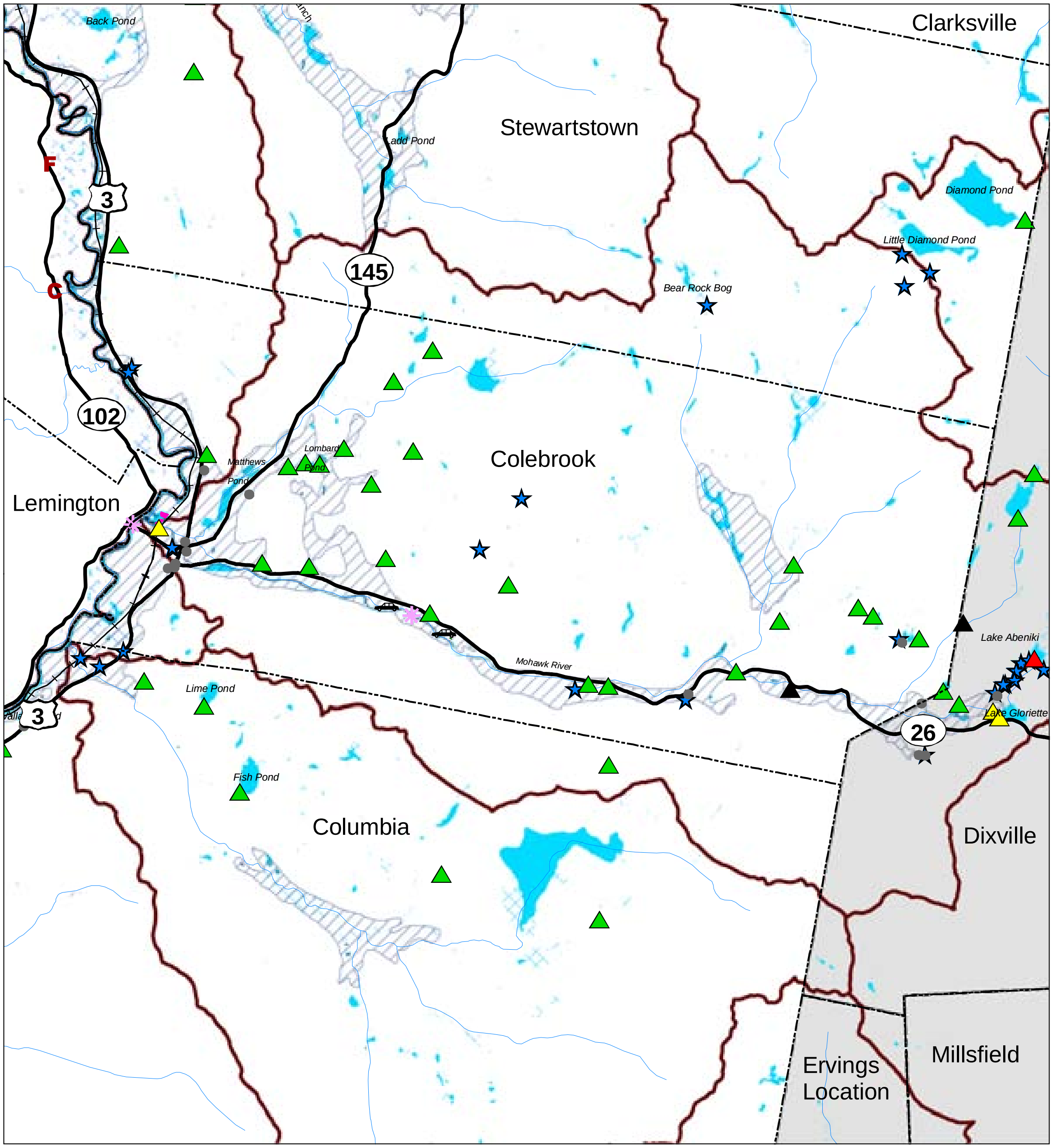

Water Resources - Colebrook, NH

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
xxxxx Impoundment Zone

Public Water Supply

Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

Water Quality Threats

VT Pollution Source Inventory of 1980
C Petrochemicals
F Agricultural Wastes
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand

Underground Storage Tank Facilities

NH Water Quality Threat Inventories
Automobile Salvage Yard
Snow Dump/Salt Storage
Large Septic System
Lagoon
Landfill/Dump

1 0 1 2 Miles

1:100,000

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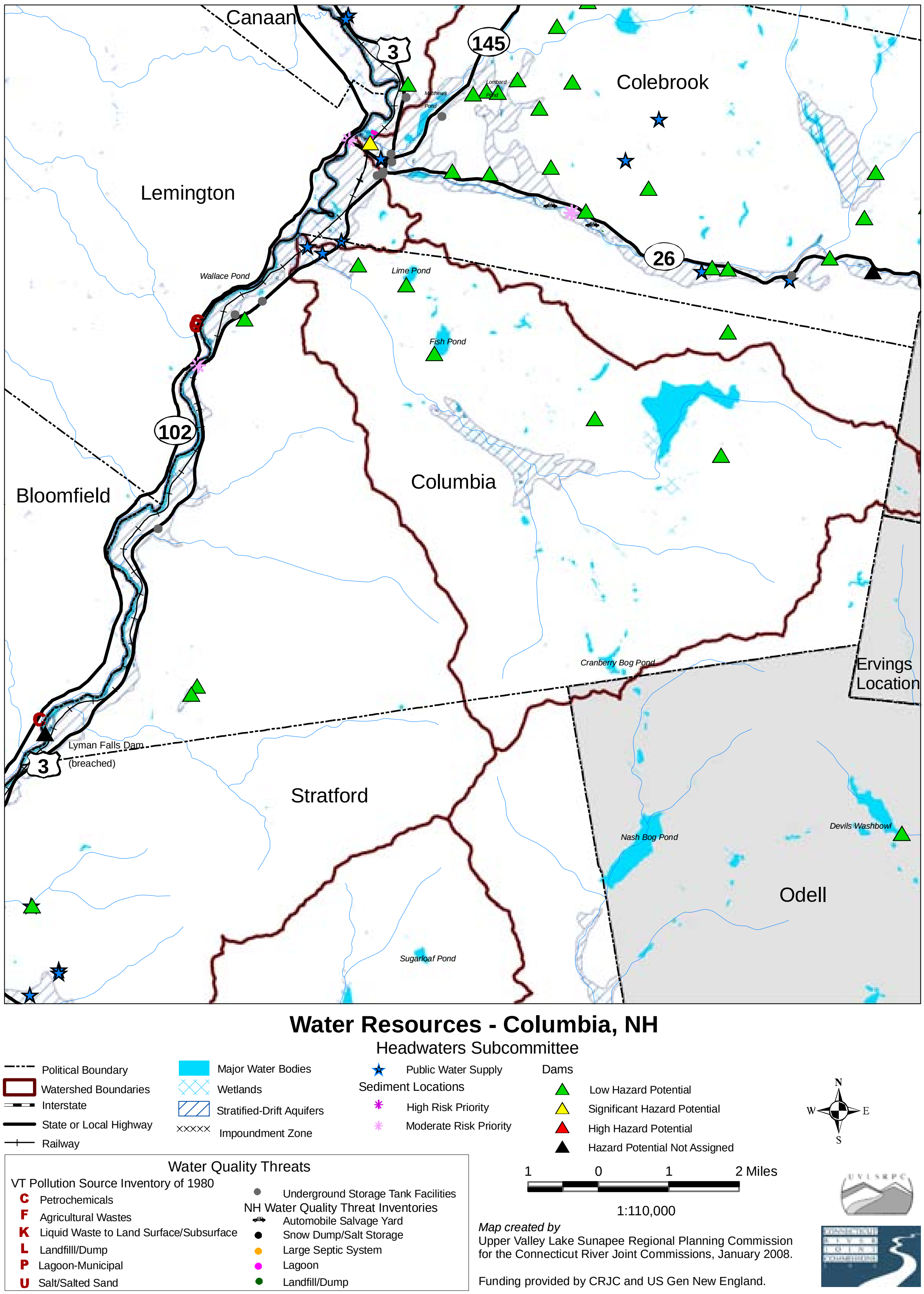

Canaan
3
145
Colebrook
Lemington
Wallace Pond
Lime Pond
26
Fish Pond
102
Bloomfield
Columbia
Cranberry Bog Pond
Ervings Location
Lyman Falls Dam (breached)
3
Stratford
Nash Bog Pond
Devils Washbowl
Odell
Sugarloaf Pond
Water Resources - Columbia, NH
Headwaters Subcommittee
Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway
Major Water Bodies
Wetlands
Stratified-Drift Aquifers
XXXXX Impoundment Zone
Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority
Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned
N
W
E
S
Water Quality Threats
VT Pollution Source Inventory of 1980
C Petrochemicals
F Agricultural Wastes
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand
Underground Storage Tank Facilities
NH Water Quality Threat Inventories
Automobile Salvage Yard
Snow Dump/Salt Storage
Large Septic System
Lagoon
Landfill/Dump
1 0 1 2 Miles
1:110,000
Map created by
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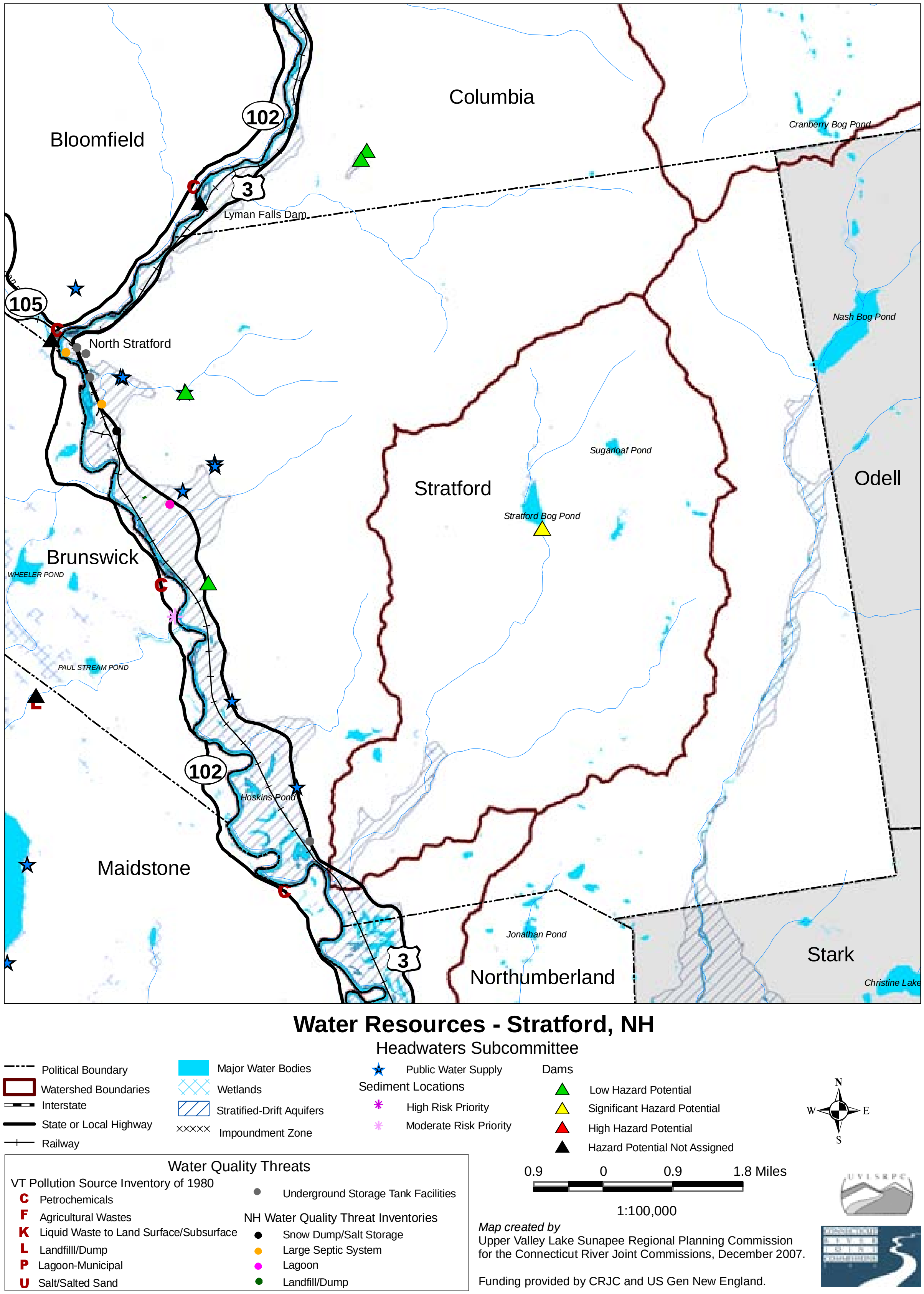
Columbia
Bloomfield
Lyman Falls Dam
North Stratford
Cranberry Bog Pond
Nash Bog Pond
Sugarloaf Pond
Stratford
Stratford Bog Pond
Odell
Brunswick
WHEELER POND
PAUL STREAM POND
Hoskins Pond
Maidstone
Jonathan Pond
Northumberland
Stark
Christine Lake
Water Resources - Stratford, NH
Headwaters Subcommittee
Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway
Major Water Bodies
Wetlands
Stratified-Drift Aquifers
Impoundment Zone
Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority
Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned
Water Quality Threats
VT Pollution Source Inventory of 1980
C Petrochemicals
F Agricultural Wastes
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand
Underground Storage Tank Facilities
NH Water Quality Threat Inventories
Snow Dump/Salt Storage
Large Septic System
Lagoon
Landfill/Dump
0.9 0 0.9 1.8 Miles
1:100,000
Map created by
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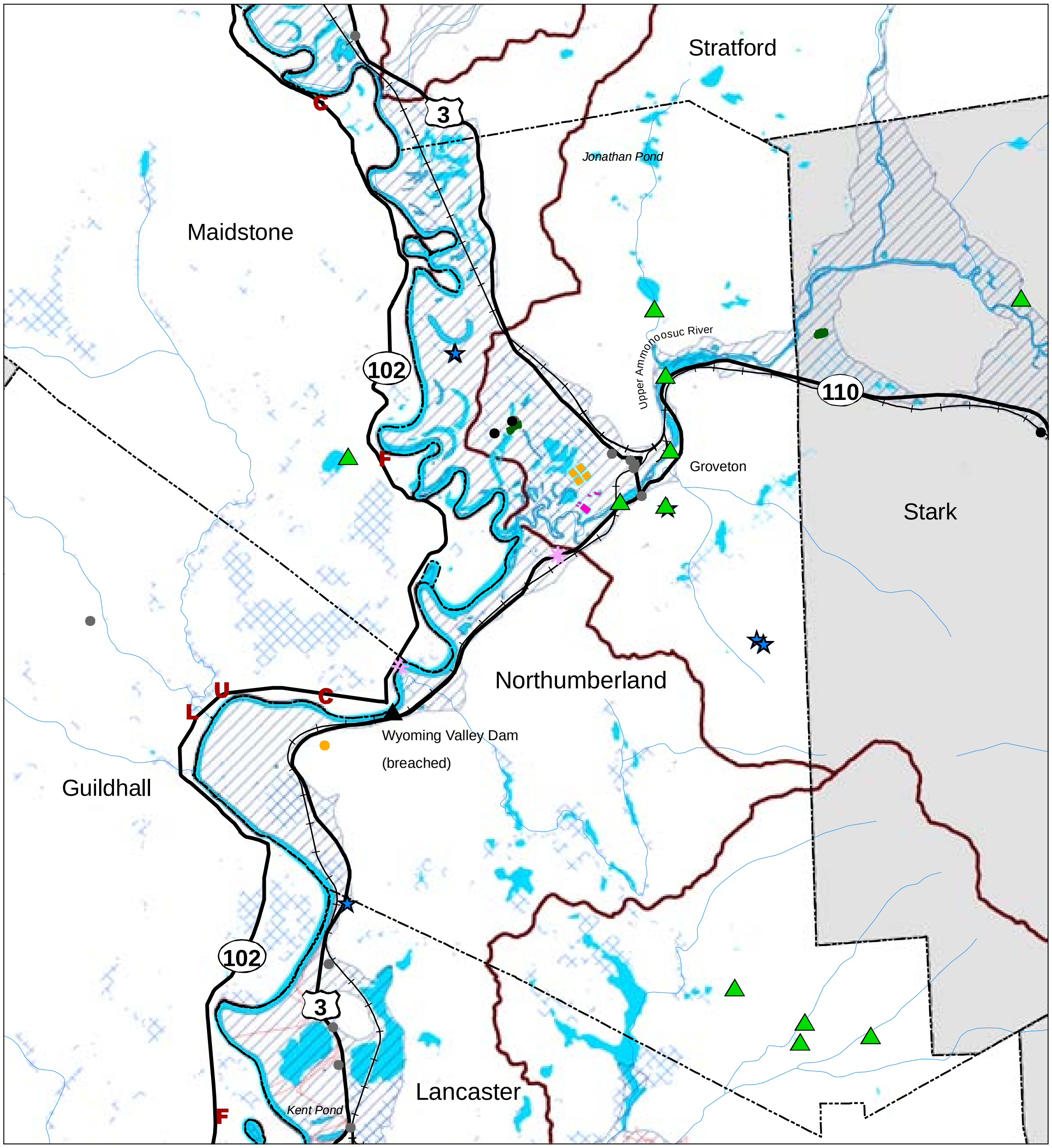
Funding provided by CRJC and US Gen New England.



Water Resources - Northumberland, NH

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
Impoundment Zone

Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority
100-Year Floodplain (Lancaster only)

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

N W E S

Water Quality Threats

VT Pollution Source Inventory of 1980
- C Petrochemicals
- F Agricultural Wastes
- K Liquid Waste to Land Surface/Subsurface
- L Landfilll/Dump
- P Lagoon-Municipal
- U Salt/Salted Sand

Underground Storage Tank Facilities

NH Water Quality Threat Inventories
- Snow Dump/Salt Storage
- Large Septic System
- Lagoon
- Landfill/Dump

1 0 1 2 Miles

1:85,000

Map created by
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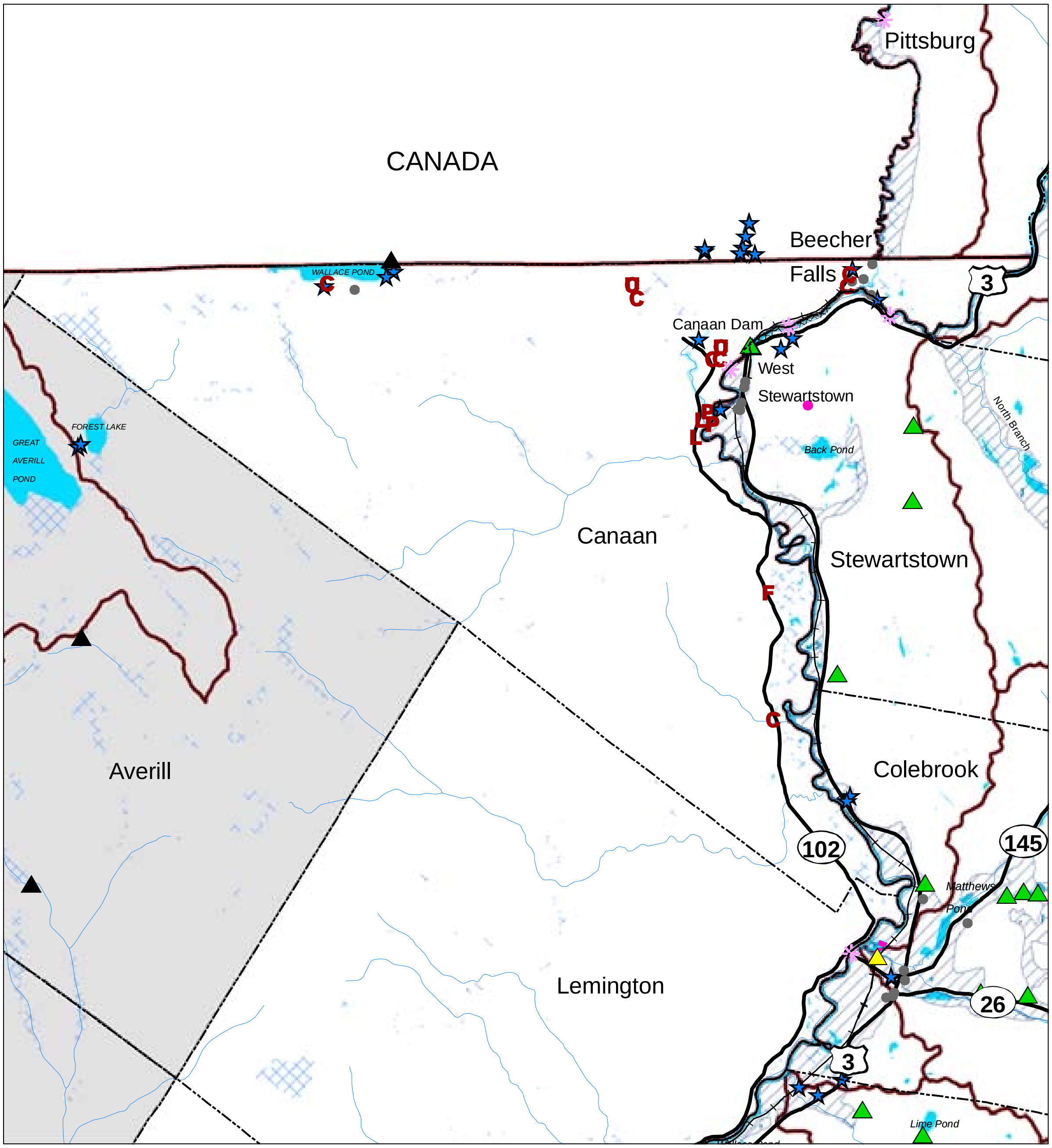
Funding provided by CRJC and US Gen New England.



Water Resources - Canaan, VT

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
xxxxx Impoundment Zone

Public Water Supply

Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

N
W E
S

Water Quality Threats

VT Pollution Source Inventory of 1980
C Petrochemicals
F Agricultural Wastes
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand

Underground Storage Tank Facilities

NH Water Quality Threat Inventories
Snow Dump/Salt Storage
Large Septic System
Lagoon
Landfill/Dump

0.9 0 0.9 1.8 Miles

1:100,000

Map created by
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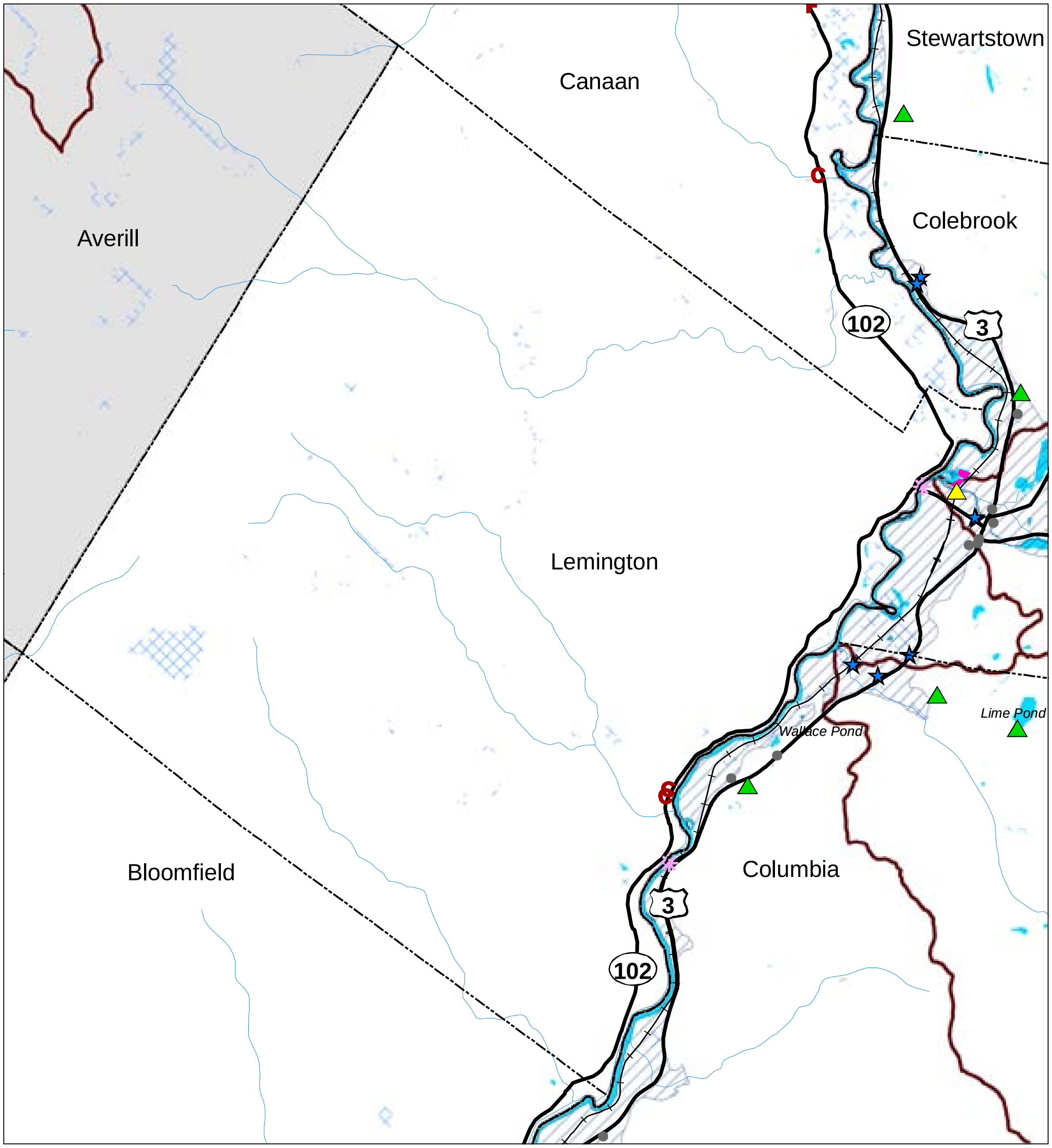
for the Connecticut River Joint Commissions, January 2008.

Funding provided by CRJC and US Gen New England.



Water Resources - Lemington, VT

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
xxxxx Impoundment Zone

Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

N W E S

Water Quality Threats

VT Pollution Source Inventory of 1980
- **C** Petrochemicals
- **F** Agricultural Wastes
- **K** Liquid Waste to Land Surface/Subsurface
- **L** Landfilll/Dump
- **P** Lagoon-Municipal
- **U** Salt/Salted Sand

Underground Storage Tank Facilities

NH Water Quality Threat Inventories
- Snow Dump/Salt Storage
- Large Septic System
- Lagoon
- Landfill/Dump

0.7 0 0.7 1.4 Miles

1:75,000

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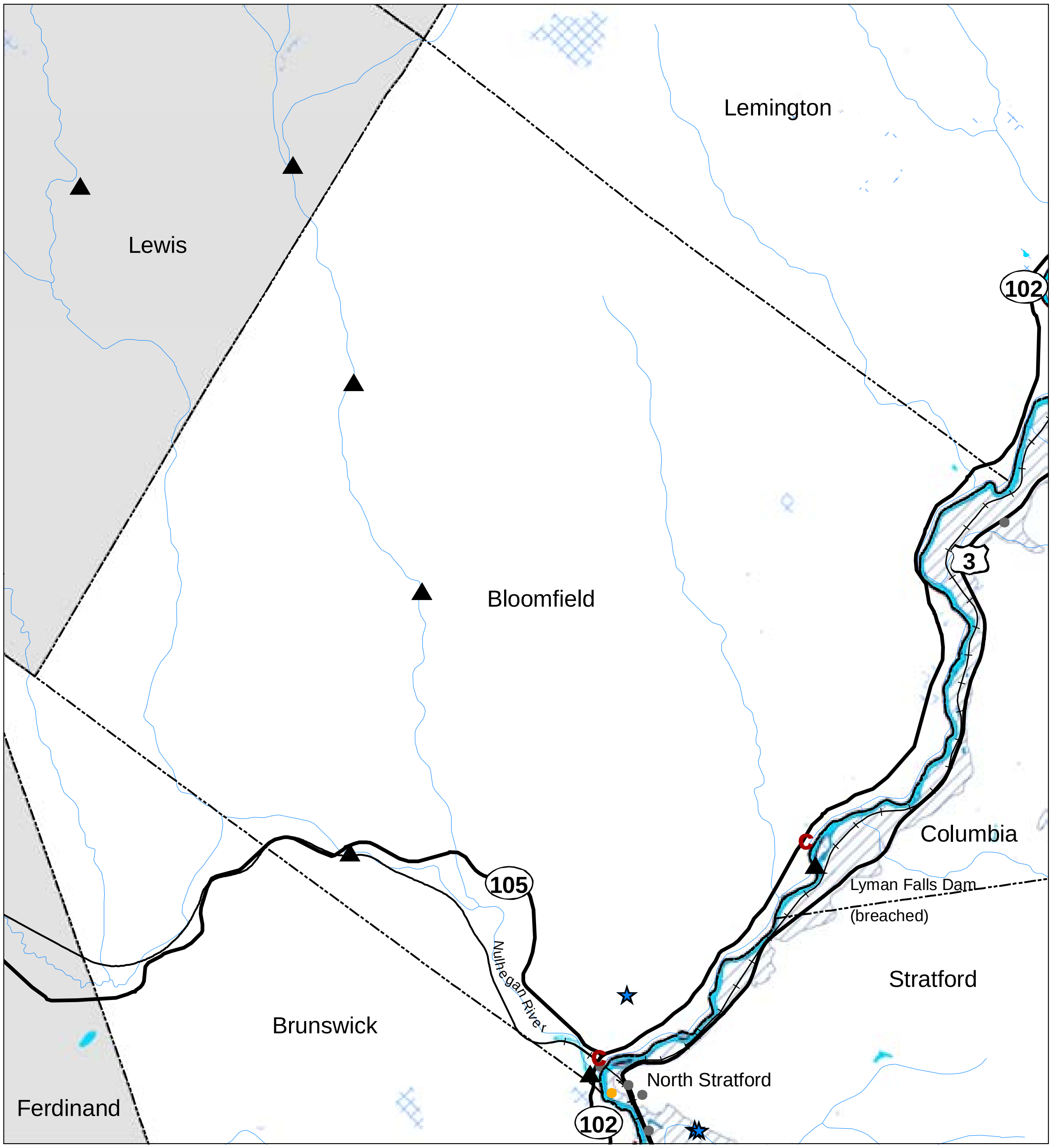

Water Resources - Bloomfield, VT

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
xxxxx Impoundment Zone

Public Water Supply

Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

N
W E
S

Water Quality Threats

VT Pollution Source Inventory of 1980
C Petrochemicals
F Agricultural Wastes
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand

Underground Storage Tank Facilities

NH Water Quality Threat Inventories
Snow Dump/Salt Storage
Large Septic System
Lagoon
Landfill/Dump

0.75 0 0.75 1.5 Miles

1:75,000

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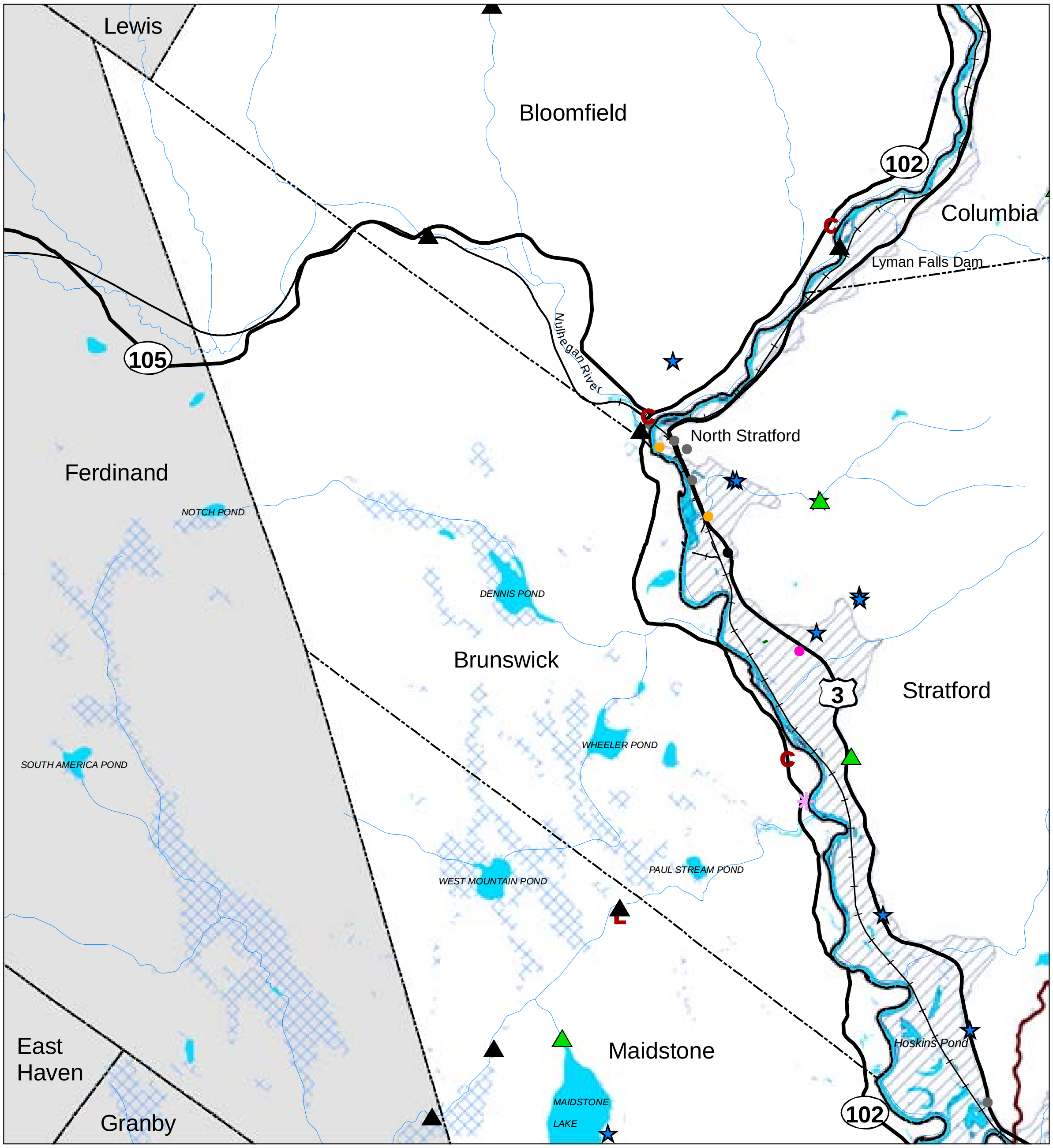

Water Resources - Brunswick, VT

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
xxxxx Impoundment Zone

Public Water Supply

Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

N W E S

Water Quality Threats

VT Pollution Source Inventory of 1980
- C Petrochemicals
- F Agricultural Wastes
- K Liquid Waste to Land Surface/Subsurface
- L Landfilll/Dump
- P Lagoon-Municipal
- U Salt/Salted Sand

Underground Storage Tank Facilities

NH Water Quality Threat Inventories
- Snow Dump/Salt Storage
- Large Septic System
- Lagoon
- Landfill/Dump

1 0 1 2 Miles

1:85,000

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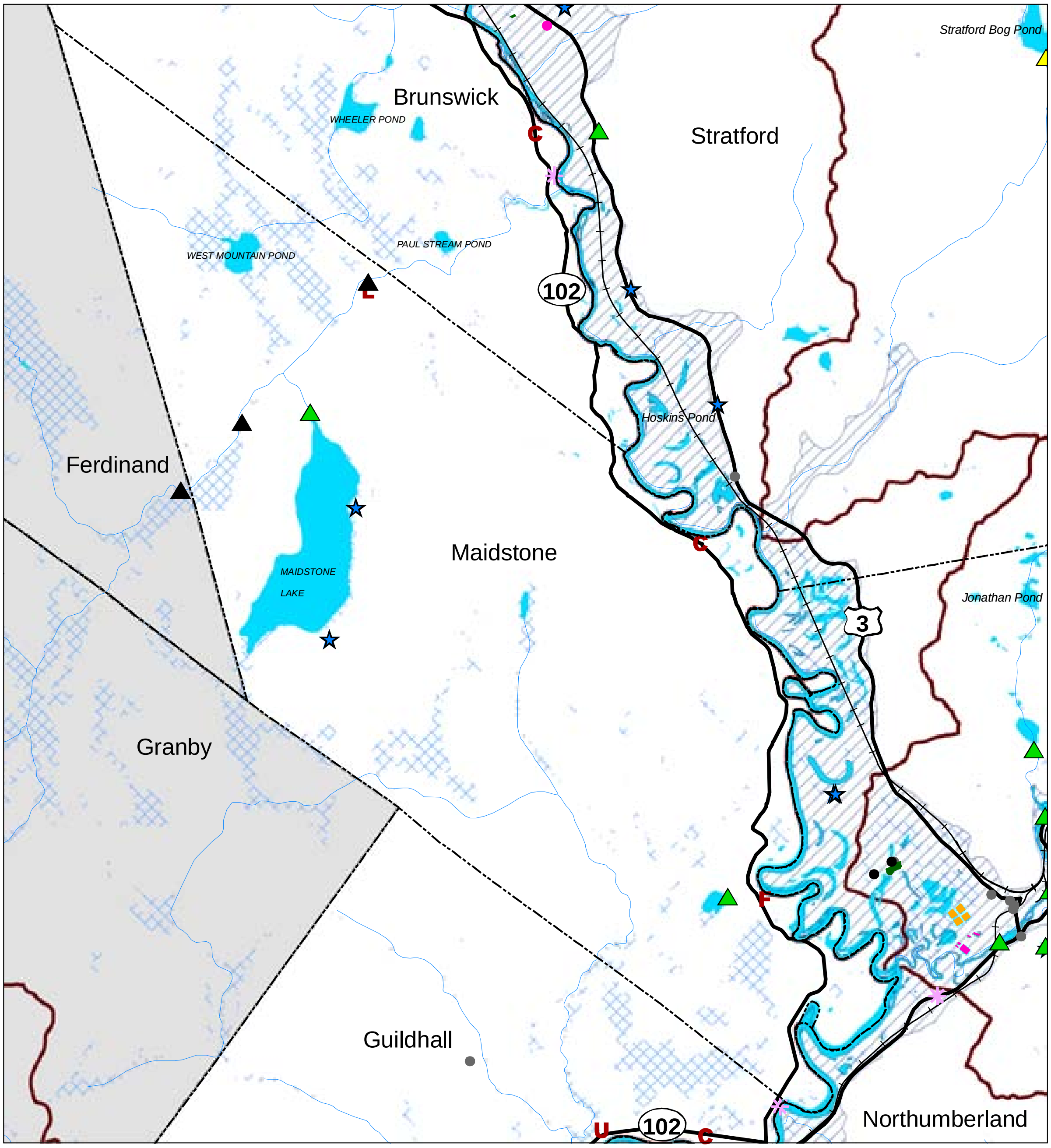

Water Resources - Maidstone, VT

Headwaters Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Stratified-Drift Aquifers
XXXXX Impoundment Zone

Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned

N
W E
S

Water Quality Threats

VT Pollution Source Inventory of 1980
- **C** Petrochemicals
- **F** Agricultural Wastes
- **K** Liquid Waste to Land Surface/Subsurface
- **L** Landfilll/Dump
- **P** Lagoon-Municipal
- **U** Salt/Salted Sand

Underground Storage Tank Facilities

NH Water Quality Threat Inventories
- Snow Dump/Salt Storage
- Large Septic System
- Lagoon
- Landfill/Dump

1 0 1 2 Miles

1:85,000

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Notes

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Joint Commissions
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Charlestown, N.H. 03603
www.crjc.org
603-826-4800