WATER RESOURCES - Executive Summary
Upper Valley River Subcommittee

INTRODUCTION

This Water Resources Plan is an updated and expanded edition of the Water Quality chapter originally published by the Connecticut River Joint Commissions as part of the *1997 Connecticut River Corridor Management Plan, Volume IV,* for the Upper Valley Region. This plan is a requirement of the New Hampshire Rivers Management and Protection Act. It was prepared by CRJC's Upper Valley Region River Subcommittee in 2005-7 by volunteer representatives of the riverfront towns from Piermont to Lebanon, NH and Bradford to Hartford, VT, assisted by CRJC's Conservation Director. Planning boards and commissions can review its recommendations and integrate them into their local master plan, and select appropriate recommendations to bring to townspeople for adoption into their zoning ordinances.

The Upper Valley Region - This segment of the river embraces 39 miles of the Connecticut River. Where it is impounded above Wilder Dam, the river functions ecologically more as a lake than a river. Riverbanks are affected by water level fluctuations at the dam and by boat wakes, as well as by natural processes including wind-driven waves, ice movement, and flooding. Below Wilder Dam, the Connecticut River functions more like a free-flowing river although it remains subject to flows that vary in volume and velocity due to peaking operations at the dam. Major tributaries to this section of the Connecticut are the Waits, Ompompanoosuc, and White Rivers and Blood Brook in Vermont, and the Mascoma River and Eastman, Jacobs, Clay, Grant, Hewes, and Mink Brooks in New Hampshire.

Economic Value of Clean Water - Good water quality is important economically for the Upper Valley region. Studies in New Hampshire have found that its rivers and lakes annually contribute an estimated $1.5 billion in total sales and $247 million in property taxes to its economy (2002 dollars). Statewide, fishing, boating, and swimming have the same economic impact as snowmobiling, ice-fishing, downhill skiing, and cross-country skiing combined. Overall, surface water recreation generates over 100 jobs in the Dartmouth-Sunapee tourism region of New Hampshire, which includes the Upper Valley. These jobs equate to $2.6 million in personal income and almost $7.5 million in business sales, totaling about 3.5% of the recreational revenue generated by anglers, boaters and swimmers in New Hampshire. A perceived decline in water clarity and purity would cause a loss of 14 jobs, about $309,000 in personal income and almost $1 million in business sales.

RIVER QUALITY

Connecticut River Water Quality - Water quality monitoring in 2004 indicated that the mainstem river meets state standards. However, because combined sewer overflows (CSOs) still exist in White River Junction and Lebanon, the State of New Hampshire continues to classify the river from its confluence with the White River to Cornish as not supporting swimming. Because bacterial contamination results when storm water overwhelms the capacity of wastewater treatment facilities, which occurs only during heavy storms, the river is probably safe for swimming on most days in this area. New Hampshire considers the entire Connecticut River contaminated by polychlorinated biphenyls (PCBs) from atmospheric deposition. Among Vermont tributaries, 16 miles of the Ompompanoosuc River system and 3 miles of Pike Hill Brook in the Waits River watershed are contaminated by metals and acid from abandoned mine drainage. Several sections are contaminated by *E. coli*, barnyard runoff, and milk-house effluent. Some New Hampshire tributaries show problems with pH, dissolved oxygen, aluminum, and *E. coli*.

Monitoring efforts are presently insufficient to determine whether or not water quality in some areas of river popular with recreationists is actually good enough to support that recreation. As of this writing, no efforts to monitor the Connecticut River are underway, despite the growth in the region's population and its dependence upon the river. In Vermont, volunteer monitoring occurs on Blood Brook and on the White, Waits and Ompompanoosuc Rivers.

Connecticut River Sediment Quality - Results of two EPA studies show that road runoff has probably affected the river as heavy metals and polyaromatic hydrocarbons (PAHs) associated with automobiles appear in the sediments. PAHs below the confluences of the White and Mascoma Rivers are in levels high enough to have an effect upon aquatic life. Sediments also show striking signs of copper contamination from abandoned mines in this part of the watershed at levels that threaten aquatic life. Other heavy metals, including zinc, lead, chromium, and nickel, appear near the I89 bridge in Lebanon in concentrations that could have these effects. Arsenic appeared above the screening level at four sites. Traces

of pesticides linger in the sediments near Dartmouth's Ledyard Boathouse swimming area just downstream from the Hanover golf course. The longest list of pollutants (37) found anywhere on a 200-mile study came from Wilder Dam Recreation Area in Hartford, where a number of contaminants were present well above levels where ecological effects can be expected. This site has a long history of industrial papermaking and was partially inundated by the construction of Wilder Dam.

Connecticut River Fish Tissue Toxins - In 2000, EPA and the four Connecticut River states conducted the first river-wide study of fish tissue in the nation. In the reach that included the Upper Valley Region, total mercury concentrations in fish were significantly higher upstream than downstream, and are a threat in this region to subsistence fishers and also to mammals and birds that eat the fish. 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. DDT breakdown products pose a risk to subsistence fishers and to fish-eating birds such as kingfishers, but not to recreational fishermen or to fish-eating mammals such as otter.

Key recommendations for river quality

- States and the federal government should provide financial assistance to Lebanon and Hartford to complete the elimination of CSOs. Lebanon and Hartford should pursue elimination of their remaining CSOs.
- The U.S. Congress and the states should take immediate action to reduce mercury contamination of the region.
- Landowners and town road crews should restore and retain riparian buffers to capture road pollutants.

RIVER FLOW

Instream Flow- Except in very high water conditions, operations at Wilder Dam almost completely control instream flow of the Connecticut River in most of the Upper Valley region. The free-flowing White River, entering just below the dam, adds natural variation to the closely managed mainstem flow, with its large watershed. One gage on the mainstem and six on tributaries provide real-time data for flow, precipitation, and air temperature via the Internet.

Flooding & Flood Control - The Connecticut River in this region typically experiences large flows with spring ice-out and snowmelt, and also following heavy rains at other times of year in the river's watershed upstream. The increasing pace of development in the Upper Valley is likely to have an increasing effect upon river flow as forests and other rainfall-absorbing land cover become roads, parking lots, roofs and lawns. Storms that affect tributary watersheds do not always have an equal effect on the mainstem. In the Upper Valley region, ice generally melts in place and does not pass through Wilder Dam. The White River delivers rubble ice to the mainstem's sheet ice just below the dam, that may ground before jamming and backing up water in the river, especially at a large ledge on the Vermont side just below the Interstate 89 bridge. Here, ice jams endanger the shopping plazas built in the floodplain at West Lebanon by deflecting the current toward the riverbank.

The dams on the mainstem of the Connecticut River were built for hydro power generation, not for flood control, although when possible, they are operated to help ease flooding in the Connecticut River. Flooding in Norwich and Hanover and below is now reduced to a minor extent by the Union Village Dam on the Ompompanoosuc River, but this dam controls only 130 of the nearly 4000 square miles of the Connecticut River watershed that lies above. The U.S. Army Corps of Engineers identified the floodplain in Bradford and Piermont as an important natural valley flood control area where the river can spread out and dissipate its energy. Additional development of the "green infrastructure" in this region will transfer flooding downstream, increasing flood damage in the Upper Valley and beyond.

Key recommendations for flow and flood control

- Public agencies and private landowners should work together to retain current natural flood storage, such as in wetlands and floodplains, which is effective and valuable.

WORKING RIVER

Wilder Dam - Wilder Dam, the major hydro power dam influencing the Upper Valley segment of the Connecticut River mainstem, is a "daily peaking" generation plant, raising and lowering water in the 45-mile Wilder impoundment as it stores and releases water during the day. Since 2000, Wilder Dam has been the control center for hydro power operations throughout the Connecticut River mainstem. Hydro dams can provide a "cold or black start" to the electrical grid, as Wilder Dam and others on the Connecticut River did during the historic widespread blackout of the Northeast in 1965. While there are many causes of riverbank erosion, the second most important in this region, as determined by the U.S. Army Corps of Engineers, is water level fluctuations from operations at Wilder Dam. The primary cause is natural scour. Rapidly changing water levels can cause pressure imbalances at the water-saturated bank face, causing water to seep out

of the bank, carrying small particles of soil with it. For this dam, the license does not spell out a "ramping rate," or how quickly the impoundment can be raised or lowered.

Key recommendations for dams

- The Federal Energy Regulatory Commission should institute a ramping rate at Wilder Dam in the next license, to reduce soil piping in the riverbanks of the impoundment and to minimize negative effects on aquatic and riparian habitat; include a provision for emergency gate operation, such as in the context of a "black start" when the dam is needed to provide immediate power in case of a blackout.

USING THE WATER

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 the watershed. The state requires registration of water withdrawals over a certain size, which helps identify future problems of well interference, declining water tables and/or diminished streamflows, but does not limit withdrawals. Vermont has no system for tracking withdrawals and the amount of water that would otherwise have flowed in the river from Vermont is unknown.

Groundwater and drinking water supplies - It is important to know where aquifers occur before development is proposed. New Hampshire has mapped stratified drift aquifers and regulates new groundwater withdrawals for community water systems and large withdrawals to prevent harm to existing water users and nearby streams and rivers. Vermont has not mapped aquifers as comprehensively and does not regulate groundwater withdrawals. Most groundwater contamination in the area is from leaking underground storage tanks. Several towns have groundwater protection regulations. Increases in population and demand have also put pressure on groundwater supplies. Changing the surface of the soil, such as through paving and development, prevents water from soaking into the soil to restore groundwater. Low impact development techniques can encourage water to soak in and recharge groundwater as it might have naturally.

Key recommendations for groundwater

- Vermont should identify and map groundwater supplies in cooperation with the towns. Towns should understand their capacity for providing drinking water, evaluate water supplies for short and long term growth, and establish a baseline for use.

LAND USE & WATER RESOURCES

Wastewater discharges - This segment of the river receives treated wastewater discharges from three municipal plants in a fairly short distance (Hanover, Hartford, and Lebanon), and water quality is noticeably poorer during times of low flow. There have been rare releases of untreated sewerage from the wastewater treatment plants in Hanover and also to the White River from a treatment plant in Bethel, Vermont. The development capacity of the region may be partially limited by the capacity of the Connecticut River to deal with the wastewater such development creates. At the same time, the cleaner river is partly responsible for the appeal of the region to new residents and businesses. Pathogens from combined sewer overflows in Lebanon and Hartford affect the river for nearly 13 miles. The most significant CSO problem in the region is in Lebanon, where the combined sewerage system dates from the 1930s.

Key recommendations for wastewater discharges

- Upper Valley towns should study their capacity for providing wastewater treatment and the river's ability to assimilate it in this region. EPA and the states should work together to establish updated rules for disposal or return of unused medicines. EPA should provide support to Hospitals for a Healthy Environment, a non-profit organization headquartered in the Upper Valley, to work with medical providers to encourage responsible disposal of pharmaceuticals.

Landfills, Junkyards, & Transfer Stations - Most of the region's older landfills, such as at Post Mills, are not lined, and their contents can still seep into groundwater and may pose a threat to drinking water supplies. Informal dumps remain untreated on several tributaries. Major landfill work has recently occurred close to the Connecticut River in Lebanon, where the city's older landfill has been capped and a new area opened. At the same time, a recycling facility has been moved and improved.

Key recommendations for landfills, junkyards, and transfer stations

- Area solid waste districts should assist towns in holding more frequent household hazardous waste collections and sites and in exploring options to create greater recycling markets and reducing solid waste.

Shoreline & Floodplain Development - The increased demand for level, easily developed soils and picturesque house sites could suburbanize the river corridor, threatening water quality and eliminating wildlife habitat and flood storage. Such development also changes the overall visual quality of the riverfront and, by fragmenting or removing what are often prime agricultural soils from potential production, threatens agriculture as a viable enterprise in the area.

Vermont is the only state in New England that does not have a statewide shoreland protection law. However, Bradford, Fairlee, Norwich, and Hartford have adopted their own shoreland protection for the Connecticut River and other streams which is comparable to or more effective than New Hampshire's shoreland protection law. The Subcommittee believes that buildings should be set a safe distance back from the river even when outside of the floodplain, to protect water quality and to reduce the risk of property loss in erodible areas. Because building in floodplains takes over valuable farmland, transfers flooding problems downstream, and costs taxpayers money when flooding occurs, several but not all towns have passed ordinances banning construction here. Others continue to permit construction in the floodplain if buildings are built according to certain restrictions. a policy that has led to heavy big box store development in Lebanon. Building a mound to raise a building above the 100-year floodplain may reduce the chance of flood damage to that particular building, but it does nothing to prevent pollution and eliminates flood storage space, forcing floodwater somewhere else.

Glacial Lake Hitchcock left behind layers of varves, ancient lake-bottom sediment layers that have differing physical properties that can slip and collapse. Siting landfills, bridges, large buildings, and other important structures on varved deposits is risky, yet most towns do not have information about the location of varves.

Key recommendations for shoreland and floodplain development

- New Hampshire DES should educate town officials, real estate agents, developers, and landowners about the Comprehensive Shoreland Protection Act, including responsibility for enforcement. The New Hampshire legislature should consider shoreland protection for tributaries not currently covered by the Act.
- Vermont should consider adopting measures to protect the shoreland of both the Connecticut River and its tributaries.
- Towns should adopt ordinances prohibiting filling and building in the 100-year floodplain and ensure that buildings are set a safe distance back from the river even when outside of the floodplain. They should encourage developers and landowners to establish and/or maintain buffers of native vegetation along rivers and streams for privacy, pollution control, and habitat.

Roads and railroads - The construction, repair, and maintenance of roads can result in loss of the riparian buffer and cause sediment to be washed into these waters. Sand from roadways and bridges can affect habitat quality of the riverbed. A sudden heavy storm can cause problems with blocked culverts and send sediment from such a blockage into a stream. Winter road salt threatens water quality in the many streams followed too closely by roads. For nearly a decade, the City of Lebanon, just upstream from one of the most biologically interesting areas of the Connecticut River, considered building a road on the edge of the riverbank to relieve traffic problems in West Lebanon. The Subcommittee strongly advises against adding more pollutants from a roadway so close to the river. Salt is a contamination problem for both surface and groundwater, brought into sharp focus in the Upper Valley when the railroad built a salt storage shed on the Fairlee/Thetford line. Shortly after the salt shed went into operation, a nearby residential well was contaminated.

Culverts and bridges can have a critical role in preventing flooding and property damage, and also in ensuring good fish passage along the streams they traverse. Because culvert and bridge size is so important for public safety, they should be checked in all towns.

Key recommendations for roads and railroads

- New Hampshire should consider working with the regional planning commissions to conduct a bridge and culvert survey program similar to Vermont's to identify culverts that are undersized or block fish passage and seek grants for replacing them where necessary. Towns should ensure that culverts are properly engineered and installed when replacing them during road work.
- Railroads should employ best management practices in siting structures such as salt sheds in order to protect water quality and expand testing of groundwater near the Ely salt shed. Towns and the railroad should locate all salt storage at least 250 feet from rivers.

Storm Water runoff - Stormwater runoff may be the simplest but least understood means of water pollution, and possibly the easiest source of pollution to control. Rising demands for impervious surfaces (roofs, roads, driveways, parking areas) cause tremendous increases in runoff and in sources of pollution. The quantity of pollutants in runoff in an urban area is directly related to the imperviousness found in its watershed. Stormwater is washing pet waste into the river in some Upper Valley towns and contributing to bacteria levels found here.

Key recommendations for stormwater runoff

- Developers should include infiltration methods such as networks of many small swales to capture runoff for groundwater recharge. Towns should encourage "low impact development" design and consider how to retrofit existing development to reduce runoff and promote stormwater infiltration.

Home landscapes - Residential development pressure is significant in the Upper Valley, and much of the riverfront, especially in Norwich, Hanover, and Lyme, features homes built to take advantage of river views. A number of them have lawns extending to the river's edge. This shift from farmland to residential use often means a change for the river. Uncontrolled and often uninformed use of fertilizers, pesticides, and other toxic materials by homeowners can lead to unintended addition of these pollutants to streams.

Key recommendations for home landscapes

- Towns should educate landowners to establish, maintain and enhance the native riparian buffer vegetation on their property. Consider a cost of community services study to 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.

Farms and cultivated landscapes - Prime agricultural soils, some of the highest quality soils in the nation, distinguish much of the floodplain in the Upper Valley region. This valuable land encourages consumption of healthy, locally grown foods and provides beautiful views. The Upper Valley River Subcommittee believes that food production is a good use of riverfront land, and that it is well worth the cost and effort to conserve this land to prevent its conversion to development. Agriculture is diversifying in the Upper Valley, and a region once known for its dairy farms now also features vegetable and fruit farms, horticultural operations, and a number of horse farms, both large and small.

Key recommendations for farming

- Cooperative Extension Service should educate hobby horse owners about ways to manage their land and animals to protect water quality. Educate the general public about the many water quality protection measures used by and/or required of farmers, including regulations surrounding septage spreading.

Brownfields - The Westboro Rail Yard in West Lebanon, NH, is such a site, with recreation, tourism, and economic development potential waiting for federal funds to assist the City in cleaning up contamination left over from this once-busy transportation hub. Others under investigation are the former Tip Top Tire site in downtown White River Junction and three other sites in Hartford, and the Thetford town garage.

Acid Mine Drainage

Vermont's Upper Valley has a long and rich history of mining that supported industrial growth for several centuries. These mines, located in the Ompompanoosuc and Waits River watersheds, include the now abandoned Elizabeth Mine, Pike Hill Mine and Ely Mine, now designated as Superfund sites. Their legacies include severe effects upon water quality from acidic water draining out of above-ground or under-ground mines and tailing piles. Mine drainage affects stream and river ecosystems by increasing acidity, depleting oxygen, and releasing heavy metals. Work has begun at the Elizabeth Mine to stabilize, regrade, and cap the tailing piles, divert stormwater, and treat runoff.

Key recommendations for brownfields and acid mine drainage

- Upper Valley Lake Sunapee Regional Planning Commission should seek a grant to conduct a brownfields inventory of its member towns, and prioritize cleanup. Lebanon should continue seeking funds to clean up the Westboro Rail Yard.
- EPA should continue with cleanup at the Elizabeth and other mines.

RIVERBANK EROSION

Erosion is a significant cause of concern for landowners on this segment of the Connecticut River. While it is a natural process, and is caused primarily by shear stress of water forced against the bank, abrasion by ice, and also wind-driven waves, erosion is made worse by human actions, particularly in the Upper Valley reach. Factors include water level fluctuations from operations at Wilder Dam, boat wakes, and removal of the riverside vegetation that naturally holds the bank together. Area landowners report that losing as much as 5-10 feet of their land along the river in a year to erosion.

Some riverbanks formerly thought to be forested and stable are actually riddled with hidden undercuts and six foot deep holes. In such places, the root structures of the trees are currently holding up the bank, but they may eventually fall, bringing a large root ball with them. Pressure imbalance at the bank face, when there is a rapid drawdown of the

water level at Wilder Dam, occurs when pressure builds up behind the bank face and seepage occurs, forcing soil particles to loosen.

Riparian Buffers - Buffers filter out sediment and debris from surface runoff; trap pollutants that could otherwise wash into surface waters and groundwater; stabilize streambanks and reduce erosion; and absorb surface water runoff and slow water velocity. Vegetated buffers are inexpensive, easy to install or encourage, and have the added advantage of providing habitat for both land-based and aquatic animal species. Studies of the Upper Valley riverbanks show that human activity appears to be affecting erosion rates in some reaches where riparian vegetation has been removed from the bank, and that landowners need to be more aware of the potential erosion problems that removing riparian buffers could cause. Buffers of 50 feet or more in width do appear to slow the rate of erosion.

Key recommendations for erosion and riparian buffers

- The USDA county conservation districts should survey the Upper Valley reach of the river for the presence of hidden riverbank undercuts, and identify and test a means of restoring these cavities. The federal government should conduct a study of the effects of dam-related water level fluctuations on bank erosion as well as upon fish habitat and populations of endangered species. The USDA Natural Resources Conservation Service should continue research into appropriate methods of bank stabilization including the funding of test areas, expand education of riparian landowners concerning methods of stabilization, expand programs that offer professional and financial assistance to riparian landowners for appropriate methods of bank stabilization, and investigate ways to simplify the permitting process.