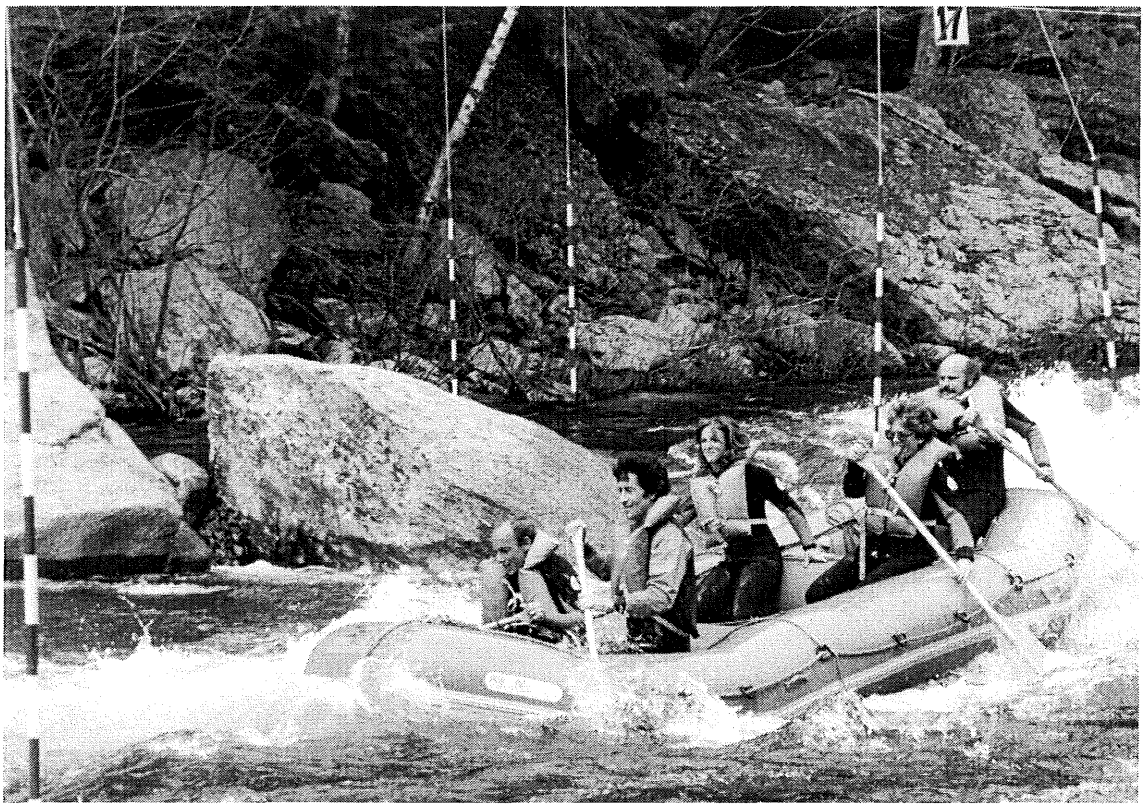
STATE OF VERMONT

2002 WATER QUALITY ASSESSMENT

305(B) REPORT



White water excitement on the West River in Jamaica, Vermont (Photo Credit: Vermont Travel Division)

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April 2002

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CLEAN WATER ACT SECTION 305(B) REPORT

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LIST OF ACRONYMS USED IN THIS DOCUMENT

AAP	Acceptable Agricultural Practices
AMP	Acceptable Management Practices (for logging)
ANCP	Aquatic Nuisance Control Program
ANR	Vermont Agency of Natural Resources
AOT	Vermont Agency of Transportation
BASS	Biomonitoring & Aquatic Studies Section
BMP	Best Management Practice
CSO	Combined Sewer Overflow (sanitary & storm sewer discharges in the same pipe)
DAF&M	Vermont Department of Agriculture, Food & Markets
DEC	Vermont Department of Environmental Conservation
Department	Vermont Department of Environmental Conservation
EPA, US EPA	Federal Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FS	Fully Supporting Uses as Defined by the Water Quality Standards
NPDES	National Pollution Discharge Elimination System
NOAV	Notice of Alleged Violation
NPS	Nonpoint Source Pollution
NRCS	National Resource & Conservation Service (Formerly Soil Conservation Service)
NWI	National Wetland Inventory
NS	Not Supporting Uses as Defined by the Water Quality Standards
GIS	Geographic Information System
GPS	Geo-Positioning System
HHW	Household Hazardous Waste
IBI	Index of Biotic Integrity
O&M	Operation & Maintenance
ORW	Outstanding Resource Water
TMDL	Total Maximum Daily Load
UST	Underground Storage Tank
VDEC	Vermont Department of Environmental Conservation
WBID	Waterbody Identification Number
WBS	Waterbody System
WMZ	Waste Management Zone
WWTF	Wastewater Treatment Facility

FOREWORD

Section 305b of the Federal Water Pollution Control Act (also known as the Clean Water Act or CWA) requires each state to submit a biennial report to the US Environmental Protection Agency (EPA) which provides information about the quality of the state's surface and ground waters. This water quality assessment report [often called the *305b Report, or 305b Process*] summarizes water quality conditions throughout Vermont during the January 1, 2000 through December 31, 2001 reporting period. Also included is water resources program information for rivers and streams, lakes and ponds, wetlands and groundwater. The report contains information on certain costs and benefits, monitoring progress, beach closures and special concerns. The Year 2002 305b Report, like reports from earlier years, is meant to provide the reader with an understanding of the programs designed to assess and reduce or eliminate water quality problems, as well as put forth particular water quality based recommendations.

A rotating basin schedule is used when assessing the state's waters, assessing roughly one-fifth of the state each year. The Year 2002 305b Report contains detailed water quality information for portions of Round 2 and Round 3 of the rotating river basin assessments. The specific basins included in this report are: Basin 7 (Lamoille River watershed) and Basin 11 (West, Williams and Saxtons River watersheds). This report also contains a summary of the entire state's water quality, which has been updated with the aforementioned rotating basin water quality information.

The Water Quality Assessment describes whether or not the state's surface water uses as defined by EPA and the State Water Quality Standards fall into one of four use support categories. The categories are *fully supported, threatened/fully supported, partially supported,* or *not supported.* Water uses include, but are not limited to, drinking, aquatic life, recreation, fish consumption and agriculture. Determination of use support may be made from *monitored*[1] information or from *evaluated*[2] information by water resources personnel, fish and wildlife biologists, aquatic biologists, lake association members and other qualified individuals or groups. The assessment report identifies the distance (in miles) of rivers and streams and area (in acres) of lakes and ponds that were either monitored or evaluated.

For CWA Section 305b reporting purposes, river or stream segments and lakes and ponds where one or more uses are not fully supported (i.e. either partially supported or not supported by either monitoring or evaluated information) are considered impaired (*Guidelines for Preparation of the Comprehensive State Water Quality Assessments [305b Reports] and Electronic Updates:*

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[1] Water quality assessment based on environmental data (biological, chemical or physical) less than 5 years old.

[2] Information used for assessments includes desktop modeling, some lay monitoring data, best professional judgement of resource managers and known sources of pollution. Also, information based on water quality sampling data which is five years old or older.

Supplement, September 1997). However, and for CWA Section 303d[3] listing and reporting purposes, impaired waters are those where one or more criteria of the Water Quality Standards are violated. Violations of Water Quality Standards are substantiated by chemical, physical or biological water quality data collected through monitoring. In accordance with EPA 303d guidance (December 2001), waters reported for 303d purposes in the year 2002 list of waters are those impaired waters that need or require a Total Maximum Daily Load.

The 305b Report is a highly visible mechanism for communicating to Congress, Vermont residents and the Vermont General Assembly the progress made in maintaining and restoring the state's water quality and the extent of the remaining problems. The 305b Report has become increasingly important to support funding decisions to the state at the federal level under the CWA Section 106 formula. EPA's Index of Watershed Indicators relies heavily on 305b reports. Also, the 305b reporting process is an important tracking tool for the performance of water quality protection initiatives under the Core Performance Measures of the Performance Partnership Agreements and the Government Performance for Results Act. Finally, the 305b water quality assessments are one of several important sources which assist in the identification of impaired waters under Section 303d of the Clean Water Act. This report, as well as previous Vermont Section 305b Reports, can be found through the internet at <http://www.vtwaterquality.org/waterq/planassess.htm>

EPA's vision for State 305b reports is the "...reports will characterize water quality and the attainment of water quality standards at various geographic scales." EPA's more detailed vision states that the 305b reports will:

- Comprehensively characterize the waters of the States, Tribes, Territories and the Nation, including surface water, ground water and wetlands. Progress should result in full coverage by 2002.
- Use data of known quality from multiple sources to make assessments
- Indicate progress toward meeting water quality standards and goals.
- Describe causes of polluted waters and where and when waters need special protection.
- Support watershed and environmental policy decision making and resource allocation to address these needs.
- Describe the effects of prevention and restoration programs as well as associated cost and benefits.
- In the long term, describe assessment trends and predict changes.
- Initiate development of a comprehensive inventory of water quality that identifies the location and causes of polluted waters and that helps States, Tribes, Territories direct control programs and implement management decisions.

In order to achieve the vision and long-term goals for the 305b process and to coordinate reporting efforts among the States, Territories, Interstate Commissions and Tribes, EPA requested that the following goals be addressed in 305b reporting:

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[3] Section 303d of the Act requires each state to identify those waters for which technology-based pollution controls are not stringent enough to attain or maintain compliance with applicable State water quality standards.

- *Adopt 2002 Integrated Water Quality Monitoring & Assessment Report Guidance*
  For the Year 2002 305b report, the Department was not able to fully adopt EPA's late-breaking guidance document. For this report, the Department has not been able to convert its assessment approach to the 'assessment unit' type/level of approach advocated by EPA guidance. Rather, the Department has continued to rely upon the well established and functional 'waterbody' as its unit of assessment and reporting. The Department, nonetheless, considers its assessment approach and findings to be largely consistent with the five categories defined in EPA guidance. The Department's assessment process identifies surface waters in full use support and less than full use support. The Department's assessment and listing processes results in the identification of waters considered as 'impaired' (consistent with guidance's category 4A, 4B and 5) and in the identification of other waters either in need of assessment (category 3) or waters altered by exotic species or flow regulation (waters for category 4C). The Department is seeking further clarification from EPA on waters assessed as category 1 and category 2 under the guidance. The reader is referred to Appendix A which contains a condensed version of EPA's December 2001 monitoring and assessment guidance.

- *Expand use of biological indicators and reporting*
  The Department has completed documentation of bio-criteria development and implementation procedures for macroinvertebrate and fish communities in wadeable streams (refer to documents entitled *"Wadeable Stream Biocriteria Development for Fish and Macroinvertebrate Assemblages in Vermont Streams and Rivers"* and *"Procedures for Determining Aquatic Life Use Status in Selected Wadeable Streams Pursuant to Applicable Water Quality Management Objectives and Criteria for Aquatic Biota Found in Vermont Water Quality Standards (VWQS) Chapter 3 §3-01, as Well as Those Specified in 3-02(A1 and B3), 3-03(A1 and B3), and 3-04(A1 and B4: a-d)"*). The language of these procedures is consistent with the Vermont Water Quality Standards revisions that became effective July 2, 2000. These procedures are currently used by the Department to make a variety of water quality management decisions. The role of biological indicators of ecological health has continued to expand throughout Department programs, including: NPDES and Indirect discharge permitting; CERCLA and RCRA hazardous materials site assessments; surface water biological classifications; accidental release and spill damage assessments; 303d listing and the development of TMDLs and restoration plans; non-target impact assessments for pest management programs; distribution of aquatic species in Vermont; and the development of water quality standards for a variety of water body types.

  The Department continues to build upon its biological assessment data base. In the last two years, more than 450 biological site assessments have been added to the Department's biological data base. Summary reports of annual assessment results for wadeable streams are compiled for purposes including but not limited to: Section 303d listing and TMDL development; Section 305b reporting; rotating watershed assessments and watershed planning initiatives. With assistance from EPA, the Department is assessing the use of biological assessments for establishing biological criteria for temporary (vernal) pools and white cedar swamps. Field data have been collected and data are being analyzed for final reporting. With the assistance of US EPA, the Department

continues to conduct research on indicators of amphibian malformations among northern leopard frogs in the Lake Champlain Valley. Development of bio-criteria for lakes is continuing.

The Water Quality Division of the Department has recently completed an updated version of its web site (http://www.vtwaterquality.org) which includes information on biological monitoring programs and indicators within the Department .

- *Improve data management, increase the documentation of data quality, and increase the use of electronic databases and geographic information systems.*
  The Department's analytical laboratory conducts its business under the auspices of EPA's Quality Assurance/Quality Control Plan (QA/QC), and monitoring is carried out under QA/QC Project Plans. The Department now uses an Access© database for improved 305b information management and has increased the documentation of data quality. Regarding electronic reporting, the Department annually submits rotating assessment data to EPA as each one-fifth of the state is completed. As to geographic information systems (GIS), Vermont is presently phasing in the ability to spatially locate water quality information for rivers and streams. At this time, lakes and ponds data have been spatially located for water quality reporting purposes.

- *Demonstrate a significant expansion in the number of waters assessed across all waterbody types and uses and improve the quality of monitoring and assessment data and reporting.*
  Vermont has responded to this goal by implementing a rotational assessment process such that the rivers and streams and lakes and ponds of all seventeen major basins in the state are assessed once every five years. This has resulted in much more detailed assessments and many more miles/acres of waterbodies being assessed each year, as well as specific follow-up action to monitor suspected problem sites and correct impairments.

- *Increase assessments of drinking water use support*
  This remains a goal for the Department. Until sufficient resources are available to specifically perform drinking water use source support assessments, they will be performed as part of the Department's yearly rotational basin assessments. It is conceivable that drinking water use source support assessments can be done via the on-going Source Water Assessment and Protection Program.

- *Develop a process for reporting by hydrologic unit (geo-referencing)*
  The Department uses waterbody identification numbers (WBID) for reporting by hydrologic unit. All waterbodies in the state are assigned waterbody identification numbers and are georeferenced. The WBID consists of the state two-letter abbreviation followed by a two-digit basin number, then a two-digit (river) or five-digit (lake) waterbody number. Waterbodies may consist of several small tributaries, a lake or a portion of the mainstem of a river. There are 556 lake and pond waterbodies and 210 river and stream waterbodies designated in Vermont. All 766 designated waterbodies have been spatially referenced onto a GIS. The Department has developed a data base table to link hydrologic unit codes (HUC-14s) to all WBIDs. This linkage allows the Department to exchange data between the two systems.

PART I: EXECUTIVE SUMMARY/OVERVIEW

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Background

Vermont has approximately 7,100 miles of rivers and streams, 300,000 acres of fresh water wetlands and 810 lakes and ponds (those at least 5 acres in size or those named on USGS maps) totaling 230,789 acres. Surface waters (not including wetlands) are classified as Class A or Class B with an overlay Waste Management Zone in Class B waters for public protection below sanitary wastewater discharges. Class A waters are managed for enjoyment of water in its natural condition, as public drinking water supplies (with disinfection when necessary) or as high quality waters which have significant ecological values.

There are approximately 165 miles of Class A rivers and streams and 1,736 acres of Class A lakes and ponds in Vermont (these figures do not include rivers/streams above 2,500 feet elevation which are also Class A). In addition, there are close to 6,935 miles of Class B rivers and streams and 229,053 acres of Class B lakes and ponds. Approximately 315 miles of the Class B rivers and streams and 15 acres of lakes and ponds have a Waste Management Zone overlay.

The Vermont portion of the Batten Kill, the West Branch of the Batten Kill, the Lower Poultney River, a segment of the Ompompanoosuc River and a segment involving Pikes Falls on the North Branch of Ball Mountain Brook have each been designated by the Vermont Water Resources Board as Outstanding Resource Waters.

Overall Description of Vermont's Water Quality

The water quality of all Vermont's rivers and streams and lakes and ponds is considered good. This overall water quality rating has not changed from that which was reported in the 2000 305b Report. The federal EPA has requested states to also assess the state's water quality considering the fish consumption advisory for mercury which was issued in June 1995 and most recently revised in June 2000. The advisory was issued as the result of fish tissue sampling which showed mercury in the tissue of all fish, particularly in walleye and lake trout, and also PCBs in lake trout[1] in Lake Champlain (see updated advisory as Appendix B). Taking the advisory into consideration, the overall water quality of all the state's waterbodies would be rated as fair.

With regard to Vermont's wetlands, their water quality is believed to be generally good. Since Vermont does not have a specific program of assessing and monitoring wetland water quality, this characterization is somewhat speculative. It has been incumbent upon the state's limited resources to insure important wetland functions and values are protected from being lost to development or other destructive practices.

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[1]Still in effect is the 1989 advisory for PCBs (polychlorinated biphenyls) in Lake Champlain.

No comprehensive studies have been completed on the quality of Vermont's ground water; however, the quality is considered to be excellent as there are very few reports of contaminated ground water public water supplies.

Water Pollution Control Program

GENERAL

Watershed Approach - Vermont has adopted a watershed approach to surface water quality planning. The DEC-prepared document, *Guidelines for Watershed Planning,* calls for basin surface water plans to be developed on a periodic basis. This document has been summarized and is included as Appendix C. For an update on progress of activities in the three river basins where water quality management plans are being developed, the reader should also refer to Appendix C.

Water Quality Standards - The Water Quality Standards are the foundation of the state's water pollution control and water quality protection efforts. Vermont's present Water Quality Standards were adopted June 10, 1999 and contain a few changes from those that were in use when the 2000 305b Report was prepared. One change to the Standards included a specific reference to a riparian policy. Another change has to do with the "typing" of waters under the Class A and Class B classification system. These revised Vermont Water Quality Standards became effective on July 2, 2000.

POINT SOURCE CONTROL PROGRAM

Approximately $41 million dollars were spent during the 2000 - 2001 reporting period on waste water treatment facility upgrades, combined sewer overflow corrections, sewer line extensions and rehabilitations and other waste water treatment system improvements in 15 municipalities.

NONPOINT SOURCE CONTROL PROGRAM

Overview - Vermont was one of the first states in the country to have an EPA-approved Nonpoint Source Management Program (March, 1989). Since its inception in 1990, Vermont has received over $8 million in Clean Water Act Section 319 Nonpoint Source (NPS) funds to implement a variety of activities directed at high priority waterbodies. The goal of the NPS management program is to encourage the successful implementation of best management practices (BMPs) by farmers, developers, municipalities, lakeshore residents, landowners and riparian landowners to prevent or reduce the runoff of pollutants. During the previous 305b reporting period, the New England regional office of US EPA approved the Upgrade for an Enhanced Vermont Nonpoint Source Management Program.

Some notable activities carried out with Section 319 funding during this 305b reporting period include completion of a 7-year agricultural BMP evaluation and development project, youth-based watershed restoration efforts, further water quality characterization for remediation of an abandoned copper mine, locally-led efforts to improve water quality for the Middlebury River and on certain tributaries to the West River and cooperative funding assistance from the Partnership Program for the Better Backroads Program to protect surface waters near town roads.

Section 604b Program - Work under the 604b Program continued during the reporting period with the award of Clean Water Act funds to the twelve Regional Planning Commissions to determine the nature, extent and causes of pollution and develop plans to resolve those problems. Other notable 604b work included field evaluation of the water quality of rivers and streams as part of the third and fourth year's rotational basin assessment and preparation of this edition of the 305b Water Quality Assessment Report.

Other Federal Sources - Federal FY1999, 2000 and 2001 Environmental Quality Incentive Program funds ($0.94 million, $0.92 million and $1 million, respectively) administered by the US Department of Agriculture (USDA) were directed as cost sharing assistance to approximately 130 farms throughout Vermont for nonpoint source pollution control and the installation of agricultural conservation practices. In the majority of cases, these USDA funds were combined with private funds from participating landowners.

Lake Champlain Management - The Lake Champlain Management Conference (currently known as the Lake Champlain Steering Committee) in its October 1996 *Opportunities for Action* plan has recommended three priorities for action to improve the water quality of Lake Champlain. The priorities are: reduce phosphorus pollution; prevent pollution from toxic substances; and manage nuisance nonnative aquatic plants and animals. Steady progress has been reported in the reduction of both point and nonpoint sources of phosphorus, and remediation of sediment-bound contaminants. A comprehensive basin-wide non-native species management plan was approved by the National Aquatic Nuisance Species Task Force in May 2000. Vermont has received funding from the US Fish and Wildlife Service for two years to implement priority action items in the plan. Also in the year 2000, the Lake Champlain Basin Program issued a report concerning an evaluation of progress towards phosphorus reduction goals. In 2001, the Lake Champlain Basin Program prepared and sought comment on a draft update to its 1996 Plan noted above.

Agriculture - Vermont's Accepted Agricultural Practices (AAPs) rules became effective in June 1995. The AAPs are basic practices that all farm operators are expected to follow without financial assistance to reduce agricultural nonpoint pollutant discharges. Voluntary Best Management Practices (BMP) were adopted and became effective as rules in January 1996. BMPs are site-specific practices prescribed to correct a problem on a specific farm. In 1995, the Vermont Legislature created a state financial assistance program to help pay for voluntary construction of farm improvements designed to abate NPS waste discharges. Since the state BMP cost share program began in 1996, approximately $3.9 million in state funds have been committed to build 947 BMP projects on about 449 farms. About 570 BMP projects (60%) involved manure storage or barnyard treatment.

During the 305b reporting period, permitting rules were adopted which affect Large Farm Operations (LFO). Since LFO rule adoption, LFO permits have been issued for 13 farming operations involving over 18,000 animal units. It has been estimated by the DAF&M there are approximately 30 farms existing in Vermont that qualify as an LFO.

Storm Water - Storm Water General Permit Rules were approved and became effective in October 1991. The Storm Water Procedures were officially adopted in December 1997. During the 1999-2000 Vermont legislative session, Act 114 was passed into law. This action served to substantially modify Title 10 VSA Section 1264 which describes the management of storm water within Vermont. Act 114 required the Department of Environmental Conservation to develop an enhanced storm water management program. A report was issued by the Department in February 2001 that outlined the policy and program options being considered. While the enhanced program has not been completely finalized at the time of this writing, elements of the improved and proposed program include creating municipally-based storm water utilities, certification/privatization of certain aspects of the storm water permitting process and use of improved storm water control measures. The centerpiece of the enhanced storm water program will be reflected in the "Vermont Storm Water Management Manual."

Flow Alteration/Regulation - Efforts to protect natural flows in Vermont's rivers and streams are ongoing. Hydroelectric facilities and water withdrawals for snowmaking and other purposes are the major causes of flow regulation. Most improvements are accomplished through application of Clean Water Act Section 401 water quality certification authority. Unlike earlier versions of the Vermont Water Quality Standards, the current standards, which became effective on July 2, 2000, contain hydrologic criteria.

Since the early 1980s, the Agency of Natural Resources (ANR) has had an active program to address flow regulation and other issues as part of the Federal Energy Regulatory Commission (FERC) hydroelectric licensing process. Two projects were certified since June 2000. One of the certified projects, the Weybridge Project, has also received a license from FERC, improving stream flows in approximately 2.5 miles of Otter Creek.

During the reporting period, ANR worked with the New Hampshire Department of Environmental Services (NHDES) to develop a water quality certification for the Fifteen Mile Falls Project on the Connecticut River. This certification, which was issued by NHDES, contains conditions that will benefit many miles of the Connecticut River between Gilman and Wells River, Vermont. A FERC license for the project is expected in the near future.

Work continues to resolve issues at five FERC-licensed projects with pending water quality certification applications: Carver Falls, Silver Lake, Lamoille, Waterbury and Clyde River. Plans call for certifications to be issued on these projects during 2002.

In addition to work on federally regulated projects, ANR is addressing flow and water level management issues at one of the 18 hydroelectric projects that are not licensed by the federal government (West Danville). In these cases, the Agency is using its authority under state statutes.

With respect to water withdrawals, the Agency has focused most of its effort on snowmaking water withdrawals at ski resorts. Of 19 Vermont ski resorts with snowmaking, nine are either in compliance

or are scheduled to come into compliance with Water Quality Standards and in accordance with ANR rules adopted in February 1996. Other water withdrawals, such as those for public water supplies and industrial or agricultural uses, are not subject to active programs at this time.

Dams - ANR is working with other state and federal agencies and NGOs to address the impacts of dams on the state's rivers. Late in 2000, these parties formed the Vermont Dam Task Force to provide a forum for discussion of specific dam removal/modification projects as well as policy issues related to dams, their environmental impacts, and public safety. Several dam removal projects are in their early stages and the task force members continue work on regulatory, funding and other issues.

River Restoration & Protection - Flash floods in many parts of Vermont during the last several years have caused considerable property damage and left many rivers and streams devoid of natural fish and wildlife habitat. In addition to these natural causes, habitat losses have also occurred following human-caused encroachments. Collectively, these events and their consequences have also left the affected river and adjacent areas susceptible to repeat flooding. This restoration and protection initiative, which relies on the principles and methods of fluvial geomorphology, coordinates federal, state and local resources to restore damaged streams back to their correct dimensions in order to reduce future flood damages and provide ecological and recreational values that were lost as a result of these events. While segments of the Trout River (Montgomery), the White River (Granville and Rochester), the Huntington River and West Branch of the Little River (Stowe) have been restored, many other rivers await attention.

Cost Benefit Assessment

The total expenditure of state, federal and local funds for all municipal wastewater treatment facilities and appurtenances to date has been approximately $553 million. These facilities have improved the water quality of 58 rivers and 3 lakes for swimming, fishing, boating and aquatic life. Annual operation and maintenance costs of these facilities (using 1994 costs) is approximately $69 million. The $553 million figure includes approximately $41 million in wastewater treatment appurtenances and improvements constructed during this 305b reporting period, which have further improved the water quality of nine rivers and one lake.

The amount of funding expended on nonpoint source (NPS) control of pollutants is not as easy to determine due to contributions by various state and federal agencies as well as those by landowners and volunteer watershed groups which deal with NPS pollution. Aside from several federal and state cost sharing programs to assist with planning and implementation of NPS reduction from agricultural sources, there are two federal Clean Water Act programs under DEC administration that address NPS pollution control - the Section 604b Pass Through program and the Section 319 program. Funding for the two programs amounted to approximately $661,000 from 1989 through 2001 (604b) and over $11 million from 1990 through 2000 (Section 319).

Special State Concerns and Recommendations

Several primary water quality concerns to the State of Vermont have been identified. The Department believes these topical areas, presented below in unranked order, deserve special targeting of resources either for protection or restoration. The reader is referred to Part 2, Chapter 5 appearing later in this report for further discussion of these concerns.

On-site wastewater disposal
Watershed and basin planning
Stormwater management
Gaging stations
Water quality monitoring strategy
305b assessment methodology
Groundwater
Polluting discharges from large farms
Road runoff to waterbodies
Lack of statewide vegetated buffer requirements
Atmospheric deposition of pollutants
Hydrologic modification to lakes & rivers
Exotic aquatic species as pollutants
Eutrophication of Vermont lakes
Nutrient criteria

Current Surface Water Quality Monitoring Program

Overview - Surface water quality monitoring undertaken by the Department during the 305b reporting period continued to support an assortment of water program activities. Long-term monitoring programs are designed to assess trends in water quality, as well as to generate baseline water quality information. The Department also maintains a strong presence on Lake Champlain and conducts a variety of short-term lake and stream-specific monitoring projects. Monitoring data is used to manage and protect Vermont waters in a pro-active manner. The reader is referred to Part III, Chapter 1 of this report for a more detailed description of DEC's surface water quality monitoring program.

Rotational Watershed Assessment - Vermont's rotational watershed water quality assessment process began in the spring of 1997. Two rounds of assessments have been completed and the third is underway. Assessment round 1 included the Otter Creek (Basin #3), Lower Lake Champlain Direct (Basin #4) and the White River (Basin #9). Assessment round 2 included the Poultney, Mettawee (Basin #2), the Lamoille River (Basin #7), Ottauquechee, Black (Basin #10), and the Stevens, Wells, Waits, Ompompanoosuc (Basin #14). Assessment round 3 included the Battenkill, Walloomsuc,

Hoosic Rivers (Basin #1), the West, Williams and Saxtons Rivers (Basin #11), the Deerfield River (Basin #12), and the Lower Connecticut River Basin (Basin #13).[2]

To date, the Department has completed an assessment report for seven river basins (Basin #2, 3, 7, 9, 10, 11, and 14). The Department can provide a copy of each completed assessment report upon request.

Plan for Achieving Comprehensive Assessments

The rotational watershed assessment process described above and in Part III of this report will help Vermont achieve a more comprehensive assessment every five years.

Assessment Methodology

River and stream and lakes and ponds data was updated and incorporated into the database for this report. Included in the database is information from the rotational watershed water quality assessments. This information consists of monitored and evaluated water quality data, best professional judgement from biologists and information from numerous agencies, offices and volunteer groups.

Most of the water quality information for rivers and streams was based on evaluated information. The remainder of the river and stream information was based on data obtained through monitoring, primarily from the Ambient Biomonitoring Network. Water quality information for wetlands was not determined because data were not available. With respect to lakes and ponds water quality information, most of the assessed inland lakes and all of Lake Champlain were monitored. The remainder of the lakes and ponds information was based on evaluated information.

In response to the growing requirement that data used in support of Section 303d listing[3] be of very rigorous standards, the Department has made modifications to the guidelines it uses to make use support decisions for surface waters. In conjunction with an effort led by New England Interstate Water pollution Control Commission (NEIWPCC) to create uniform New England 305b decision-making methods, Vermont has adopted a set of guidelines which are slightly more stringent than those used previously. This has resulted in minor reductions in acreages and miles previously identified as partially or not supporting uses based on data or information of insufficient quality. The following representative figure illustrates Vermont's assessment for surface waters and correspondence to state and federal water quality-based listings.

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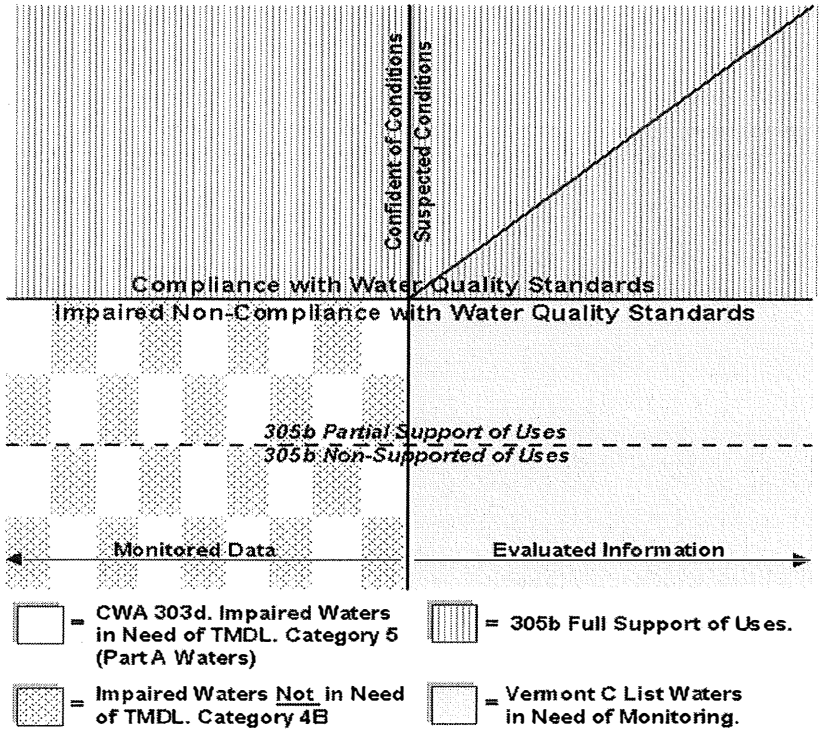
[2] As of this report date, assessment rounds 4 and 5 have not been initiated. Round 4 will involve basin #5 (upper Lake Champlain direct drainages), basin #6 (Missisquoi River) and basin #17 (Lake Memphremagog drainages). Round 5 will involve basin #8 (Winooski River), basin #15 (Passumpsic River) and basin #16 (upper Connecticut River drainages).

[3] Section 303d of the Clean Water Act requires each state to identify those waters for which technology-based pollution controls are not stringent enough to attain or maintain compliance with applicable State water quality standards.

How Assessed Waters Correspond with State and Federal Listings.



Section 303d Waters

The Vermont Year 2000 List of Waters, submitted in conjunction with Section 303d reporting (finalized in July 2000), was approved by the regional office of the US Environmental Protection Agency in May 2001. The Vermont Year 2000 List of Waters contains two sections. Part A identifies 126 impaired surface waterbodies and 203 unique water quality impairment problems, which need pollution abatement. Although each Part A listing entry has been scheduled for possible total maximum daily load (TMDL) development, it is recognized that such an approach may not be warranted in every

case. Part B is used to identify candidate waters for "de-listing." There were no waters proposed for "de-listing" on Part B of the Year 2000 List of Waters.

As of this report date, the Department has begun to prepare the Year 2002 303d List of Waters. The Year 2002 listing will be assembled in a similar two-part format (Part A & Part B) as described above. Part B of the Year 2002 will identify candidate waters for 303d de-listing and include waters that are no longer considered to be impaired and impaired waters that do not need or require a TMDL. The Year 2002 listing will also identify impaired waters being addressed under an EPA-approved TMDL. The final Vermont Year 2002 listing, eventually to be submitted to the New England regional office of US EPA for approval, will be made available separately.

TMDL Program

A TMDL, also known as a Total Maximum Daily Load, is the calculation of the maximum amount of a pollutant that a waterbody can receive and still meet applicable water quality standards. In a broader sense, a TMDL is a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards and develops a means to implement those reductions. TMDLs are meant to analyze water pollution problems from a watershed perspective and develop a balance among pollution sources where the needed pollution reductions will occur.

During the reporting period, several TMDL-related efforts were initiated or completed. TMDLs were finalized by the Department and approved by EPA for the Winooski River (Cabot) and the Black River (Ludlow). TMDL approval is pending for TMDLs developed for two streams in the vicinity of Stratton.

TMDL efforts are underway and in various stages of completion for nine segments of Lake Champlain (phosphorus), sediment affecting Allen Brook (Williston) and temperature for the Mettowee River (Pawlet). The Department is in the early stages of TMDL development which concern some forty waterbodies that are impaired from acidic (i.e. low pH) atmospheric deposition.

Rivers and Streams Water Quality Assessment (Statewide)

Including the waters assessed in the last two years, 78% of Vermont's total assessed miles (5,450 miles) fully support designated water uses and 22% do not fully support designated uses. The fish consumption use is not factored into the overall use support category because the effect of a statewide fish consumption advisory would mask the extent of other threats to Vermont's waters. Two percent of the waters do not fully support fish consumption and 98% are threatened due to the statewide advisory. The shift from partial support status to threatened status since the Year 2000 305b report is due to a change in EPA guidance. Of the 5,450 miles of rivers and streams assessed for use support, 15% (838 miles) are based on in-stream monitoring data and 85% (4,612 miles) are based on a variety of other information and information sources. As stated in the Year 2000 305b report and as is the case for the Year 2002 305b report, nonpoint sources of pollution remain the most widespread cause of water quality impairment affecting rivers and streams.

Lakes and Ponds Water Quality Assessment (Statewide)
Overall statewide use support indicates that 32,117 acres (58% of the total assessed inland lake acres of 55,447 acres) fully support all uses. Approximately 18,950 of these fully supporting acres (59%) are threatened. Approximately 29,006 acres (42% of total lake acres assessed) either partially support all uses or do not support uses.

Fish consumption uses are fully supported on only 40,732 inland lake acres (83%). This is a result of the existing Vermont Department of Health advisory against consumption of freshwater fish due to mercury contamination. If the fish consumption advisory were applied, based on the strictest interpretation of EPA guidelines as discussed above, 100% of Vermont's inland lake acres would not fully support fish consumption uses.

Rotating Basin Assessment (Specific Watersheds)
Use support status of the Lamoille River basin (Basin 7) and Basin 11 (includes the West, Williams, and Saxtons Rivers) is given in Appendix D. Also found in Appendix D are summary findings from the Nulhegan River (one drainage of Basin 16) biological assessment.

Wetlands
An analysis of wetland loss between 1990 and 1999 showed a total of 522 acres of documented wetland loss and impairment. During the same period, approximately 540 acres of wetlands were saved from loss/impairment by encouraging developers to adjust the footprints of their proposed developments to avoid wetlands.

Public Health/Aquatic Life Concerns
There were four reported public beach closures in Vermont in the two years of this reporting period. It is believed that most of the Burlington area (Lake Champlain) beach closures were due to urban runoff and faulty septic systems. The on-going and permanent closing of Blanchard Beach at Oakledge Park in Burlington due to high bacteria levels is believed to be caused by illegal sewer pipe connections to the stormwater system plus contributions from urban land surface runoff.

Fish consumption advisories continue to be in effect for lake trout, walleye and all other fish due to mercury contamination. Still in effect is the 1989 fish consumption advisory for lake trout over 25 inches in length in Lake Champlain due to PCBs.

There were no closures of drinking water supplies during the reporting period; however, there were five boil water notices issued during the period.

Ground Water
The majority of Vermont's citizens continue to depend upon ground water for drinking and other uses. Generally, the quality of Vermont's ground water is considered to be excellent, although no comprehensive studies have been completed on ground water quality to confirm that characterization

due to a lack of data and resources required to gather and assess the needed data. The ground water quality assessment rating of "excellent" is based on the small number of public water supplies which have detected contamination.

The quality and quantity of Vermont's ground water is not often considered except when there is problem. Ground water problems within Vermont are most often associated with drinking water supplies and can range from localized ground water contamination to well interference which reduces well yields.

A major concern with ground water resources throughout Vermont is the public's assumption that ground water is pure and safe and that it will stay that way. This attitude is due primarily to the fact that Vermont's ground water is generally safe and plentiful and the public is not well aware of how easily the resource may become contaminated or degraded by peoples' activities.

Vermonters have recently become aware of risks to drinking water safety associated with naturally occurring geologic sources of materials known as radionuclides found in certain bedrock formations. Exposure to radionuclides (includes uranium, thorium, radium and radon) at levels exceeding health standards poses a risk to water consumers, particularly when exposure continues over a long period of time. To better understand those risks, efforts are underway to delineate those areas within Vermont that are prone to having radioactive groundwater. An important component of this three year endeavor involves an evaluation of the fate, transport and concentration of radionuclides discharged to septic systems and leaching fields and whether concentrated waste result in health hazards.

PART II: BACKGROUND

PART II: BACKGROUND

Chapter One: Vermont's Surface Water Resources

Vermont has approximately 7,100[1] miles of rivers and streams, 230,790 acres of lakes, reservoirs and ponds and 300,000 acres of freshwater wetlands. The surface area of lakes, ponds and wetlands represent approximately 828 square miles of water or about 8.6% of the state's total 9,609 square miles. Vermont's border waters include the Connecticut River on the east (border with New Hampshire), Lake Memphremagog on the north (partial border with the Province of Quebec) and the Poultney River and Lake Champlain on the west (border with New York). There are seventeen major river basins in Vermont, which drain to one of four regional drainages: Lake Champlain, the Connecticut River, Lake Memphremagog, or the Hudson River.

Table II.1.1. Atlas.

State population	608,827 (2000 Census)
State population change (1990 - 2000)	8.2 % increase
State surface area	9,609 square miles
State population density	63.36 persons/sq mi
Number of water basins	17
Miles of perennial rivers & streams[2]	7,099
Border miles of shared rivers/streams (subset)[3]	262
Number of lakes, reservoirs & ponds (at least 20 acres)	287
Number of lakes, reservoirs & ponds (at least 5 acres but less than 20 acres)	317
Number of significant, lakes, reservoirs & ponds (less than 5 acres)	206
Acres of lakes, reservoirs & ponds[4]	230,789
Acres of freshwater wetlands[5]	300,000

[1] Source of figure is EPA's Total Waters Database. Past 305(b) reports have relied upon Don Webster's 1962 list of Vermont waters. However, a number of omissions have been discovered in this early listing. Many small streams had been overlooked and the lengths of some rivers and streams had been significantly underestimated.

[2] Includes the Connecticut River.

[3] Connecticut River - 238 miles; Poultney River - 24 miles.

[4] Figure includes the Vermont portion of Lake Champlain, some private waters and some waters less than 5 acres in size. This figure also accounts for two large CT River impoundments, Moore and Comerford Reservoirs, which are 1,255 and 777 acres in size, respectively. These were not previously tracked in Vermont's Lake Inventory Database.

[5] Figure does not include wetlands found on agricultural lands which are actively used for agricultural purposes.

There are no coastal waters, estuaries or tidal wetlands in Vermont. However, due to the size of Lake Champlain (approximately 120 miles long and 12 miles wide at its widest point), the lake is considered an inland sea by residents of Vermont, New York and Quebec. The Atlantic Ocean and Inland Waterway are accessible from the Lake via the New York Barge Canal to the south and the Richelieu and St. Lawrence Rivers to the north through Canada.

Total Waters/Mapping

Until Vermont completes its GIS mapping of waterbodies, the 305b Report will use EPA's 1995 estimate of total river and stream miles. Using Clean Water Act Section 604b Pass Through funding, the 12 Regional Planning Commissions (RPC) of Vermont have corrected/digitized many of Vermont's waterbodies on GIS maps by waterbody identification number. The Vermont Center of Geographic Information has received some funding to continue the correction/digitizing of waterbodies on a statewide basis. When the waterbodies have all been mapped, Vermont will then be able to determine the total mileage of its rivers and streams. More information about these efforts is available in Part III, Chapter 2.

Chapter Two: Water Pollution Control Program

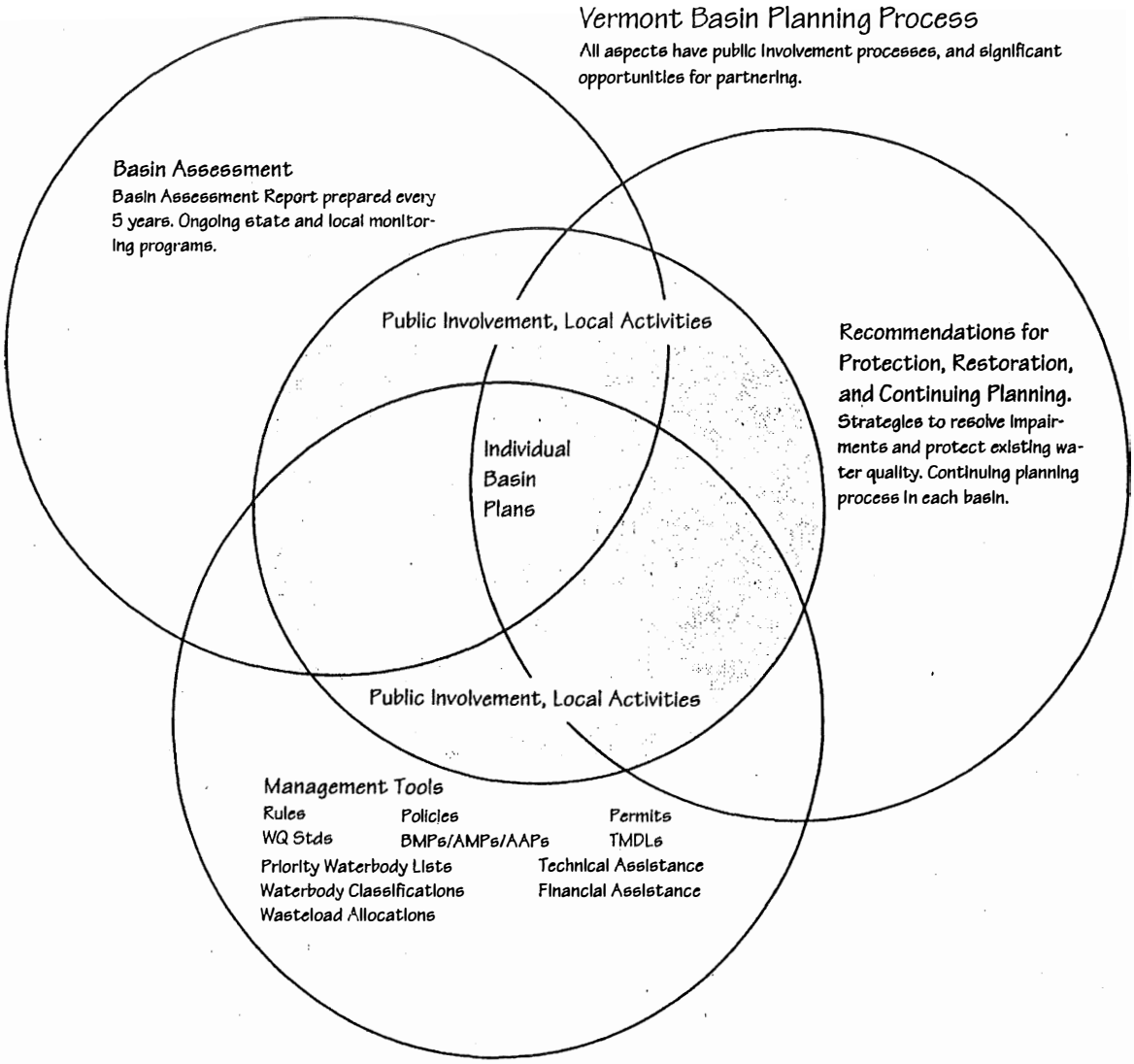
Watershed Approach

The General Assembly and the Vermont Water Resources Board have revised the deadline for the Agency of Natural Resources to complete new watershed plans to January 2006 (refer to Title 10 VSA Section 1253(d); Vermont Water Quality Standards - effective July 2000). With the assistance of a public and statewide "Framework Committee," VDEC is refining a "Guidelines for Watershed Planning." (See draft Guidelines and a description of the ongoing planning in the three planning basins in Appendix C).

The Department has begun to implement a new Watershed Initiative. Three Watershed Coordinators are conducting Watershed Planning in the White, Lamoille and Poultney/Mettowee River watersheds. One Coordinator is located in Rutland, a second will be working in Essex Junction and a third is based in Waterbury. The Coordinators provide individual assistance to lake, river and watershed groups, personally work with landowners to correct water quality problems, help form Watershed Councils/Teams and determine the watershed management needs of communities, among other responsibilities.

It is hoped that this approach, pieced together from the methods of other states and public ideas, will help the public to understand the Watershed Planning Process and how they can work with the Watershed Coordinators to motivate state and local interests, including towns, local commissions and watershed groups to improve water quality. A manageable number of watershed protection and restoration goals will be identified. Specific outputs of the approach will include, among others, seventeen watershed assessments with basin plans revised and adopted every five years and implementation of countless restoration actions related to the highest priority issues in each watershed.

The watershed planning process is an inclusive public process that takes into account current and past assessment, planning, and implementation activities at the state and local levels. Assessments are followed by the basin plans that will summarize current and past (within five years) water pollution or water quality management activities. This rotational planning process will also identify topics or areas of special importance in the basin, identify available management tools to address those topics, and make specific recommendations on how to address key topics, including recommendations for continuing community-based planning or implementation action. Each basin plan updates previous basin plans. Each basin is unique in its problems and opportunities. The following diagram illustrates the concept that Assessment, Planning and Implementation are constantly occurring at many different levels from the activities of landowners to municipal, state and federal levels and evolving with public participation. The Watershed Planning document looks at all of these activities including the condition of the waters in a given point in time and makes conclusions and recommendations for the future.



Although the myriad of assessment, planning and management activities within a basin are too numerous to capture in a single document, a basin plan can, with the help of an interested public, isolate specific high priority issues and elevate them for attention during and after the planning process.

Water Quality Standards

The Water Quality Standards are the foundation for the state's water pollution control and water quality protection efforts. The Standards provide the specific criteria and policies for the management and protection of Vermont's surface waters. The classification of waters as Class A, Class B or Class B with Waste Management Zone (WMZ) are the management goals to be attained, if not already attained. The classification also specifies the designated water uses for each class. The existing Water Quality Standards became effective July 2, 2000 and were used as a basis for this report.

The Water Quality Standards call for the protection of existing uses and the maintenance of water quality necessary to protect those existing uses. Existing water uses are those uses which have actually occurred on or after November 28, 1975 in or on a waterbody whether or not the uses are included in the standard for classification of the particular waterbody. Determinations of what constitutes an existing water use on a particular waterbody shall be made on a case-by-case basis by the Secretary. The Water Quality Standards include detailed narrative criteria for the Water Quality Management Types (B1, B2 and B3) for Class B waters. These revised Standards also include greater detail concerning regulation of stream flows and inclusion of specific criteria for minimum conservation flows.

Surface Water Classification and Typing

Introduction to Classification and Typing

All surface waters in Vermont are presently classified as either Class A or Class B. Class B waters comprise approximately 95% of all waters in the State. They are managed to achieve and maintain a high level of quality that is compatible with designated uses. The July 2, 2000 Water Quality Standards recognize two categories of Class A waters. Waters designated as Class A(1) are Ecological Waters, which are managed to maintain waters in an essentially natural condition. Waters designated as Class A(2) are Public Water Supplies and allow slightly greater change from the reference condition for habitat, aquatic macro-invertebrates and fish assemblages than A(1). This is due to the fluctuations found in water supply reservoirs and streams. The new Standards contain a requirement that calls for all Class B waters to be eventually designated either Water Management Type 1, Type 2 or Type 3, depending upon the goals of the community for protection and management. The Type must recognizes the attainable of uses at the level of water quality protection associated with the Type and the level already afforded under the anti-degradation policy described in the Vermont Water Quality Standards.

Class A Re-classifications

The 1986 "Pristine Streams Act" created the opportunity for any waterbody supporting habitat that is ecologically significant and has water quality that meets at least Class B standards to be re-classified to Class A. A re-classification is a rule making procedure before the Water Resources Board where a public interest determination must be made pursuant to Vermont's Water Pollution Control Statute, Title 10 VSA Section1253. No streams have been reclassified to Class A since the 1998 305b Report.

Outstanding Resource Waters

An overlay of both Class A and Class B waters is the Outstanding Resource Water (ORW). ORWs are waters of the State designated by the Water Resources Board as having exceptional natural, recreational, cultural or scenic values. To gain an ORW designation, the petitioners must, in a contested case hearing before the Board, provide evidence and testimony that the waters in question have exceptional natural, cultural, scenic, or recreational values.

Reporting Note: The Vermont Natural Resources Council filed a petition with the Vermont Water Resources Board during the 305b reporting period to re-classify the Nulhegan River and its tributaries to Class A and a second petition for designation as an Outstanding Resource Water. Both petitions were withdrawn due to the recognized need for more water quality and aquatic biota data. The Department conducted a water quality assessment for the Nulhegan River during 2000. The reader is referred to Appendix D for a summary of the Nulhegan River assessment.

Table II.2.1. Summary of Classified Uses & Values (Existing).

Classified Uses & Values	Total Size Classified for Use	
	Rivers (miles)	Lakes (acres)
Class A: • water quality uniformly excellent • enjoyment of water in its natural condition • contact recreation when compatible • public water supply with disinfection • high quality waters with significant ecological value	164 approximately (does not include mileage for all waters above 2500' elevation)	1,736
Class B: • water consistently exhibits good aesthetic value • swimming & recreation • public water supply with filtration & disinfection • high quality habitat for aquatic biota, fish and wildlife • irrigation and other agricultural uses	6,935	229,053
TOTALS	**7,099**	**230,789**

Point Source Control Program

Vermont administers a well-planned and comprehensive direct discharge water pollution control program, consisting of planning advances, construction grants and loans, permitting and compliance monitoring. With the construction of the state's last originally identified municipal waste water treatment facility (WWTF) and completion of the upgrades from primary to secondary, the program has continued to place emphasis on refurbishment of existing WWTFs, the completion of phosphorus reduction upgrades (refer to Table II.2.2), advanced waste treatment, correction of combined sewer overflows (CSO) (see Table II.2.3), control of toxics, pollution prevention activities and facility enlargements.

During the 2000 - 2001 reporting period, construction commenced on CSO corrections, sewer line rehabilitations and extensions, sewer system improvements, wastewater treatment plant upgrades, and phosphorus reductions. These various projects, located in three of the four major drainages within Vermont, are being funded by state, federal and local resources and total approximately $41 million (refer to Table II.2.4).

The three phosphorus reduction projects in the Vermont portion of the Lake Memphremagog drainage basin have been completed. Of the 31 facilities with planned phosphorus reduction projects in the

Vermont portion of the Lake Champlain basin, 28 have been or are close to being completed.

Of the 32 planned CSO correction projects, 20 have been completed, 5 are underway and 7 are pending. It is interesting to note that after an initial assessment/survey, it was determined there was no need for CSO construction in Bennington, St. Albans City, Winooski and Woodstock.

Table II.2.2. Status of Phosphorus Removal/Reduction Projects.

Municipality	Construction Status	Comments
***** LAKE CHAMPLAIN DRAINAGE *****		
Barre City	completed	
Brandon	completed	work started in 2000
Burlington (north)	completed	
Burlington (main)	completed	
Burlington (east)	completed	
Cabot	completion by 10/01	work started in 2000
Castleton	completed	
Enosburg Falls (Phase 1 - chem)	completed	
Enosburg (Phase 2 - bio)	completion by 12/01	work started in 2001
Essex Junction	completed	
Fair Haven	completion by 12/01	work started in 2000
Hinesburg	completed	
Johnson	completed	
Middlebury	completion in 2001	
Milton	construction in 2002	may start later
Montpelier (Phase 1)	completed in 2000	
Montpelier (Phase 2)	completion in 2001	work started in 2000
Morrisville	completed	
Northfield	construction in 2002	may start later
Poultney	started in 2001	currently underway
Richmond	construction in 2002	may start later
Rutland City	completed	
South Burlington (Bartlett Bay)	completed	
South Burlington (Airport Parkway)	completed	
Shelburne (Plant #1)	completed	

Municipality	Construction Status	Comments
Shelburne (Plant #2)	completed	
St. Albans City & NW Corrections	completed	
Stowe	completed	
Swanton	completed	
Vergennes	completed	
West Rutland	completed in 2000	
Winooski	completed	
*** LAKE MEMPHREMAGOG DRAINAGE ***		
Barton Village	completed	
Newport City	completed	
Orleans	completed	

Table II.2.3. Construction Status - Combined Sewer Overflow (CSO) Projects.

Municipality	Construction Status	Comments
****** LAKE CHAMPLAIN DRAINAGE ******		
Brandon	completed	
Burlington	completed	
Enosburg Falls	completed	
Hardwick	completed	
Middlebury	completed	
Montpelier (Phase 1)	completed	
Montpelier (Phase 2)	started fall 1999	partially done; balance by 2003
Northfield	completed	
Poultney	underway	infiltration/inflow versus CSO
Richford	underway by Village	
Rutland City (Phase 1)	completed	
Rutland City (Phase 2A)	pending	monitoring Phase 1
Rutland City (Phase 2B)	pending	monitoring Phase 1
Swanton	completed	
Vergennes	completed	project effectiveness study underway in 2002
****** LAKE MEMPHREMAGOG DRAINAGE ******		
Barton	completed	project completed but overflow events still occur; evaluation study underway
Newport City	completed	
Orleans	completed	
****** CONNECTICUT RIVER DRAINAGE ******		
Bellows Falls	completed	
Hartford	completed	project completed but Order issued to abate remaining overflows
Ludlow	completed	done without state assistance
Lunenburg	completed	done without state assistance
Lyndon	completed	
Randolph	completed	project completed but overflow events still occur; evaluation study underway
Springfield (Phase 1)	started spring 2000	partially done; balance by 2003

Municipality	Construction Status	Comments
Springfield (Phase 2)	initiate 2003	completion by 2005
St. Johnsbury (Phase 1)	underway by town	work on-going since 1984; consists of storm water separation affecting 7 of 20 sewer overflow locations
St. Johnsbury (Phase 2)	initiate spring 2003	
St. Johnsbury (Phase 3A)	initiate spring 2002	
St. Johnsbury (Phase 3B)	initiate spring 2004	
St. Johnsbury (Phase 4)	initiate spring 2005	
Wilmington	completed	done without state assistance; done during WWTF upgrade
Windsor	completed	infiltration/inflow problems with no CSO

Table II.2.4. Municipal Pollution Control Project Starts. (January 1, 2000 to December 31, 2001)

Community	Description	Est. Project Cost
****** LAKE CHAMPLAIN DRAINAGE ******		
Barre City	WWTF disinfection improvements to increase plant capacity from 3.4 MGD to 4.0 MGD	$ 800,000
Brandon	plant upgrade for phosphorus removal	553,000
Cabot	new WWTF & sewage collection system	4,559,000
Enosburg Falls Village	Phase 2 phosphorus removal improvements - biological removal of phosphorus	410,000
Fair Haven	plant upgrade for phosphorus removal - contract 1	528,000
	sewer rehab to correct I/I & overflow problems - contract 2	215,000
	sewer I/I corrections - pump station improvements - contract 3	350,000
Montpelier	Phase 2 CSO - contract 6	1,773,000
	Phase 2 CSO - contract 7	1,630,000
Poultney	WWTF upgrade for phosphorus removal & to eliminate plant bypass	3,886,000
Shelburne	sewer extension to Shelburne Heights	815,000
Shoreham	new WWTF & sewage collection system	2,458,000
Stowe	WWTF upgrade & enlargement, increase capacity from 0.25 MGD to 1.0 MGD	12,040,000
	sewer extension to Notchbrook Rd - contract 4	1,800,000
	sewer extension to Stowe Mtn Resort - contract 5	1,450,000
Vergennes	WWTF & pump station improvements to correct I/I & plant overflow problems	2,500,000
****** LAKE MEMPHREMAGOG DRAINAGE ******		
Derby Center Village	sewer extension to MHP - new pump station & force main	250,000
Newport City	upgrade Indianhead PS & install new force main	723,486
****** CONNECTICUT RIVER DRAINAGE ******		
Springfield	Phase 1 CSO - contract 1 - PS rehab	700,000
	Phase 1 CSO - contract 2 - sewer separation	1,196,000
	Phase 1 CSO - contract 3	2,048,000
Windsor	rehab of Weston Heights WWTF & sewers	850,000
TOTAL COST		**$41,534,986**

Chapter Three: Nonpoint Source (NPS) Control Program

Pollution from nonpoint sources continues to be the major source of water use impairment to Vermont surface and ground water resources. It is estimated that close to 90% of the miles and acres of the state's impaired surface waterbodies are the result of NPS.

As one of the first states in the nation to have an EPA-approved NPS Management Program (March 1989), Vermont has been able to effectively target areas, design work plans, compete for and capture funding and implement NPS projects directed at restoring and protecting water uses and values. In the twelve years of available Section 319 NPS implementation funding (1990-2001), Vermont has received about $11 million to implement a variety of activities.

In response to the release of the President's Clean Water Action Plan (February 1998), the State of Vermont and the EPA worked together to review the NPS Management Program document of 1988 as well as revise and implement enhanced State NPS management programs that incorporate the nine essential and key elements of a state program defined by US EPA. Those states which incorporate all nine key elements in their enhanced programs will receive financial incentives - such as being eligible to receive additional Section 319 funds - beginning in federal fiscal year 2000. The Enhanced Vermont NPS Management Program was approved by the regional office of US EPA (October 1999).

Specific details regarding NPS program and project activities are available from the Department. Readers of this 305b Report can refer to previous 305b reports for a listing of earlier 319-assisted project titles by funding year. Vermont will continue to pursue and apply Section 319 NPS funding in targeted areas that are likely to result in the successful implementation of Best Management Practices (BMP) and programs

Section 319 Special Projects

The following describes seven Section 319 Special Projects selected as examples of the types of projects taking place under this grant program.

1) Lake Champlain Basin Agricultural Watersheds Section 319 National Monitoring Program Project (1994 - 2001)

EPA supported this water quality monitoring and evaluation project located in the Missisquoi River watershed in Franklin County since 1994. Aside from visible degradation of the watershed, the receiving waters have suffered from increased bacteria and total phosphorus levels.

The seven year project, completed in June 2001, was designed to measure the water quality effectiveness of certain agricultural management practices, including: livestock exclusion fencing, protected livestock stream crossings, establishment of riparian buffers, and bio-engineering streambank erosion controls. Monitoring efforts of the project focused on water quality and aquatic biota changes in two small treatment watersheds compared to those in a control, untreated watershed.

The project successfully documented reductions in phosphorus, nitrogen, suspended solids and indicator bacteria in response to applied treatments. Treatments had a positive effect on stream biota (macroinvertebrates). Treatment effectiveness was reduced under unusual hydrologic events. In addition, the project was able to show the extent to which water quality impacts arising out of a single, acute problem can overwhelm the ability to detect response to land treatment.

2) The Vermont Better Backroads Program
This special project continued as a partnership between DEC and several outside organizations. A Small Grants Program was initiated during the summer of 1997 and continues to be administered by grant through the Northern Vermont Resource Conservation and Development Council.

The 1999 Vermont Legislature, through the House Transportation Committee, provided additional funding to the Small Grants Program which doubled the available funding for this effort. The Small Grants Program is currently emphasizing road inventory and capital budgeting projects as a means for towns to more effectively and systematically address road-related erosion. During the reporting period, 39 Better Backroads projects were funded (21 projects in 2000, 18 projects in 2001), at a combined cost of $136,000.

3) Demonstration of alternative manure management technology
The purpose of this special project is to demonstrate, on a farm within the Lake Champlain basin, the performance and adaptability of an electric reactor-type technology for treating dairy manure in northern New England conditions. Specifically, the project will evaluate how the technology may perform in a cold climate and its potential for "fitting into" current dairy manure management. The project involves a close and working partnership between the cooperating farm operator located in East Montpelier, the state and federal departments of Agriculture, the University of Vermont and the Winooski Natural Resources Conservation District.

4) Connecticut River sustainable riverbanks
One purpose of this special project affecting the upper reaches of the Connecticut River - a designated American Heritage River - and carried out by the Connecticut River Joint Commissions, was to establish riverbank stabilization priorities from previous riverbank erosion surveys and to demonstrate assistance with the stabilization of the highest priority sites. Of the 27 problem sites inventoried in the upper reaches bordering Vermont and New Hampshire, 3 sites were selected and given top priority for restoration. Two of the three priority sites are located on the Vermont shoreline.

The second project purpose, carried out by the Connecticut River Watershed Council, was to manage and coordinate the inventory of erosion problems, riparian habitat and different land uses along the lower portions of the Connecticut River in Massachusetts and Connecticut. This effort identified 173 problem sites (99 in Massachusetts and 74 in Connecticut).

5) Middlebury River water quality improvement
The purposes of this noteworthy project were to further define the source(s) contributing to unacceptably high bacteria levels in the lower reaches of the river and to generate local interest in

selecting and carrying out preferred improvement actions. A locally-based group of concerned citizens organized by the Otter Creek Natural Resources Conservation District spearheaded the project. Not only did the project result in greater environmental awareness of the problem and the development of an improvement plan, the project also resulted in the formation of the group now known as the Middlebury River Watershed Partnership.

6) Restorative & protective actions for a tributary to the West River
In response to a 1998 stream assessment survey, the Bonnyvale Environmental Education Center (BEEC) was awarded 319 funds to select, target and implement certain measures on priority streambanks and riparian areas in need of treatment. Following selection of three sites and the planned conservation measures, BEEC organized an outreach and education effort including recruitment of volunteers. The project provided an outdoor hands-on lab for students, volunteers and landowners. The project also demonstrated the power of partnerships by raising awareness of erosion and control methods.

7) Youth-based watershed restoration
The purpose of this project is two-fold: to address NPS problems and to provide meaningful short-term employment to high school and college-aged youth. Working in a supervised setting under the Vermont Youth Conservation Corps, participants are provided on-the-job training along with the opportunity to broaden their base of conservation consciousness. Corps members are assigned various in-stream, streambank and riparian restoration projects. Such youth-based efforts and activities, assisted by Section 319 funding, have been underway for several years. "Watershed crews" have been situated in Chittenden County, Franklin County, Caledonia County and Washington County. Recently, "roving crews" have been added to the program which provides further NPS pollution control capabilities.

Section 604b
Use of Clean Water Act Section 604b funds by the Department is directed at the inventory, evaluation, strategic planning and management of water resources within the state. Work under the 604b program during the reporting period has included the award of pass through grants to the 12 Regional Planning Commissions to determine the nature, extent and causes of point and NPS pollution problems and to develop plans to resolve those problems. Appendix E contains an updated inventory of pass through activities undertaken by each planning commission.

Section 104b3
The following project is an example of work being performed under this Partnership Program.

Urban Stormwater Management
This project involves the implementation of watershed management and watershed protection activities in a number of Chittenden County watersheds characterized as impaired by urban stormwater runoff. This project has supported the following activities: creation of a municipal-state-utility partnership to design and construct an extended detention wetland for a significant nonpoint source discharge to Shelburne Bay, mapping assistance to South Burlington to develop an accurate inventory of their storm

sewer infrastructure, research/development of appropriate erosion control ordinances and stormwater maintenance guidelines for area towns, education/outreach on riparian buffer zones for the Malletts Bay watershed, and coordination of regional discussions on stormwater management and watershed management.

Public information, technical assistance and both volunteer and contractual (Vermont Youth Conservation Corps) based watershed restoration activities have been carried out in targeted watersheds. Also, project activities have included: coordination of drinking water source protection activities with the Champlain Water District in the Shelburne Bay watershed (LaPlatte-Potash-Monroe-McCabes-Bartlett subwatersheds); participation in urban long term chemical and biological monitoring; investigation of water quality violations; research on urban stream channel morphology, and development of municipal stormwater guidance.

Other Federal Sources

Agriculture
Agricultural NPS control efforts in the state continued with financial and technical assistance being provided through several programs within the US Department of Agriculture (USDA). Federal FY1999 and FY2000 Environmental Quality Incentive Program funds (about $1 million per year) were directed as cost sharing assistance to approximately 120 farms annually for best management practices to protect waterbodies from agricultural-related runoff.

Lake Champlain Steering Committee & Lake Champlain Basin Program (LCBP)
The LCBP, in their October 1996 publication, *"Opportunities for Action,"* set out three priorities for action to improve the water quality of Lake Champlain. These priorities (reducing phosphorus pollution, toxic pollution prvention, managing non-native nusiance aquatic species) were discussed in detail in the 1998 305b Report. In October 2001, the Basin Program issued the updated draft of *"Opportunities for Action"* in order to address emerging issues, use new scientific and technical information and reflect important progress over a five-year period. The following paragraphs are provided as brief updates to those three priority areas. The reader is encouraged to contact the Basin Program (phone: 1-800-468-LCBP or via internet: www.lcbp.org) to obtain further details on the Program and progress.

- *1) Reducing Phosphorus Pollution.* In their 1999 publication (entitled *Progress '99*), the LCBP reports on significant progress made in the arena of phosphorus reduction. As for point sources of phosphorus, treatment plant upgrades are progressing on-schedule in Vermont (as reported earlier in Part II, Chapter Two) and are proceeding at an accelerated schedule in New York, thanks to the New York State Bond Act. Regarding nonpoint soures of phosphorus, LCBP reports significant progress, both by large agricultural projects and via local small-scale implementation grants.

  In June 2000, the LCBP issued a report entitled *Preliminary Evaluation of Progress Toward Lake Champlain Phosphorus Reduction Goals*. The authors of the report found that Vermont,

New York and Quebec will have reduced the input of phosphorus to the lake by about 39 metric tons per year by 2001, a figure exceeding the five-year interim reduction goal. Attainment of phosphorus loading reduction targets would not, however, be accomplished in all lake segments within the 20-year timeline, especially with regards to phosphorus reduction from nonpoint sources. Further, accelerating the timeframe to meet nonpoint source reduction targets in fewer than 20 years would require not only new control techniques but also higher annual funding commitments.

- *2) Preventing Pollution from Toxic Substances.* Burlington Harbor, Outer Malletts Bay and New York's Cumberland Bay remain sites of active toxics monitoring and research. In Burlington Harbor, the University of Vermont has received funding through the Pine Street Barge Canal settlement to conduct advanced research into the nature of the site's contamination. Tetra Tech, an EPA consultant, also did work in Burlington Harbor, assessing the biological impacts of the sediment contamination. Toxic substances of concern in this area include lead, mercury, silver, zinc and polycyclic aromatic hydrocarbons (PAH). Toxic substances of concern in Outer Malletts Bay are arsenic, nickel and manganese. The State of New York has completed a three-year $35 million remediation project to remove the PCB contaminated soil from the Wilcox Dock area of Cumberland Bay where toxic substances of concern include PCBs, PAHs, copper and zinc.

- *3) Managing Nuisance Nonnative Aquatic Plants and Animals.* A comprehensive management plan was approved by the Aquatic Nuisance Species Task Force in May 2000. Two years of USF&WS funding to implement the Plan have been received to date. There exists evidence that the impact of sea-lamprey on the salmonid fishery has lessened dramatically due to the Federally funded sea-lamprey control program. Recent commitments to funding water chestnut management by the Department, the LCBP and the Army Corps of Engineers, plus substantial volunteer assistance continue to slow the northward expansion of this species in Lake Champlain. In fact and during 2001, significant progress was made in pushing water chestnut back down Lake Champlain. The northern 30 miles of infestation are now controllable by handpulling alone.

State Sources

Many nonpoint source planning and management activities funded primarily from state sources were discussed in the 1996 305b Report, to which the reader is referred. The following are those state-funded activities which had notable changes during the reporting period.

Agriculture

The Vermont Legislature required the Commissioner of the Vermont Department of Agriculture, Food and Markets (DAF&M) to develop by rule, implement and enforce two types of agricultural land use practices - accepted agricultural practices (AAPs) and best management practices (BMPs) - in order to reduce pollutants entering waters of the state.

The AAP Rules, which became effective in June 1995, are statewide restrictions designed to reduce agricultural nonpoint pollutant discharges through implementation of improved farming techniques. The

AAPs are basic practices that all farm operators are expected to follow without financial assistance as a part of normal operations.

The DAF&M has developed BMP rules. BMPs are voluntary and are more effective than AAPs and will be site specific practices prescribed to correct a problem on a specific farm. BMPs were adopted and became effective as rules in January 1996. The Vermont General Assembly authorized in 1995 the creation of a state financial assistance program to help agricultural operators in support of their voluntary construction of on-farm improvements designed to abate nonpoint source agricultural waste discharges. Since the program's inception approximately $3.8 million in State General Funds have been committed to help in the installation of 947 BMPs on some 449 farms. Approximately 89% of these BMPs are located on farms in drainages to Lake Champlain or Lake Memphremagog. Approximately 60% of the BMPs installed statewide under this funding assistance program have been for "waste utilization" (i.e. manure /waste storage) and "barnyard treatment" (i.e. barnyard paving).

During the reporting period, permitting rules affecting Large Farm Operations were adopted. The LFO Rules, administered by the Vermont Department of Agriculture, Food and Markets, regulate farms that exceed a certain number of animal units. Existing farms, new farms or farms undergoing expansion will be affected by these requirements that are intended to minimize various environmental impacts. To date, there are 13 LFOs permitted within Vermont.

Storm Water

Hydrologically Sensitive Waters (HSW)

Due to rapid development of certain watersheds in Vermont, and concern over in-stream gravel mining, VDEC formed a Steering Committee to provide direction to the Department for controlling or mitigating these activities that encourage flooding and destruction of a stream's biological community. The Committee commissioned the study of hydrologically sensitive streams to be performed in three phases.

Phase I was completed in January 1998 and resulted in a literature search. The result of this search, entitled *Final Report for Watershed Hydrology Protection and Flood Mitigation: Phase I*, found that, based on studies from locations outside Vermont, human-induced land use changes cause various hydrologic (stream flow) and geomorphic (stream shape, size and alignment) adjustments, including the size and timing of flood peaks. Increased surface runoff from land changes can produce changes in the morphology of a stream with sediment release that have a potential to impact aquatic biota.

Phase II was completed in September 1999 and consisted of two parts. The first part, *Watershed Hydrology Protection and Flood Mitigation Project, Phase II - Technical Analysis, Stream Geomorphic Assessment*, quantifies the relationship between stream geomorphology (stream ecology, hydrology, and stream channel shape and size) and various watershed land use activities for Vermont. This part of the study provided a foundation for possible future guidance governing storm water management and other land use strategies for flood hazard mitigation and stream resource protection. The second part and entitled *"Impact Assessment of Instream Management Practices on Channel*

Morphology," described the impact on channel form associated with gravel extraction practices and instream works for flood hazard mitigation.

Phases III and IV have involved the development of management tools to address the connections outlined in the Phase II documents. The Steering Committee and its consultant (The Center for Watershed Protection) considered development of a set of draft activities which would result in recommended changes to the Vermont Stormwater Management Procedures, procedures that were adopted by VDEC in 1997. These draft activities were developed after consideration of watershed approaches, thresholds, the Vermont Water Quality Standards and its classification system, and legislation promulgated by the 2000 Vermont General Assembly. The five major elements of this work were:

a. Identify vehicles to change watershed development patterns so as to reduce Vermont flood losses and maintain and improve stream stability.
b. Develop acceptable development practices for managing stormwater hydrology and quality.
c. Develop handbook(s) of acceptable development practices and vehicle to reduce flood losses.
d. Evaluate current Vermont Stormwater Procedures.
e. Recommend changes to the Vermont Stormwater Management Procedures based on the results of all of the above.

The draft *Vermont Stormwater Management Manual* was prepared for public comment in June and August 2001. A finalized version of the manual was presented to VDEC in January 2002. For the enhanced management of stormwater within Vermont, the manual promotes the five step/element integrated stormwater management concept:

1. better site design practices and techniques;
2. unified design criteria for stormwater control requirements;
3. downstream assessment;
4. stormwater credits for site design; and,
5. selection of structural stormwater controls.

In February 2001, the Department released a report entitled *Management of Storm Water Runoff in Program and Policy Options."* This report, prepared for the Vermont General Assembly pursuant to Act 114, outlines the principal ingredients of an enhanced program to manage storm water. The enhanced program would rely on a new set of storm water control measures and could include use of municipally-based storm water utilities and certification/privatization of particular aspects of the storm water permitting process. The Department released in June 2001 a draft document entitled *"The Vermont Storm Water Management Manual"* in order to take comment on the set of control measures and criteria for adoption.

<u>Storm Water Phase I and Phase II Rules</u>

Phase I of EPA's storm water program was promulgated in 1990 under the Clean Water Act. Phase I addressed storm water runoff from municipalities larger than 100,000 population (as Vermont has no municipalities of this size, the state was exempt from this category of permit requirements). Another

category of the Phase I Rules requires the issuance of permits for construction projects larger than 5 acres, as well as certain state and industrial projects. The Department has been issuing Stormwater General Permits for construction projects involving more than 5 acres since 1991, and is in the process of drafting General Permit Rules for state and industrial projects.

EPA has promulgated Storm Water Phase II Rules, which became effective in December1999. Storm Water Phase II Rules are intended to further reduce adverse impacts to water quality and aquatic habitat by instituting the use of controls on the unregulated sources of storm water discharges that have the greatest likelihood of causing continued environmental degradation. The new rules apply to "urbanized areas" as delineated by the Bureau of the Census, which have separate storm sewer systems (MS4s). The new rules also apply to small construction activities that disturb 1-5 acres. Any other storm water discharges could also be regulated if it is determined that storm water controls are necessary.

The new Storm Water Phase II Rules will likely apply to Burlington, South Burlington, Essex Junction and Winooski. Other towns in Chittenden County and Rutland County may possibly come under these new rules but this will not be determined until the 2000 Census has been completed and population data further analyzed.

A regulated municipality under Phase II will be required to apply to the Department for NPDES permit coverage, most likely under a general rule rather than an individual permit, and to implement storm water discharge management controls (best management practices). Among other things, a regulated municipality must include the following six minimum storm water control measures:

1. public education and outreach;
2. public participation/involvement;
3. illicit discharge detection and elimination ;
4. construction site runoff control;
5. post-construction runoff control; and,
6. pollution prevention/good housekeeping.

River Restoration & Protection

The Vermont Agency of Natural Resources is embarking on several new watershed initiatives in response to statutory mandates, identified public need and a growing constituency for watershed protection and restoration. The Agency has become equipped and more proficient with the tools necessary to formulate, implement and sustain these initiatives effectively.

Initiatives started in the 1970's, such as municipal wastewater treatment, were successful because they looked at a specific problem and solved the problem of wastewater assimilation at the watershed scale. Today, the problems involve the often competing demands for the use and enjoyment of waters, polluted runoff, exotic species and the pervasive problem of stream instability. To be effective, basin planning and other initiatives (such as stormwater management, TMDLs, riparian buffers, hazard mapping, public education) must go beyond the enumeration of symptoms and use the analysis of

physical, chemical, biological, and social data to explain the root problems of Vermont's troubled waters.

Watershed assessments in Vermont's 305b reporting to Congress have described erosion/ sedimentation and phosphorus as the largest categories of pollution in the state. These two concerns are related, in that eroding stream bank soils may very well be one of the largest sources of sediment and phosphorus entering our watersheds. The root causes for eroding stream bank soils are the removal of riparian vegetation, hydrologic modifications, flood plain and channel encroachments and the channel management practices that have been conducted to address the symptoms of these original causes. These activities have caused stream instability at the watershed scale, wherein bank erosion at one location triggers further stream bed and bank erosion in both upstream and downstream directions.

As a result of intensive staff training in recent years, the Agency has begun to implement the principles and applied methods of fluvial geomorphology in stream alteration permits, river restoration, public hazard identification, and river education programs. Initial success with explaining complex stream problems and restoring stream reaches using a geomorphic approach presents an important opportunity for resource managers and watershed constituents. Fluvial geomorphology - a science which seeks to explain the physics of flowing water and sediment in different land forms - is an essential tool and organizing principal for community-based watershed protection and restoration. The field data derived through physical assessments conducted on streams following a rigorous geomorphic-based methodology can be supportive of many other state water resource initiatives and programs.

The geomorphic river assessment which the Department is currently organizing, promoting and making available for river restoration and protection is outlined on the following page. The Department is aware of current geomorphic assessment programs in the following areas:

Basin 1: Walloomsac River, Batten Kill
Basin 2: Poultney River
Basin 3: Lewis Creek, Middlebury River
Basin 6: Tyler Branch
Basin 7: Lamoille River and certain tributaries
Basin 8: Mad River, upper Winooski main stem
Basin 9: White River and certain tributaries
Basin 13: Mill Brook

Vermont Geomorphic River Assessment Outline

1. Objectives

Stream Condition - departure analysis comparing the existing condition to the reference condition.
Adjustment Process or physical change currently underway due to natural causes or human activity.
Sensitivity of the channel condition to change due to natural causes and/or human activity.

2. Approach

Phase I - remote sensing, existing data and windshield surveys.
Phase II - qualitative and rapid assessment field surveys.
Phase III - field survey assessments (quantitative).

3. Parameters

Watershed inputs - flow and sediment discharge
Valley setting - geography and geology
Stream and flood plain geomorphology
Watershed and riparian corridor land use and land cover
Instream channel modifications and their effects.
Flow modifiers and their effects.
Flood plain modifications and their effects.
Erodibility of bed and bank material.
Stream and riparian habitat characteristics.

4. Products

Data base and map products containing stability assessments of river reaches and segments.
A watershed problem solving tool for river corridor protection, management, restoration and education.

Readers of this report who are interested in further details regarding fluvial geomorphology as a framework for watershed protection, management and restoration are referred to Appendix I.

TMDL (Total Maximum Daily Load) Program

A TMDL is the calculation of the maximum amount of a pollutant that a waterbody can receive and still meet the water quality standards. A TMDL serves as a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards and develops a means to implement those reductions.

Under Section 303d of the Clean Water Act, all states are required to develop lists of impaired waters. These impaired waters are lakes, ponds, rivers and streams that do not meet the water quality standards developed by each individual state. In Vermont, these waters are described on the state's List of Impaired Waters. The Clean Water Act requires that TMDLs be developed for impaired waters on the list and the list provides a schedule as to when the TMDLs will be completed. (Refer to Part I and Part III, Chapter 2 for further discussion on 303d and listing of impaired waters).

TMDL determinations are unique to each individual waterbody but the general process by which they are developed can be summarized in the following manner:

Problem Identification – the pollutant for which the TMDL is developed must first be identified. Examples might include sediment that impacts habitat for aquatic organisms, nutrients that cause excessive algal growth, or bacteria that creates an unsafe environment for swimming.

Identification of Target Values – this establishes water quality goals for the TMDL. These may be given directly in the Water Quality Standards or may need to be interpreted.

Source Assessment – all significant sources of the pollutant in question must be identified in the watershed. This often requires additional water quality monitoring.

Linkage Between Targets and Sources – this process establishes how much pollutant loading can occur while still meeting the water quality standards. This step can vary in complexity from simple calculations to development of complex watershed models.

Allocations – once the maximum pollutant loading is established, the needed reductions must be divided among the various sources. This is done for both point sources and nonpoint sources.

Public Participation – stakeholder involvement is critical for the successful outcome of TMDLs. Draft TMDLs are also released for public comment prior to their completion.

EPA Approval – EPA approval is needed for all TMDLs as required by the Clean Water Act.

Followup Monitoring – additional monitoring may be needed to ensure the TMDL is effective in restoring the waters.

The table that appears on the following page is provided as a summary update of TMDL progress and an expression of near future TMDL direction.

Lake Champlain Phosphorus TMDL

In June 2001, the Department released a preliminary draft Lake Champlain Phosphorus TMDL for the Vermont portion of the Lake Champlain basin. The draft TMDL, which was discussed during a series of public meetings in August and September 2001, included five different point source wasteload allocation alternatives for consideration and refinement. Some of these alternatives would require wastewater treatment well beyond current phosphorus removal requirements. The treatment level required of municipal point sources affects the phosphorus loads from nonpoint sources such as farms and developed areas since the total allowable load to Lake Champlain is finite.

After further analysis and consideration of relevant issues, VDEC will revise the draft Lake Champlain Phosphorus TMDL by defining a preferred point source wasteload allocation and nonpoint source load allocation. This next revised draft Lake Champlain Phosphorus TMDL may be distributed for public review as early as April 2002.

Table II.2.5. TMDL Project Update.

Segment	Waterbody ID & Pollutant	Project Status	Projected TMDL Submittal
Winooski River (Cabot)	08-09 Pathogens	TMDL Complete	Approved by EPA (3/01)
Black River (Ludlow)	10-14 Phosphorus	TMDL Complete	Approved by EPA (5/01)
Trib #1, N. Branch Ball Mtn. Bk. (Stratton)	11-15 Sediment	TMDL Complete	Final Dec 2001
Styles Brook (Stratton)	11-15 Sediment	TMDL Complete	Final Dec 2001
Cedar Swamp (Shoreham)	03-10 Pathogens	Draft submitted to EPA. No formal comments received. Impairment eliminated since WWTF project is complete to correct problematic discharges.	Draft July 2000
Allen Brook (Williston)	08-02 Undefined NPS	Field data collection complete. Project progress report received 10/01. TMDL methodology and modeling being developed. Public outreach activities continuing. Extensive cooperation between the Town and contractor.	2002
Mettawee River (Pawlet)	02-05 Temperature	Data collection complete. Expect report by spring 2002. TMDL to be based on results of modeling.	2002
Lake Champlain	9 Segments Phosphorus	Draft TMDL prepared. Nine public briefing sessions complete. Final draft TMDL expected by 4/02.	2002
Acid Impaired Waterbodies	34 ponds 6 streams	Developing acid deposition loading estimates for the 34 lake watersheds. Monitoring NYSDEC approach. Anticipate utilizing USFS screening model to determine usefulness for TMDLs.	2003 (est)
Mercury Impaired Lakes	8 lakes 8 river segments	Have outlined needs to cover TMDL development for waters impaired due to mercury in fish tissue. Potential TMDL development to begin in late 2002 following REMAP project.	2003 (est)

Chapter Four: Cost/Benefit Assessment

Quantifying the costs of construction and operation of facilities (such as wastewater treatment facilities) or river improvement projects (such as the Trout River project) can be done rather routinely. Quantifying the environmental and human benefits in dollars as the result of an improved wastewater treatment plant or a stabilized river bank, however, is not an exact science, especially since the benefits of the projects may not be known for many years.

Point Sources/Combined Sewer Overflows

Vermont has constructed 93 municipal wastewater treatment facilities, 50 industrial pretreatment facilities and 53 industrial wastewater treatment facilities. The total expenditure for the public facilities has been approximately $553 million of state, federal, and local funds. This figure includes approximately $41 million of public wastewater treatment facility improvements made during the last two years. There has been no recent estimate of the total amount spent on capital construction of industrial wastewater treatment facilities. The amount of money spent on operation and maintenance of municipal and industrial WWTFs (approximately $69 million in 1994) has not been updated since the 1996 305(b) Report.

In general, improved water quality has meant less weed and algae growth, resulting in improved aesthetics and enhanced swimming, fishing and boating uses. Also, it was assumed that improved water quality meant less human sickness due to better removal of pathogens. As a result of these public and private expenditures, approximately 58 rivers and 3 lakes have benefitted from improved water quality and enhanced recreational, fishery and aesthetic uses.

During the period January 1, 2000 through December 31, 2001, $41.5 million of federal, state and local funds were spent on CSO corrections, WWTF improvements, construction of new WWTFs, sewer line extensions and rehabilitations, and phosphorus removal involving work at 15 communities. These expenditures have resulted in additional improvements to the water quality of 7 rivers and two lakes.

To give a more complete picture, one must also consider the costs and benefits of nonpoint source pollution control practices. A discussion of this effort follows.

Nonpoint Sources

Aside from several federal and state cost sharing programs to assist with pollution reduction from agricultural sources, there are two federal Clean Water Act programs to assist with planning and implementation of NPS pollution reduction. The first is the Section 604b Pass Through Program, awarded to regional planning commissions to assess, map, plan or report on areas of NPS pollution. The other federal program is the Section 319 program which awards grants (on a competitive basis) to water protection groups to be used to repair eroded banks and other areas which cause pollution. Updated costs of the Section 319 implementation program for twelve years, from 1990 through 2001 are approximately $11 million. Grant funds from the Section 604b Pass Through Program from 1989 through 2001 reached approximately $661,000.

Upper White River Stream Enhancement Project

The project involved work at six different sites from May to October, 1997 by the White River Partnership, and included streambank stabilization, buffer strip re-establishment and instream fish habitat activities. The result of the work was a total of 4,525 feet of shoreline being stabilized and/or enhanced for fisheries and riparian habitat. In 1999, the Partnership won national recognition for its work, and the Upper White River was named a National Showcase River for its successful and pioneering stream corridor restoration efforts.

Trout River Improvement Project

The Agency's newly adopted approach to river restoration and flood hazard mitigation is demonstrated for the first time on an approximately one mile reach of the Trout River in the Town of Montgomery. The town and river were devastated by flash floods in 1997. The new approach uses national emerging river restoration techniques to mitigate flood hazards and restore water quality, recreational values and aquatic and riparian habitat functions. Fundamental to the Trout River project was a high level of cooperation and coordination between the town, landowners and many state and federal agencies. During 1999, the river's dimensions, meander, slope and riparian vegetation were restored. Landowners agreed to maintain the riparian vegetation and to allow the river to naturally meander.

Urbanizing Watersheds

Chittenden County is Vermont's fastest growing county. As a result, some streams have not been protected from development, and much of their riparian buffer has been removed. Also, development of their watersheds has caused increased runoff with associated pollutants and streambank erosion. An attempt has been made to stabilize streambanks and restore streamside vegetation on certain streams, including Allen Brook with some good results.

Hydroelectric Facilities

Two Clean Water Act Section 401 water quality certifications were issued to hydroelectric facilities during the 1998-1999 reporting period. These were for the Vergennes Project and the Middlebury Lower project. The Vergennes Project has been issued a Federal Energy Regulatory Commission (FERC) license to operate, which will improve flows in approximately 10 miles of Otter Creek. The Middlebury Lower Project license is expected to be issued in 2000, and will improve flows in an

additional approximately 2 miles of Otter Creek when the project begins operating under the new license.

During the reporting period, the Agency entered into an agreement with Central Vermont Public Service Corporation for the withdrawal of their appeal for a denial of their Lamoille River project which includes four dams. It was agreed that the utility would complete additional scientific studies before again seeking a water quality certificate. This 401 Water Quality Certificate, when issued, will improve 29 miles of the Lamoille River.

The Department is party to a settlement agreement between the FERC and State of New Hampshire regarding licensing of the Fifteen Mile falls project on the Connecticut River. The 401 Water Quality Certificate, if approved, will improve many miles of the Connecticut River, plus surface areas of the Moore-Comerford and McIndoes Falls impoundments. The certificate would include an agreement on the regulation on flows of the Upper Connecticut River Lakes, including Lake Francis.

Chapter Five: Special State Concerns & Recommendations

The following section describes primary water quality concerns of the State of Vermont. The discussion below, presented in unranked order, provides focus to areas of work which the Department believes deserve special targeting of resources either for protection or restoration of waters.

Onsite Domestic Waste Water Disposal

New on-site waste water rules have been discussed for many years and have not been achieved for a variety of reasons. There has been ongoing concern that the 10 acre exemption from subdivision permits is causing sprawl. There has been a parallel concern that the elimination of the exemption would render large parcels un-developable if the current onsite waste water control standards were to be applied.

There is now on the table a new initiative to 1) consolidate on-site waste water rules, 2) to provide the maximum flexibility feasible to help land owners do as they wish with their property within health and environmental protection objectives, 3) eliminate the 10 acre exemption, 4) allow towns with strong site planning and zoning to use the updated minimum site provisions when the rules go into effect, 5) give towns without planning, zoning or sewage ordinances time to decide whether they wish to implement land use controls contemplated by the new program and 6) after five years, the site condition standards would apply statewide, whether or not a town has chosen to adopt land use tools.

The Department is committed to reduce sprawl and other unintended consequences of the present law while assuring that the best and most modern wastewater treatment technology is applied to new systems.

Watershed Planning

Watersheds typically include a broad range of land uses. Some land uses are designed with their effect on water quality considered and minimized. Others have taken account of water quality consequences to a minimal or negligible degree. As a result of the myriad of land uses in our watersheds some streams, rivers, lakes and ponds achieve water quality standards, others do not. In general, the character of impaired waters is a reflection of the cumulative land runoff (and point sources). Recognizing this, and acknowledging that the conservation of high quality waters and the restoration of impaired waters will depend on the cooperation of many landowners, Vermont has initiated a highly public watershed planning program (Watershed Improvement Program).

Three Watershed Coordinators have been hired and a Framework Guidance document has been prepared. The Coordinators have assembled Watershed Councils/Teams to bring together representatives of the various stakeholders. Meetings are widely publicized. The goal is to produce plans that will begin to address some of the more pressing problems that are identified by the public and the state (under the law). The present level of effort is modest (three Coordinators - 17 basins requiring plans). Despite this, the public has been participating actively in forums, Council meetings and in site visits on the land along waters. In addition, Watershed Coordinators have been working directly

with land owners where there is an apparent cause and effect relationship between the condition of the waters and the use of the land. In this way, VDEC is setting examples of techniques that can be used to restore waters during the planning process. The intentions of the planning process are to create an atmosphere in which there will be agreement on the most pressing issues in the basins and that a process will be set in motion to continue resolving problems with a lower level of input from the Watershed Coordinator once the plan is completed.

Stormwater Management

Urban stormwater is receiving more and more attention, partly as a result of identifying waters on the 303d list as impaired and partly due to the slow pace with which this huge problem can be addressed. Because of the effect and importance of the approach on the nonpoint source program, a full description of Vermont's program is provided as Appendix F.

Gaging Stations

Stream flow gages provide important information to towns, the state, hydro-electric companies, recreationists and engineers. The information is used in the design of infrastructure such as waste water treatment facilities, bridges and dams for flood control. Many permitting processes use the information from stream gages to establish minimum flows for fish and wildlife below dams. Gages are also critical in the development of pollutant loading estimates. These and many other uses of gage information are in jeopardy as the state and federal governments attempt to balance their budgets by eliminating funding for the gaging network operated by the US Geological Survey. A dependable source of revenue to support the collection of this vital information is needed on a continuing basis. Without this network, the ability to make necessary management decisions will be significantly diminished.

Water Quality Monitoring Strategy

During the course of the reporting period, the Water Quality Division prepared a draft Surface Water Quality Monitoring Strategy. The Strategy is intended to comprise one element of Vermont's eventual Consolidated Listing and Assessment Methodology. The Strategy presents information on Vermont's current water quality monitoring programs and includes details on specific projects, and on quality assurance and data management issues. Also included are specific action items related to monitoring project review, enhancement, and modification all of which are intended to lead to comprehensive assessments of surface waters on a statewide basis. The Strategy is currently undergoing internal review and should be available by late summer 2002.

305b Assessment Methodology

During the reporting period, and following up regional efforts at developing consistency among States in methods for assessing use support, the Department has made significant improvements to the way in which it's assessment methodology is structured and presented. In some cases (e.g. rivers and streams), the actual methods have not changed drastically, but in other cases (largely lakes and ponds), methods have been changed significantly. In all cases, the presentation of these results has been improved and clarified. This assessment methodology is presented in Part III, Chapter 2.

Groundwater
Vermont's major needs are for a statewide groundwater quality and quantity monitoring network, geologic maps (i.e., fracture traces, bedrock and surficial geology, and aquifer maps), groundwater education and outreach for schools and planning commissions, and GIS locations of potential and actual sources of groundwater contamination. Many of these activities are being pursued; however, they have an extremely long timeframe for completion or are limited in scope.

Although the state has the necessary statutory and regulatory authority to complete these activities, it is hampered by the lack of adequate funding and in turn the personnel to carry out these tasks. A dedicated source of long-term funding for groundwater projects would allow Vermont to identify and prioritize groundwater projects with state, regional, and local entities.

To protect groundwater, additional monetary and personnel resources are needed to:

* Establish a monitoring and evaluation program of the ambient groundwater quality and quantity
* Assist municipalities and regional planning commissions with plans and programs to protect groundwater and drinking water
* Educate children and the general public on ways to protect and conserve groundwater resources
* Map groundwater and geologic characteristics to provide for protection and planning at the state, regional, and local level
* Improve existing GIS data layers and create new data layers on potential contaminants, geology, aquifers, soils and wells.
* Provide internet access to all of this information.

Preliminary estimates for completing this work are $250,000 per year.

Polluting Discharges from Large Farms
From a water quality perspective, there is concern regarding potential shifts in agricultural production from a large number of smaller farms to increasing numbers of larger farms. The water pollution potential from such large farming operations (LFOs) is equivalent to the waste generated by a small to medium sized city. It is recommended and essential that waste management and pollution prevention efforts are well coordinated. The new Large Farm Operation Rules, administered by the Vermont Department of Agriculture, Food and Markets, will help ensure animal wastes on these larger facilities are managed effectively.

Road Runoff to Waterbodies
Threats and some water quality problems as the result of runoff from local roads, as well as from state highways, are widespread. The problems arise from maintenance procedures that are not sensitive to water quality and allow sand and gravel to erode and wash into surface waters.

The Department has developed a small grant program entitled, "Vermont Better Backroads," to assist local road commissioners with better backroad maintenance and planning. The Department is being

assisted by many partners, including: the Vermont Local Roads Program at St. Michael's College, Resource Conservation and Development Councils, the Environmental Protection Agency (funding), Regional Planning Commissions, Vermont Lake Associations, Vermont Agency of Transportation and many others. The program offers small grants on a competitive basis for following up on local situations where there are no current water quality violations but where road practices threaten adjacent rivers, streams, lakes or wetlands. It is a good and effective program, but only a few towns are able to be helped each year due to limited resources. The 1999 Legislature, recognizing the value of the program, provided additional funding, effectively doubling the amount of the Section 319 federal funding. During the present reporting period, 39 projects were funded at a combined total cost of $136,000.

Lack of Strategic Statewide Vegetated Buffer Requirements

Undisturbed vegetation along stream, river and lake shorelines reduces pollutants from reaching surface water. Other than Act 250 development constraints and a few regulations adopted by a small number of municipalities, there are no strategic statewide requirements that riparian landowners maintain a minimum width of vegetation along bodies of water as there are in other states. As a result, many miles/acres of state waters are impaired by urban runoff, sediment, temperature changes, fertilizers, manure, and other pollutants which can be reduced or eliminated by properly-maintained vegetated buffers.

As the result of the recognized importance of riparian buffers to water quality in certain strategic locations, a Buffer Procedure Action Team was formed by Secretary John Kassel and met for the first time in October 1999. The Team was composed of staff from the Agency, whose task was to develop a revised Agency buffer policy and procedure, including general and site specific standards. The revised Buffer Procedure, once finalized, will be used by the Agency in the Act 250 process and as guidance to riparian landowners, including public and quasi-public agencies.

The Department has made some strides in the educational effort to inform the public and municipal planning commissions about the environmental benefits of riparian vegetation. The Department and Regional Planning Commissions have been working with municipalities to strengthen their municipal plans and zoning regulations to maintain streamside vegetation and have sponsored some workshops for town officials and the general public regarding strategies to encourage the maintenance of existing riparian vegetation, as well as promoting the planting of riparian areas lacking vegetative buffers. The Department, YCC, watershed groups and other volunteer groups have worked on many streamside planting projects around the state. However, there is still need for additional public education about the need to maintain riparian buffers for water quality protection and wildlife habitat. It is recommended that the Agency make more use of the print media, TV and radio to draw the public's attention to the benefits of maintaining riparian vegetation.

Atmospheric Deposition of Pollutants

Deposition of pollutants to the Vermont landscape from the atmosphere is principally responsible for the partial support of fish consumption and aquatic life uses on 15,356 inland lake acres and on all Vermont river and stream miles. Atmospheric deposition is the principal source of two major causes of

use loss in Vermont: elevated mercury and low pH. The two causes are linked, since in many instances, lakes which are vulnerable to acidification are also those which transfer atmospherically deposited mercury to the aquatic food web in the toxic methyl- form. There may be other lake types which are not at risk of acidification, but have the ability to transfer mercury into the trophic chain via alternate geochemical pathways. This is the subject of ongoing research in Vermont, and a major goal of this inquiry is to make refinements to the existing Vermont Department of Health fish consumption advisory.

Atmospheric deposition of mercury has resulted in the issuance of fish consumption advisories for any Vermont lake or river containing walleye, lake trout, smallmouth bass, and chain pickerel and for all fish except brown bullhead on the five Deerfield chain reservoirs, and two Connecticut River hydroelectric reservoirs within the Fifteen Mile Falls Project. The method by which the Department assesses fish consumption uses has been further refined during the reporting period, and is provided in detail in Part III, Chapter 2.

The impacts of mercury deposition are not, however, limited to loss of fish consumption uses. Recent research[6] has identified reproductive and behavioral impacts to wildlife that feed on fish which inhabit many northern New England lakes, including those in the Deerfield chain. Potential impacts to upper trophic level biota are presently being measured in several other Vermont lakes in conjunction with the on-going mercury studies (REMAP).

Loss of uses associated with atmospheric deposition also result from regional and long-range emissions of acid-inducing compounds. The atmospheric deposition of nitrous oxide (NO_x) and sulfate (SO_4) from Midwestern sources has resulted in acidification (low pH) of 34 lakes and six streams within Vermont. In Vermont, the potential for acidification is measured by direct measurement of pH, as well as corollary measures such as acid neutralizing capacity, NO_x , SO_4 and others. Deposition of SO_4 and in-lake SO_4 concentrations are presently decreasing.

Vermont continues to work at the local, regional and national scale, to research the environmental effects associated with atmospherically deposited pollutants, reduce Vermont's locally-generated emissions, and influence the development of Federal legislation aimed at reducing atmospherically-derived pollution. Specifically, the Department has recently completed a revised draft mercury emissions inventory, and is issuing grant awards under the REMAP project to map atmospheric mercury deposition to waters statewide, and to model mercury bioaccumulation in REMAP project lakes. Further, the Vermont Advisory Committee on Mercury Pollution continues to identify areas in Vermont where mercury use and emissions can be reduced. During the reporting period, the Committee also spent a significant portion of the year 2000 modifying legislation initially drafted by NEWMOA, for adoption by the General Assembly. Finally, VDEC staff continued to interact with the congressional delegation to address this issue from a national perspective.

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[6]See http://www.vtwaterquality.org/hgreview.pdf.

Hydrologic Modifications in Lakes
In Vermont, water level manipulations are a source of use impact to lakes. There are 32 lakes and ponds (about 9,000 acres) in Vermont for which one or more uses are impaired due to water level manipulations. Flow alteration affects aquatic life uses due to littoral habitat loss. In some instances, flow alteration can also affect aesthetic, swimming, and even boating uses, depending on the severity and/or timing of the drawdown.

The Department's Lake Bioassessment Program needs to obtain more precise and quantitative estimates of aquatic life use impairments in flow-altered lakes and reservoirs. There also exists the need to quantify the effect of water level fluctuation on the bio-accumulation of mercury in reservoirs.

The Department has designed a 'decision-making tree' to make the assessments uniform in lakes, ponds, and reservoirs in relation to hydrologic modifications. This is presented in Part III, Chapter 2.

Hydrologic Modifications in Rivers & Streams
As humans develop watersheds more intensely, remove stream gravel and alter the stream channel, increased flooding, impaired water quality, and impacts to aquatic resources are the unwanted results. Land use changes and instream management activities and their relationship to adverse impacts on rivers and streams are the focus of studies either completed or currently being undertaken by the Department. The recommendations of the studies have caused the Department to develop the *Stream Geomorphic Assessment Handbook* and are likely to result in changes to the *Stormwater Management Procedures*.

It is recommended that the Department encourage municipalities to incorporate the future revised management procedures in their plans and ordinances through workshops sponsored by regional planning commissions meeting with selectboards, conservation commissions and local planning commissions. In addition, additional resources are needed to assist with channel restoration of flood-damaged rivers and streams.

Exotic Aquatic Species as Pollutants
Vermont has a history of impacts related to non-native nuisance plants and animals in its lakes, and unfortunately, the number of non-native introductions to inland Vermont lakes continues to increase. In 1999, zebra mussels (*Dreissena polymorpha*) were found for the first time, either in adult or larval form, in three large and heavily-used inland lakes (Bomoseen, Dunmore, and Hortonia) near Lake Champlain. Fortunately, only Lake Bomoseen appears to have developed a viable adult population in the past two years. The existence of zebra mussels in Lake Bomoseen increases greatly the risk of infestation of other inland waterbodies, as this species is commonly spread by boating activities. A risk assessment performed by the Department in 1997 identified a large number of recreationally used lakes as being at significant risk of infestation by zebra mussels.

During this 305b reporting period, Eurasian watermilfoil was discovered in six new lakes (Crystal, Clyde, Derby, Great Hosmer, Ninevah, and Beaver in Proctor). Despite some targeted spread control initiatives, Eurasian watermilfoil continues to spread around Vermont at an alarming rate (refer to the figure on the following page). Significant increases to personnel and financial resources will need to be directed toward spread prevention efforts if Vermont is to be successful in slowing the rate of spread of this nuisance species.

Water chestnut (*Trapa natans*) was discovered in the Lemon Fair River and at several new sites in wetlands and tributaries near Lake Champlain during this reporting period. Of major concern is the discovery in 2001 of a water chestnut infestation in the Pike River in Canada. This new infestation places Missisquoi Bay in Lake Champlain in extreme jeopardy of an infestation.

On a more positive note, sustained hand pulling efforts appear to have eliminated the water chestnut populations in Root Pond and Lake Bomoseen. The population in Lake Paran is nearly eradicated as well. It is essential that the Department receive continued funding for water chestnut control at or above existing levels to maintain the ground gained in the last two years in the battle against water chestnut in Lake Champlain (mentioned earlier in Chapter 3) and the inland lakes.

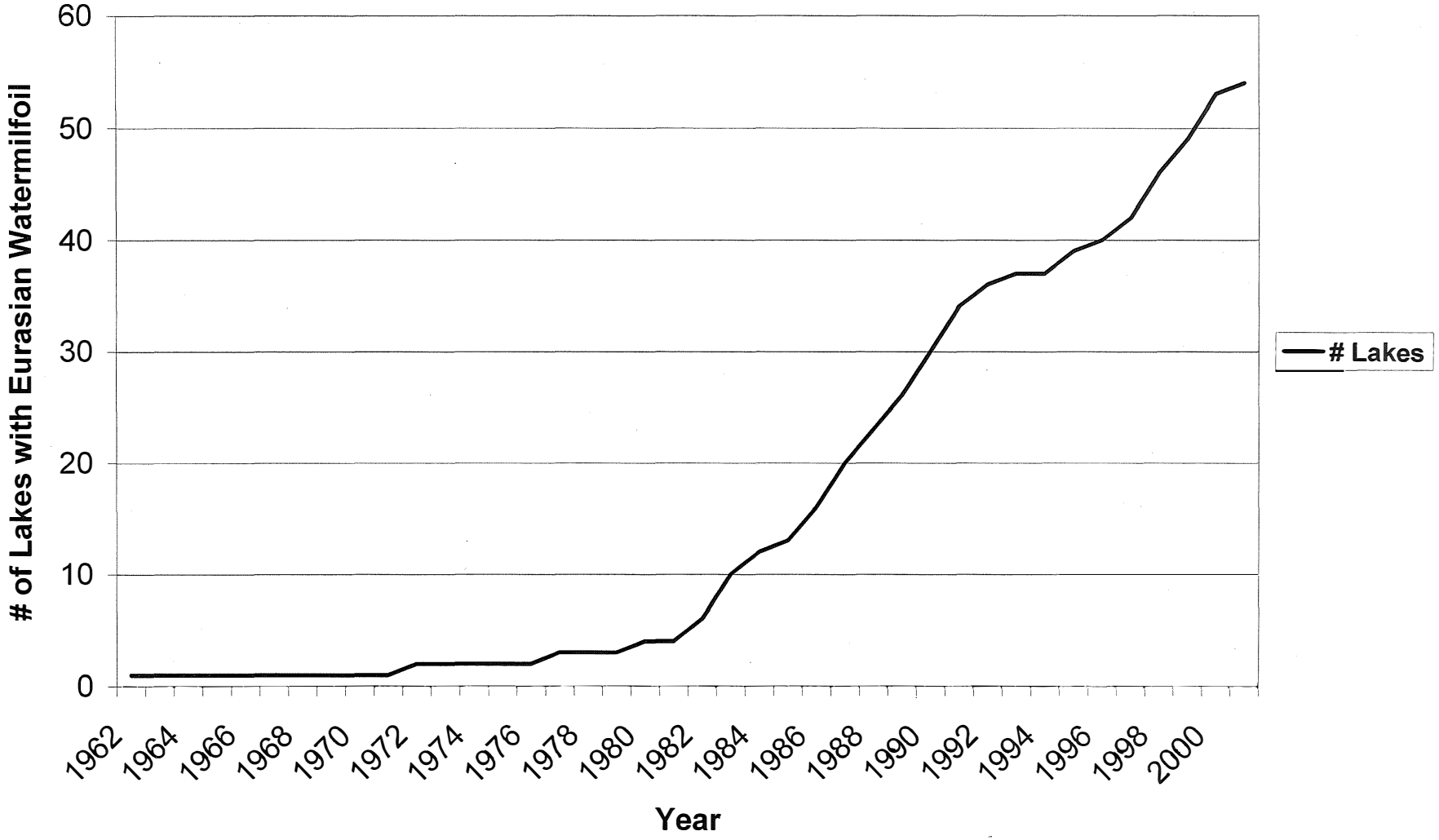
Lake Hortonia and Burr Pond were treated with a low concentration of the aquatic herbicide *Sonar*® in 2000 to selectively manage dense Eurasian watermilfoil populations there. A Eurasian watermilfoil population in Sunrise Lake was similarly treated in 2001. All of the treatments achieved 90-95% removal of the milfoil, and native plants began rebounding even in the year of treatment. Recreational uses that had been severely impaired for years in Lake Hortonia and Burr Pond have now been restored. Biological studies related to these treatments, involving target and non-target plants, macroinvertebrates, fisheries, reptiles, and amphibians, are ongoing. Given the success of these initial treatments, it is anticipated that numerous communities and/or local organizations will request permits and funding to conduct herbicide treatments on other lakes in Vermont in the next few years to restore recreational uses and native aquatic habitat that has been impaired by Eurasian watermilfoil infestations.

Heavy infestations of Eurasian watermilfoil and water chestnut have an impact on aesthetic, aquatic life, swimming, and boating uses in those areas where these plants grow densely. Zebra mussels in inland lakes at the present time only threaten swimming uses (due to the ease with which one gets cut by the extremely sharp shells). As infestations develop in inland lakes, they may affect aquatic life uses due to changes in the aquatic food web. The Department has quantified this effect in Lake Champlain, but not for inland lakes, as inland lake infestations, thankfully, have not yet developed sufficiently. The first report of a zebra mussel-clogged water intake pipe in Lake Bomoseen occurred in the fall of 2001.

Eutrophication of Vermont Lakes

The Department commits significant resources to the management of human-caused eutrophication affecting Vermont lakes. Vermont has relatively unproductive lakes as compared to other parts of the country. This is attested to by the fact that only two inland lakes appear on Vermont's Year 2000 303d list as impaired due to excessive eutrophic conditions (Shelburne Pond and Lake Carmi). The

Figure II.1. **Spread of Eurasian Watermilfoil in VT**



Department considers that proactive protective actions to reduce human impacts on lake health before impairments occur address the problem of eutrophication in a much more efficient manner than waiting until restoration is needed. Several such lake protection projects are described elsewhere in this document.

Eutrophication can simultaneously affect aesthetic, aquatic life, swimming, and in some instances even boating uses. The major causes related to eutrophication for inland Vermont lakes are nutrients, siltation, and organic enrichment. The major sources of these pollutants are construction, urban and suburban runoff, road maintenance and runoff, agriculture, silviculture, and other nonpoint sources. Since Vermont is only part way through the process of reassessing all of its lakes under the rotational watershed assessment process, the reader is urged to exercise caution in interpreting use impacts, causes, and sources related to eutrophication. In many instances to date, upon reassessment, use impacts related to eutrophication have been changed from partial support to fully supported but threatened based on a thorough review of available data in light of the new Water Quality Standards. This is likely to occur for a portion of the remaining Vermont lake acres which are to be assessed over the next two years as well.

Nutrient Criteria

During the reporting period, the Department has continued to participate in EPA's Regional Nutrient Criteria Technical Advisory Group. As of this writing, VDEC is developing a state-specific nutrient criteria implementation plan for lakes and rivers. The plan, once completed, will be consistent with the guidelines provided in the November 2001 memorandum issues to States from EPA's Office of Science and Technology.

Vermont's nutrient criteria implementation plan will focus on developing quantitative relationships between nutrient parameters and designated uses such as recreation, aesthetics, aquatic habitat, and public water supply. The Department will work to propose scientifically defensible nutrient criteria for adoption by the Vermont Water Resources Board within the three-year (2004) timeframe established by EPA.

PART III: SURFACE WATER ASSESSMENT

Chapter One: Current Surface Water Monitoring Program

Overview

Surface water quality monitoring undertaken by the Department during the 305b reporting period continued to support an assortment of water program activities. Long-term monitoring programs are designed to assess trends in water quality, as well as to generate baseline water quality information. The Department also maintains a strong presence on Lake Champlain and conducts a variety of short-term lake and stream-specific monitoring projects. Monitoring data is used to manage and protect Vermont waters in a pro-active manner.

The following describes the Department's current overall surface water monitoring program which is comprised of twenty-seven discrete projects. VDEC's monitoring efforts are classified herein as **physical/chemical**, **biological**, **volunteer** and **other**. Within each of these classes, monitoring projects are further described as 'core' (describes long-term projects), 'diagnostic studies' (intended to identify the cause of a particular water quality problem), and 'special studies' (monitoring studies intended to provide information and data on a specific water quality issue).

PHYSICAL & CHEMICAL Monitoring

Core Programs

The ***Spring Phosphorus Program*** collects spring overturn nutrient, physical, and chemical data on Vermont lakes and ponds that are 20 acres in size or larger. Parameters include total phosphorus and total nitrogen, alkalinity, calcium, magnesium, hardness, Secchi disk transparency, and multi-probe profiles (temperature, dissolved oxygen, conductivity, pH). Two hundred and thirty-two lakes have been monitored in conjunction with this program. Forty lakes have over ten years of project data and 12 of these lakes have fifteen or more years of data. The Spring Phosphorus database contains over 1500 records collected since1978. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized in the Lake Inventory and stored in the long-term 'WQDATA' databases.

The ***Lake Assessment Program*** is designed to rapidly assess the extent to which lakes meet designated uses for 305b reporting purposes and to gather information to focus lake protection efforts. The degree of sampling intensity for assessment lakes varies with the degree to which impairment must be documented. In general, lakes are circumnavigated and detailed assessment observations are made regarding in-lake and shoreline conditions with respect to designated uses and threats to lake water quality. Detailed notes are made regarding the extent and composition of the macrophyte community. Sampling is performed for total phosphorus, alkalinity, Secchi disk transparency, and multi-probe profiling. Additional sampling may be performed as necessary to identify departures from Vermont Water Quality Standards. Since 1989, some 238 lakes have been assessed. Data from the project are summarized in the Lake Inventory and stored in the long-term 'WQDATA' databases. Information collected in conjunction with field visits is stored in the Lake Assessment database.

The ***River Assessment Program*** is designed to assess the extent to which rivers and streams support designated uses for 305b reporting purposes and for focusing protection efforts. The assessment itself involves identifying, collecting, compiling, analyzing and evaluating all water quality data and information as well as point and nonpoint source pollution impacts on designated uses specific to the basins being assessed in any given year. VDEC presently conducts the majority of its assessments on a five-year rotational watershed basis. Rivers and streams in the basins of focus are visited to look for obvious sources of pollution from the land or indicators of problems or threats in streams such as sedimentation, heavy algae growth, or water with unnatural color or odor. A provider of much of this information is the VDEC ***Ambient Biomonitoring Program*** that conducts bioassessments to determine a waterbody's aquatic life use support and compliance with Vermont Water Quality Standards. Temperature, nutrients, pH, conductivity, and alkalinity are parameters commonly measured coincident with the biological sampling. The ***Ambient Biomonitoring Program*** monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized and stored in the long-term 'Biology' database. Data and information from the River Assessment Program is stored in the River Assessment database.

The ***Water Level Monitoring Program*** monitors lake surface elevations to establish mean water levels for a variety of purposes, most notably to help determine the jurisdictional boundary of the state's lakes and ponds encroachment permit program. This monitoring effort is not subject to an EPA-approved Quality Assurance Project Plan (QAPP). Data from the project are maintained in paper files.

The Lake Champlain Long-Term Monitoring Program surveys the quality of Lake Champlain waters on a bi-weekly basis (May to November) at 12 locations throughout the lake. Eighteen major tributaries are sampled on an event basis as well. The program's large physico-chemical parameter list includes species of phosphorus, nitrogen and organic carbon; chlorophyll-a; base cations and alkalinity; total suspended solids; dissolved oxygen, conductivity; and pH. As of 1999, this program had assembled a database comprising 4,462 lake and 3,259 tributary sampling events. More data are currently available. This monitoring effort is subject to an EPA-approved QAPP. Data from the project are summarized in the Lake Champlain Monitoring Database and stored in the long-term 'WQDATA' databases.

The Long-Term Monitoring (LTM) Acid Lakes Program collects chemical and biological data on lakes located in low alkalinity regions (those sensitive to acidification based on the bedrock buffering capacity) to determine the effects of acid deposition on Vermont's lakes. Nearly 200 lakes statewide were surveyed during the winters of 1980 through 1982 to identify the acid sensitive areas of the state. Eleven lakes selected from these areas are now included in the LTM Program and are sampled at least eight times every year for 16 chemical parameters related to acidification. Data is used to: 1) classify lakes according to their acidification status; 2) evaluate spatial and temporal variability in measured parameters; 3) track changes in acidification status over time as related to reductions in atmospheric emissions of acid precursors (e.g., oxides of sulfur and nitrogen); and 4) evaluate impacts of acidification on aquatic biological communities. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data

from the project are summarized in the 'AcidLake' database and are stored in the long-term 'WQDATA' databases.

The Stream Geomorphic Assessment Program collects geomorphologic data on streams throughout the state for purposes of assessing stream geomorphic stability and developing regime relations for Vermont's streams. Stability assessments allow for the prediction of expected rates of river adjustment and an evaluation of the effects of various land and river management practices on geomorphic stability and physical habitat quality. Regime relations serve to guide stream protection, management, and restoration projects as well assisting VDEC in the establishment of Vermont-specific physical criteria for water quality classification and use attainment determinations. Parameters measured include channel dimension (cross section), pattern (meander geometry), longitudinal profile, channel substrate conditions, structure and composition of riparian vegetation, and floodplain and valley morphology. This effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized in Microsoft Excel workbooks, and are stored in the Stream Geomorphology database.

Diagnostic Studies

Diagnostic studies are typically aimed at identifying the cause of eutrophication in Vermont lakes. Over the past twenty years, Vermont has performed numerous such monitoring studies and the results of many of these studies have led to concrete remediation and correction steps. Lakes on which notable diagnostic studies have been performed include Harvey's Lake (Barnet), Lake Morey (Fairlee), Lake Iroquois (Hinesburg) and Lake Champlain. Presently, VDEC has active diagnostic studies on three recreationally used lakes (Lake Carmi in Franklin, Lake Parker in Glover and Ticklenaked Pond in Ryegate).

A wide variety of parameters are sampled in conjunction with diagnostic studies, with the actual tests performed specific to the project. Standard eutrophication parameters (phosphorus, Secchi transparency, dissolved oxygen) are always measured. Other parameters from both the sediment and the water column are measured as needed. Data from recent projects are summarized in the 'Lake Projects database' and are stored in the 'WQDATA' database. Data from the older projects are stored in the long-term 'WQDATA' databases.

One example study is taking place on Ticklenaked Pond located in Ryegate. Arising from a concerted effort by the Natural Resources Conservation Service (NRCS), a Ticklenaked Pond Watershed Association (TPWA) was formed to address what shoreline and watershed property owners perceive as declining water quality. Reduced clarity, algal scums and recurrent beach closures all have been noted by residents. In response to a request for technical assistance by NRCS and the TPWA, the Department added the pond to the state's listing of waters in need of assessment to determine if violations of the Vermont Water Quality Standards exist. Monitoring and research activities during the past two years included: bi-weekly depth profile monitoring for clarity, phosphorus and physio-chemical parameters; weekly citizen monitoring in the photic zone for transparency, phosphorus, and chlorophyll-a; a comprehensive biological assessment; and a paleolimnological analysis of the lake's sediments using elemental and stable isotopic carbon and nitrogen ratios as proxies for trophic condition. Recommendations for future action are being developed.

Special Studies

Special studies are those which are performed to gain more information about a particular environmental issue of importance to VDEC. There are presently four such projects being cooperatively managed by the Department.

1) The EPA-sponsored ***REMAP Assessment of Mercury in Sediments, Waters and Biota of Vermont and New Hampshire Lakes Project*** is a three-year effort to identify the lake types occurring in Vermont and New Hampshire which have elevated levels of mercury in fish and in upper trophic level biota. The parameter list for this integrated collaborative monitoring project is large, and includes standard limnological measurements; base cations and aluminum; and mercury in total and methyl phases in sediment, water, and biota. There is also a paleolimnological component to the project that aims to determine the extent to which atmospherically deposited mercury has entered lakes in the study set. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from this ongoing project are stored in the 'REMAP' database, and will be stored in the long-term 'WQDATA' databases. Data from this project is being integrated with larger, synthetic data-review projects funded by EPA-ORD, and also by the Northeast Ecosystem Research Center.

2) The ***Lake Champlain Agricultural Best Management Monitoring Project*** is a seven-year project which was completed in 2001. This comparative observational study employed a three-way experimental design featuring one control and two treatment watersheds. Parameters measured included total phosphorus, total and Kjeldahl nitrogen, total suspended solids, and *E-coli*. Biological assessments were also performed on each of the three watersheds. The goal of this large project was to evaluate the efficacy of both low and high intensity whole-watershed BMP implementation strategies. This project was subject to an EPA-approved QAPP. Data from the project are presently summarized in spreadsheets and ultimately are to be archived to the EPA STORET system.

3) The ***Best Management Practices Effectiveness Demonstration Project*** is a stream monitoring effort designed to assess the efficacy of best management practices in controlling nonpoint source pollutant runoff. This cooperative VDEC-USGS project differs from the project described above in that it employs an upstream-downstream approach to pinpoint the reductions in pollutant runoff attributable to specific installed Best Management Practices. This project is being carried out on one agricultural stream (Little Otter Creek) and one urban stream (Englesby Brook) in the Lake Champlain Basin. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized in an MS-Access© database and, once validated, will be stored in the long-term 'WQDATA' database.

4) In conjunction with the ***Paleolimnology of Vermont Lakes Project***, the Department is collaborating with the University of Vermont to develop a set of indicators of present and historical trophic status based on the paleolimnology of carbon and nitrogen stable isotopes ($d^{13}C$ and $d^{15}N$). Using cores from the sediments of several lakes, VDEC is working to identify the extent to which the present trophic conditions in these lakes deviate from the historic background. Such information will be instrumental in understanding the extent to which productivity (and thus phosphorus) has been elevated since the lake watersheds were first disturbed. Data from the project are summarized in the 'Lake Projects' database.

BIOLOGICAL Monitoring

Core Programs

The ***Ambient Biomonitoring Program*** conducted by biologists in VDEC's Biomonitoring and Aquatic Studies Section (BASS), was established in 1982 to: 1) monitor long-term trends in water quality as revealed in changes over time to ambient aquatic biological communities; 2) evaluate potential impacts from permitted direct and indirect discharges, Act 250 projects, nonpoint sources, and spills on aquatic biological communities; and 3) establish a reference database that would facilitate the generation of Vermont-specific biological criteria for water quality classification and use attainment determinations. Since 1985, the Department has used standardized methods for sampling fish and macroinvertebrate communities, evaluating physical habitat, processing samples, and analyzing and evaluating data. The program has led to the development of two Vermont-specific fish community Indexes of Biotic Integrity (IBI) and selected macroinvertebrate metrics. Guidelines have been developed for determining water quality classification attainment by using both macroinvertebrate community biological integrity metrics, and the IBI. Approximately 75 sites per year are assessed using fish and/or macroinvertebrate assemblages. Alkalinity, pH, conductivity, temperature and such measurements as substrate composition, embeddedness, canopy cover, percent and type of periphyton cover, and approximate velocity are routinely monitored. From 1985 to 1999, approximately 1,225 stream assessments were completed using macroinvertebrate and/or fish from about 850 wadeable stream reaches. This monitoring effort is subject to an EPA-approved QAPP. Data from the project are summarized and stored in the 'Biology' database.

The ***Aquatic Macrophyte Monitoring Program*** collects baseline information on aquatic plant communities in Vermont lakes by conducting descriptive surveys using a pre-established plant cover scale. This program has been active since the late 1970's, and information is available from hundreds of discrete surveys. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized and stored in the 'Lake Inventory' database. Paper files are maintained as well.

The Department of Environmental Conservation conducts numerous **Aquatic Nuisance Species Searches and Surveys** each year to search for new populations and monitor existing populations of nuisance aquatic species, primarily Eurasian watermilfoil (*Myriophyllum spicatum*), water chestnut (*Trapa natans*), zebra mussels (*Dreissena polymorpha*), and the wetland invasive purple loosestrife (*Lythrum salicaria*). This includes what is presently the longest ongoing zebra mussel monitoring program in the nation, the ***Lake Champlain Zebra Mussel Monitoring Program***. In conjunction with the zebra mussel program, 11 in-lake and 12 shoreline stations in Lake Champlain are monitored for larval and settler zebra mussel presence and density on a biweekly basis. In addition, adult zebra mussel surveys are performed at selected shoreline locations during late summer. As of 2001, there were 1,466 veliger records and 651 settler records within this program's data records. The Lake Champlain Zebra Mussel Monitoring Project is subject to an EPA-approved quality assurance project plan. Data from that project are summarized and stored in the 'ZebraMonitor' databases.

Special Studies

The ***Biodiversity Monitoring Program*** evaluates the status of selected biological species and communities. Specific activities include: 1) distribution surveys of aquatic plant, fish and macroinvertebrate species listed by the Vermont Endangered Species Committee as rare, threatened or endangered, or of special concern; 2) distribution surveys of other communities not currently listed but having species considered likely candidates for eventual listing (e.g. snails); and 3) monitoring of biological communities or community types whose diversity is threatened (e.g. Lake Champlain mussel and cobble/shale macroinvertebrate communities which are threatened by zebra mussels). Data are used to 1) describe species distribution; 2) identify species/communities at risk; and 3) develop management plans for the protection of identified species/communities. This monitoring effort is subject to an EPA-approved QAPP. Data from the project are summarized and stored in the 'Biology' database.

The ***Vermont Wetlands Bioassessment Project*** is a coordinated effort between VDEC and the Vermont Nongame and Natural Heritage Program to document and understand the biological and physical characteristics associated with seasonal pools (vernal pools) and northern white cedar swamps in Vermont. Since 1999, the project has collected biological, physical and chemical data from 28 seasonal pools throughout the state. Information collected on the invertebrates, amphibians, algae and plants associated with seasonal pools will be used to develop a biological monitoring program to assess and monitor the ecological health of seasonal pools in Vermont. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized and stored in the 'Biology' database.

The ***Lake Bioassessment Project*** is the principal vehicle by which biological criteria are being developed for Vermont lakes. This monitoring effort was originally launched in 1996 as a cooperative project with the State of New Hampshire. The project has developed consistent protocols by which the trophic status, and the phytoplankton, macrophyte, and macroinvertebrate communities in lakes can be measured. To date, 12 New Hampshire and 33 Vermont lakes have been included in the project. The goal of the project is to develop numeric measurements of the communities listed above to assess aquatic life use attainment. At present, trial multimetric criteria have been developed for the phytoplankton community and are in development for macrophytes and macroinvertebrates. This monitoring effort is subject to an EPA-approved quality assurance project plan. Data from the project are summarized in the 'Lake Bioassessment' database, and stored in the 'Biology' database.

The ***Lake Champlain Long-Term Monitoring Program*** also performs biological sampling which is primarily aimed at assessing phytoplankton, zooplankton, and macroinvertebrate communities. This monitoring effort, which is cooperative with New York State DEC, is subject to an EPA-approved quality assurance project plan. Data from the project are currently stored at NYSDEC.

Other ***Biological Monitoring Projects*** either ongoing or conducted on a periodic basis include:

- monitoring nontarget impacts to aquatic biota on lakes chemically treated in 2000 with SONAR® to control Eurasian milfoil infestations;
- monitoring the effects on both target and nontarget organisms of copper sulfate treatments to control the snails partially responsible for swimmer's itch in a pond; and
- monitoring the effects on nontarget fish and macroinvertebrates in those rivers subject to lampricide (TFM) treatments.

Activities for these projects are subject to the EPA-approved quality assurance project plan that applies to the Ambient Biomonitoring Network. Data from these projects are summarized and stored in the 'Biology' database.

Northern Leopard Frog Surveys in the Lake Champlain Basin are the Department's response to reports of malformed frogs in the Lake Champlain Basin of Vermont in the summer of 1996. Malformed frogs were reported from twelve sites in five counties within the Lake Champlain Basin. Systematic field surveys were initiated in 1997 and targeted the northern leopard frog (*Rana pipiens*). The frequency and morphological characteristics of gross abnormalities among newly metamorphosed northern leopard frog populations have been recorded at 20 sites within the Lake Champlain drainage basin. VDEC has examined over 6,000 northern leopard frogs since 1996 and external malformations have been detected in 7.5% of the frogs examined. VDEC continues to gather data characterizing the gross abnormalities and describing the frequency and occurrence of abnormalities within northern leopard frog populations at 10 established sites within the Lake Champlain Basin.

All findings are reported to the North American Reporting Center for Amphibian Malformations (http://www.npwrc.usgs.gov/narcam/). VDEC also continues to collaborate with the National Institute of Environmental Health and Sciences and the National Wildlife Health Center and other researchers, providing environmental samples and specimens to help further the malformed frog investigation. This project is subject to an EPA-approved QAPP. Data from this project are summarized and stored in the 'Biology' database.

VOLUNTEER Monitoring

Citizen groups are becoming increasingly involved in monitoring, education, protection and restoration projects in Vermont. VDEC provides assistance and training to volunteers whenever possible. Watershed associations are presently active on numerous rivers and lakes in the state. Previous 305b reports discussed the fact that citizens groups are involved in stream and lake monitoring, education and restoration projects. Due to greater attention to the state's water quality, it is of utmost importance for citizens to continue to assist in this important work. The Department is most grateful to these dedicated citizens groups and will continue to provide technical assistance to them as much as possible. Appendix H is the directory of known watershed and lake association groups at work in Vermont.

Core Programs

The Vermont Lay Monitoring Program equips and trains local lake users to measure the nutrient enrichment of lakes by collecting water quality data following a rigorously documented and quality assured methodology. This citizen monitoring program is mainly based on trophic parameters and monitors approximately 40 inland lakes and 25 Lake Champlain stations per year. All Lake Champlain stations and many inland lakes in the program are sampled for chlorophyll-a, total phosphorus and Secchi disk transparency. The remaining inland lakes in the program, from which limited data are needed, are sampled only for Secchi transparency. All sampling occurs on a weekly basis during the summer. Since the development of the Lay Monitoring Program in 1979, data has been generated on 91 lakes and 36 Lake Champlain stations. Fifty-six inland lakes and 36 Lake Champlain stations have five or more years of full season data. In addition to their standard monitoring, Vermont's citizen lake monitors also assist in the ANS Watchers Program (see below), and in collecting data for the Lake Bioassessment Program. This program is subject to an EPA-approved quality assurance project plan. Data are summarized in the 'Laymon' database, and stored in the 'WQDATA' database.

The ***Citizen Lake and Watershed Survey Program*** provides survey sheets and technical training for volunteers, lake and watershed associations, and other interested groups to enable them to perform screening level assessments to identify potential nonpoint sources of pollution to lakes by conducting in-lake, lakeshore, and lake watershed surveys. Information gathered in conjunction with this program is stored in paper files. An excellent example of one such program activity is the ***Lake Parker Watershed Protection Project***. In conjunction with this project, a dedicated group of local volunteers has surveyed the Lake Parker watershed and is in the process of implementing projects in the watershed to reduce nutrient and sediment runoff to the lake. VDEC is providing technical assistance to this effort and is studying the lake to help the group decide on an achievable in-lake water quality goal for this lake protection project.

The ***Aquatic Nuisance Species (ANS) Watchers Program*** trains citizen volunteers to monitor for the presence of important nonnative aquatic species. The program is currently focusing on monitoring for Eurasian watermilfoil, water chestnut, and zebra mussels. There are presently 124 ANS Watchers throughout Vermont. Information gathered in conjunction with this program is stored in paper files.

The ***Volunteer Acid Precipitation Monitoring Program*** was initiated in 1980 to assess the impact of the 1970 Clean Air Act which mandated the improvement of air quality in the vicinity of Midwestern and southeastern fossil fuel burning plants. Dedicated volunteers at six sites throughout Vermont (Holland, Morrisville, Mt. Mansfield, St. Albans, St. Johnsbury and Underhill) collect precipitation samples on an event basis. The volume and pH of each storm event is recorded. Additional parameters such as conductivity and wind direction are recorded at individual stations. This data is used to: 1) assess spatial and temporal variability in the pH of bulk precipitation; and 2) assess changes in the pH of bulk precipitation over time and as related to reductions in atmospheric emissions of acid precursors (e.g., oxides of sulfur and nitrogen). This program is subject to an EPA-approved quality assurance project plan. Data are summarized in the 'Acidrain' database and are stored in the long-term 'WQDATA' database.

OTHER Monitoring

The Fish Contaminant Monitoring Program is managed by VDEC and performed in cooperation with the Vermont Department of Fish and Wildlife and the Vermont Department of Health (VDOH). Edible tissue from game fish acquired throughout the state is analyzed for mercury and other contaminants and these data are used in the setting and subsequent refinement of VDOH fish consumption advisories. This project is subject to an EPA-approved quality assurance project plan. Data are summarized and stored in the 'Vermont Fish Contaminant Monitoring' database. This is considered a core monitoring project.

Data Interpretation & Communication

The information from the rotational assessments is incorporated into the Water Quality Assessment database. From the database, reports are generated for waterbodies in river basins for 305b annual electronic reporting as well as biennial reports, general information, review and feedback purposes. Feedback is requested from the district fisheries biologists, watershed association leaders, US Forest Service fisheries biologists, NRCS and the local USDA working groups.

The lakes portion of Vermont's 305b Assessment database continues to be fully compliant with the most recent version of the EPA's ADB 305b database. The lakes portion of the database contains rigorous error and redundancy checking and has a number of programmed queries to facilitate not only electronic reporting to EPA via its contractor RTI but also to automate the preparation of required tables.

Beginning with the 1996 report, Vermont's 305b Water Quality Assessment Reports have been placed on the Department's web site and are available to any member of the public with internet access. This has saved considerable paper resources and duplicating costs.

Plan for Achieving Comprehensive Assessments

Vermont's watershed management and assessment approach to water quality planning, as outlined in Appendix C, plus the state's rotational watershed assessment procedure (see narrative in Chapter Two below), constitutes Vermont's plan for achieving comprehensive assessments.

Chapter Two: Assessment and Listing Methodology and Mapping Approach

2001 River and Lake Water Quality Assessment Methodology

Several years ago, Vermont adopted a rotational watershed assessment strategy for the purposes of assessing and reporting water quality information. The state has been divided into 17 major planning basins that have from four to 22 river sub-basins and main stem segments within them. The surface waters within these sub-basins are referred to and have been designated as 'waterbodies.' There are 210 river and 556 lake designated waterbodies in Vermont. VDEC plans to assess the waters of all 17 major basins at least once every five years. By focusing annual evaluations on selected watersheds, more systematic and intensive efforts can be made to collect and evaluate information on nonpoint and point sources of pollution.

The assessment itself involves identifying, compiling and evaluating all available water quality data and information as well as point and nonpoint source pollution impacts on designated uses specific to the basins being assessed in any given year. The data are maintained in MS-Access© databases which are specifically designed to be consistent with EPA's current Assessment Database package. Vermont relies on the following sources of data and information in assessing designated use support:

1) VDEC Water Quality Division (monitoring data)

2) VDEC Wastewater Management Division (WWTF permit compliance)

3) VDEC Waste Management Division (solid & hazardous waste site monitoring data)

4) Vermont ANR Enforcement Division (violations of water quality standards)

5) Vermont Department of Fish & Wildlife (game fish data, temperature data, studies)

6) Vermont Department of Health (beach closure information and fish consumption risk assessments)

7) Vermont Department of Forests, Parks, and Recreation (bacteriological testing and beach closure information)

8) Vermont Department of Agriculture (agricultural water quality violations)

9) Vermont Regional Planning Commissions (known locations of problems)

10) USDA Natural Resource Conservation Service (agricultural nonpoint sources and locations of pollution abatement projects)

11) Citizens and citizen associations (citizen monitoring data, location of sources, complaints)

12) US Geological Survey Water Resources Division (monitoring and research)

13) US Forest Service (fish habitat and water quality data and information)

14) US Environmental Protection Agency (monitoring and research)

15) US Army Corps of Engineers (Environmental assessments of Project waters)

16) University of Vermont and Vermont State Colleges System (monitoring and research)

VDEC's ambient biomonitoring network (ABN) provides most of the data used in the assessment of monitored river miles (see more complete description below). VDEC's lakes and ponds program provides most of the data used in the assessment of monitored lake acres. The other sources listed above provide fewer and more widespread data points.

Evaluated information used for assessments includes desktop modeling, some lay monitoring data, best professional judgement of resource managers, known sources of pollution, and analytical results that exceed five years in age.

Biological Assessments

Assessment of biological integrity is conducted on the state's rivers and streams for the purpose of trend detection and site-specific impact evaluation. Macroinvertebrate and/or fish populations of rivers and streams are assessed by comparing a series of biometrics measuring community structure and function to a set of biocriteria that represent the biological potential for the ecoregion/habitat being evaluated. The biomonitoring activities can be placed into two categories; 1) long-term monitoring of reference level sites and 2) site specific impact evaluations.

The biological potential for various sites is established through long term reference site monitoring. Information from this program element also serves to refine existing biocriteria and detect trends in baseline biological integrity. The long-term monitoring is conducted on a set of reference sites on a 5-year rotating basis, so as to give five years of continuous data for each site. Sites are stratified across stream ecotypes differing in drainage area size, elevation, and alkalinity. Human activity in reference site drainages is judged to be minimal relative to other streams in the ecoregion.

Where site-specific impact assessments are conducted, potential pollution sources are spatially bracketed with sample sites to determine impact/non-impact on the aquatic biota attributable to the pollution source. Either macroinvertebrate or fish populations or both may be sampled. Approximately 50 river sites are assessed each year in the late summer-early fall (Sept-Oct15) on a five year rotational watershed basis. From 1982 to 2000, the state has evaluated over 1,000 sites.

Detailed biological assessment procedures for wadeable streams are available on request. Trial biological criteria procedures have also been developed for plankton communities within Vermont lakes, and are used in corroborating assessments of Aquatic Life Uses. Other biological assemblages are being evaluated for assessing lake biological integrity as well. Macroinvertebrate and amphibian community indices are also being evaluated for use as biomonitors of aquatic life use support for intermittent wetlands.

Use Support Determinations for Rivers and Streams

The following paragraphs provide the reader with specific criteria and other information VDEC uses to determine use support for individual designated uses and make an assessment of water quality in rivers and streams. Information is presented to show how the water quality monitoring data and information relates directly to the degree of use support for 305b reporting purposes.

1. Aquatic Biota/Habitat (Aquatic Life)Use

Biological Monitoring

- FULL SUPPORT: Overall macroinvertebrate or fish community biological integrity is good, very good or excellent as determined by the Vermont Water Quality Division ABN program. (See above for elaboration of ambient biomonitoring program and metrics)
- PARTIAL SUPPORT: Overall macroinvertebrate or fish community biological integrity is rated fair by the Vermont Water Quality Division ABN program.
- NON SUPPORT: Overall macroinvertebrate or fish community biological integrity is rated poor to very poor by the Vermont Water Quality Division ABN program.

Habitat Assessment

- FULL SUPPORT: High quality habitat. All life-cycle functions, including overwintering and reproductive requirements are maintained and protected. Depending on the classification (A1, A2, B1, B2, B3) minimal to moderate changes from natural or reference condition. All B waters not as Types 1,2 or3 must exhibit no change from reference conditions that would have an undue adverse effect on the composition of the aquatic biota, the physical or chemical nature of the substrate or the species composition or propagation of fishes. Stream condition is stable or in transition to stable as determined using accepted geomorphic assessment techniques.
- PARTIAL SUPPORT: Physical habitat changes do not support optimum overwintering and reproduction for the aquatic life. Depending on the classification, changes to the habitat are greater than minimal to moderate. There is an undue adverse effect on the physical nature of the substrate. Stream condition is in transition to unstable with moderate loss of floodplain connectivity; or moderate to major planform adjustment that could lead to channel avulsions as determined using accepted geomorphic assessment techniques.
- NON-SUPPORT: Habitat alteration of the same nature as above however, much more severe or extreme in degree. Stream condition is unstable with significant channel and floodplain modifications that have altered the channel dimension, pattern and/or profile such that the stream is not in balance with the flow and sediment produced.

Conventionals (temperature, dissolved oxygen)

- FULL SUPPORT: Temperatures support coldwater species if waters are designated a coldwater fishery. Also the total increase from the ambient temperature due to all discharges and activities is not known to exceed 1.0 F for a coldwater fishery and the total increase from ambient temperature due to all discharges and activities shall not exceed the temperature criteria derived from tables 1 or 2 in Section 3-01.B.1.c. except as provided for in Section 3-01 B.1.d. of the Vermont Water Quality Standards (pertaining to both a coldwater and warmwater fishery). Applicable dissolved oxygen levels support coldwater or warmwater species, as defined by the Standards.
- PARTIAL SUPPORT: Temperatures are too high to fully support coldwater fish species in waters designated as a coldwater fishery - one or more trout species limited in number or biomass as compared to reference condition.
- NON-SUPPORT: Temperatures are so high that trout species are essentially absent (coldwater only).
- PARTIAL SUPPORT or NON-SUPPORT: The total increase from the ambient temperature due to all discharges and activities exceeds 1.0 F for a coldwater fishery and the total increase from ambient temperature due to all discharges and activities exceeds the temperature criteria derived from tables 1 or 2 in Section 3-01.B.1.c. except as provided for in Section 3-01 B.1.d. of the Vermont Water Quality Standards (pertaining to both a coldwater and warmwater fishery). Fluctuations in applicable dissolved oxygen levels below the minimum values pertaining to coldwater and warmwater fish habitat.

Toxicants (priority pollutants, metals, chlorine and ammonia)*

- FULL SUPPORT: *For any one pollutant, no more than 1 exceedance of acute criteria (EPA's criteria maximum concentration or applicable State criteria) within a 3-year period, based on grab or composite samples and no more than 1 exceedance of chronic criteria (EPA's criteria continuous concentration or applicable State/Tribal criteria) within a 3 year period based on grab or composite samples.*
- PARTIAL SUPPORT: *For any one pollutant, acute or chronic criteria exceeded more than once within a 3-year period, but in less than 10 percent of samples.*
- NON-SUPPORT: *For any one pollutant, acute or chronic criteria exceeded in greater than 10 percent of samples.*

  Note: The above assumes at least 10 samples over a 3 year period. If fewer than 10 samples are available, the State should use discretion and consider other factors such as the number of pollutants having a single violation and the magnitude of the exceedance(s).

(*) Portions in italics are from the 1998 federal guidance on 305b use support determination or subsequent guidance.

2. *Fish Consumption Use**

- FULL SUPPORT: *No fish consumption restrictions or bans are in effect.*
- FULL SUPPORT BUT THREATENED: *"Restricted consumption" of fish in effect (restricted consumption is defined as limits on the number of meals or size of meals consumed per unit time for one or more fish species); or a fish ban in effect for a subpopulation that could be at potentially greater risk, for one or more fish species; but no waterbody specific data.*
- PARTIAL SUPPORT: *"Restricted consumption" of fish in effect (restricted consumption is defined as limits on the number of meals or size of meals consumed per unit time for one or more fish species); or a fish ban in effect for a subpopulation that could be at potentially greater risk, for one or more fish species and there is fish tissue data from the waterbody in question.*
- NON SUPPORT: *"No consumption" fish ban in effect for general population for one or more fish species; or commercial fishing ban in effect.*

(*) Portions in italics are from the 1998 federal guidance on 305b use support determination or subsequent guidance.

3. *Swimming/Contact Recreation*

<u>Bacteria/E. Coli</u>

- FULL SUPPORT: Geometric mean of samples taken not greater than 77 organisms/100 ml.
- FULL SUPPORT BUT THREATENED: If only one or two samples are available so that calculating a geometric mean is not possible but single samples are sometimes greater than 77 organisms/100 ml. and sometimes not
- PARTIAL SUPPORT: Geometric mean met sometimes and not other times in a given stretch.
- NON-SUPPORT: Geometric mean not met for all sampling sites in a given stretch.

Note: Data for at least two seasons is usually necessary to make non-support and partial support determinations. The time at which the sample is taken is also considered. If the numbers are high, the data are limited in scope, and the sampling was done during a high flow event then the situation is considered less of a problem then if the numbers are high, the data show this over a number of sample dates and seasons and the high numbers occur during high and low flows.

In addition, the following parameters may be used to determine support of contact recreation: turbidity, odor, abundance of algal growth and flow.

4. *Secondary Contact/Non-Contact Recreation*

- FULL SUPPORT: Water quantity and quality sufficient for boating, wading and fishing.
- PARTIAL SUPPORT: Boating or fishing limited by flows, odor, color, plant growth, or a diminished fishery.

- NON SUPPORT: Lack of water for boating, or fishing; or water quality of such poor quality that the fishery is almost non-existent; or unnatural plant growth so extreme that boating is not possible.

  Note: Partial or non-support due to algal or other plant growth is used only if VDEC is reasonably confident the plant densities are not natural.

5. *Drinking Water Supply**

- FULL SUPPORT: *Drinking water use restrictions are not in effect.*
- PARTIAL SUPPORT: *Drinking water use restrictions resulted in the need for more than conventional treatment with associated increases in cost.*
- NON SUPPORT: *Drinking water use restrictions resulted in closures.*

(*) Portions in italics are from the 1998 federal guidance on 305b use support determination or subsequent guidance.

6. *Aesthetics*

- FULL SUPPORT: Water character, flows, water level, be and channel characteristics, exhibiting good to excellent aesthetic value. Water clarity and substrate condition good. No floating solids, oil, grease or scum. Intact, natural riparian zone.
- PARTIAL SUPPORT: Aesthetic quality compromised somewhat. Water unnaturally turbid. Moderate unnatural plant growth. Small or disturbed riparian zone.
- NON-SUPPORT: Aesthetic quality poor. Water is frequently and unnaturally turbid. Excessive unnatural plant growth covers the channel bottom, rocks or water surface. Substrate unnaturally silt-covered or mucky. Presence of floating solids, scum, oil or grease. Stained channel rocks. No riparian vegetation or a highly degraded riparian zone. Unnatural, slumping banks.

7. *Agricultural Water Supply and Industrial Water Supply*

- There are currently no EPA definitions or state standards for agricultural and industrial water supply. These uses are currently unassessed.

8. *Overall*

- FULL SUPPORT: All individual designated uses are fully supported and there are no known exceedances of State Water Quality Standards
- PARTIAL SUPPORT: One or more uses are partially supported and the remaining uses are fully supported
- NON-SUPPORT: One or more uses not supported

Use Support Determinations for Lakes and Ponds

In concert with regional consistency efforts undertaken during 1999 by the New England Interstate Water Pollution Control Commission, VDEC has made minor modifications to its methods for determining degree of use support for lakes. The following is a summary of the decision criteria used by VDEC to assess use support for lakes. Partial Support and Non Support use determinations are no longer made based solely on public opinion, town clerk, or Fish and Wildlife warden comments. Lacking any scientifically derived supporting data, comments such as those are only used to indicate a potential threat to a use.

1. Aquatic Biota/Habitat (Aquatic Life)

Biological Assessment

Until recently, very little biological assessment data has been available for lakes, except for a rather comprehensive, long-term database describing the distribution of aquatic macrophytes in lakes. Past assessments often relied on qualitative observations of habitat conditions, in some cases using the aquatic macrophyte data.

VDEC is in the final stages of developing a multimetric biological index based on phytoplankton communities, and is also developing a multimetric index to describe the condition of macroinvertebrate communities within lakes. It is anticipated that future assessments will be more directly based on biological data for phytoplankton, macrophyte, and macroinvertebrate assemblages. Insofar as sufficient data are available, Aquatic Life Use Support decisions are made consistent with the existing methods detailed in the Vermont 1996 Water Quality Assessment 305b Report. Where data are available, results of phytoplankton community assessments are being incorporated into the assessments of individual lakes. As of the date of this writing, a series of newly derived, trial criteria for macroinvertebrates is being tested.

Presumed Aquatic Life Use Attainment for Fluctuated Reservoirs

Reservoirs present a special case in regards to assessment of Aquatic Life Use Support. In the absence of direct biological measurements, Aquatic Life Use Support is assessed using the following decision making 'tree.'

1) Can the level of the waterbody be regulated by an artificial structure (e.g. dam, sluice, wier)?

   Answer is NO: no threat to ALUS due to water level fluctuation.

   Answer is YES: go to 2.

2) Is the waterbody connected to a licensed or unlicensed hydroelectric generating system, a flood control system, or subject to promulgated Vermont Water Resources Board rules regulating the fluctuation?

   Answer NO: a threat to ALUS could exist, but the threat must be verified by direct assessment before the waterbody is assessed as threatened.

   Answer YES: go to 3.

3) Is the waterbody regulated by a CWA Section 401 water quality certification issued after January 1, 1990?

Answer NO: go to 4.

Answer YES: go to 5.

4) Is the waterbody in fact subject to periodic fluctuations that are attributable to operation or manipulation of the outflow structure?

Answer NO: a threat to ALUS is presumed to exist, due to the ability of the outflow operators to fluctuate water levels if the need arises, which can negatively impact littoral zone communities. Littoral zone impacts will have cascading effects within the remaining trophic web of the waterbody. Accordingly, all of the waterbody's acreage will be assessed as threatened for ALUS.

Answer YES: Review maximum and mean waterbody depth, and shoreline development index (which relates to the linear distance of littoral zone potentially impacted). Evaluate the proportion of the littoral zone affected by the drawdown regimen. Review available biological data, in particular the presence and distribution of aquatic macrophytes within the littoral zone, where these data are available. Go to 5.

5) Does there exist a sufficient area of littoral habitat below the drawdown zone to enable establishment of a viable and stable aquatic community while accommodating the drawdown regimen, **or**, does available biological data suggest that a viable and stable aquatic community exists within the drawdown zone?

Answer NO: ALUS is partially supported. Littoral zone impacts of this magnitude will have cascading impacts throughout the remaining trophic web. Accordingly, the entire acreage is assessed as partially supporting. Direct biological assessment is warranted to upgrade this waterbody to threatened status.

Answer YES: a threat to ALUS is presumed to exist, due to the negative impact incurred by the littoral zone habitat actually subject to the drawdown. Littoral-zone impacts will have cascading effects within the remaining trophic web of the waterbody. Accordingly, all of the waterbody's acreage is presumed to be threatened for ALUS.

<u>Conventionals (alkalinity, DO)</u>

FULL SUPPORT: Acid neutralizing capacity (ANC) greater than or equal to50 ueq/l during the spring runoff period.

Reliable data indicates that hypolimnetic dissolved oxygen minima are non-persistent. In addition, epi- and metalimnetic dissolved oxygen concentrations show depression below Vermont Water Quality Standards in less than ten percent of samples.

- PARTIAL SUPPORT: Reliable long-term monitoring data indicates that ANC routinely drops below 50 *u*eq/l (2.5 mg/l as CaCO3) during the spring runoff period.

  Reliable long-term monitoring data indicates that a lake's hypolimnetic dissolved oxygen concentration periodically falls to (or near) zero mg/l or zero percent saturation during peak summer stratification **and** the hypolimnetic sediments are devoid of a macroinvertebrate community as determined by a rapid bioassessment procedure. The area designated as partially supporting aquatic life uses is limited to the lake acreage underlain by the hypolimnetic oxygen-deficient area. If, in the best professional judgement of VDEC scientists, the dissolved oxygen deficit is due to natural causes, aquatic life uses will be considered fully supported but threatened instead. The epi- and metalimnetic lake waters will be considered Partially Supported if dissolved oxygen concentrations fall below Vermont Water Quality Standards in ten or more percent of samples.

- NON SUPPORT: Reliable long-term monitoring data indicates that a lake's acid neutralizing capacity routinely drops below 0 *u*eq/l (0 mg/l as CaCO3) during the spring runoff period.

  Reliable long-term monitoring data indicates that, for the entirety or the majority of a lake's acreage, dissolved oxygen concentrations seasonally fall to zero mg/l or zero percent saturation during peak summer stratification and fish kills result.

- THREATENED: Reliable long-term monitoring data indicates that a lake's acid neutralizing capacity routinely drops below 250 *u*eq/l (12.5 mg/l as CaCO3) during the spring runoff period.

  Reliable long-term monitoring data indicates that a lake's hypolimnetic dissolved oxygen concentration periodically falls to (or near) zero mg/l or zero percent saturation during peak summer stratification, but macroinvertebrates are present. The area designated as threatening aquatic life uses is limited to the lake acreage underlain by the hypolimnetic oxygen-deficient area.

<u>Non-Native Species:</u>

Non-native species such as Eurasian milfoil (Myriophyllum spicatum), water chestnut (Trapa natans), and zebra and quagga mussels (Dreissena spp.) have been determined by VDEC to be a biological pollutants which have to have significant impacts on existing macrophyte and benthic macroinvertebrate communities.

- FULL SUPPORT: No established population of an invasive, non-native nuisance species.

- PARTIAL SUPPORT: Non-native species present in densities sufficient to alter littoral communities. The overall density is classified as "moderate" by VDEC.

- NON SUPPORT: Non-native species present in densities classified by VDEC as "heavy," which is considered sufficient to preclude the establishment of expected, native littoral communities.

- THREATENED: Non-native species present, but in low densities. In the case of Eurasian milfoil, lakes with a ten mile radius of an infested lake are considered Threatened, unless access the lake is remote or inaccessible by conventional means.

Nutrients

VDEC has segment specific nutrient criteria for Lake Champlain and Lake Memphremagog. As promulgated by US EPA (GPO 2001a), Vermont will work with US EPA New England to develop scientifically sound nutrient criteria for other Vermont waters for inclusion into Vermont's Water Quality Standards by 2004. Vermont's final nutrient criteria will also address Swimming and Aesthetic Uses.

2. Fish Consumption

New guidance on assessment of fish consumption use attainment (US EPA, 2000) is now being used to revise Fish Consumption use support on a lake-by-lake basis, as each lake is reassessed. Vermont interprets the US EPA guidance on fish consumption use attainment in the following manner: For any lake on which a species is present which is the subject of a 'no-consumption' advisory for a sub-population (women of childbearing age or children), fish consumption use is considered only partially supported. Any lake on which a no-consumption advisory is in place for the general population would be assessed as not supporting fish consumption uses. For lakes on which fish consumption is limited, but not banned, for a sub-population and/or for the general population, the use is considered supported. This is because fish can indeed be consumed from those waters, albeit at a reduced rate.

As of this writing, US EPA has promulgated new criteria for methylmercury in fish tissue, and ASWIPCA is currently preparing an implementation plan for this criterion. In addition, US EPA is issuing revised, national level general consumption guidelines for non-commercial freshwater fish. VDEC's present assessment methodology may change based on a review of these new criteria and guidelines.

The following summarizes the current assessment guidelines for fish consumption use:

- FULL SUPPORT: No fish consumption bans are in effect for the general population (limited consumption advisories may apply).
- PARTIAL SUPPORT: For a given species, a 'no consumption' advisory is in place for a designated sub-population (e.g., children or women of childbearing age).
- NON SUPPORT: For a given species, a 'no consumption' advisory is in place for the general population, or a commercial fishing ban is in place.

Under these guidelines, fish consumption use is considered Not Supported or Partially Supported only in the event that the fish species subject to the consumption advisory is documented by the Vermont Department of Fish and Wildlife to exist in the lake.

3. Swimming Uses

Swimming uses are assessed based on beach closures, resulting from bacterial contamination, or due to the presence of non-native aquatic nuisances such as Eurasian milfoil, water chestnut, or zebra mussels. For beach closures, the acreage occupied by the beach tested is identified as not fully supporting. For non-native nuisance species, the area impaired by the infestation is identified as not fully supporting.

- FULL SUPPORT: No beach closures are in effect during the assessment cycle. Non-native nuisance species absent or present in light densities.
- PARTIAL SUPPORT: No more than one beach closure per year, of less than 1 week duration. Non-native nuisance species present, but at densities which do not entirely preclude swimming uses. Areas where routine harvesting of non-native macrophytes controls densities may be considered Partially Supported.
- NON SUPPORT: On average, one beach closure per year, of greater than one week duration, or, more than one beach closure per year. Non-native nuisance species present in such densities as to preclude swimming uses. Typically, these areas are characterized by greater than 75% cover of a non-native macrophyte.

4. Secondary (Non-Contact) Recreation

- FULL SUPPORT: Water quantity and quality sufficient for boating, wading and fishing.
- PARTIAL SUPPORT: Boating or fishing limited by flows, odor, color, plant growth, or a diminished fishery.
- NON SUPPORT: Lack of water for boating or fishing; or water of such poor quality or unnatural plant growth so extreme that boating is not possible.

5. Drinking Water Supply

The Safe Drinking Water Act (SDWA) criteria for finished water are now being used to assess Drinking Water Supply use. A waterbody is considered not fully supporting only in the event that violations of SDWA criteria are found in finished, supplied drinking water. The process for assessing these uses is completely characterized by US EPA (2001).

6. Agricultural Water Supply and Industrial Water Supply

There are currently no EPA definitions or state standards for agricultural and industrial water supply. These uses are currently unassessed and will likely be removed from future versions of Vermont's Assessment Database.

7. Aesthetics

A closer look is presently being taken at the reliability of the information used to make this use support assessment and what the correct threshold level should be for considering aesthetic uses as only partially supported or not supported. The guidelines for assessing Aesthetic Uses for rivers may also be applied to lakes.

8. Additional Considerations for Lake Champlain and Lake Memphremagog

Vermont's Water Quality Standards contain segment-specific total phosphorus criteria for Lake Champlain and Lake Memphremagog. These scientifically-derived, lake segment-specific standards are used to evaluate Aesthetics and Swimming Use Support for each segment.

9. Overall Uses

- FULL SUPPORT: All individual designated uses are fully supported and there are no known exceedences of Vermont Water Quality Standards, in frequencies exceeding those established for the individual uses discussed above.
- PARTIAL SUPPORT: one or more uses are partially supported and the remaining uses are fully supported.
- NON SUPPORT: one or more uses are not supported.

Clean Water Act Section 303d Waters

The Department has begun to prepare the Vermont Year 2002 303d List of Waters. The Year 2002 listing will be assembled in a format similar to the EPA-approved Year 2000 List of Waters. Part A of the Year 2002 List of Waters will identify impaired waters in need of a Total Maximum Daily Load (TMDL) determination. Part B of the Year 2002 List of Waters will identify candidate waters for 303d "de-listing." Candidate waters for "de-listing" will be in one of two categories - waters no longer considered to be impaired and impaired waters that do not need or require a TMDL. The Year 2002 303d List of Waters will also contain a third component and identify impaired waters being addressed under an EPA-approved TMDL.

The final three-part Vermont Year 2002 listing, eventually to be submitted to the New England regional office of US EPA for approval after an opportunity for public review and comment, will be made available separately.

Geo-referencing, Database-GIS Linking, and Mapping

The Department maintains geographic data layers for rivers and streams, lakes and ponds, wetlands, and ground water resources. During the reporting period, the Department geo-referenced the lakes and ponds

data layer to the 1:24,000 scale. In addition, a reasonable streams data layer exists at the 1:100,000 scale. Mapping the rivers and streams data layer, even at the 1:24,000 scale, remains a goal which will take at least one additional 305b assessment cycle.

For purposes of presenting 305b assessment geographically, the Department uses the existing lakes and ponds, and rivers data layer, on a PC-ArcView (v3.1, ESRI) platform. Over the course of the reporting period, waterbody identification codes and waterbody names were geo-referenced within both data layers (this had been partially completed for lakes and ponds as of the 2000 305b report, but not at all for streams). Vermont is now in a position to provide maps of the locations of waterbodies, along with their 305b assessment findings, for all designated uses. Maps of overall use support for rivers/streams and lakes/ponds are provided in Chapters III-4 and III-5, respectively. Additional tasks remain in order to bring the streams data layer to the point that individual segments within waterbodies can be geographically referenced using the GIS-Assessment database linkage. Specifically, individual waterbody segments impaired for specific uses need to be identified within the rivers assessment database. These same segments will then need to be identified in the streams data layer. While there are several reasons why segmentation and stream layer improvement is not yet complete, the geo-referencing of existing waterbody identification codes and the resulting ability to cross-query to both the lakes and streams assessment databases, is a significant step forward for Vermont.

Presently, VDEC biennially revises a database used for identifying 303d listed waters, which is separate from the streams database used to map 305b findings. While this may not be the most efficient method to maintain assessment-related GIS information, the Department is evaluating how to best merge these two separate data systems. The Department is working with the Vermont Center for Geographic Information (VCGI) to develop a method by which the waterbody identification codes for both streams and lakes can be transferred to the National Hydrography Dataset (NHD). This data set is still under development for Vermont. VCGI staff are working to generate an NHD for all of Vermont (at a scale of 1:24,000) and have an active pilot project to refine NHD to 1:5,000. Over the course of the next reporting period, the Department's ability to bridge assessment data to the NHD will be clarified, as will progress towards segmenting stream waterbodies.

Chapter Three: Rivers & Streams Water Quality Assessment

Statewide Water Quality Assessment/Designated Use Support

Vermont's statewide surface water quality has been determined by updating past years' statewide assessment data with water quality information and data from watersheds assessed in the last two years. The tables and narrative below give the overall and individual use support summaries for the state's waters.

According to EPA, Vermont has approximately 7,100 miles of perennial rivers and streams. Of the 5,450 river and stream miles assessed for this report, overall approximately 78% are in compliance with the state's water quality standards and fully support designated uses, and 22% are not in compliance with the water quality standards or do not fully support the designated uses.

Of the 5,450 miles of river or stream assessed for use support, 15% (838 miles) of the assessments are based on in-stream monitoring data and 85% (4612 miles) of the assessments are based on a variety of other information including habitat assessments, conditions such as channelization, combined sewer overflows (CSO), or severe streambank erosion judged to cause impairments or threats, modelling, and non-singular incidences of fish kills or spills.

For this assessment cycle, the Department is also providing the results of a statistically designed estimation of aquatic life use support for all waters statewide. This probabalistic assessment of aquatic life use support used existing data from 301 individual monitoring sites across Vermont, which were subsampled using the spatially randomized selection employed by the US EPA EMAP program.

Individual Use Support Summary

Table III.3.1 below is a summary of the number of miles of rivers and streams throughout Vermont which fully support or do not fully support the water quality standards or designated uses of the waters. For each river use or value that is assessed, the miles of river or stream fully supported, fully supported but threatened, partially supported, or not supported are determined. For example, river miles that are fully supported for aquatic biota have macroinvertebrate and fish communities in good to excellent health based on a number of metrics for each community. River miles that are fully supported for swimming have no known high levels of *E. coli*, a bacteria that is used as an indicator for pathogens. A full description of the assessment methodology is given in Chapter Two. Overall use support, expressed as proportion of miles meeting/not meeting uses, by waterbody, is shown in Figure III.3.1

The number of miles in each support category are provided for seven uses or values: aquatic biota and/or habitat, contact recreation (swimming, tubing), secondary contact recreation (boating, fishing), aesthetics, fish consumption, drinking water supply and agricultural water supply. The use called "overall" reflects the miles for which one or more of the uses are not supported, partially supported, threatened or fully supported. The fish consumption use is not factored into the "overall" category because all miles of river and stream are at least threatened for fish consumption due to a statewide fish consumption advisory. If taken into account in "overall", this status would mask the extent of other threats.

Table III.3.1. Statewide Overall and Individual Use Support Summary.
*** Rivers and Streams ***

Designated Use	Full support (miles)	Full support but threatened (miles)	Partial support (miles)	Non-support (miles)	Total assessed miles
Overall	3,184.6	1,084.1	968.0	213.1	5,449.8
Aquatic biota/habitat	3,267.1	1,103.6	912.1	167.0	5,449.8
Contact recreation	4,162.0	686.3	405.4	85.1	5,338.8
Secondary contact recreation	4,329.5	447.5	495.2	97.5	5,369.7
Aesthetics	3,818.3	836.8	669.1	107.9	5,432.1
Drinking water supply	3,262.1	197.2	69.6	32.1	3,561.0
Agricultural water supply	835.0	119.9	43.7	23.2	1,021.8
Fish consumption	0.0	5,696.7	76.5	34.5	0.0

Causes and Sources[1] of Impairments, Impacts, and Threats

A cause is a pollutant or condition that results in a water quality impairment, impact or threat; a source is the origin of the cause and can be a facility, a land use, or an activity. The sources are subdivided into point and nonpoint, and a nonpoint source is defined as any pollutant not discharged directly from the end of a pipe. Tables III.3.2 and III.3.3 summarize the miles of rivers and streams affected by various causes and sources, respectively.

[1]These cause and source categories have been established by the U.S. Environmental Protection Agency.

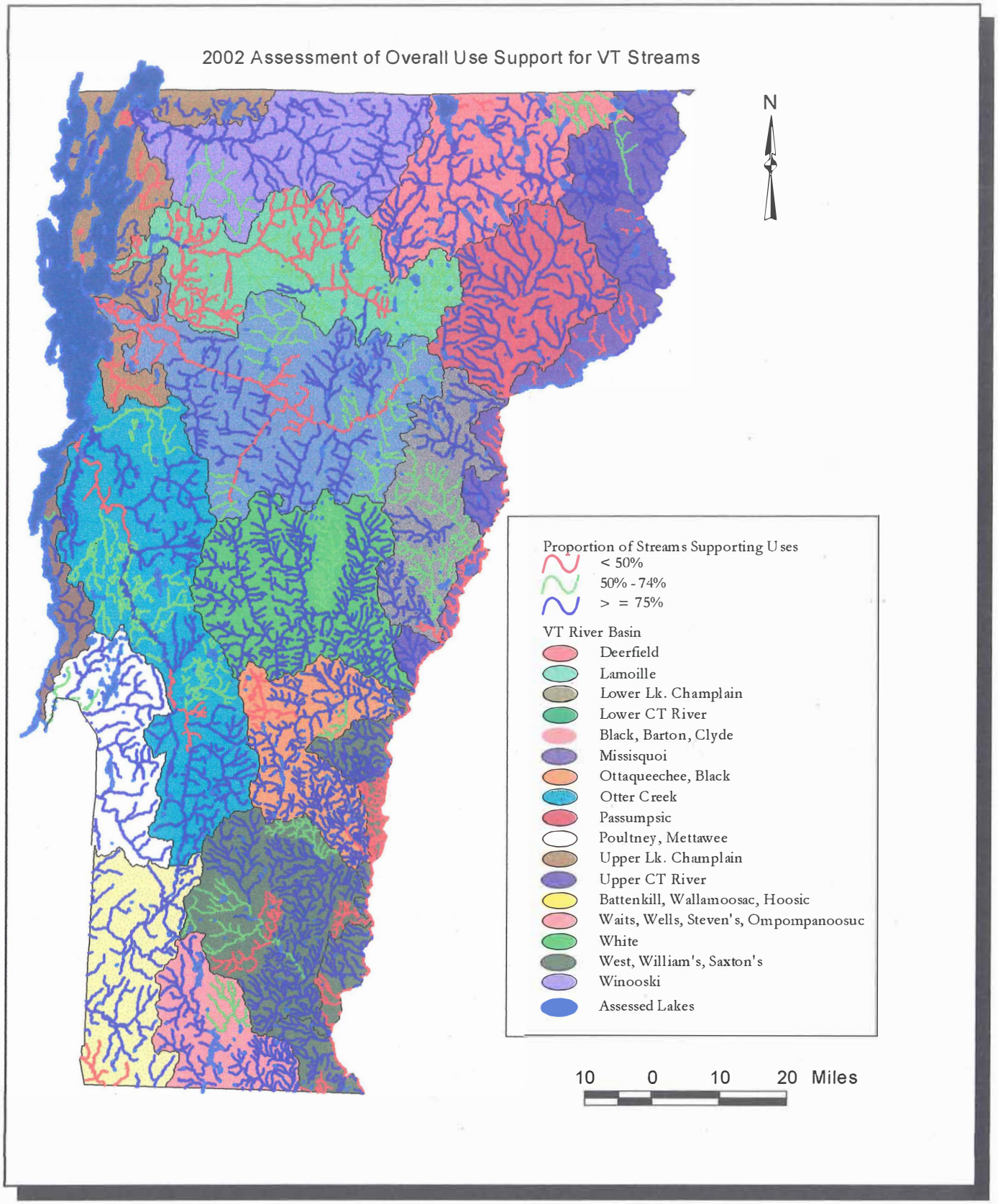


Figure III.3.1

Because a stretch of river or stream may be affected by more than one cause or source, the same mileage may be tallied in several places in Tables 3.2 and 3.3. For this reason, the two columns on each table are not additive because the total would overestimate the total number of miles affected by all causes and sources in Vermont. The purpose of these summaries is to give natural resource managers and the public, in relative terms, an idea of the relative size of impact of different pollutants or conditions on Vermont's waters and from which land uses or activities they may originate.

Summary of Causes

Sedimentation/siltation is the largest cause of impacts and impairments to river or stream water quality or aquatic habitat in Vermont. Sedimentation/siltation has long been the leading pollutant of our flowing waters. Unnatural levels of sediment alter or destroy macroinvertebrate habitat and fish spawning areas, fill in swimming holes, and cause the river or stream channel to become unstable. Sedimentation affects about 860 miles of river and stream and threatens another 983 miles based on the information available at this time.

The second largest documented cause of impacts and impairments is thermal modification or water temperature increases. This problem affects about 472 miles and threatens another 324 miles. A close third in terms of pollutants or conditions is nutrient loading to waters. Nutrients affect 451 miles of river and stream and threaten another 486 miles.

The other substantial causes identified include: flow alterations affecting 358 miles and threatening another 124 miles; physical habitat alterations affecting 340 miles and threatening 188 miles; pathogens affecting 335 miles and threatening 512 miles; organic enrichment/low dissolved oxygen affecting 328 miles and threatening 222 miles; metals affecting 238 miles and threatening another 139 miles; and turbidity affecting 234 miles and threatening 119 miles.

Past assessments have generally had similar results in terms of which pollutants or conditions have the most impact on water quality or aquatic habitat. Sedimentation was the most extensive cause of pollution in the 2000, 1998 and 1996 305b assessments. The next six causes following sedimentation have been thermal modifications, nutrients, flow alteration, physical habitat alteration, pathogens, and organic enrichment/low dissolved oxygen in at least the last three assessments although not in the same order each assessment year.

Table III.3.2. Total River and Stream Miles with Impairments, Impacts, or Threats by Cause Category.

Cause of impairment	Magnitude of impairment (miles)		Total miles impaired by cause	Miles threatened by cause
	High	Moderate		
Sedimentation	382.6	477.0	859.6	983.2
Thermal modifications	142.6	329.1	471.7	324.1
Nutrients	148.6	302.7	451.3	485.6
Flow alterations	186.7	178.4	365.1	124.1
Physical habitat alterations	177.3	162.2	339.5	187.9
Pathogens	95.9	238.9	334.8	512.1
Organic enrichment/low D.O.	88.3	239.9	328.2	221.9
Metals	191.5	46.5	238.0	138.8
Turbidity	4.2	229.5	233.7	119.0

Summary of Sources

Streambank erosion, as in past assessments, ranks first among all the pollution sources with 603 miles of impact and 409 miles of threats from this problem. Streambank erosion is described as a source in and of itself, but this 'source' results from other 'sources' such as riparian vegetation removal and channel instability. Streambank erosion is the primary source of the sediments that are the top cause of water quality and aquatic habitat impacts.

Agricultural land uses and activities affect the second greatest number of river miles with 528 miles of impact and 560 miles threatened. Agricultural activities can result in nutrient, pathogen and/or sediment runoff from pasture land, crop production and animal management areas and can also result in loss of riparian vegetation.

Removal of riparian (streamside) vegetation is the third highest source of impact or impairment to Vermont's rivers and streams, with 422 miles affected by this activity and 318 miles threatened. Removal of riparian vegetation continues to be a growing problem in the state. Individual residential and commercial landowners, farmers, town road crews and the Agency of Transportation all encroach on the riparian zone with their activities and the result is the loss of the trees and shrubs protecting rivers and riverbanks. Flooding and channel instability also result in loss of riparian vegetation. Riparian vegetation removal results in sedimentation and thermal modification, the two largest causes of river and stream impacts.

The fourth and fifth highest sources of pollution are flow modification and upstream impoundment, respectively. Flow regulation below hydroelectric power and flood control dams causes low and fluctuating flows or dewatering of channels; snowmaking and water supply withdrawals also alter natural flows.

Reduced or fluctuating flows affects the amount of aquatic habitat available downstream as well as dissolved oxygen levels, temperature and other water quality parameters. Flow regulation has an impact on 392 miles and threatens another 64 miles.

Upstream impoundments are bodies of water behind hydroelectric or other dams. Impoundments cause warming of the water, streambank erosion, act as sediment traps, and change fish and wildlife habitats from quick-moving water to still or slow-moving water. Upstream impoundments impair 296 miles of streams and rivers and threaten another 18 miles.

The sixth highest source of surface water pollution is land development. Land development includes clearing, grading, excavation and filling, done in many cases with no or improperly maintained erosion control devices. Runoff from land development caused 228 miles of impact or impairment and threatens another 394 miles.

Atmospheric deposition, the seventh highest source, is primarily responsible for mercury and acidified conditions in Vermont's surface waters. While these conditions are most exacerbated in lake systems, stream biological communities do exhibit quantifiable impacts, particularly due to acidification. The extent to which river and stream systems are impacted by mercury (also expressed as Hg) is ill-studied in Vermont with the exception of the Deerfield River watershed area. In this well-studied area, where fish tissue mercury concentrations are high, the cause is presumably due to enhanced methylation of Hg at the de-watered littoral interface of the five reservoirs and can be coupled with some of the highest mercury wet-deposition rates in the State. Deposition of mercury and acid precipitation results from a mix of out-of-state and regional sources. The emissions of mercury from Vermont to its' airshed have recently been found to be minimal. Emissions of acid-forming presursors such as SO4 and NOx are limited relative to neighboring States and nationally. These difficult problems are being addressed at several levels and in a variety of ways, at regional and national scales. This is discussed further in Part II, Chapter 5.

Road and bridge runoff is the eighth largest source of impact affecting 167 miles and threatening another 302 miles with the information available to date. Most of the road/bridge water quality impairments come from gravel town roads that drain toward streams and discharge silt to them. Runoff from bridges over streams goes directly into streams. Road runoff also goes to slopes adjacent to the bridge abutments, which causes the slopes to erode to the streams. In addition, highway maintenance often includes washing pollutants off bridges into adjacent rivers and streams.

The ninth highest source, onsite wastewater systems, as listed in the "Source" table are failed septic systems which may directly or indirectly discharge to nearby streams. The 134 stream miles affected by this source is a concern from a human health viewpoint.

The tenth highest source of water quality impairment is developed land runoff, which has affected 131 miles of rivers and streams. This category includes runoff from any urban, suburban, village or other developed areas. Developed land changes the amount and timing of runoff reaching rivers and streams and the runoff contains many pollutants including sediment, metals, nutrients and organic compounds.

Table III.3.3. Total Miles of Rivers and Streams with Impairments, Impacts or Threats by Source Category.

Source of impairment	Magnitude of impairment (miles)		Total miles impaired by source	Miles threatened by source
	High	Moderate		
Agriculture	206.4	321.2	527.6	560.5
Riparian vegetation removal	116.1	306.4	422.5	318.3
Flow modification	190.7	208.6	399.3	63.9
Upstream impoundment	75.6	194.0	269.6	18.5
Land development	133.1	95.0	228.1	394.2
Atmospheric deposition	173.7	2.0	175.7	75.1
Road/bridge runoff	2.5	164.8	167.3	302.1
Onsite septic systems	3.7	130.5	134.2	82.1
Developed land runoff	80.6	50.2	130.2	125.9
Channel instability	63.9	46.5	110.4	11.9
Municipal point sources	17.4	91.6	109.0	102.5
Floods	26.8	80.2	107.0	21.4

Probabilistic Statewide Assessment of Aquatic Life Use Support

During the reporting period, the Department worked collaboratively with investigators at US EPA's National Health and Environmental Effects Laboratory, Western Ecology Division, to assess the proportion of *all* Vermont wadeable streams meeting aquatic life uses. Existing and available macroinvertebrate (301 sites) and fish (153 sites) monitoring data from the Ambient Biomonitoring Network (ABN) were used in conjunction with spatially randomized techniques for sample site selection, to derive a statistically unbiased overall assessment of aquatic life use. These unbiased estimates were then compared to results from assessments which were made directly using findings from the non-randomized Vermont biological database. This represent the first statistically-derived, unbiased estimate of overall aquatic life use support for all wadeable Vermont streams.

For the unbiased statewide estimation, aquatic life use support was assessed using macroinvertebrate data from 50, 100, 200, and 301 sites, and fish from 50, 100 and 153 sites. In all cases, the proportion of sites exhibiting excellent or good biotic integrity was unaffected by assessment intensities (number of sites included in the subsample). The proportion of sites identified as fair increased with increasing intensity. In relation to the non-randomized findings, the subsampling-based estimates consistently identified a greater proportion of sites as exhibiting 'excellent' or 'good' biotic integrity, and a lower proportion of sites exhibiting poor integrity, indicating that a bias towards assessing potentially degraded streams is inherent in the design of the ABN. Figure III.3.2 shows the geographic distribution of ABN sites as well as that of the probability-based sampling locations for the macroinvertebrate-based assessment made with 100 randomly-subsampled sites. Figure III.3.3 compares results of the random and ABN macroinvertebrate assessments for the same 100 sites. Figure III.3.4 compares results of the random and ABN fish assessments at a 50 site assessment intensity level.

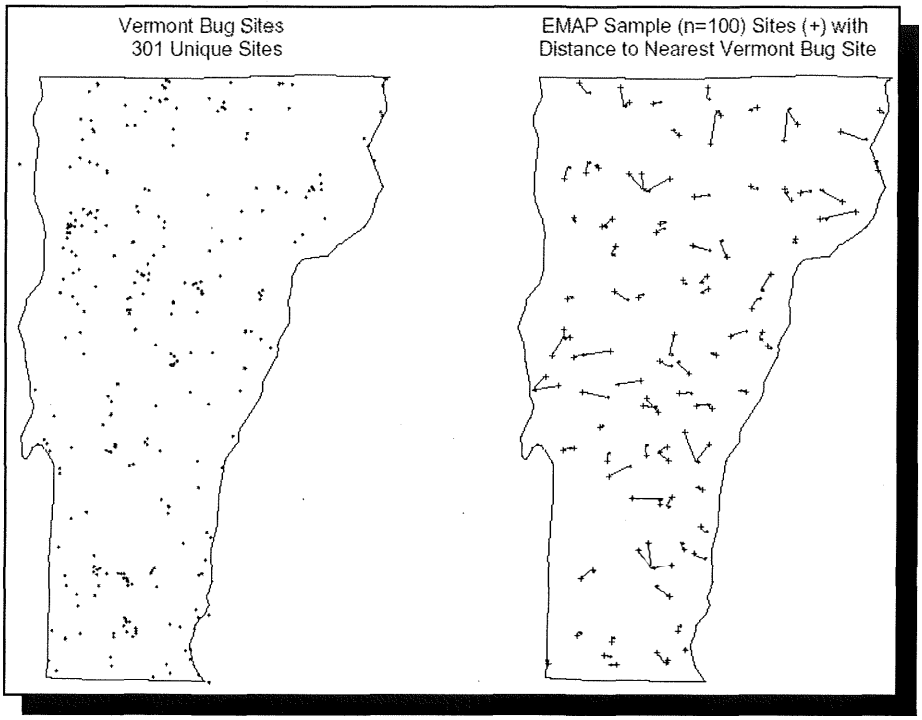


Figure III.3.2. Approximate locations of ABN macroinvertebrate sites (left) and distribution of 100 randomly-selected locations with distance to the ABN location used to represent the randomly selected site (right).

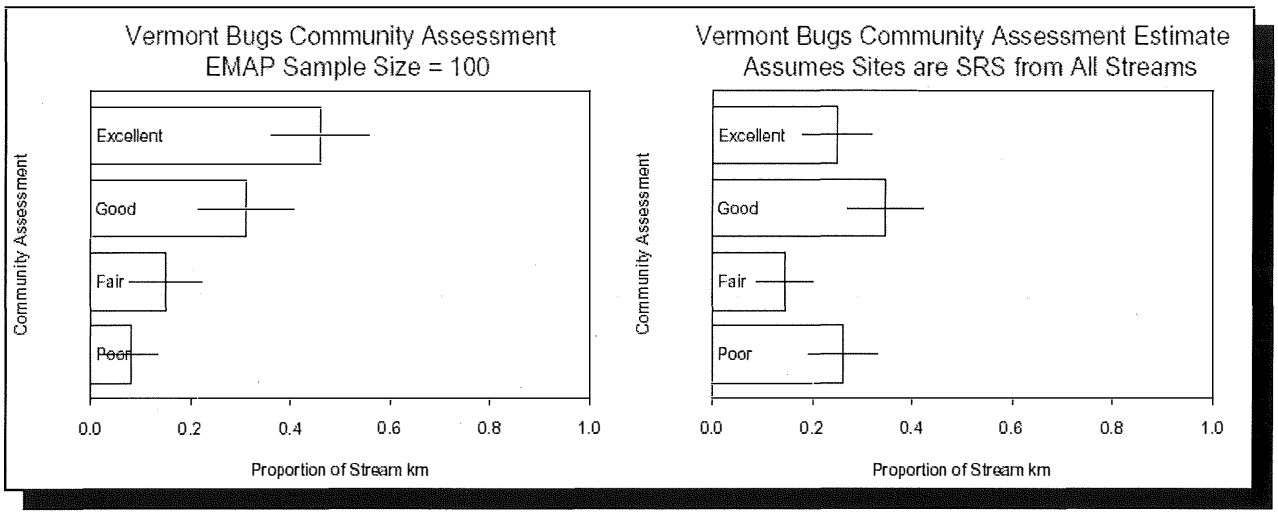


Figure III.3.3. Potentially unbiased (left) and biased (right) assessment of macroinvertebrate biological integrity for wadeable Vermont streams. Error bars are 95% confidence intervals. The 'biased' assessment includes data from 301 sites within the ABN database.

The probability-based assessment approach identifies a greater proportion of sites attaining aquatic life uses. This is because, outside of reference characterization efforts, ABN sampling most commonly involves sites of either known or suspected impairment. This is shown in Figure III.3.2 (left image) by the geographic 'clustering' of sample locations. The approach used here of subsampling a well-populated database using a randomized design permits reporting of potentially unbiased estimates of use attainment, without needing to design and execute additional costly studies. The presumption that the random site selection minimizes the bias of the underlying assessment is rebuttable since some circularity is inherent in this assessment approach. This is because the random sites are not independent of the ABN sites. Project collaborators concede that mathematically describing the degree to which bias has been

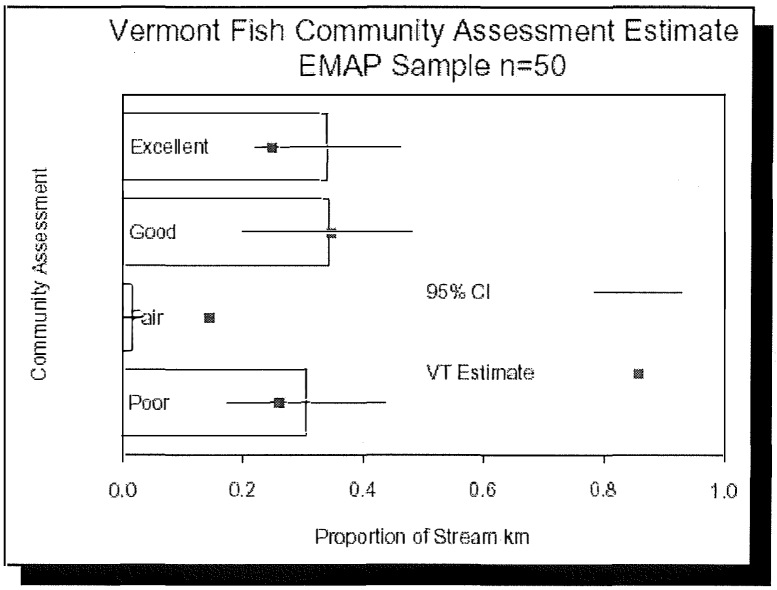


Figure III.3.4. Unbiased (bars) and biased (points) assessment of fish biological integrity for wadeable Vermont streams. The 'biased' assessment includes data from 153 sites within the ABN database. Confidence bounds relate to the 'unbiased' estimates.

reduced using the subsampling approach is not feasible. The Department believes, however, that the process eliminates some sources of bias in the assessment data base, by selecting sampling locations in proportion to the density of waters in a given geographic region, and thus provides a result that approaches the "true condition." This approach shows potential for reporting overall attainment for a variety of uses, for areas where developed fixed-station monitoring networks in place (and thus where initiating truly randomized probability-based field assessments in undesirable). VDEC intends to conduct further evaluations of the potential of this method to provide a realistic and defensible statewide assessment of aquatic life use support status. The Department is also evaluating the feasibility of using other databases such as those describing fish tissue contaminants and lakes trophic status, to subsample and subsequently report statewide use support.

Chapter Four: Lakes and Ponds Water Quality Assessment

This chapter reports on overall use support, and on the causes and sources of stressors which engender non-support of uses, for inland Vermont lakes. The reader will note reasonably significant changes in the values presented in this 2002 305b report relative to prior reports. The reasons for these changes are largely related to comprehensive reassessments which have been performed on approximately one quarter of the 558 lake waterbodies in the assessment database since the issuance of the 2000 report.

Vermont's lake assessment database remains in a period of flux. As waters are revisited and the assessments re-evaluated and revised, many of the older observations which were previously used to make a determination of "not fully supporting" have been subjected to rigorous comparisons with available modern and historical data. For example, many waters were previously identified as partially or not supporting uses solely on the basis of observations such as "algae in the water column," or "sediment on the bottom." In those instances where the observations were not validated with data indicating a deviation from the Vermont Water Quality Standards, or by a record of public complaints regarding the condition (which would suggest a loss of a designated use), the partial or non support acreage was converted to full support, or fully supported but threatened. Since the Department is three-quarters through the comprehensive 5-year rotating reassessment period, the following tables capture simultaneously revised, corrected assessments, and older, to-be-revised assessments.

It is the intent of the Department to perform all revisions to the 11 Lake Champlain waterbody segment entries in the database at the completion of the 5-year rotating assessment cycle. Accordingly, for an assessment of use support, causes, and sources for Lake Champlain, the reader is referred to Vermont's 1996 305b Report.

This chapter is formatted such that uses, causes, and sources are presented individually, and are only cursorily related to each other. The major threats and stressors to inland Vermont lakes are then highlighted.

Assessment of Use Support for Inland Vermont Lakes:

Individual use support for inland lakes and ponds is highlighted in Table III.4.1 and Figure III.4.1. There are 55,477 assessed inland lake acres in Vermont. This represents an increase of 1,869 acres, which are due to the addition of two large reservoirs (Moore and Comerford located in Concord and Waterford) to the Lake Assessment Database. Overall, 32,117 lake and pond acres (58% of the total) fully support all uses. Of these acres, 59% are presently considered to have overall uses threatened. Aesthetics are supported on 48,190 acres (87%), and this use is considered threatened on 22% of these acres. Aquatic life uses are supported on 37,292 acres (67%), and this use is considered threatened on 42 % of the supported acres. Fish consumption uses are supported on only 40,732 acres (83%), which is a direct manifestation of the existing Vermont Department of Health advisory against consumption of freshwater fish due to mercury contamination, and reflects those waters where the Department considers fish consumption uses truly impaired (see Chapter 2, above, for methodological considerations). Secondary contact and swimming uses are supported on 42,693 (74%), and 47,907 (84%) acres, respectively, with

20% of these acres threatened in both cases. Agricultural, industrial, filtered, and drinking water supply uses are unassessed for the majority of Vermont lake acres. A comparison of these values to those reported in 2000 suggest a significant improvement in overall use support for Vermont lakes. This simultaneously reflects water quality improvements, as well as the comprehensive reassessments using new and robust methods.

Table III.4.1. Statewide Use Support.
547 Inland Vermont Lakes and Ponds

Use	Acres Fully Supporting Uses	Acres with Uses Threatened	Acres Partially Supporting Uses	Acres Not Supporting Uses	Acres Not Assessed
Overall Uses	13,160	18,957	19,541	3,662	157
Aesthetics	37,469	10,721	3,923	3,193	171
Aquatic Life Use Support	21,447	15,845	15,803	2,225	157
Agricultural Water Supply	0	0	0	0	53,465
Drinking Water Supply	1,268	0	123	0	123
Fish Consumption	40,732	6,152	7,835	0	758
Filtered Water Supply	1,289	0	123	0	52,053
Industrial Water Supply	0	0	0	0	53,465
Secondary Contact Uses	34,037	8,656	7,999	3,208	1,577
Swimming Uses	38,281	9,626	2,785	3,208	1,577

Assessment of Causes of Use Support Impairment for Inland Vermont Lakes

There are 18 general causes of use impairments for Vermont lakes. These are listed in Table III.4.2. When referring to Table III.4.2, the reader should be aware that, in many cases, several of these causes simultaneously impact uses on a single lake. Thus, the acreages impacted by these causes cannot be summed to arrive at an estimate of the entire acreage impacted statewide for all causes. Causes are arrayed in order of decreasing total impaired acreage.

Ten separate cause categories impact uses on at least 1,000 lake acres. The most widespread of these is metals; most specifically mercury. A related cause is low pH, which is the third largest cause of impact to Vermont lakes. Flow alteration is the second largest cause of impact to Vermont lakes. Causes related to eutrophication (nutrients, algae, siltation, and organic enrichment) constitute the fourth through seventh largest causes, respectively. While the acreage impacted by exotic species is low relative to some of the above mentioned causes (1,383 acres), the importance of exotic species as the cause of serious degradation to Vermont lakes cannot be underestimated (refer to Part II under State Concerns and Recommendations).

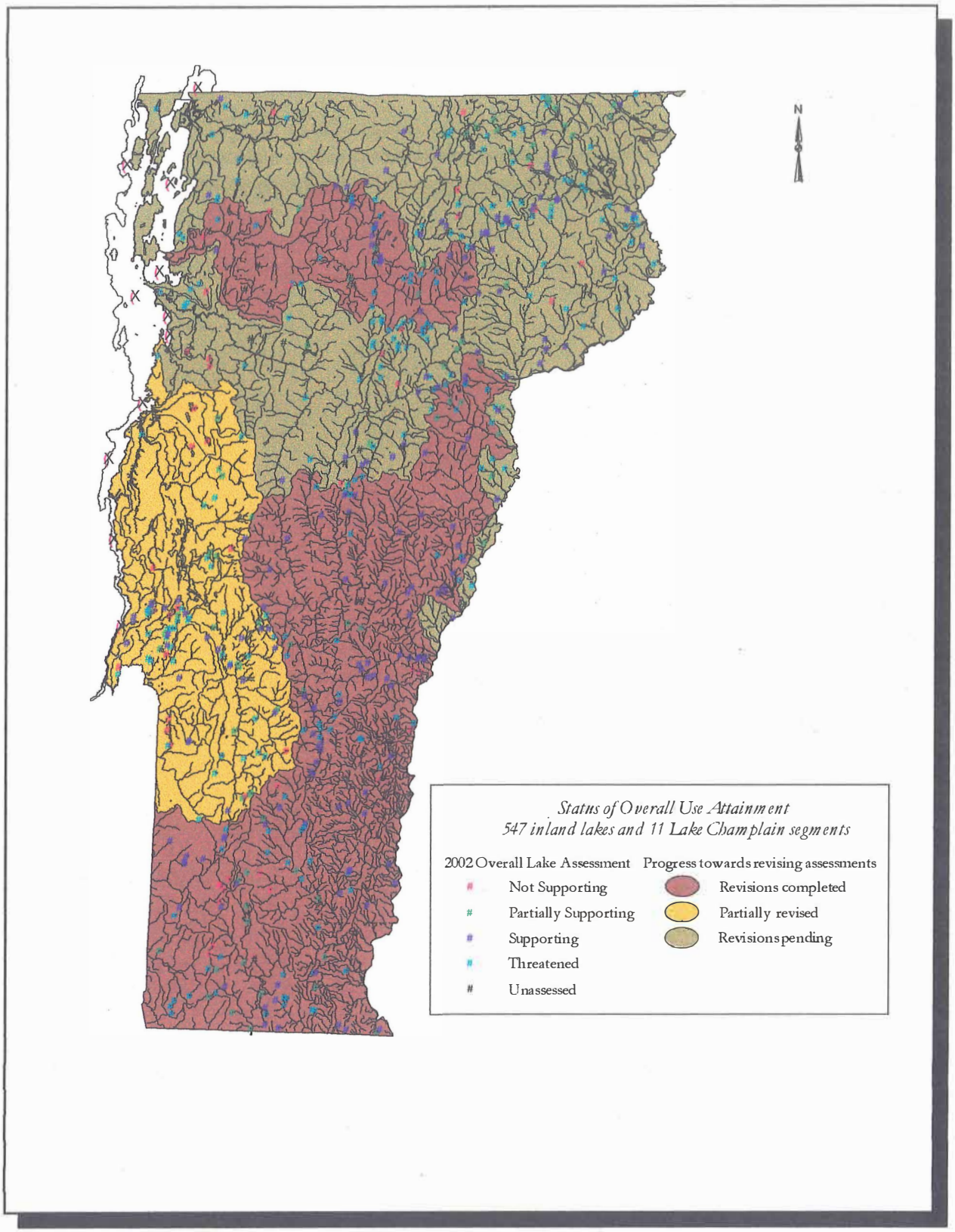


Figure III.4.1. Overall use support for assessed lakes and ponds in Vermont. Progress towards complete reassessment, by major river basin, is also shown.

Table III.4.2. Total Size of Waters Impaired of Threatened by Causes of Impacts (in Acres).
*** 547 Inland Vermont Lakes and Ponds ***

Cause of impact	Magnitude of impact			Total acres impaired by	Acres threatened by
	High	Moderate	Low		
1500 Flow alteration	4,240	4,960	0	9,200	2,315
0500 Metals	6,311	760	0	7,071	6,152
0560 Mercury	6,311	760	0	7,071	6,152
1000 pH	711	3,692	0	4,403	6,790
0900 Nutrients	3,421	565	59	4,045	4,937
0910 Phosphorus	3,421	565	59	4,045	4,962
2210 Noxious aquatic plants - Algae	1,597	1,552	0	3,149	2,789
1100 Siltation	1,151	1,032	583	2,766	3,165
1200 Organic enrichment - DO	1,866	30	0	1,896	690
2600 Exotic Species	1,344	149	0	1,493	5,156
2200 Noxious aquatic plants - Native	424	338	477	1,239	838
0000 Cause unknown	26	0	0	26	0
1700 Pathogens	13	0	0	13	828
0800 Other inorganics	6	0	0	6	0
2400 Total Toxics	1	0	0	1	0
1300 Salinity - TDS - chlorides	0	0	0	0	9
2300 Filling and Draining	0	0	0	0	49
2500 Turbidity	0	0	0	0	51

With the exception of metals and mercury, the same causes listed above also constitute the major threats to uses on Vermont lakes. While pH impacts uses on 4,403 acres, it represents the single greatest threat to uses on 6,790 lake acres. An even more striking example is that of exotic species, which impact 1,493 acres but threaten 5,156 acres. Other major threats, in order of magnitude, include: nutrients; siltation; algae; and organic enrichment. The relative importance of native aquatic plants as a cause of both impact and threat to uses in Vermont lakes should be treated cautiously. In the process of performing the reassessments completed to date, impacts related to native aquatic macrophytes were one of the most commonly modified entries, with most of the impacts being changed to threats. Since approximately one quarter of the inland lake waterbodies have yet to be reassessed, Table III.4.2 overestimates the extent of impairments due to native aquatic plants.

Assessment of Sources of Use Support Impairment for Inland Vermont Lakes

There are several general sources of use impairments for Vermont lakes (Table III.4.3). When referring to Table III.4.3, the reader should be aware that the acreages impacted by these sources cannot be summed to arrive at an estimate of the entire acreage impacted statewide. In many cases, several of these

sources simultaneously impact uses on a single lake. Sources are arrayed in order of decreasing total impaired acreage.

Of the 42 separate sources of impacts on uses, eight major sources account for impact to at least 1,000 acres. The single most important source, impacting 11,224 lake acres, is hydromodification including flow alteration. Acidic deposition is the second most important. Natural sources, which relate to acidification, are the third most important. Agriculture (4th), general nonpoint sources (5th), and land disposal (8th), are all related to eutrophication. Finally, in-water releases of exotics due to boating traffic constitutes the seventh most important source.

Table III.4.3. Total Size of Waters Impaired or Threatened by Various Sources (in Acres).

*** 547 Inland Vermont Lakes and Ponds ***

Source of impact	Magnitude of impact			Total acres impaired by source	Acres threatened by source
	High	Moderate	Low		
7400 Flow Regulation/Modification	4,252	6,972	0	11,224	2,444
7000 HYDROMODIFICATION	4,256	4,960	0	9,216	2,426
8100 ATMOSPHERIC DEPOSITION	7,205	791	1,212	9,208	11,294
8600 NATURAL SOURCES	111	4,154	550	4,815	7,329
1000 AGRICULTURE	3,195	586	0	3,781	1,355
9070 VT-UNSPECIFIED NONPOINT SOURCE	2,718	79	52	2,849	468
1100 Nonirrigated Crop Production	2,288	518	0	2,806	615
1400 Pasture Grazing-Riparian and/or Upland	1,650	679	0	2,329	879
1800 VT-Animal holding/management area	2,115	91	0	2,206	555
7900 MARINAS AND RECREATIONAL BOATING	1,366	189	0	1,555	5,207
7910 In-Water releases	1,366	189	0	1,555	5,130
7550 HABITAT MODIFICATION (OTHER THAN HYDROMOD)	871	356	2	1,229	37
6000 LAND DISPOSAL	452	0	694	1,146	825
7700 Streambank Modification/Destabilization	871	135	1	1,007	100
6500 Onsite Wastewater Systems (Septic Tanks)	0	0	694	694	154
3000 CONSTRUCTION	256	421	16	693	3,695
3200 Land Development	256	421	12	689	3,695
8300 HIGHWAY MAINTENANCE AND RUNOFF	294	74	173	541	3,746

Source of impact	Magnitude of impact			Total acres impaired by source	Acres threatened by source
	High	Moderate	Low		
0200 MUNICIPAL POINT SOURCES	0	521	0	521	0
0400 COMBINED SEWER OVERFLOW	0	470	0	470	0
6400 Industrial Land Treatment	452	0	0	452	446
7600 Removal of Riparian Vegetation	0	306	1	307	1,109
1500 Range Grazing-Riparian and/or Upland	0	173	0	173	0
8950 Other	0	100	0	100	0
9000 SOURCE UNKNOWN	27	58	0	85	1,099
2000 SILVICULTURE	66	10	0	76	2,195
2100 Harvesting, Restoration, Residue Management	61	0	0	61	1,900
8530 INTERNAL NUTRIENT CYCLING (LAKES)	54	0	0	54	72
0100 INDUSTRIAL POINT SOURCES	6	0	0	6	11
4000 URBAN RUNOFF/STORM SEWERS	1	3	0	4	1,147
5000 RESOURCE EXTRACTION	1	0	0	1	21
5100 Surface Mining	1	0	0	1	21
1200 Irrigated Crop Production	0	0	0	0	20
1410 Pasture Grazing-Riparian	0	0	0	0	11
2300 Logging Road Construction/Maintenance	0	0	0	0	20
3100 Highway/Road/Bridge Construction	0	0	0	0	4
4300 Other Urban Runoff	0	0	0	0	163
4500 Highway/Road Bridge Runoff	0	0	0	0	135
4600 Erosion and Sedimentation	0	0	0	0	3
6300 Landfills	0	0	0	0	14
7300 Dam Construction	0	0	0	0	37
8520 DEBRIS AND BOTTOM DEPOSITS	0	0	0	0	20
8700 RECREATIONAL AND TOURISM ACTIVITIES (NOT BOATING)	0	0	0	0	105

With respect to sources that result in threats to uses of Vermont lakes, the roster is similar. Ten major sources comprise threats to at least 1,000 acres statewide. Natural sources and atmospheric deposition are the most important sources of threats. While boating and associated in-water releases are the source of impacts to

1,555 acres, about 5,207 acres are threatened by this exotic species spread vector. Highway (and other roadway) maintenance (4th), construction (5th), silviculture (7th), agriculture (8th) and urbanrunoff (7th), are all sources of threats related to eutrophication. Finally, hydromodification (6th) threatens uses on 2,423 acres.

Based on the use support, cause and source information presented above, the following issues surface as the most important ones presently affecting inland Vermont lakes: *Atmospheric Deposition of Pollutants, Hydrologic Modifications, Exotic Aquatic Species as Pollutants*, and *Eutrophication of Vermont Lakes.* For a discussion of these issues, please refer to Part II, Special State Concerns and Recommendations. Table III.4.4 summarizes the trophic status for inland Vermont lakes. The vast majority of lakes assessed for trophic status are mesotrophic, although numerous oligotrophic and eutrophic lakes also exist in Vermont.

Table III.4.4. Trophic Status of Significant Inland Lakes.

Trophic State	Number of individual lakes	Total acres in category
Unclassified	334	12,638
Dystrophic	21	587
Eutrophic	30	6,252
Hypereutrophic	2	473
Mesotrophic	125	25,549
Oligotrophic	35	9,978
Total	547	55,477

Chapter Five: Basin Assessments Completed During the 2002 305b Reporting Period

During the 2002 305b reporting period, VDEC was able to complete its assessment of two river basins (Basin 7 and Basin 11). Also during the period, an assessment for a portion of Basin 16 was completed. Assessment findings for each of these areas are provided below. For greater detail on the findings of these assessment efforts, the reader is referred to Appendix D.

Summary for Basin 7 - Lamoille River Basin

Of the 611 miles of rivers and streams identified to date in the Lamoille River watershed, 35% of the miles (216) fully support aquatic biota and habitat with no threats identified, 4% (27 miles) fully support this use but threats are known and 28% (172 miles) do not fully support aquatic biota/habitat. Approximately 32% of the miles in the basin (197) were not assessed. Sediment and habitat alterations are the major causes of the habitat problems. Loss of riparian vegetation, streambank erosion, and channel instability result in the sediment and physical alterations that affect aquatic habitat through much of the Lamoille River watershed.

Riparian vegetation removal, streambank erosion, floodplain encroachments, floods, and agricultural land uses are the five top sources that affect the water quality and aquatic habitat of the Lamoille River. Agricultural land use in the productive floodplain of the Lamoille resulted in some riparian vegetation removal. The lack of vegetation along, and back from, the riverbank is often a major contributing factor to stream bank erosion and channel instability. The habitat alteration and flood damage was greatly exacerbated by the unstable condition of the river and the lack of riparian vegetation along the Lamoille and some of its tributaries such as the Wild Branch. The dams and impoundments for hydro-electric production on the Lamoille River also alter the river's condition by degrading water quality, substrate composition and thermal regime from flow fluctuations, drawdowns and desilting.

Summary for Basin 11 - West, Williams & Saxtons Rivers Basin

There are approximately 432 miles of rivers and streams in Basin 11, all of which were assessed. Of these miles, 54% of the miles (235) fully support aquatic biota and habitat with no threats identified, 19% (83 miles) fully support this use but threats are known and 26% (114 miles) do not fully support aquatic biota/habitat. The cause of most river miles with impacts is thermal modification or water temperatures that are too high to fully support a coldwater fishery. Removal of the riparian trees and shrubs, which is the source affecting the most river miles, results in these higher temperatures. Dams and the resulting impoundment of water also results in higher downstream water temperatures. Much of the Williams River and West River as well as the lower half of the Saxtons River have high temperatures in the summer, which have an impact on the coldwater fishery.

Physical habitat alterations are a result of flow regulation, channelization/instream modification, road and bridge work, and channel instability. Other pollutants or conditions affecting the rivers or streams in this basin include flow alteration primarily from the two Army Corps of Engineers flood control dams, nutrients primarily from agricultural land activities, low pH as a result of acid rain and pathogens possibly from failed septic systems.

Summary for Basin 16 (partial) - Nulhegan River, Paul & Wheeler Streams

During 1998, the State of Vermont and the US Fish and Wildlife Service acquired a vast tract of land in northeastern Vermont from the Champion International Corporation. At that time, little biological survey information existed from the several ponds and numerous rivers and streams in these newly-acquired areas. In order to assist with the development of management plans affecting this vast tract of land, a biological survey of fish and macroinvertebrates was conducted in lakes and rivers within a 48,000 acre area. The following paragraphs summarize the survey's findings.

Nulhegan River

The streams that were sampled in the Nulhegan River watershed during the summer 2000 were fairly dilute with specific conductances ranging from 14-60 μmhos. The total variation in pH among the sites sampled was 5.45-7.68. The three sites on the Yellow Branch of the Nulhegan River had the lowest pH values and alkalinities (pH 5.45-5.83, and alkalinity 2- 4.5mg/l). These values represent summer flows and likely are considerably lower during spring snow melt events, which often bring the highest acidities of the year. As a result, the pH values and alkalinity in the Yellow Branch will be limiting to sensitive fish and macroinvertebrate taxa especially in the orders Ephemeroptera, Bivalvia, and Gastropoda. Other stream reaches that also had low alkalinity and therefore probably undergo a period of low pH in the spring are: Tuffield-Willey and Bluff Mountain Brooks. The low pH and alkalinity of these two streams indicates that other, very high elevation (greater in elevation than 600m) streams with small watersheds, most likely undergo a period of very low pH and alkalinity.

Fish Assemblages

Twelve sites from eight streams and rivers were sampled within the Silvio Conte lands of the Nulhegan drainage. A total of 450 fish from 16 species were collected. Vermont Department of Fish & Wildlife collected an additional two species and a total of 31 Atlantic salmon, two brook trout, one brown trout and one rainbow trout on the Nulhegan (river mile 1.8) in 2000. The 18 species collected during this survey can be compared to the 30 species actually collected historically from Vermont waters of the Connecticut River drainage.

Index of Biologic Integrity (IBI) values could be generated from only three of 12 sites in the Silvio Conte Refuge. The three sites scored 36 (rating of "very good"), 39 ("excellent") and 9 ("poor"). Five of the sites were classified as low gradient and, consequently, no IBI has been developed as yet for this assemblage type. Two sites supported only brook trout and consequently did not provide enough information to calculate an IBI. Three sites were qualitatively sampled and did not provide data of suitable quality to calculate an IBI. The "poor" evaluation given the Yellow Branch-Nulhegan site (river mile 7.6) may have been due to natural limitations of that river reach. Further assessment in this area may be warranted.

Macroinvertebrate Assemblages

A total of 223 taxa were identified from the 17 stream sites sampled within the Silvio Conte lands of the Nulhegan River watershed. Aquatic insects were the dominant macroinvertebrate class with 195 taxa, broken down by insect order as follows: 81 Diptera (58 Chironomidae), 44 Trichoptera, 19 Coleoptera, 18 Ephemeroptera, 17 Plecoptera, 9 Odonata, 2 Megaloptera and 4 Hemiptera. The remaining taxa were mainly

from the class Mollusca, Gastropoda (eight), and Bivalvia (six). These findings by no means should be considered even close to a complete taxa list of the macroinvertebrate species from running waters within the Silvio Conte lands of the Nulhegan River watershed.

The macroinvertebrate assemblage integrity was evaluated from 12 of the 17 stream reaches sampled for macroinvertebrates. The stream reaches from the Silvio Conte National Refuge were assigned into an assemblage type based on stream size, elevation and alkalinity. Nine of the reaches were evaluated under the Small High Gradient category and three the Medium High Gradient category. The remaining reaches were considered low gradient meandering streams that could not be quantitatively assessed using VDEC protocols. Eight of the 12 stream reaches were rated as either very good or excellent. These streams would be considered very near reference condition compared to other streams from a similar category in Vermont. The four other streams were rated good condition; moderately altered from the natural condition, but still considered to be meeting their Class B water quality management designation.

Paul & Wheeler Streams

The data indicate the waters of these drainages are somewhat soft with specific conductances ranging from 26-41 μmhos and alkalinities from 6.2-21.3 mg/l. Measured pH values were near neutral and ranged between 6.51-7.52. Within the Paul Stream watershed, the smaller streams generally had lower alkalinities (less than 10 mg/l). Dennis and Notch Pond brooks had significantly higher alkalinity than all the other stream sites.

Fish Assemblages

A total of 1,763 fish from 20 species were collected from ten stream sites. In addition, a collection conducted by the VDF&W on lower Paul Stream (river mile 3.1) tallied 124 Atlantic salmon and 10 brook trout and an undetermined number of non-game species.

Of the 10 sites sampled in the West Mountain Wildlife Management Area (WMA), six could be evaluated for biological integrity using one of the two IBIs. The North Branch Paul Stream site supported only brook trout (to apply the CW-IBI there must be at least two species). Two sites on Paul Stream were Type 4 - low gradient- sand bottom sites (no appropriate IBI has yet designed to apply to this type of site). One site was only sampled qualitatively for species presence and, therefore, the data were not of sufficient quality to generate a score. Where IBI scores could be calculated, scores ranged widely for the six sites: 31 ("good") to 45 ("excellent"). All sites where an IBI was calculated met the State Water Quality Standard biocriteria for fish assemblages of Class B waters.

Macroinvertebrate Assemblages

A total of 147 taxa were identified from the seven stream sites sampled within the West Mountain WMA. Aquatic insects were the dominant macroinvertebrate class with 131 taxa, broken down by Insecta order as follows: 52 Diptera (37 Chironomidae), 31 Trichoptera, 16 Ephemeroptera, 15 Plecoptera, 7 Coleoptera, 6 Odonata, 2 Megaloptera and 2 Hemiptera. The remaining taxa were mainly from the Gastropoda (5) and Bivalvia (4). This should not be considered even close to a complete taxa list of the running waters from the West Mountain WMA.

The integrity of the macroinvertebrate assemblage was evaluated from six of the seven stream reaches. The stream reaches from the Paul Stream drainage were assigned into an assemblage type based on stream size, elevation and alkalinity. Three of the stream reaches were considered to be Small High Gradient streams, and three Medium High Gradient streams. The seventh, Paul Stream (river mile 12.8), is a slow, meandering stream that appears to be of good biological integrity but could not be quantitatively evaluated using VDEC protocols. The biological integrity from two of the Small High Gradient streams was rated as excellent or within the range of natural condition. Dennis Pond Brook was rated as very good and may have been a result of the natural influence of significant wetlands and a pond immediately upstream from the reach sampled.

Chapter Six: Wetlands Assessment

Background

Vermont wetlands are significant resources that contribute to the economic, cultural, and physical well being of its residents. Wetlands provide numerous ecological functions and social values, including habitat for fish and wildlife, recreational and educational opportunities, habitat for threatened and endangered species, temporary storage of flood waters, and they aid in the maintenance of water supply and quality. However, these resources have been significantly affected by human land and water use activities.

The Department provides comment on Act 250 applications that involve wetland issues. The Department also conducts pre-Act 250 determinations to assist potential developers in meeting the requirements of the Act. Staff provide comment and advice to other state agencies and they are called upon as wetland experts wherever testimony is deemed appropriate. The Department reviews projects that involve wetland filling under Section 401 of the Clean Water Act based on compliance with the Vermont Water Quality Standards and other applicable provisions of State law. On January 23, 1996, the Vermont Water Quality Standards included the statement that the Standards shall apply to "all waters of the United States," as defined in 40 C.F.R. §122.2 (1995). This wording, therefore, includes wetlands as being part of "all water..." with respect to having met the goals of the Water Quality Standards.

Extent of Wetland Resources

Recently, the Agency of Natural Resources digitized all the National Wetland Inventory (NWI) maps for the state. For Vermont, a total of 232,000 acres of palustrine wetlands is depicted in the maps. Until a more accurate figure has been determined, Vermont has used the figure of 300,000 acres of wetlands of all types. Wetland inventories conducted in selected towns around Vermont indicate there is considerably more acres of wetland in Vermont than was identified by the NWI project.

Wetland Loss

A recent analysis of all completed projects reviewed by the Department shows that there has been a total of 522 acres of documented wetland loss and impairment over the period 1990 through 1999 (see Table III.6.1 below). No comparable project information is available for the years 2000 and 2001. The analysis was based on the Wetland Program's database which tracks wetland losses associated with projects reviewed by the program. Only Class 3 wetlands under review for 401 Water Quality Certification, Act 250 or voluntary review are included in this table.

These figures do not represent all wetland impacts as they are based only on summaries of projects that have been completed for each year. It is likely that many of the projects that have not been completed are larger projects and may represent substantial areas of wetland impacts. Also, it is clear that there are many wetland alterations still occurring that are not reported to the Department and are not included in this database.

Table III.6.1. Acres of Wetland Loss and Impairment 1990 through 1999[1]

	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99
No. of Completed Projects	474	482	559	454	393	377	321	368	359	328
Acres of Wetland Loss										
Class One & Two Wetlands	19.4	12.1	11.7	19.1	4.0	5.9	5.3	4.8	2.9	3.5
Class Three Wetlands	22.4	10.0	8.0	11.6	6.6	12.2	9.7	7.1	4.6	4.7
Acres of Wetland Impair.										
Class One & Two Wetlands	47.8	40.2	111.3	19.0	24.6	30.9	4.3	3.7	3.2	16.8
Class Three Wetlands	3.1	7.8	7.2	4.6	10.5	4.0	8.9	1.6	1.4	.49

The database analysis also shows that there were over 500 acres of wetlands saved during the 1990-1999 period. This was achieved by encouraging developers to move their projects out of wetlands or to reconfigure them so as to have little or no impact on wetlands.

Wetlands Protection Mechanisms

On October 15, 1997, the State of Vermont and the US Army Corps of Engineers issued the State General Permit for projects in waters of the United States that occur in Vermont. Under this program, any fill under 3,000 square feet (except in Class Two wetlands, or special wetlands, or wetlands adjacent to international bodies of water, or in the towns of Athens, Brookline, Grafton, Newfane, Putney, Rockingham, or Townshend) do not have to report their fill activity to either the Corps of Engineers or the State of Vermont. Fills between 3,000 square feet and 43,560 square feet (one acre) are reviewed by an interdisciplinary team. The Vermont Water Quality Standards are the basis for review of projects under Section 401 Water Quality Certification. The Vermont Water Quality Standards do not specifically address wetlands. The Standards address discharges to open water and impacts to surface water which are used by the Wetlands program to evaluate wetland impacts. The Department works closely with the US Army Corps of Engineer's Vermont Field Office staff on many projects.

A Conditional Use Determination (CUD) is used to allow reasonable development in and around wetlands while protecting the functions and values of this natural resource. CUDs are issued by the Vermont Wetlands Program only when it is determined that undue adverse impacts will not result from a proposed project.

Geographically, Chittenden County is the area of the state with the highest acreage of wetland alteration (refer to Figure III.6.1). Chittenden County remains the area of the state with the largest number of Department site visits and the largest area of wetland loss.

For projects completed during the 1990-1999 period, the Department's database shows that of the project types, public projects (164 acres) and commercial/industrial development (214 acres) resulted in the greatest

[1] Figures are based on the projects that have been completed. (Source: Wetlands Office Database).

area of wetland loss and impairment, followed by 127 acres from agriculture projects and 116 acres from pond construction (refer to Figure III.6.2). Commercial/industrial development, residential development and road construction generally result in mostly wetland loss with small areas of wetland impairment.

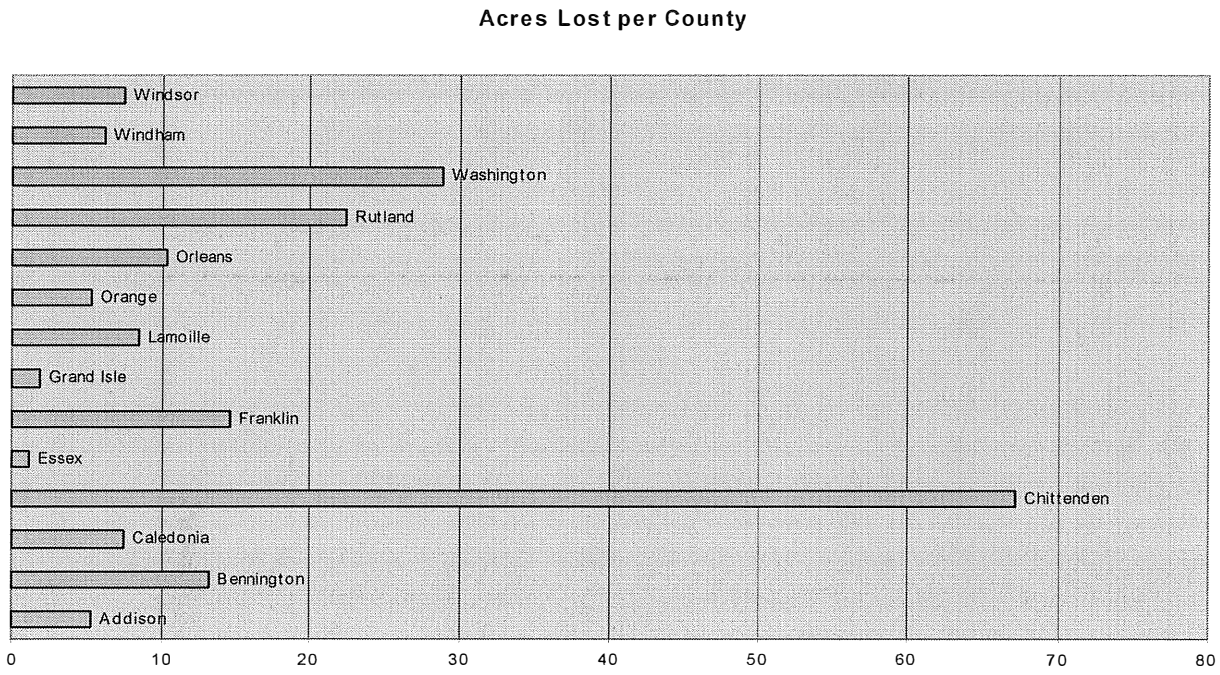


Figure III.6.1. Wetland loss, 1990 to 1999.

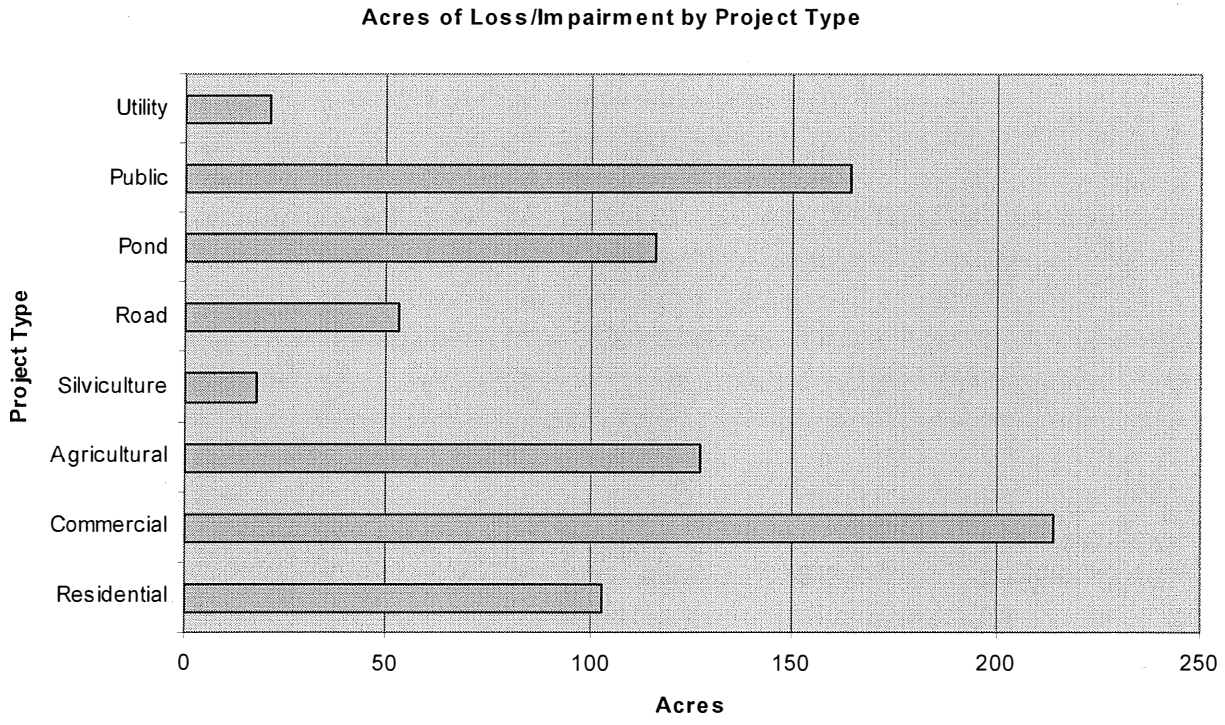


Figure III.6.2. Wetland loss by project type, 1990-1999.

Figure III.6.3 below shows the area of wetland loss and impairment over the period 1990 to1999 based on the functions identified to be present in each altered wetland. A particular wetland, where an alteration occurred, may provide one or many of the ten functions and values listed, the documented area of alteration for that wetland is included in the totals for each function and value provided by that wetland. The surface water quality protection and wildlife habitat functions were the most commonly occurring functions in altered wetlands.

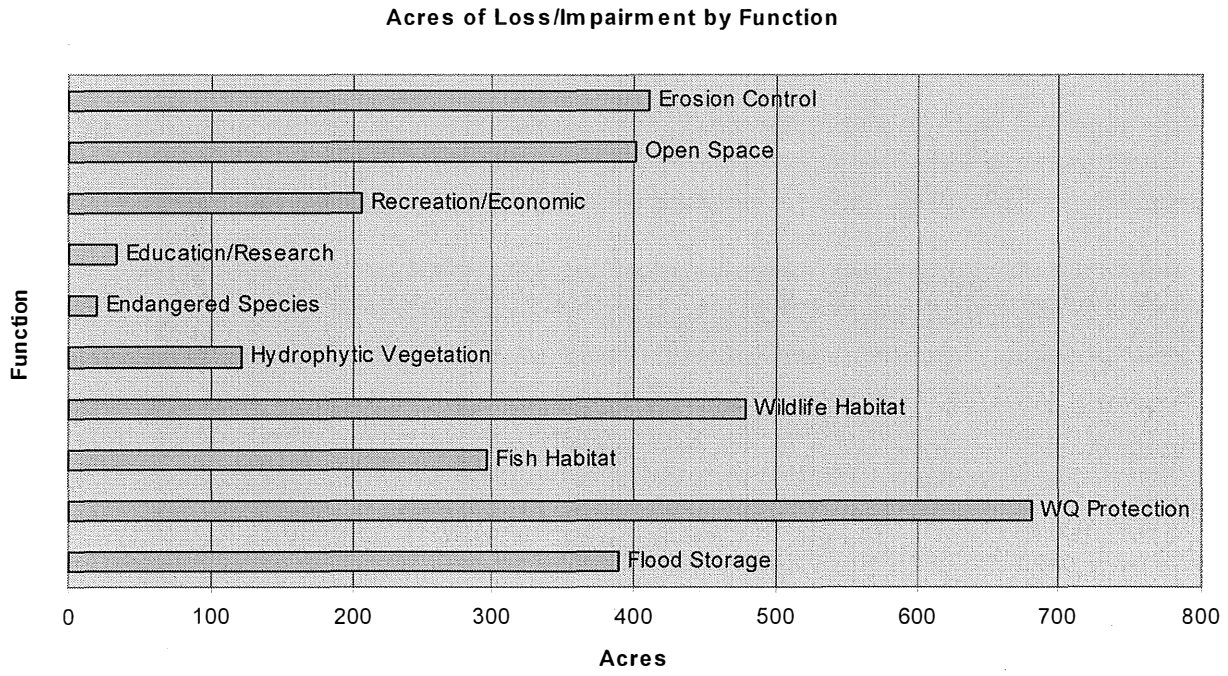


Figure III.6.3. Wetland loss in relation to wetland function, 1990-1999.

Table III.6.2, found on the following page, shows the percentage of projects reviewed by the Vermont Wetlands Program by wetland type. As shrub swamps are the most common wetland type, this type has the highest percentage of project. Emergent marsh and forested wetlands have the next highest percentage of projects.

In 1999 VDEC began carrying out a biomonitoring project. The focus of the project is to investigate biological indicators of the health of vernal pools and cedar swamps. The project goal is to describe 20 reference sites. The characteristics (metrics) that have been studied include macroinvertebrates, reptiles, amphibians, algae, and plants. The project included study of the land 492 feet (150 meters) around vernal pools to characterize the buffers. The study of cedar swamps was similar but the emphasis will focus on plants and birds as potential indicators. The data for the biomonitoring project has been collected, and the next step will be to analyze it. The project is unique because it is a multi-disciplinary study involving programs from Vermont Department of Fish & Wildlife, the Biomonitoring and Aquatic Studies Section (BASS) and the Wetlands Office.

Table 6.2. Percentage of Projects by NWI Wetland Type.

NWI Wetland Type	Type Description	Percentage of Projects
PEM	palustrine - emergent	17.7
PFO/PEM	palustrine - forested/emergent	1.5
PFO/PSS	palustrine - forested/scrub-shrub	8.0
PFO1	palustrine - forested (broad leaved deciduous)	17.6
PFO2	palustrine - forested (needle leaved deciduous)	0.7
PFO4	palustrine - forested (needle leaved evergreen)	3.5
PFO5	palustrine - forested (dead)	0.2
POW	palustrine - open water	12.8
POW/PEM	palustrine - open water/emergent	1.3
POW/PFO	palustrine - open water/forested	0.2
POW/PSS	palustrine - open water/scrub-shrub	0.3
PSS/PEM	palustrine - scrub-shrub/emergent	14.4
PSS1	palustrine - scrub-shrub (broad leaved deciduous)	21.1
PSS3	palustrine - scrub-shrub (broad leaved evergreen)	0.7

The Wetlands Office has again sponsored work on bio-control of purple loosestrife. The goal of the program is to reduce purple loosestrife in Vermont by 90%. To accomplish this goal, the program's work has been divided into three main aspects: biological control, documentation of purple loosestrife populations, and education and outreach. Since 1996, approximately 193,792 beetles have been released on 669.25 acres of land throughout Vermont. In 2001, approximately 52,889 beetles were released on 97.35 acres of land. An ongoing monitoring program was also initiated and has enlisted the help of the Vermont Agency of Transportation. Through education and outreach, the program strives to help prevent the intentional spread of purple loosestrife by informing the community of the consequences of this invasive species.

The Department assisted in the planning of several voluntary wetland restorations and protection projects in cooperation with Natural Resources Conservation Service, EPA, the US Army Corps of Engineers and other programs. One project in the West Rutland Marsh complex will eventually restore 145 acres of wetlands through the restoration of natural hydrologic conditions in the area. Another project in the Whiting Swamp area will restore 45 acres of wetland forests along the Otter Creek. A third project along the Lemon Fair River will protect 39 acres of emergent palustrine and riverine wetlands through purchase. Lastly, another site of 35 acres of emergent and riverine wetland was purchased along the Lower Otter Creek with the assistance

of the state waterfowl startup funds. The Vermont Wetlands Program offers technical and permitting assistance for wetlands restoration purposes.

Education is an important approach in dealing with issues related to beaver populations in Vermont. Because beaver activity result in changes to water levels, many conflicts between landowners, local road commissioners and beavers have arisen. The state has been spending an increasing amount of time solving before and after-the-fact problems with beaver dams. The state has organized a task force to study the issue and provide recommendations. The study report has been drafted and it is in the process of review. Other education efforts include developing an Educational Plan with the Water Resources Board. The Program has also coordinated with the Agency of Transportation to address routine maintenance issues such as ditching and culvert replacement. The agricultural community has benefitted from workshops developed by NRCS, the Army Corps of Engineers, Conservation Districts and the Wetlands Program.

Chapter Seven: Public Health / Aquatic Life Use Concerns

Size of Water Affected By Toxicants

Outside of fish consumption advisories discussed below, there are currently no waterbodies where toxicants are known to be impairing uses related to public health. NPDES and water supply monitoring continue to provide information related to environmental occurrences of toxicants in permitted municipal and industrial discharges and public water supplies respectively.

Changes to Fishing Advisory

Vermont's Fish Advisory was last updated in June 2000. Prior to this, existing special advisories were in place, warning against consumption of: walleye from several Vermont lakes and ponds; large lake trout from Lake Champlain; and, most fish in Grout Pond and Somerset, Harriman, Sherman and Searsburg Reservoirs. During the reporting period, two new reservoirs, Moore and Comerford Reservoirs, were identified as having particularly elevated concentrations of mercury in resident fish. These reservoirs are located along the mainstem of the Connecticut River, and are power generating hydroelectric facilities which are in the process of final FERC re-licensing as part of the Fifteen Mile Falls Hydroelectric Project. These reservoirs have been specifically identified in the new advisory. Vermont's current Fish Advisory (see Appendix B) is also available online at http://www.state.vt.us/health/record/fish.htm.

Cyanobacteria

While not necessarily a pollutant, the occurrence of toxic strains of blue-green algae (cyanobacteria) in Lake Champlain has generated some concern over the last three years. The University of Vermont, in collaboration with several state and federal agencies, has been assessing the risks related to the occurrence of cyanobacteria in Lake Champlain and reports results in a report for the Lake Champlain Basin Program and the Centers for Disease Control, entitled "*Evaluation of Potential Blue-Green Algal Toxins in Lake Champlain - Summer 2000*" (Barry H. Rosen Ph. D., USDA-NRCS, Watershed Science Institute et al 10/9/2001 with Angela Shambaugh. Lisa Ferber. Felicity Smith, Mary Watzin (Ph. D.), Cathi Eliopoulos, and Peter Stangel). Additional assessments were made during the summer of 2001.

Current Use Pesticides

A collaboration of the University of Vermont, the Vermont Department of Agriculture, Food and Markets, the Vermont Pesticide Advisory Council, the US Geological Survey, and the Department conducted an initial screening of the occurrence of selected current use pesticides in storm water from urban and suburban areas. Initial results were reported in "Pesticides in the Surface Waters of Chittenden County" (see Appendix G). The collaborative effort is continuing assessment activities in and around Chittenden County and Lake Champlain.

Small Community Untreated Waste Discharges

Several small communities throughout the state have been discharging untreated wastes to the state's waters due to the lack of treatment facilities. The discharges from these areas constitute threats to public health. Included are the villages of East St. Johnsbury, Pownal and Warren. The Department is providing technical assistance to these communities to help them plan for the installation of appropriate wastewater treatment

facilities. Two municipalities (Shoreham and Cabot) where similar discharges had been discovered are now significantly advanced in the pollution abatement process. Wastewater treatment facilities have been constructed in each community and wastewater discharge permits have been issued.

Sites of Known Sediment Contamination

Previous 305b reports identified toxic contamination in Lake Champlain sediments. While no new information is available regarding these well-characterized sites, one new sediment contamination site was identified during the reporting period. This site is located on the east shore of South Bay in Lake Memphremagog, adjacent to a drain which channels runoff from a railyard. Within the one-acre area of contaminated sediments, very high concentrations of cadmium, lead and total petroleum hydrocarbons have been measured. Toxicity testing of the sediments from this area produced up to 95% mortality relative to controls for multiple organisms. The site has an open hazardous waste site file and is being managed by the Department's Waste Management Division. The area of influence of the contaminants has been determined to be one acre, and the remediation plan includes removal of the contaminated sediment. VDEC issued a permit for this activity in September 2001 and remediation is expected to take place in 2002. This site is presently on the Vermont list of Priority Waters Needing Assessment ("Part C list"). The discharge was stopped in 1992, but the site did not recover and recent follow-up site assessments have determined that aquatic habitat in the area remains impaired. The Lakes and Ponds section has determined that the site should remain on the "C list" pending follow up assessments after the sediments have been removed.

Restrictions on Bathing Areas

Table III.7.1 below summarizes certain Lake Champlain beach closures for the reporting period due to non-toxics (i.e. high E.coli bacteria counts).

Table III.7.1. Closures of Bathing Areas Due to Non-toxics.[2]

Waterbody/Swim Area	Dates of Closures
Leddy Beach, Burlington	July 18th, 2000
North Beach, Burlington	July 18th, 2000
North Beach, Burlington	August 21st, 2001
Bayside Park, Colchester	June-August, 2001 (12 days)

Restrictions on Surface Drinking Water Supplies

There were no closures of surface drinking water supplies during the reporting period; however, there were 5 boil water notices issued for the period. The Allen Point Water Supply and Rutland Town Mendon FD 2 systems are under indefinite boil water notices due to system deficiencies which have been in effect since September 1987 and January 1971, respectively. Table III.7.2 below lists the boil water notices which were issued by VDEC's Water Supply Division to systems with surface water sources.

[2] During the summer of 2000, a portion of the White River located downstream of the Bethel Wastewater Treatment Facility was closed to swimming uses due to the failure of the facility's disinfection system.

Table III.7.2. Boil Water Notices, January 1, 1998 through December 31, 1999.

Water System Name	Source
Allen Point Water Supply	Lake Champlain
Bolton Valley Water and Sewer	Joiner Brook (and East Branch of same)
Greensboro FD#1	Lake Caspian
Newbury Village Inc.	Unnamed reservoirs
Rutland Town Mendon FD2	Tenney Brook

Fish Kills (3)

The Department is aware of three fish kills which impacted fish communities in Vermont during the reporting period. The first of these occurred in June 2000 on Lake Carmi. The incident was classified by VANR's district fisheries biologist as 'moderate' with a variety of species involved. The fisheries biologist attributed the incident to natural post-spawning stress. Lake Carmi is impaired due to excessive algae blooms caused by excess nutrients. It is unclear whether there exists a linkage between poor water quality at Lake Carmi and the observed fish kill. Minor annual fish kills involving brown bullhead are common at Lake Carmi.

On August 13, 2000, a massive fish kill resulted from a catastrophic fire which destroyed a feed mill on the Missisquoi River in Troy, Vermont. The Old Mill Inc. was located directly on the banks of the river and ensuing firefighting efforts caused the release of unknown quantities of both copper sulfate and zinc compounds (e.g. $ZnPO_4$ and $ZnSO_4$). As Troy, Vermont is adjacent to and directly upstream of the Canadian border, the effect of the release caused the death of thousands of fish of numerous species which was first noticed in Canadian waters. US EPA and VDEC spill response personnel were on the scene by Monday and contaminated runoff from firefighting was prevented from leaving the site. By this time, residents as far downstream as East Berkshire, Vermont were notifying VDEC of foul odors and the presence of occasional dead fish in the river. Initial monitoring data from waters immediately downstream of the burned mill showed total recoverable copper and zinc at 225 ppb and 227 ppb, respectively. Site-specific acute criteria for copper are 9.2 ppb and 6.5 ppb for zinc. In Richford, Vermont the maximum observed copper concentration was approximately 12 ppb. Follow-up monitoring data collected by Canadian investigators and VDEC personnel showed that copper concentrations declined to below criterion limits within one week after the event. The river was closed to all uses as far downstream as Richford for the week following the release. The site was cleaned up as soon as safely practical after the fire was completely extinguished and Canadian biologists reported that fish were re-populating the affected reaches of the Missisquoi River, presumably from tributary refugia, shortly thereafter.

Finally, during the early to mid-summer 2001, there was a major fish kill on Lake Champlain. This incident was first observed in the South Lake section of Lake Champlain and appeared to be specific to white perch. Later in the summer, dead and dying fish of a variety of species exhibited similar symptoms in more northern sections of the lake. The fish kill was investigated by VANR's fish pathologist, and was determined to be caused by a naturally occurring parasitic bacterium *Columnaris sp.* Early-season rapid temperature fluctuation in the lake, related to the long winter followed by a rapid changeover to summer conditions, was identified as a key factor which predisposed Lake Champlain fish to the bacterium *Columnaris sp.*

PART IV: GROUNDWATER ASSESSMENT

PART IV: GROUNDWATER ASSESSMENT

Groundwater Importance

Groundwater is vital to the livelihood of Vermont's residents. Although Lake Champlain supplies potable water to approximately 19% of the population, the majority of drinking water is supplied from groundwater sources. Furthermore, groundwater is used to support a variety of commercial, industrial, and agricultural activities, including ski resorts and family farms.

How Good is It?

The quality and quantity of groundwater varies due to both natural and human influences. No comprehensive studies have been completed on the quality of the resource. A limited number of public water supplies have detected contamination from anthropogenic sources. The annual report on drinking water quality violations is available on the Water Supply Division's website at http://www.vermontdrinkingwater.org. Although Vermont's historically rural landscape has precluded large-scale contamination of groundwater, nearly 2,500 contaminated sites have been identified which threaten Vermont's groundwater (refer to the figure on the following page). As Vermont's population and industrial development increase, the quality and quantity of the resource will be threatened further unless it is properly protected.

Recently, there has been an increase in concern and awareness of risks to drinking water safety associated with naturally occurring geologic sources of radionuclides (includes uranium, radium, radon, thorium) found in certain bedrock formations. Exposure to radionuclides at levels which exceed health standards poses a health risk to water consumers, particularly when that exposure occurs over a long period of time. The Agency of Natural Resources has started a three year effort that will delineate areas prone to radioactive groundwater. Identification of these areas will help achieve three goals: (1) provide warning to people that may currently be consuming groundwater that exceeds health standards; (2) inform public officials of potential consequences from development in these areas; and (3) to identify radioactive-free areas that may be used as alternative groundwater sources.

Closely related to the identification of radionuclide-bearing groundwater areas is the concern over the disposal of drinking water treatment process wastes. Use of softening/ion exchange systems in homes or by water suppliers effectively removes problematic dissolved constituents in water, concentrates those materials and sends them to individual wastewater disposal systems (septic tank solids and leach field effluent). In order to determine the fate, transport and concentration potential of radionuclides discharged to septic systems and leaching fields, the Department will be conducting an evaluation at several residential and very small water treatment units.

Costs of Contamination

Each year, an estimated $5 - 10 million is spent for cleanup of contaminated groundwater at publically and privately funded cleanup sites. Over 75% of the sites are associated with above ground and

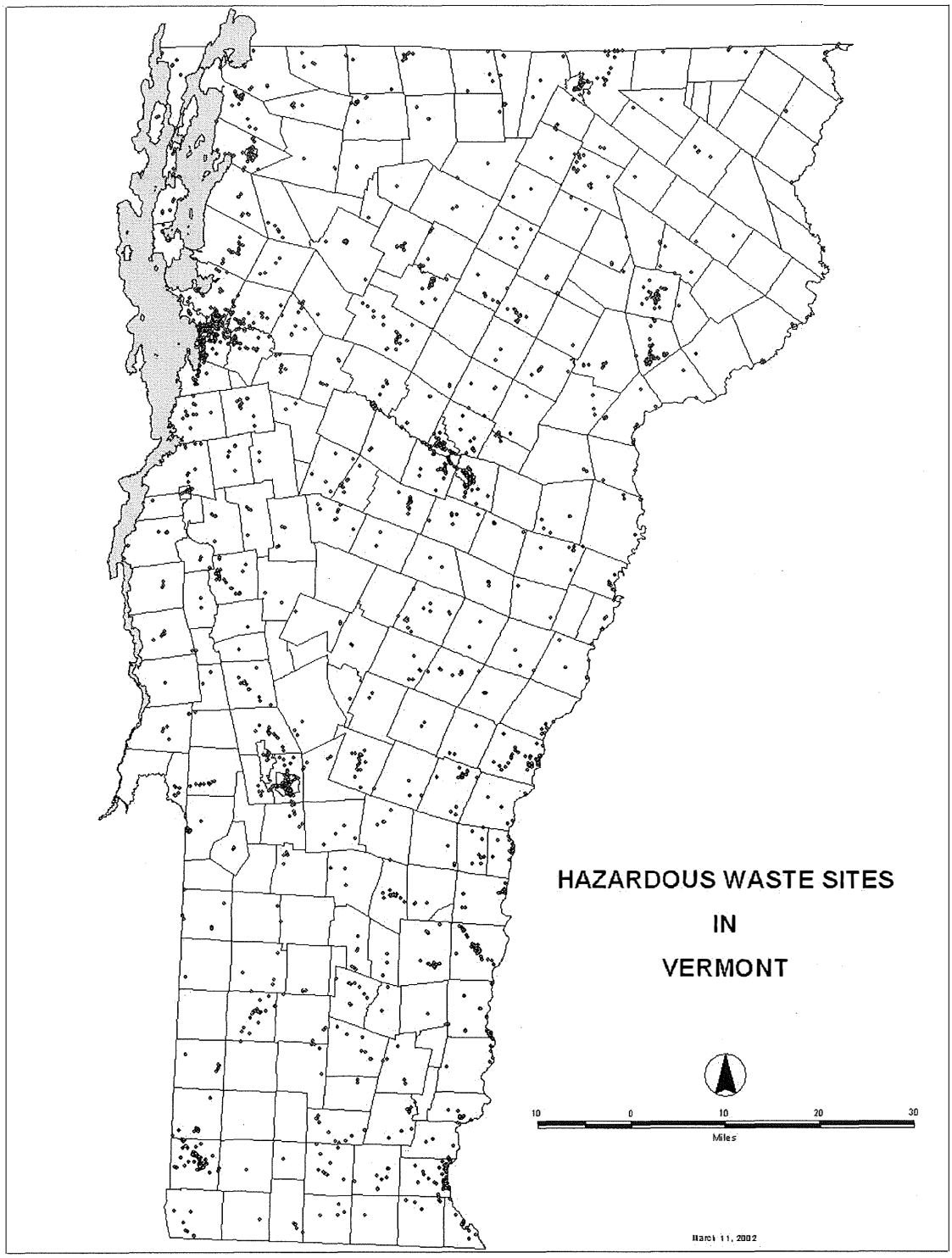


Figure IV.1. Hazardous Waste Site Locations.

underground storage tanks (UST). At one site, a leaking UST contaminated 27 private wells and threatens an additional 80 wells.

Several well known examples of contaminated groundwater exist in the state: the *Pine Street Barge Canal* in Burlington, the *Unifirst site* in Williamstown, and *unlined landfills* across the state. Many of these hazardous sites have not only contaminated groundwater, but also private and public drinking water sources. The cleanup of public drinking water supplies is especially costly due to the difficulties in locating groundwater in adequate quantities to serve the community. As an example, the Unifirst Site in Williamstown required the replacement of a public water supply well, extending water lines to several homes served by private wells which were contaminated, and the installation of a groundwater collection and treatment system. The operation and maintenance costs of the collection and treatment system alone totals $75,000 per year. The cost of developing and installing a new groundwater source for a public water supply is estimated between $500,000 and $1,000,000.

Although historic industrial practices have polluted groundwater, other activities, such as improper disposal of household hazardous waste, leaking home heating oil tanks, inappropriate use of pesticides and fertilizers, excessive road salting, and failing septic systems can also lead to groundwater pollution. Many of these problems can be prevented through education and improved management practices.

Efforts to Protect Groundwater

Vermont is working at the state, regional, and local level to protect groundwater. Many communities have local zoning ordinances to protect public drinking water supplies. The majority of Public Community Water Systems have plans in place to protect their water sources. The twelve Regional Planning Commissions are working to provide information on groundwater protection to their respective communities. At the state level, the Department administers permit programs designed to protect groundwater and public health, provides education on groundwater issues, and manages the cleanup of contaminated sites. The Vermont Department of Agriculture, Food, and Markets, in cooperation with VDEC, has established Acceptable Agricultural Practice rules to protect groundwater and surface water. The Vermont Agriculture Department also monitors numerous drinking water wells for pesticide and nitrate contamination to protect public health and determine groundwater vulnerability to contamination. Numerous other state agencies, such as the Vermont Department of Health, also provide services to protect groundwater and public health. The coordination of many of these activities occurs through the Groundwater Coordinating Committee, an inter-agency organization, which is managed through the Agency of Natural Resources.

Efforts to Protect Drinking Water

As part of the requirements of the Federal Safe Drinking Water Act Amendments of 1996, Vermont is implementing a Source Water Assessment Program (SWAP). Vermont has taken a unique approach of integrating the federal SWAP requirements with the state's long-established Source Water Protection Program. Under the Source Water Protection Program, all Public Community and Non-transient, Non-community Public Water Systems develop a Source Protection Plan. Among other

things, the Source Protection Plan identifies actual and potential sources of contamination. The Source Protection Plan also assesses the risk of these potential sources of contamination in relation to the drinking water source. For Transient, Non-community Public Water Systems, the Water Supply Division of the Department of Environmental Conservation is preparing Source Water Assessments that also include the inventory of potential sources of contamination and the assessment of risk.

The Source Protection Plan information provides a comprehensive look at the anthropogenic threats within each water system's Source Protection Area. These plans can become a vital tools for water systems to use in prioritizing protection activities.

APPENDIX A

EPA 2002 Integrated Water Quality Monitoring & Assessment Report Guidance

Category #1. Attaining the water quality standard and no use is threatened.
Assessment units (AU) should be listed in this category if there are data and information that meet the requirements of the state's or territory's assessment and listing methodology and support a determination that the water quality standard is attained and no use is threatened. States and territories should consider scheduling these AUs for future monitoring to determine if the water quality standard continues to be attained.

Category #2. Attaining some of the designated uses; no use is threatened; and insufficient or no data and information is available to determine if the remaining uses are attained or threatened.
Assessment units should be listed in this category if there are data and information, which meet the requirements of the state's or territory's assessment and listing methodology, to support a determination that some, but not all, uses are attained and none are threatened. Attainment status of the remaining uses is unknown because there is insufficient or no data or information. Monitoring should be scheduled for these AUs to determine if the uses previously found to be in attainment remain in attainment, and to determine the attainment status of those uses for which data and information was previously insufficient to make a determination.

Category #3. Insufficient or no data and information to determine if any designated use is attained. AUs should be listed in this category where the data or information to support an attainment determination for any use is not available, consistent with the requirements of the state's or territory's assessment and listing methodology. To assess the attainment status of these AU's, the state or territory should obtain supplementary data and information, or schedule monitoring as needed.

Category #4. Impaired or threatened for one or more designated uses but does not require the development of a TMDL.

4A. **TMDL has been completed.** AUs should be listed in this subcategory once all TMDL(s) have been developed and approved by EPA that, when implemented, are expected to result in full attainment of the standard. Where more than one pollutant is associated with the impairment of an AU, the AU will remain in Category 5 until all TMDLs for each pollutant have been completed and approved by EPA. Monitoring should be scheduled for these AUs to verify that the water quality standard is met when the water quality management actions needed to achieve all TMDLs are implemented.

4B. **Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.** Consistent with the regulation under 130.7(b)(i),(ii), and (iii), AUs should be listed in this subcategory where other pollution control requirements required by local, state, or federal authority are stringent enough to implement any water quality standard (WQS) applicable to such waters. EPA expects that these requirements must be specifically applicable to the particular water quality problem. Monitoring should be scheduled for these AUs to verify that the water quality standard is attained as expected.

4C. **Impairment is not caused by a pollutant.** AUs should be listed in this subcategory if the impairment is not caused by a pollutant. States and territories should consider scheduling these AUs for monitoring to confirm that there continues to be no pollutant-caused impairment and to support water quality management actions necessary to address the cause(s) of the impairment.

Category #5. The water quality standard is not attained. The AU is impaired or threatened for one or more designated uses by a pollutant(s), and requires a TMDL.
This category constitutes the Section 303(d) list of waters impaired or threatened by a pollutant(s) for which one or more TMDL(s) are needed. An AU should be listed in this category if it is determined, in accordance with the state's or territory's assessment and listing methodology, that a pollutant has caused, is suspected of causing, or is projected to

cause an impairment. Where more than one pollutant is associated with the impairment of a single AU, the AU will remain in Category 5 until TMDLs for all pollutants have been completed and approved by EPA.

For AUs listed in this category, states or territories should provide monitoring schedules that describe when data and information will be collected to support TMDL establishment and to determine if the standard is attained. EPA recommends that while the state or territory is monitoring the AU for a specific pollutant to develop a TMDL, it also monitor the watershed to assess the attainment status of other uses.

A state or territory must submit a schedule for the establishment of TMDLs for all waters in Category 5. This schedule must reflect the state's or territory's own priority ranking of the listed waters.

APPENDIX B

HEALTH ALERT

The Vermont Department of Health recommends that people limit consumption of some fish caught in Vermont waters.

	Women of childbearing age — particularly pregnant women, women planning to get pregnant, and breastfeeding mothers — **and children age 6 and under**	**All other individuals**
Brown Bullhead Pumpkinseed	No Advisory	No Advisory
Walleye	0 Meals	No more than 1 meal/month
Lake Trout Smallmouth Bass Chain Pickerel American Eel	No more than 1 meal/month	No more than 3 meals/month
Largemouth Bass Northern Pike	No more than 2 meals/month	No more than 6 meals/month
Brook Trout Brown Trout Rainbow Trout Yellow Perch	No more than 3-4 meals/month	No Advisory
All Other Fish	No more than 2-3 meals/month	No more than 9 meals/month
Lake Carmi - Walleye	No more than 4 meals/month	No Advisory
Lake Champlain - Lake Trout (larger than 25 inches)	0 meals (includes all children under 15)	No more than 1 meal/month
Hoosic River - All Fish	0 meals	0 meals
Deerfield Chain (Grout Pond, Somerset Reservoir, Harriman Reservoir, Sherman Reservoir, and Searsburg Reservoir)		
Brown Bullhead Brook Trout	No Advisory	No Advisory
Rainbow Trout Brown Trout (smaller than 14 inches) Rock Bass Rainbow Smelt Yellow Perch	No more than 1 meal/month	No more than 3 meals/month
Brown Trout (larger than 14 inches) All Other Fish	0 meals	No more than 1 meal/month
15 Mile Falls Chain (Comerford Reservoir and Moore Reservoir)		
All Fish	0 meals	No more than 2 meals/month
15 Mile Falls Chain (McIndoes Reservoir)		
Yellow Perch	No more than 2 meals/month	No more than 6 meals/month
All Other Fish	No more than 1 meal/month	No more than 3 meals/month

The Vermont Department of Health

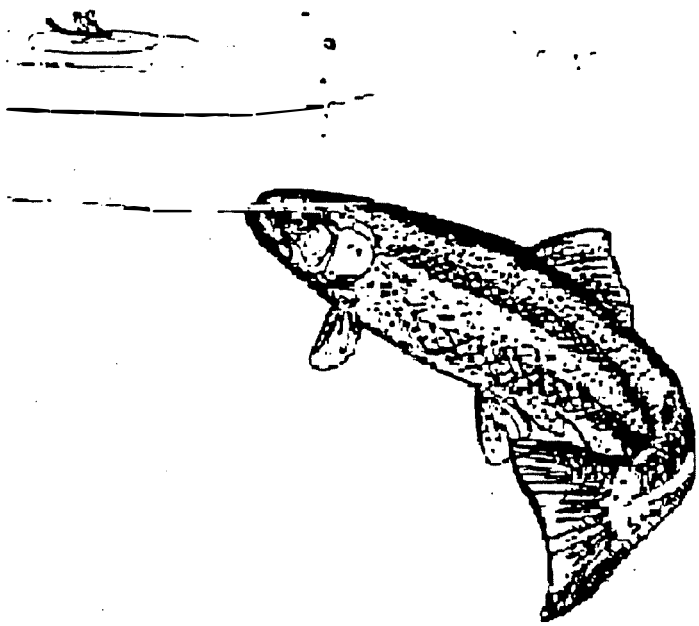
June 2000

APPENDIX C

D R A F T
FOR PUBLIC COMMENT

Vermont Watershed Initiative

Guidelines for Watershed Planning



Prepared through a collaboration of a public Statewide Watershed Framework committee &
The Vermont Department of Environmental Conservation
November 2001

Table of Contents

1. Introduction

This guide to developing river basin water quality management plans has been designed as a tool for use by the public, Watershed Coordinators, watershed organizations, Watershed Council members and anyone else interested in understanding and being involved in the basin planning process.

River basin plans help communities decide how to:

- Restore the waters most affected by polluted run-off
- Protect the waters and adjacent access threatened by pollution.

Voluntary action, public involvement, adequate funding to clean up waters, and common sense approaches are the keystones on which plans must be based. The job of minimizing polluting runoff from the land can only occur if everyone understands the techniques and does their part.

Industry, residences, shops, farms and forest lands all have important places on the Vermont landscape. Yet each also has a responsibility to do its best to control water and pollutants washing into rivers and streams (non-point source runoff). People need information about polluted waters and recommended solutions. These can be significant parts of a basin plan.

In the words of Thomas Jefferson: "People ..... are inherently capable of making proper judgments when they are properly informed." It is this approach that is the keystone of the basin planning process.

Local watershed associations are also important in developing basin plans. Many are already engaged with landowners or have projects for restoring water quality. The Department of Environmental Conservation strongly supports the ongoing efforts of local landowners, communities and community organizations. Indeed, the Department is eager to help new organizations at the local level become established where they see important work to be done in regard to our water resources.

2. Background

Following concerns expressed by Vermonters and the U.S. EPA about the impact of storm water and pollutants washing into Vermont's rivers and streams the Department of Environmental Conservation has worked to learn about the successes and failures of basin planning in other states.

As a result, DEC has sought staff and financial resources to support such planning in Vermont and engage members of the larger Vermont community in a Framework Committee to provide guidance for the work of the Agency of Natural Resources in carrying out comprehensive basin planning in the State.

In 1998 the Department engaged a faculty member and student of the Vermont Law School to review basin planning efforts throughout the country.

The report's major finding was that pollutants washed from diffuse, non-point sources, cause the majority of Vermont's current water-related problems. The Department's response was to establish a state-wide basin planning framework to focus on non-point pollution sources.

In addition, the report found that:

> *"A statewide basin planning initiative offers Vermont a unique opportunity to greatly improve the state's natural resource management structure and programs for the 21st century. But the potential of this opportunity will only be fully realized if the program's concept and framework are developed with an ecological focus, progressive vision, extensive planning, adequate resources, hard work, and last, but most importantly, stakeholder support and participation." (Duery 1999)*

In response to this guidance the Commissioner of the Department of Environmental Conservation invited members of the Water Quality Standards Task Group and others to a meeting to discuss approaches to watershed planning with Kimberly Brewer a representative from the consulting firm Tetra Tech. The goal of the meeting was to learn from the experiences of other states that have moved to statewide watershed or basin management, to see how the state basin level planning can be strengthened and connected to the more local watershed focus of the Watershed Improvement Project.

The group reviewed approaches of other states. There was the greatest interest in the approach taken by the State of Kentucky. There was the feeling that certain portions of that framework would work well in Vermont and deserved careful study. There was interest in an approach that was both top down and bottom up with the state taking a facilitating role (hybrid).

3. Principles

In implementing the basin planning process, each of the 17 individual plans must meet or exceed the applicable requirements of state and federal law. In doing so, the local basin planning process will be guided by the following principles:

1. The purpose of the statewide effort is to provide an overall framework and inclusive process to guide each of the 17 individual plans in order to ensure a basic level of consistency.

2. Plans should emphasize voluntary actions to solve identified problems.

3. The completion of these 17 individual plans will be given the highest priority by the Agency and thus the Agency will seek and should be given the appropriate resources to ensure that all of the plans are completed by the statutory deadline of January 1, 2006.

4. The process should be inclusive – maximize public participation and involvement in the local decision-making and action.

5. The state program should both complement and support existing and new stewardship efforts in each watershed and be flexible and responsive to the needs and priorities of the people.

6. Each of the 17 individual basin plans will contain objectives, policies, benchmarks and tasks in order to facilitate the implementation of the plans. The basin planning process will need to be action-oriented in order to maintain public enthusiasm and make real progress in improving the management of Vermont's water resources.

7. When completed, the 17 individual basin plans should act as guiding planning documents for water quality management in Vermont and resource documents for the respective regions and their municipalities.

8. Vermont by tradition has a working landscape. This process is committed to working together to achieve the public's water quality goals, while respecting the rights of landowners.

4. Statewide Coordinating Council

Introduction

The Statewide Coordinating Council is a volunteer group made up of community, stakeholder and government representatives which will ensure the watershed planning process remains public and achieves the goals described in this document.

The Council will have a significant voice in determining ANR and DEC policies on watershed management. The Council will undertake the roles described below with the administrative support of the Agency of Natural Resources. It will maintain continuity and institutional memory in the basin process, identify statewide issues that need attention, share ideas, solutions and information, review final products and coordinate efforts between various basins.

4.1 Roles

- Monitors statewide watershed planning process in each basin periodically for consistency with this Framework and reports to the Commissioner, Department of Environmental Conservation and legislature on implementation,
- Adjusts "Guidelines for Watershed Planning" as necessary,
- Seeks to assure that resources are available for all participants in the watershed planning process to achieve 2006 completion date,
- Supports and coordinates participatory commitment of resource technical advisors
- Assists watershed coordinators in attaining full range of representation on watershed councils; actively engages constituents and encourages their participation in the basin planning process
- Ensure that watershed plans contain required elements prior to submission to the Secretary of ANR (checklist)
- Share good ideas and coordinate efforts between basins (technology transfer); provides a forum for communication between constituent groups and between constituents and their representatives
- Tracks implementation and evaluation of basin plans; reports statewide results - tracks statewide issues, solutions, and resolutions

4.2 Membership

The Statewide Coordinating Council is envisioned to be a volunteer group. The ANR will provide logistical support. The Council will establish its own operating procedures, including its method of decision making. The individuals and representatives of the organizations listed below will be invited each year to join the committee. The Secretary will select from among the individuals who apply to serve. Meetings will be run as open public meetings and others are invited to attend to participate. Membership may include but is not limited to representatives of:

Deputy Secretary of the Agency of Natural Resources
Commissioner Department of Environmental Conservation
Commissioner Department of Agriculture, Food and Markets

Member appointed by the Speaker of the House
Member appointed by the Committee on Committees for the Senate
Secretary of Agency of Transportation
Natural Resources Conservation Districts
Other agriculture interests such as the Grange, Farm Bureau, etc.
Natural Resources Conservation Service
Regional Planning Commissions
Watershed affiliated organization from each the Connecticut, Memphremagog, Hudson and Champlain Basins
Statewide non-governmental natural resources oriented organization
Statewide industry
Major private landowner
Agriculture and forestry interests
Fisheries interest and other recreation and sports enthusiasts
Local Government
Municipal Conservation Commission or local "environmental" Group
Regional development corporation
Regional marketing organization
Water users: power companies, public water systems, ski resorts and mining
Public land managers: VTrans, USFS, ANR, USFWS, park districts, and towns

4.3 Meeting conduct and frequency

The Council will meet quarterly. ANR will provide logistical support, and the meetings will be held in accordance with all applicable state and federal laws. At the meetings the watershed coordinators may present a discussion of obstacles encountered, successes, and barriers.

5. Watershed Council Structure

A Watershed Council will be the main body to guide the basin planning process within each watershed. The open ended Council, comprised of volunteer local watershed constituents, will be guided and supported by a Watershed Coordinator and Technical Advisors.

Watershed Councils will encourage constituents' participation in the planning process and conduct outreach and education to inform constituents and others about watershed issues. Watershed Councils will prioritize water quality issues and concerns through a public participation process, with the assistance of Technical Advisors, who may meet separately with Issue Teams to develop solutions for specific problem areas. Outlined below are the roles and interrelationships of the Watershed Councils, Watershed Coordinators, Technical Advisors, and Issue Teams.

5.1 Planning Bodies and Roles

5.1.1 Watershed Councils (also called watershed teams)

- Each council member represents a given constituency(s); existing watershed groups may serve as the council if watershed constituents are fully represented, or an existing group may serve as the foundation on which to build a fully inclusive council.

  Watershed Councils consist of the following invitees as appropriate: large land users (farmers, loggers, ski resorts, large business); Watershed groups (local); Environmental Groups (local); Non-profits (local); Natural Resources Conservation Districts (local); Vt. Dept of Agriculture (local representation for all agricultural interests); U. S. Forest Service (where office is local); Vermont Department of Fish and Wildlife (local biologists); Vermont Department of Environmental Conservation (Watershed Coordinator); Vermont Department of Forests and Parks (local representation); Regional Planning Commissions; Town Conservation Commission Members; Town Select Board Members; Town Planning Commission Members; Business, Community, Regional Chamber of Commerce, recreational and sport enthusiasts (regional and local); and Major Water Users (forestry, ski, large business, public water systems, power companies). Watershed Coordinators and watershed organizations will staff the Councils, where appropriate.

- Council members encourage constituents' participation and conduct outreach/education to inform constituents about the watershed and known watershed issues
- Develop and conduct watershed forums (assisted by facilitators)
  Forums' purpose: to identify water resources issues (assets and problems), related community needs, and potential solutions.
- Identify immediate or ongoing water quality improvement projects to be undertaken during the planning process
- Prioritize issues, select highest priority issues to be addressed in plan
- Determine Issue Teams (see 5.1.4 below)
- Approve Issue Teams' proposal (including identifying problems and recommending solutions) and develops draft watershed plan
- Guides plan through review, revision, and approval process (see section 5.4.2)
- Implement the plan

5.1.2 Watershed Coordinator (could be contracted with NRCDs, RPCs, local watershed groups, or other)

- Watershed Coordinators meet with and solicit participation of constituent groups, education and outreach on basin planning process and watershed issues
- Form Watershed Councils with sizes and composition appropriate to the individual watersheds, respecting existing watershed-based organizations
- Staff Watershed Councils and Issue Teams
- Facilitate meetings
- Compile factual material related to the waters of the watershed
- Serve as a liaison between the Technical Advisors and Council / Issue Teams
- During the planning process, seeks technical and financial resources for water quality improvement projects identified by watershed constituents
- Prepare (write) draft and final plans
- Update Coordinating Council regularly on the watershed planning process in each watershed
- Facilitate watershed plan implementation

5.1.3 Issue Teams

- Issue Teams are subcommittees of watershed councils (including additional citizens and technical advisors) that develop solutions (action steps, practices, benchmarks. and future tasks) for each major water resource problem and threat selected by the council to be addressed in the plan
- Solutions should only be those that members of the Issue Teams (or their constituents) are committed to implementing
- Identify immediate or ongoing water quality improvement projects to be undertaken during the planning process
- Review draft and final plans
- Implement the plan

5.1.4 Resource Technical Advisors

- Each agency/department/organization has a "point person" that supports and coordinates the participation of their technical staff in the basin planning process; this list of "point persons" is provided to the Coordinator who will then work with these contacts to identify the appropriate technical advisors
- Educate Watershed Councils and Issue Teams on technical aspects of water resource issues
- Work closely with Issue Teams to determine solutions to watershed issues
- Identify immediate or ongoing water quality improvement projects to be undertaken during the planning process
- Ensure legal compliance of plans (each Agency responsible for statutes/laws by which it is directed)

5.2 Potential Participants

5.2.1 Watershed Council Members - at a minimum, the following constituent groups should be considered in identifying representatives to the Watershed Councils:

		Minimum Number of Desired Representatives
Select Boards and Village Trustees	(Managers and Administrators)	1+
Municipal and Regional Planning Commissions	(Planners)	1+
Municipal Conservation Commissions and Local "Environmental" Groups		1+
Watershed Affiliated Organizations	(lake associations, river groups, etc...)	1+
Regional Development Corporations		1
Regional Marketing Organizations / Chambers of Commerce / other small business rep.		1
Natural Resource Conservation Districts		
Recreation and Sports Enthusiasts (land and water)		2+
Major Land and Water Managers relevant to all watersheds		2+
• Agriculture		
• Forestry		
Major Land and Water Users – watershed specific		1+
• Power Companies		
• Public Water Systems		
• Ski Resorts		
• Mining		
Public Land Managers – Government Land Owners		1 per major land holding entity
• VTrans, USFS, ANR, USFWS, park districts, towns		
	TOTAL	**12+**

NOTE: Technical Advisors may also serve their agency in an "advocacy" or "constituent" role on the Watershed Council depending on the nature of the agency's land ownership and management responsibilities in the watershed. In such cases, it is generally more appropriate for local agency staff to serve as council members, than centralized staff, as local staff is tapped-into the watershed community.

5.2.2 Technical Advisors - consist of technical staff of the appropriate resource related organizations who provide information to the Watershed Council, Issue Teams, and Coordinator on each identified major issue and assist in identifying solutions. Technical Advisors may include:
Vermont Agency of Natural Resources Legal Advisor Department of Environmental Conservation • water quality (+ stormwater) • water quantity • water supply • wastewater management • wetlands • lakes and ponds • invasive exotics • river management (floodplains) Department of Fish and Wildlife • non-game / natural heritage • fisheries • wildlife Department of Forests, Parks and Recreation • forests • parks • recreation
Vermont Department of Agriculture
Vermont Natural Resource Districts
Vermont Agency of Transportation District Representatives
Federal Agencies Environmental Protection Agency Army Corps of Engineers US Fish and Wildlife Service – Conte and Lake Champlain offices USDA - Natural Resources Conservation Service - US Forest Service – Green Mountain National Forest US Department of Transportation
Other Resources Vermont Local Roads Representative UVM Extension SeaGrant Lake Champlain Basin Program Local and Regional Land Trusts Colleges/Universities/Schools Nonprofits and citizen groups (watershed groups, environmental groups,...) Private industry, consultants

NOTE: Agency representatives may be one per department/agency or several per department depending on basin issues.

6. Planning Process and Public Participation

In general, the planning process should include the following steps:

- issue identification,
- issue prioritization,
- strategy and solution development,
- allocation of resources and funding, and
- implementation.

The planning process will occur for each watershed on a five-year cycle, incorporating planning, implementation, monitoring, and evaluation. Every 5th year, the renewed plan will steer a continually evolving course of watershed improvement activities for the basin.

6.1 Public Participation Fundamentals

> "*We must engage a broad cross-section of Vermonters in each watershed in developing these action plans and working to implement their own strategies for watershed improvement. The Agency will provide leadership and support this effort, but the best, most successful strategies for managing our waters will come from the people who live, work, and play in each watershed.*" – Canute Dalmasse, Commissioner, VT Department of Environmental Conservation

To succeed, the basin planning process must encourage and support meaningful, effective, and enduring public participation (Wondolleck et al, 2000), as well as sustaining and nurturing an atmosphere of cooperation. Remember, however, that since each watershed is inherently different in its natural, cultural, and economic resources, each watershed plan will be unique and may require that a variation on the proposed process be implemented.

The planning process should emphasize collaboration and consensus. While consensus isn't always possible, it is important to promote a shared-learning environment on most issues that will help to ensure ownership of the problem-solving approach and its outcomes by Watershed Council members and their constituents.

Engaging the public early on, and often, throughout the decision-making process is one effective way ensuring broad ownership of the problem solving approach. Thus, by ensuring that the Council is inclusive and representative of constituents in the watershed, a meaningful planning process can take place.

Remember effective and efficient meetings where people feel valued for their input will help to ensure meaningful public participation through a Watershed Council. One key component of maintaining effective meetings has been through the use of a facilitator. Successful watershed planning initiatives in other states have shown that a facilitator was critical to the process and that their watershed programs would have been unsuccessful without them (Durey, 1999). The State of Vermont has recently hired regional watershed coordinators to serve this purpose for each watershed planning process in each basin. Another means to promote meaningful

participation is to maintain an efficient organizational structure. Because collaborative efforts involve stakeholders who represent different constituencies, so must the issues on which each representative chooses to focus. By forming Issue Teams, stakeholders can uphold their advocacy role for their constituents without becoming overwhelmed by the entire watershed planning process.

Finally, in order for the watershed planning process to continue to be successful, the people involved in the process must continue to feel as though they have a part in it, that their opinions are being heard and that they are able have an impact on the outcomes and actions that come from the process.

Encouraging stakeholders to work together using meaningful and legitimate objectives that have been identified through consensus-based decision-making is also critical to maintaining ongoing and enduring public participation. "Ultimately, they are self-sustaining because a structure is provided that facilitates productive interaction, and the partners continue to benefit from it." (Wondolleck et al, 2000)

Successfully creating a meaningful, effective, and enduring planning process is the key to solving water quality problems in Vermont's watersheds. Such participation and decision making will entail a significant level of staff time by supporting agencies.

Durey, Hunt, Watershed Management and Public Participation: A Summary Report, Masters Internship of Studies in the Environmental Law Program, Vermont Law School *prepared for* Water Quality Division, Department of Environmental Conservation, Vermont Agency of Natural Resources. March 1999.
Wondolleck, Julia M., and Steven L. Yaffee, Make Collaboration Work. Washington D.C: 2000 pp 99-117.

6.2 Plan Development

1.General outreach, education, and solicitation of constituent groups by coordinator and existing active watershed groups, conservation districts, regional planning commissions or others to inform of planning process and opportunities for serving on Council. Public participation tactics might include working with the mass media and speaking at local organizations' meetings to help raise awareness of possible participants. **3 months**

2.Form an inclusive and representative Watershed Council with size and composition appropriate to the watershed, respecting any existing organizations and their structures. Provide education for the Council members about public participation objectives and the basin planning process. Allow time to refine organizational structure of the Council to assure efficient and effective future operations. Define roles of Council members and the watershed coordinator. Formulate ground rules for Council function including commitment to the collaborative process. Identify and address any funding needs of Council participants to assure enduring participation. **3 months**

3.Council members encourage constituents' participation in planning process and conduct outreach/education to inform constituents and others about the watershed and watershed issues/opportunities. Provide facilitation training to the Council members so that they can work more effectively with their constituents. Examples of outreach include, but are not limited to, mass media, ANR watershed website, direct mail to members of constituent groups, or articles in groups' newsletters/websites to convey the importance and need for the planning effort. **2-3 months**

4.Coordinator, Council, and other constituents identify and implement ongoing water quality improvement projects during the planning process to keep the process action-oriented, and to encourage and celebrate early successes.

5.Councils develop and conduct watershed forums to learn about needs, attitudes, and behaviors of general public. The main purpose of the forums is **to identify water resources issues** (assets and problems), related community needs, and potential solutions. Efforts are made to draw in local citizens as much as possible. Other public participation may include educational workshops or field trips to help public understand options and increase shared learning. **2-3 months**

6.Council prioritizes issues, selects highest priority problems, threats, and opportunities; and establishes issue teams. **1 month**

7.Issue teams develop recommendations to the Council including potential implementation activities to address each high priority water resource opportunity, problem, or threat identified by the Council. Process needs to include adequate time for science-based education for Council and Issue Team members to reach a level of shared learning that will allow effective and meaningful participation. **4-6 months**

8.Council approves issue teams' proposals and determines resource allocation and funding priorities. Using these proposals and other public and technical input, the Coordinator writes a draft watershed plan in close consultation with the Council. **2 months**

Public participation includes publicity of accomplishments; and celebration/reward of the important work of the Council and Issue Team members and others.

Subtotal	**17-21 months**

6.3 Plan Review and Approval

1. Council releases draft plan to public and Coordinating Council for review. Public participation tactics include, but are not limited to, mass media, web-site comments "bulletin board", and public hearings.	**2 months**
2. Council (and Issue Teams) re-work draft addressing feedback received.	**2 months**
3. Council releases semi-final plan to public and steering committee for review. Public participation tactics include, but are not limited to, mass media, web-site comments "bulletin board", and public hearings.	**1 month**
4. Council (and Issue Teams) re-work semi-final plan addressing feedback received.	**1 month**
5. Council submits final plan to ANR for signature. (ANR guides plan through federal approval process with the EPA – not included in this timeline). ANR staff submits plan to WRB as petition for reclassification of waters and ORW nominations, as needed. (WRB conducts public participation on reclassifications and ORWs – not included in this timeline.)	**1 month**
Subtotal	**7 months**
TOTAL	**24-28 months**

6.4 Planning Timeline

	Month																								
Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Organize Planning & Coordinate Council & Team(s)																									
Negotiate any contracts if necessary with any entities that may be helping with the effort (I.e. RPCs, RCDs, watershed associations, consultants, etc.)																									
Hold as many planning strategy sessions as are necessary																									
Identify potential council representatives and hold targeted outreach meeting(s) and establish watershed council (1)																									
Educate council members on history, evolution of process, state framework, objective of watershed plan, mandatory components of watershed plan, areas of flexibility in watershed plan, desired outcomes of watershed plan, etc. (2)																									
Prepare/conduct public forums and educate constituents (3&4)																									
Develop a vision for the watershed, identify issues and establish respective issue teams (5)																									
Identify and discuss issues of concern regarding the watershed / and special areas the plan should focus on																									
Gather Information																									
Inventory/document past and existing related efforts and products																									
Understand watershed's current conditions																									
Identify gaps in the existing data / information																									
Identify and prioritize which gaps are to be filled first																									
Issue teams work with technical advisors to fully understand their issues and to develop recommended solutions (6)																									

Develop Watershed Plan																									
Finish documenting current and desired conditions, vision and issues						■	■	■	■	■	■	■	■	■											
Draft plan - develop objectives, tasks, responsible parties, schedule, potential funding sources, benchmarks (7)												■	■	■	■	■	■								
Plan Review and Approval Process																									
Review of draft plan by state steering committee and public (1)																		■	■						
Revise draft plan based on feedback received (2)																				■	■				
Review semi-final plan by state steering committee and public (3)																						■			
Revise semi-final plan based on feedback received (4)																							■		
Submit final plan to VANR's Secretary for approval (5)																									■
Reclassification and ORW Review and Approval Process (separate process of the Water Resources Board (WRB) - not included in this chart)																									
REVISE PLAN to integrate WRB decisions																									

6.5 Outreach Contacts

At a minimum, the Watershed Coordinator and Council should contact the following groups in their watershed on a regular basis to inform and educate them about the status of the watershed planning process, accomplishments, challenges, etc:

1) Constituents: all those identified in the basin, whether they are participating in the planning process or not
2) Technical advisors: those pertinent to the watershed and agency/department point contacts
3) Media: radio, TV, newspapers (local/regional)
4) Legislators
5) Other interested individuals: any who sign up at watershed planning public meetings, or otherwise express interest in being updated on the watershed planning initiative

7. Plan Structure

Although each plan will be somewhat different, the White River Plan table of contents below provides a general representation of the structure of a basin plan. The plan must be understandable by the public, reflect the direction for water resources restoration and conservation recommended by the public and comply with the legal requirements for a basin plan. The table of contents below is an initial example of how this goal can be achieved.

Example Table of Contents

List of Figures

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Appendices

(All appendices prepared by DEC unless otherwise noted)

Appendix E: Agriculture in the White River Basin: by the Department of Agriculture, Food and Markets

Appendix F: Trout and Salmon Habitat in the White River Watershed: by the Department of Fish and Wildlife

Appendix G: White River Basin - Potential Reference Reaches
Appendix H: The Nine Step Planning Process used and prepared by USDA-NRCS
Appendix I: Typing and Classification
Appendix J: 10 V.S.A. §1424a Outstanding Resource Waters (Vermont state statute)
Appendix K: Review of Municipal and Regional Plans: by Two Rivers-Ottauquechee Regional Commission

8. Implementation and Results

No planning process is complete without feedback on the elements of the plan. This can take the form of documenting the actions taken on the land in an effort to improve water quality to placing a conservation easement on a swimming hole to assure its protection for future generations. Periodically, during the implementation phase of the plan, progress can be measured by checking on the different strategies completed or in progress in various parts of the basin.

9. Legal Aspects

9.1 Executive Summary

In a nutshell, Basin Planning is required to be a public process that inventories both water uses and problems and that develops strategies for enhancing water quality. Of particular importance is identifying strategies (including Total Maximum Daily Loads and Best Management Practices) for remedying water quality problems and assigning Water Management Types so as to attain and maintain water quality.

A basin plan is intended to provide the Secretary of the Agency of Natural Resources with the data, rationale, and community-based recommendations to support petitions to the Water Resources Board for any changes in the classification and typing of rivers and streams or specific reaches or bodies of water within a given watershed.

The document dated November 3, 2000 and entitled "Water Quality Division Interpretation of Water Quality Standards" provides succinct guidance for assigning Water Management Types. Some of the issues related to this topic, particularly as they relate to changing an B designation to a B1, B2 or B3 are complex and subject to ongoing disagreement within the legal community. It is the sense of the Legal Subcommittee that these issues are best resolved with a concrete fact pattern and that the ultimate goal of protecting water quality, enhancing our State's anti-degradation efforts and common sense should be the principle guides for Coordinator's and Watershed Planning Committees' for recommending and, ultimately, for assigning Water Management Types.

The Vermont Statutes create special obligations on the part of the Commissioners of the Department of Environmental Conservation and the Department of Agriculture, Food and Markets to work cooperatively

to resolve farm related water quality problems with respect to Basin Plans. The Secretary of the Agency of Natural Resources retains ultimate responsibility regarding Non Point Sourcesof pollution relative to Basin Planning and agriculture.

The references to the legal aspects of basin planning (examined in detail in appendix 1) are:

- Vermont's July 2, 2000 Water Quality Standards
- 40 CFR sec. 130.6
- 6 VSA ch. 215
- 10 VSA section 1253 (d)

10. Evaluation

Periodically the State-wide Coordinating Committee must take stock of the process and examine accomplishments in planning and implementation. Subjects to be considered the adequacy of the process set forth by the Guidance document, the progress of the basin planning process, reactions of the public to the process, and the adequacy of resources to conduct planning and implementation. In addition, the Statewide Coordinating Committee will make a report to the Secretary every year initially and later as needed

11. Watershed Council Toolkit

Each Watershed council needs a basic background tool kit that describes the basin and the major known issues. Items that should be included at a minimum include:

1. Copy of the watershed assessment
2. The list and map of impaired waters in the basin
3. The explanation of water quality classification and typing.
4. Copy of the Framework Committee Report "Guidelines for Watershed Planning"

These basic materials will help the citizen become familiar with some of the known issues that will be the subject of discussion.

Appendix 1. Legal Aspects

Points Required in Basin Plans

Federal and state law and regulation call for the review of specific topics in basin plans. In the material below the reader will find underlined the sources of the requirements followed by a brief summary of the major requirement.

July 2, 2000 Water Quality Standards - Section 1-02 D - Basin Planning and
40 CFR, Part 130, Section 130.6 - Water Quality Management Plans and
Vermont Agricultural Non-point Source Pollution Reduction Program Law and Regulations and the Memorandum of Understanding between the ANR and DAF&M
10 VSA section 1253 (d)

Following is a summary of basin planning points that have been extracted from the Vermont Water Quality Standards (WQS), the Federal Register and the Department of Agriculture, Food and Markets' (DAF&M) *Accepted Agricultural Practice Regulations* (Effective June 29, 1995), their *Best Management Practice Regulation* (Effective January 27, 1996), and the Memorandum of Understanding between the ANR and the DAF&M. All appropriate points must be included in basin plans before they can be adopted by the Secretary of the Agency of Natural Resources (ANR). Organizations are encouraged to include as many points as possible in their basin planning efforts. The Department of Environmental Conservation (DEC) will incorporate this information in the development of basin plans.

Following are points contained within the July 2, 2000 Water Quality Standards

1. Basin plans inventory the existing and potential causes and sources of pollution that may impair the waters.

2. Basin plans establish a strategy to improve or restore waters.

3. ....shall seek public participation to identify and inventory problems, solutions, high quality waters, existing uses, other water uses, and significant resources of high public interest.

4. ....shall consider approved municipal and regional plans adopted under 24 V.S.A. Chapter 117.

5. ....shall coordinate and cooperate with the Commissioner of DAF&M, as provided for in 6 V.S.A. Chapter 215.

6. ....shall identify strategies, where necessary, by which to allocate levels of pollution between various sources as well as between individual discharges.

7.....should, to extent possible, contain specific recommendations by the secretary that include, but are not limited to the identification of all known:
   a. existing uses
   b. salmonid spawning or nursery areas important to the establishment or maintenance of such fisheries
   c. reference conditions appropriate for specific waters
   d. any recommended changes in classification and designation of waters
   e. schedules and funding for remediation

f. stormwater management
g. riparian zone management
h. other measures or strategies pertaining to the enhancement and maintenance of the quality of waters within the basin.

8. In basins that include class B waters which have not been allocated into one or more Water Management Type or Types pursuant to Section 3-06 of the WQS, the basin plan.....shall propose the appropriate Water Management Type or Types based on both the existing water quality and reasonably attainable and desired water quality management goals.

Following are points contained within 40 CFR, Section 130.6:

9. Water Quality Management (WQM) plans....consist of initial plans produced in accordance with sections 208 and 303e of the Clean Water Act (CWA) and certified and approved updates of those plans.

10. State water quality planning should focus annually on priority issues and geographic areas and on the development of water quality controls leading to implementation measures.

11. WQM plans are used to direct implementation.

12. WQM plans draw upon the water quality assessments to identify priority point and nonpoint water quality problems, consider alternative solutions and recommend control measures, including the financial and institutional measures necessary for implementing recommended solutions.

13. State annual work programs shall be based upon the priority issues identified in the state WQM plan.

14. The following plan elements shall be included in the WQM plan or referenced as part of the WQM plan if contained in separate documents when they are needed to address water quality problems:

(1) Identification of anticipated municipal and industrial waste treatment works, including
(a) facilities for treatment of stormwater-induced combined sewer outfalls;
(b) programs to provide necessary financial arrangements for such works;
(c) establishment of construction priorities and schedules for initiation and completion of such treatment works including:
(i) an identification of open space and recreation opportunities from improved water quality in accordance with sections 208(b) (2)(A) and (B) of the CWA.

(2) Nonpoint source management and control
(a) describe the regulatory and non-regulatory programs, activities and best management practices (BMPs). Economic, institutional and technical factors shall be considered.... BMPs shall be identified for the nonpoint sources identified in Section 208(b)(2)(F)-(K) of the CWA and other nonpoint sources as follows:
(i) Residual waste
(ii) Land disposal
(iii) Agricultural and silvicultural
(iv) Mines
(v) Construction
(vi) Urban stormwater

(3) Effluent limitations - including water quality based effluent limitations and schedules of compliance
(4) Total maximum daily loads
The nonpoint source plan elements outlined in #14 above shall be the basis of water quality activities implemented through agreements or memoranda of understanding between EPA and other departments, agencies or instrumentalities of the United States in accordance with section 304(k) of the CWA.
(5) Identification of management agencies necessary to carry out the plan and provisions for adequate authority for intergovernmental cooperation.....
(6) Identification of implementation measures necessary to carry our the plan, including financing, time needed to carry out the plan, and the social, economic and environmental impact of carrying out the plan in accordance with 208(b)(2)(E).
(7) Identification and development of programs for the control of dredge or fill material in accordance with section 208(b)(4)(B) of the CWA.
(8) Identification of any relationship to applicable basin plans developed under section 209 of the CWA.
(9) Identification and development of programs for control of groundwater pollution including the provisions of section 208(b)(2)(K) of the CWA. States are not required to develop groundwater WQM plan elements beyond the requirements of section 208(b)(2)(K) of the CWA, but may develop a groundwater plan element if they determine it is necessary to address a groundwater (water) quality problem [see section 130.6(c)(9) for specifics of the groundwater plan element.

Following are points contained in Title 6, Ch. 215, Agricultural Non-Point Sources Pollution Reduction Program and Memorandum of Understanding Between the ANR and DAF&M:

15. The Commissioner of DAF&M shall cooperate with the Secretary of ANR in the basin planning process with regard to the agricultural nonpoint source waste components of each basin plan.

16. Any person with an interest in the agricultural nonpoint source component of the basin planning process may petition the Commissioner (DAF&M) to require, and the Commissioner may require, BMPs in the individual basin beyond accepted agricultural practices (AAPs) adopted by rule, in order to achieve compliance with the water quality goals in section 1250 of Title 10 and any duly adopted basin plan.

17. The Secretary shall retain state and federally mandated responsibilities related to basin planning, water quality management planning and the wasteload allocation process except that the Secretary shall coordinate with the Commissioner DAF&M about those aspects of basin planning and water quality management planning which relate to the agricultural NPS component of each plan.

18. The Secretary shall be responsible for determining the extent to which designated water uses and water quality standards are supported or impaired and for determining the causes and sources of water quality problems. The Commissioner DAF&M may assistthe Secretary with these determinations.

19. The Commissioner DAF&M shall cooperate with the Secretary in basin/water quality management planning processes by preparing appropriate sections of each plan which relate to the implementation of controls and programs affecting agricultural NPS wastes and runoff.

20. The wasteload allocation process results in the allocation of a river's limited assimilative capacity to receive discharges from point and nonpoint sources. The Commissioner DEC shall be responsible for the designation of wasteload allocations within specific river basins or watersheds. The Commissioner DEC

shall coordinate with the Commissioner DAF&M when making determinations regarding the magnitude of any wasteload allocation dedicated to pollution from agriculture nonpoint sources.

21. The Commissioner DAF&M shall follow the priorities identified in the most recent version of the Vermont State Clean Water Strategy, which describes the nature, location and extent of agricultural NPS pollution and the prioritization of river basins or waterbodies for further action.

22. The Commissioner DAF&M, in collaboration with the Commissioner DEC, shall conduct evaluations to determine to what extent and which land treatment measures, including BMPs, are necessary in each basin to achieve water quality standards.

23. The Commissioner DAF&M shall cooperate with the Commissioner DEC and shall be responsible for preparing descriptions of agricultural NPS programs and practices for the biennial water quality assessment report required by Section 305(b) of the federal Clean Water Act (and for the report required under Title 10 V.S.A. Chapter 47).

24. The Commissioner DEC shall retain the responsibility for evaluating the effectiveness of agricultural NPS control programs in attaining water quality standards. Such evaluations will be based on all available information with an emphasis on water quality monitoring data. The Commissioner DAF&M shall be responsible for determining the effectiveness of land use practices to reduce the release of agricultural pollutants and for compatibility with sound agricultural practices.

Lamoille River Watershed Activities Update (November 26, 2001)

Lamoille Watershed Council Formation
A Watershed Council was formed representing a diverse mix of stakeholders within the watershed. Watershed Council members represent constituents from various backgrounds including farmers, foresters, loggers, business owners, municipal officials, anglers, local watershed organizations, environmental groups, teachers, utility companies, regional planners, and ski areas. The Watershed Council is guiding the development of the watershed plan and assist in the implementation of watershed restoration projects.

Public Forums
Eight public forums were held throughout the watershed to listen to residents concerns and visions regarding water quality in the Lamoille River watershed using the Nominal Group Process. The top issues of the forums are being used to direct the Watershed Council on developing strategies, securing funds, and recruiting technical advisors to improve water quality within the basin.

The Browns River Watershed Council in conducted 4 additional public forums to hear from watershed residents.

Assessments
Stream stability assessments have been completed for Lamoille, Caledonia, and Orleans Counties sponsored by FEMA Project Impact and the 4 Natural Resource Conservation Districts within the watershed. The assessments will be used to target unstable stream segments for flood remediation and infrastructure protection and to identify reference stream segments for protection.

A FEMA Project Impact sponsored stream stability assessment is underway in the Wild Branch watershed. The Vermont Geologic Survey is undergoing this assessment that will lead to the development of a non-flood plain hazard map for the Towns of Wolcott and Craftsbury for future town planning guidance.

Several municipal road improvement projects were inventoried and funding secured for restoration projects. Municipal road and bridge improvement projects have been completed in Johnson, Cambridge, and Hyde Park. Municipal infrastructure projects included stone and grass lining of road drainage ditches, culvert and bridge replacement, and the purchase of a hydro-seeder to encourage the revegetation of disturbed vegetation.

A stream reach was inventoried for possible sources of pollutants of an impaired tributary to the Brewster River in Cambridge.

Riparian Buffer Initiative
US Fish and Wildlife Service, Natural Resources Conservation Service, and the Lamoille County Conservation District to identify, assess, and implement streamside buffer programs through the *Trees for Streams, Conservation Reserve,* and *Partners for Fish and Wildlife* programs. New buffers were established on over 5 miles of streambank in the last 2 years.

Watershed Restoration Projects

A stream restoration projected was completed using the Natural Channel Design concepts on Foot Brook in Johnson. This site was designated a high priority site for restoration due to its proximity to infrastructure in the *Stream Stability Assessment of Lamoille County*. This was a collaborative project which included FEMA Project Impact, Lamoille County Planning Commission, US Fish and Wildlife Service, Vermont Fish and Wildlife, VDEC River Management Section, USDA Natural Resources Conservation Service, Lamoille County Natural Resources Conservation District, Lamoille River Anglers Association, and local landowners.

The Vermont Youth Conservation Corps completed streambank restoration projects on 8 sites using soil bioengineering techniques.

Numerous site visits and meetings were held in a collaborative effort to identify and remediate non-point source pollutants to Deer Brook, which is an impaired stream in Georgia. Georgia and Milton town officials, Vermont Agency of Transportation, and VDEC technical staff from Wetlands, Stormwater, Planning, and Hydrology/Act 250 have been involved in this process.

Two ANR and USDA NRCS stream stability restoration projects have been identified and surveyed on the Lamoille River and Gihon River. These projects will be designed in the winter of 2001-2002 and implemented in spring of 2002.

Outreach and Education

Numerous newspaper and radio interviews were conducted and articles written on the Lamoille River Watershed Planning process including the *Stowe Reporter, News and Citizen, Hardwick Gazette, VNRC Newsletter,* and UVM's *Food for Thought* program.

Presentations and field workshops were conducted to several area high school and middle school classes as well as Johnson State College and Sterling College. Training was provided on stream stability assessment methodology to Sterling College students.

Several public meetings regarding the possible removal of Jackson Dam in Hardwick were sponsored by the Vermont Natural Resources Council and the Lamoille River Anglers Association.

Presentations were held on the Lamoille River planning process to the Vermont Planners Association, Arrowhead Mountain Lake Association, and Lamoille River Anglers Association.

Additional water quality improvement workshops are being planned for winter and spring 2002. Topics include:

- Construction site erosion control measures
- Stream instability and flooding
- Municipal road improvement demonstrations
- Alternatives to streamside storing of snow removal
- Development, sprawl and working landscapes

White River Watershed Activities Update (December 10, 2001)

Release of the White River Basin Working Draft
The first of 17 Basin Plans for the State of Vermont was prepared and released (as draft) in September 2001.

Third Branch Assessment Completed
The Agency's Geology and Water Quality Divisions and the White River Partnership will expand the work done by USDA to include fluvial geomorphological information on all of the 18 tributaries of the Third Branch. This work will be used to produce the following:

- a map of hazard areas including flood and erosion hazard areas; and
- a specific plan for channel protection, management, and restoration along the Third Branch.

A hazard map identifies areas of high risk for bank failure and erosion during flooding. With these maps, towns can clearly identify areas where development would be an unwise investment on the land. The Vermont Geologic Survey will produce a hazard map for the Third Branch of the White River Basin in 2002.

The hazard map will be beneficial to towns adjacent to the Third Branch in their planning efforts. The map could be used to help situate development to avoid property loss and to protect riparian corridors from unwise encroachments. The data collected to produce the map can also be used to develop a plan for channel protection, management, and restoration.

- The Agency will work with volunteers from the White River Partnership on the Third Branch to collect data on slope and river instability (fluvial geomorphological information). The use of volunteers will enable the data to be collected in a relatively short time-period.

Upper White River Restoration Project in Granville
The combined effects of historical efforts to increase channel capacity by gravel mining and a 1998 flood event destabilized a portion of the upper river channel in Granville. State and federal agencies, towns, landowners along the river and local interests, coordinated by the White River Partnership, initiated efforts to develop a channel restoration design for about 5,000 feet of the Granville section shortly after the event. The ensuing "natural channel" design called for a two-phase project. The first phase of the restoration, which involved some 1,000 feet of channel, was completed in August, 2000 and included the installation of a riparian buffer and a series of rock vanes and weirs (grade control structures) designed to create the type of natural "step-pool channel" found in steep mountain settings. The second project phase, involving 4,000 feet of river, was largely completed in August, 2001. This phase involved extensive earth work to restore the natural width, depth, meander pattern, and slope of a "riffle-pool" channel and floodplain. Rock vanes, root wads, rock revetments, and bio-engineering methods (consisting of logs and live vegetation) were used to enhance instream habitats and stabilize river banks. The banks will be further protected and restored with willow plantings in the fall of 2001 and a riparian buffer will be planted using native woody vegetation in the spring of 2002.

Public Forums

Four public forums in November/December 2000 on basin planning were held in various locations throughout the watershed. The forum drew over 125 people to discuss concerns that were used to develop objectives and strategies in the plan.

White River Partnership E.coli Monitoring Project

The White River Partnership began a volunteer monitoring program for the purpose of developing an overall picture of water quality in the watershed and educating citizens about pollutants. The Partnership has worked with River Network and the DEC BASS lab to develop a program to measure *E. coli* levels, turbidity, temperature and conductivity. The Partnership's first field season was in the summer of 2001.

White River Partnership Public Access Site Development

Watson Park in Hartford was surveyed on July 24, 2001, and the topography has been plotted and site features are currently being plotted. Design for a non-motorized access will begin shortly and we hope to have a copy of the plans to Tad Nunez, Hartford's recreation director, and others in the near future. The Vermont Agency of Transportation site was surveyed on Thursday, September 20, 2001 and we hope to have this plotted and designed shortly. The Sharon Dam site has not been assigned a date for survey as yet, however we are anticipating a survey for this site before winter. Once these designs are reviewed and comment has been received by all key individuals, the application process for any necessary permits should be pursued by the Town representatives and/or shared amongst WQD and FED as outlined in the Memorandum from the Watershed Coordinator as of June 25, 2001.

White River Partnership Erosion Survey

With the help of the Two Rivers-Ottauquechee Regional Commission and a Clean Water Act Section 604(b) pass-through grant from the Agency, the Partnership began a project to survey erosion sites and rank the instability of sites in spring 2000. To date, the Partnership has completed the upper White River from Granville to Stockbridge. The Partnership would eventually like to create a basin-wide picture of erosion in the watershed that could help with prioritizing sites for their River Enhancement Projects.

Poultney- Mettowee Watershed Activities Update (December 28, 2001)

Mettowee River Assessment & Survey
The VDEC's watershed coordinator has been involved in many aspects of the Mettowee River Thermal Restoration Project. This includes the completion of a rapid habitat and geomorphic assessment of the mainstem and several tributaries. The assessment and survey work will contribute to the greater thermal modification project that will result in recommendations included in the basin plan for remediating the thermal impairment of the Mettowee River.

The survey work, including Total Maximum Daily Load studies, have taken place along 17 miles of the mainstem.

Stormwater Management Projects including a municipal road improvement project in Pawlet
The Town of Pawlet road crew recently installed two settling basins on Waite Hill Road. Settling basins are pre-cast concrete structures designed to catch silt and sand running off of roads before it reaches nearby rivers or streams. Left unchecked, this erosion causes a kind of water pollution called *sedimentation*. The basins are designed so that excavating equipment can clean out the gravel that gets caught and re-use it for road surfacing — with the potential of saving towns' road maintenance budgets. Funding for the six-basin Pawlet project came from the National Fish and Wildlife Foundation and the Vermont Better Back Roads Program. The Town of Pawlet provided in-kind and financial support.

The Pawlet road crew has removed two dump truck loads full of sediment from these basins already this year. With a 4-yard capacity each, that's 8 cubic yards of sediment, even in a (relatively) dry year.

Hubbardton River Watershed Initiative
The VDEC watershed coordinator has collaborated on the implementation of Hubbardton River Watershed Initiative – a demonstration Project based on the Poultney River Assessment Report done by The Nature Conservancy and Green Mountain College. A grant through the National Fish & Wildlife Foundation was awarded for the Hubbardton River Watershed Initiative, which includes a demonstration project on the mainstem of the River. Many landowners along the mainstem of the Hubbardton are participating in this unique restoration project, which will ensure a greater degree of success.

As a collaborative effort between the Partnership, state and federal agencies, this watershed restoration project will enhance streambank stabilization, riparian buffer establishment, and cattle exclusion of approximately 50 acres along the Hubbardton and Poultney Rivers.

Clean Water Act Section 604b Pass Through Project - Rutland Regional Planning Commission
The 1999 604b project summarizes and compares water quality sections of each of the town plans in the Rutland Region with the corresponding zoning and subdivision ordinances where applicable. There are 15 towns in Basin 2 where this assessment has occurred.

Wastewater treatment plant upgrades – VDEC Wastewater Management Division
The following municipal wastewater treatment plants have either recently undergone phosphorus removal projects (either through phosphorus reduction upgrade, advanced waste treatment, correction of CSOs, control of toxics, pollution prevention activities, and facility enlargements) or are in the process of doing so:

- **Castleton**, wastewater treatment plant expansion and upgrade, with addition of phosphorus removal.
- **Fair Haven**, wastewater treatment plant upgrade, with addition of phosphorus removal.
- **Fair Haven**, wastewater collection system rehabilitation, including abatement of Adams Street pump station overflow.
- **Poultney**, wastewater treatment plant expansion and upgrade, with addition of phosphorus removal.

Riparian Restoration Work
The U.S. Fish & Wildlife Service Partners for Wildlife Program together with the USDA Natural Resource Conservation Service (NRCS) and supported by the Nature Conservancy have implemented a number of livestock exclusion (fencing), buffer re-establishment (tree and shrub planting) and streambank stabilization projects along the Mettowee River, the Poultney River or tributaries to them. Between 1996 and 1999, there were 17 riparian restoration projects covering 67,650 bank feet or 12.9 miles.

Seven projects were in the Mettowee watershed which resulted in 23,500 feet (4.5 miles) of riparian zone restoration with 11 acres of upland and 20.5 acres of wetland restored or protected. Ten of the projects were in the Poultney watershed which resulted in 44,150 feet (8.4 miles) of riparian zone restoration with 38 acres of upland and 48.5 acres of wetland restored or protected.

APPENDIX D

Basin 7 Assessment Information (from Report dated February 2001)

River & Stream Use Support Status

The Lamoille River mainstem is recognized and named as beginning in the northwest corner of Wheelock, along the east side of Vermont Route 16, at the outlet of Horse Pond. It flows 84.9 miles in a generally westerly direction until it empties into outer Malletts Bay of Lake Champlain ten miles north of Burlington. It is a pool-riffle gravel bottom river for the majority of its length although there are smaller reaches of dune-ripple sand bottom and plane-bed cobble-boulder bottom. From its headwaters to the mouth, the river descends approximately 1,200 feet and drains a 706 square mile watershed, which is 7.5 percent of Vermont's land area. The basin occupies the major part of Lamoille and lesser parts of Franklin, Chittenden, Orleans, Washington, and Caledonia Counties.

Of the 611.1 miles identified to date in the Lamoille River watershed, 35% of the miles (216) fully support aquatic biota and habitat with no threats identified, 4% (27 miles) fully support this use but threats are known, 32% of the miles (197) have not been assessed, and 28% (172 miles) do not fully support aquatic biota/habitat. As discussed below, sediment and habitat alterations are the major causes of the habitat problems. Loss of riparian vegetation, streambank erosion, and channel instability result in the sediment and physical alterations that affect aquatic habitat through much of the Lamoille watershed.

Table 1. Use Support Status of Basin 7 Rivers and Streams.

Use	Miles of full support	Miles threatened	Miles of partial support	Miles of non-support	Miles not assessed
Overall	215.7	27.2	155.5	16.3	196.8
Aquatic biota/habitat	215.7	27.2	155.5	16.3	196.8
Contact recreation	198.8	74.3	39.3	0.9	297.8
Secondary contact recreation	210.7	65.9	78.9	13.5	242.1
Aesthetics	230.2	35.9	133.2	7.3	204.5
Drinking water supply	62.1	1.8	0	0.9	546.3
Agriculture water supply	0	0	0	0	611.1
Fish consumption	0	602.6	8.5	0	0

E. coli or other bacteria data needed to determine if swimming is supported is limited, and, therefore, 49% of the miles (298) are not assessed for "contact recreation". Thirty-two percent (199) of the miles fully support swimming with no identified threats, 12% (74 miles) fully support swimming with threats identified,

and about 7% (40 miles) do not fully support swimming. Failing septic systems, manure runoff, high turbidity, severe siltation, and lack of flow are the reasons that the swimming use is partially to non-supported.

Secondary contact reaction, primarily fishing, is fully supported with no known threats for 34% (211) of the river miles. This use is fully supported but threatened on 11% (66) of the miles. Fishing is partially or not supported on 15% (92) of the miles. Forty percent of the miles were not assessed for this use. Fishing was not fully supported where there were habitat alterations, sedimentation, flow alterations, and temperature modification.

Fish consumption is considered threatened statewide because there is a "health alert" that recommends that people limit consumption of fish caught in Vermont waters. Where there is waterbody-specific fish tissue data showing high levels of mercury or PCBs then the miles of river or stream containing the contaminated fish are listed as partial or non-support. In the Lamoille River watershed, 99% (603) of the miles are considered threatened for fish consumption and 1% (8.5 miles) are partially supported because of mercury in walleye that were sampled at the mouth of the Lamoille.

Thirty-eight percent of the river miles are fully supported (230 miles) and 6% (36 miles) are fully supported but threatened for aesthetics. Twenty-three percent of the river miles do not fully support aesthetics and 33% of the miles were not assessed for this use. Physical alterations to the stream channel, streambank erosion, low flow, turbidity, and excessive algae all affect the support status of aesthetics.

Causes and Sources of Impacts & Threats

The major causes of impacts to the Lamoille River and its tributaries are sediment and habitat alteration/channel instability, which are integrally connected. Nutrients and thermal modifications affect the third and fourth greatest number of miles. See Table 2 below for the cause (a pollutant or condition) and the number of miles affected by each cause.

Riparian vegetation removal, streambank erosion, floodplain encroachments, floods, and agricultural land uses are the five top sources that affect the water quality and aquatic habitat of the Lamoille River (Table 3). Again these sources are integrally related. Agricultural land use in the productive floodplain of the Lamoille resulted in some riparian vegetation removal. The lack of vegetation along, and back from, the riverbank is often a major contributing factor to streambank erosion and channel instability. The habitat alteration and flood damage was greatly exacerbated by the unstable condition of the river and the lack of riparian vegetation along the Lamoille and some of its tributaries such as the Wild Branch. The dams and impoundments for hydro-electric production on the Lamoille also alter the river's condition by degrading water quality, substrate composition and thermal regime from flow fluctuations, drawdowns, and desilting.

Table 2. Causes of River Impacts and Threats in the Lamoille Watershed.

Cause or Pollutant	Miles of high impact	Miles with moderate impact	Total miles of impact	Miles threatened
Sediment	64.9	91.1	156.0	25.0
Habitat alteration	77.7	69.7	147.4	17.9
Nutrients	2.5	83.3	85.8	9.5
Thermal modifications	0	82.2	82.2	5.0
Flow alterations	20.5	17.9	38.4	5.0
Turbidity	0	33.8	33.8	0
Pathogens	0	31.8	31.8	48.0
Low dissolved oxygen	0	8.5	8.5	0

Table 3 . Sources of River Impacts and Threats in the Lamoille Watershed.

Source	Miles of high impact	Miles with moderate impact	Total miles of impact	Miles threatened
Riparian vegetation removal	15.0	111.5	126.5	6.5
Streambank erosion	61.3	48.8	110.1	11.2
Floods	26.8	80.2	107.0	0.4
Habitat modification*	58.9	46.5	105.4	11.9
Agriculture	8.5	92.3	100.8	26.0
Flow modification - hydro	9.7	21.0	30.7	5.0
Road/bridge runoff	0	30.2	30.2	8.2
Land development	0	26.9	26.9	7.0
Upstream impoundment	0.9	24.2	25.1	5.0
Urban runoff	0	15.7	15.7	0
Road/bridge construction	15.5	0	15.5	1.5

*Habitat modification - sum of channel instability, floodplain encroachments, and past instream work that has led to current channel adjustment.

Assessment of Lakes and Ponds in the Lamoille River Basin

The Lamoille River Basin is characterized by having numerous lakes. There are 79 lakes and ponds in the basin, comprising 4,268 acres. Forty-eight of these lakes (4,144 acres) are tracked in VDEC's Lake Assessment Database. Of these 4,144 acres, 3,739 are monitored (24 lakes) while 405 are evaluated (24 lakes).

Overall and Individual Use Support, Causes, and Sources of Impacts to Lakes in the White River Basin

Overall, there are 1,493 lake acres in Basin 7 which only partially support one or more uses, and 115 acres where one or more uses are precluded. All designated uses are fully supported on 2,507 assessed lake and pond acres in Basin 7. Table 4 provides an accounting of lake acres where designated uses are supported, threatened, or not fully supported.

Table 4. Designated use support for lakes in the Lamoille River Basin.

Use	Acres fully supporting uses	Supporting acres with uses threatened	Acres partially supporting uses	Acres not supporting uses	Acres not assessed
Overall Uses	459	2048	1493	115	29
Aesthetics	3195	805	0	114	30
Aquatic Life Use Support	459	2048	1607	1	29
Agricultural Water Supply	0	0	0	0	4144
Drinking Water Supply	27	0	0	0	24
Fish Consumption	3344	0	760	0	40
Filtered Water Supply	27	0	0	0	4117
Industrial Water Supply	0	0	0	0	4144
Secondary Contact Uses	3012	695	293	114	30
Swimming Uses	3153	847	0	114	30

The principal cause of impairment to lakes in the Lamoille River Basin is flow alteration (drawdown of water levels) which affects aquatic life uses on several lakes as discussed in section III (below) for a total of 1,607 acres. Mercury contamination in fish tissue impairs 760 acres. Critically low pH in a tiny pond impairs aquatic life uses on one lake acre, but an additional 899 acres are threatened by low buffering capacity, which could lead to episodic low pH events. Siltation impairs aquatic life uses in the 194 acre Hardwick Lake and is noted as a threat to uses on 295 additional acres, though some reassessment of this threat is warranted (see section IV below). The consequences associated with existing or potential infestations of exotic species impair 114 acres, and threaten an additional 434 lake acres. Table5 provides an accounting of the causes of impacts to lakes in this basin.

Table 5. Causes of impacts to lakes in the Lamoille River Basin.

Cause of impact	Acreage by magnitude of impact			Total acres not fully supporting	Total acres threatened
	High	Moderate	Minor		
0500 Metals	0	760	0	760	0
0560 Mercury	0	760	0	760	0
0900 Nutrients	0	0	0	0	421
1000 pH	1	0	0	1	899
1100 Siltation	0	145	0	145	295
1200 Organic enrichment - DO	0	0	0	0	100
1500 Flow alteration	1607	0	0	1607	1470
2200 Noxious aquatic plants - Native	0	0	0	0	25
2210 Noxious aquatic plants - Algae	0	0	0	0	163
2600 Exotic Species	114	0	0	114	434

The most important source of impairment to Lamoille River Basin lakes is flow regulation which impairs 1,607 lake acres due to habitat modification and partial loss of aquatic life uses. Atmospheric deposition is largely the source of mercury found in fish tissue, and this impairs fish consumption uses on 760 lake acres. Atmospheric deposition is also responsible for the critical acidification of one lake acre, and threatens an additional 899 acres. Some of these waterbodies may also exhibit natural sensitivity to acidification, which explains some of the 861 threatened acres attributable to natural sources. Boating traffic ('in-water releases') among waterbodies is assumed to be the primary vector for Eurasian watermilfoil (Myriophyllum spicatum) introduction to lakes. This impairs 114 lake acres and threatens an additional 395 acres. Boating traffic also threatens an additional 194 acres due to shoreline erosion. Finally, general land development and construction threatens 364 lake acres with sedimentation and/or organic enrichment. Table 6 provides an accounting of the sources of impairment and threats to lakes in the Lamoille River Basin.

Table 6. Sources of impacts to lakes in the Lamoille River Basin.

Source of impact	Acreage by magnitude of impact			Total acres not fully supporting	Total acres threatened
	High	Moderate	Minor		
1000 AGRICULTURE	0	0	0	0	64
1100 Nonirrigated Crop Production	0	0	0	0	21
1800 VT-Animal holding/management area	0	0	0	0	42
2000 SILVICULTURE	0	0	0	0	35
2100 Harvesting, Restoration, Residue Management	0	0	0	0	35
3000 CONSTRUCTION	0	0	0	0	364
3200 Land Development	0	0	0	0	364
4000 URBAN RUNOFF/STORM SEWERS	0	0	0	0	153
4300 Other Urban Runoff	0	0	0	0	148
4500 Highway/Road Bridge Runoff	0	0	0	0	5
5000 RESOURCE EXTRACTION	0	0	0	0	15
5100 Surface Mining	0	0	0	0	15
7000 HYDROMODIFICATION	1607	0	0	1607	515
7400 Flow Regulation/Modification	1607	0	0	1607	436
7900 MARINAS AND RECREATIONAL BOATING	114	0	0	114	589
7910 In-Water releases	114	0	0	114	395
8100 ATMOSPHERIC DEPOSITION	1	760	0	761	899
8300 HIGHWAY MAINTENANCE AND RUNOFF	0	0	0	0	211
8600 NATURAL SOURCES	0	1	0	1	861

Basin 11 Assessment Information (from Report dated November 2001)

River & Stream Use Support Status

The Basin 11 planning unit includes three watersheds: the West, Williams, and Saxtons Rivers watersheds. Basin 11 is located in the southeastern corner of Vermont and drains the eastern slope of the Green Mountains. It covers approximately 395,520 acres. The rivers and their tributaries flow down from the mountains through the foothills and across the Vermont Piedmont to the Connecticut River Valley where they join the Connecticut River. The Williams River joins the Connecticut River in Rockingham, the Saxtons River joins the Connecticut River in Bellows Falls, and the West River joins it in Brattleboro. There are approximately 431.8 river miles total assessed for Basin 11.

Table 1. Use Support Status of Basin 11 Rivers and Streams.

Use	Miles of full support	Miles threatened	Miles of partial support	Miles of non-support	Miles not assessed
Overall	235.4	72.2	120.5	3.7	0
Aquatic biota/habitat	235.4	82.7	110.0	3.7	0
Contact recreation	364.3	51.0	14.0	2.5	0
Secondary contact recreation	291.8	22.6	114.9	2.5	0
Aesthetics	320.0	70.0	39.3	2.5	0
Drinking water supply	46.9	0.1	0	2.5	382.3
Agricultural water supply	15.9	0.1	0	2.5	413.3
Fish consumption	0	431.8	0	0	0

The designated use most affected by pollution or undesirable conditions is secondary contact recreation (fishing and the fishery) with aquatic habitat/biota closely following in terms of miles having impacts. Water temperature data showed that a number of stretches in all three watersheds of the basin had high temperatures that affect the health and sustainability of the fishery and its habitat. Sedimentation and physical habitat alterations also affected the aquatic habitat and its inhabitants.

Aesthetics is the third most affected designated use. The loss of riparian vegetation, physical alterations to the channel, streambank erosion and the resulting sedimentation all have an impact on, or threaten, aesthetics.

There were not as many miles where contact recreation was not in full support. Impacts to this use are listed where *E. coli* data indicate potential pathogen problems or where physical alteration to the river or stream diminished the opportunity for swimming.

The miles of full support, threatened, partial support, and non-support for each use for each river segment or tributary watershed (waterbody) are given in tables in the individual waterbody reports in Appendix E. A narrative is also given in these individual reports that explains the causes and sources responsible for the lack of full support or the threats.

Causes and Sources of River Impacts & Threats

Causes are the pollutants or conditions that threaten or have an impact on the aquatic biota, the aquatic habitat, swimming, fishing, the fishery, boating, drinking water supply, fish consumption or other "uses" of the river or stream. The top causes of riverine water quality or aquatic habitat problems in Basin 11 are listed in Table 2 below along with the miles of river or stream that they affect. These are discussed in more detail below.

Table 2. Causes of River Impacts and Threats in Basin 11.

Cause or pollutant	Miles of high impact	Miles with moderate impact	Total miles of impact	Miles threatened
Thermal modification	76.2	30.8	107.0	36.0
Sedimentation	3.0	54.8	57.8	97.0
Physical habitat alteration	0	44.3	44.3	39.5
Flow alteration	21.9	12.0	33.9	12.5
Nutrients	0.5	10.5	11.0	13.5
pH	0	8.4	8.4	0
Pathogens	0	7.0	7.0	17.0
Metals	0.5	0	0.5	8.6

Sources are the land uses, human activities, or occurrence of conditions responsible for the causes named above and that are the origin of the impacts on river or stream water quality or aquatic habitat. Table 3 below lists the primary sources of river and stream impacts and threats in the basin.

Table 3. Sources of River Impacts and Threats in Basin 11.

Source	Miles of high impact	Miles with moderate impacts	Total miles of impact	Miles threatened
Riparian vegetation removal	26.5	69.0	95.5	36.0
Streambank destabilization	0.5	44.8	45.3	65.5
Flow regulation/modification	33.9	1.3	35.2	18.0
Channelization	7.0	14.5	21.5	33.3
Road/bridge runoff	0	20.8	20.8	57.0
Upstream impoundment	20.4	0	20.4	6.0
Land development	2.5	14.5	17.0	37.0
Agricultural activities	0	12.5	12.5	8.0
Recreational activities	1.0	10.0	11.0	6.5

The cause of most river or stream miles with impacts is thermal modification or water temperatures that are too high to fully support a coldwater fishery. Removal of the riparian trees and shrubs, which is the source affecting the most river miles, results in these higher temperatures. Dams and the resulting impoundment of water also results in higher downstream water temperatures. Much of the Williams River and West River as well as the lower half of the Saxtons River have high temperatures in the summer, which have an impact on the coldwater fishery.

Sedimentation is the second greatest cause of impacts to the rivers and streams in this basin. It is also the largest threat to aquatic habitat, biota, and other uses of these waters. Sources of sediment include streambank erosion, land development and road runoff among others.

Physical habitat alterations are a result of flow regulation, channelization/instream modification, road and bridge work, and channel instability. Other pollutants or conditions affecting the rivers or streams in this basin include flow alteration primarily from the two Army Corps of Engineers flood control dams, nutrients primarily from agricultural land activities, low pH as a result of acid rain and pathogens possibly from failed septic systems.

Assessment of Lakes and Ponds in the West, Williams, and Saxton's River Basins

West, Williams, and Saxton's River Basins are characterized by having relatively few lakes. There are 49 lakes and ponds in the three basins, comprising 1,030 known acres. Twenty-nine of these lakes (1,005 acres) are tracked in VDEC's Lake Assessment Database. Of these 1,005 acres, 775 are monitored (11 lakes), while 230 are evaluated (18 lakes).

Overall and Individual Use Support, Causes, and Sources of Impacts to Lakes in the West, Williams, and Saxton's River Basins

Overall, there are 360 lake acres in the Basins which only partially support one or more uses, and 21 acres where one or more uses are precluded. All designated uses are fully supported on 624 assessed lake and pond acres. Table 4 provides an accounting of lake acres where designated uses are supported, threatened, or not fully supported.

Table 4. Designated use support for lakes in the West, Williams, and Saxton's River Basins.

Use	Acres fully supporting uses	Supporting acres with uses threatened	Acres partially supporting uses	Acres not supporting uses	Acres not assessed
Overall Uses	88	536	360	21	0
Aesthetics	746	66	193	0	0
Aquatic Life Use Support	88	543	353	21	0
Agricultural Water Supply	0	0	0	0	1005
Drinking Water Supply	101	0	0	0	0
Fish Consumption	1005	0	0	0	0
Filtered Water Supply	101	0	0	0	904
Industrial Water Supply	0	0	0	0	1005
Secondary Contact Uses	939	66	0	0	0
Swimming Uses	939	66	0	0	0

The two principal causes of impairment to 193 acres in these watersheds, flow alteration and siltation, are both related to operation of two flood control reservoirs, which affects aquatic life uses. The critically low pH exhibited by several ponds impairs aquatic life uses on 181 lake acres. An additional 533 acres are threatened by acidification due to their low buffering capacity, which renders lakes susceptible to episodic low pH events. Table 5 below provides an accounting of the causes of impacts and threats to lakes in these basins.

Table 5. Causes of impacts and threats to lakes in the West, Williams, and Saxton's River Basins.

Cause of Impact	Acreage by Magnitude of Impact			Total Acres Not Fully Supporting	Total Acres
0900 Nutrients	0	0	0	0	10
1000 pH	181	0	0	181	533
1100 Siltation	85	108	0	193	41
1200 Organic enrichment - DO	0	0	0	0	15
1300 Salinity - TDS - chlorides	0	0	0	0	9
1500 Flow alteration	193	0	0	193	7
2200 Noxious aquatic plants - Native	0	0	0	0	25

The most important source of impairment to lakes in the West, Williams, and Saxton's River Basins is hydromodification, which impairs 193 lake acres due to habitat modification and partial loss of aquatic life uses. Shoreline destabilization, related to flow modification, impairs 85 acres on one flood control impoundment. Atmospheric deposition has critically acidified 181 lake acres, and presently threatens an additional 533 acres. Some of these acid-threatened waterbodies may also exhibit natural sensitivity to acidification, which explains the 533 threatened acres attributable to natural sources. Finally, general land development, construction, and associated shoreline destabilization threatens 41 lake acres. Table 6 provides an accounting of the sources of impairment and threats to lakes in the West, Williams, and Saxton's River Basins.

Table 6. Sources of impacts to lakes in the West, Williams, and Saxton's River Basins.

Source of impact	Acreage by magnitude of impact			Total acres not fully supporting	Total acres threatened
	High	Moderate	Minor		
3000 CONSTRUCTION	0	0	0	0	41
3200 Land Development	0	0	0	0	41
7000 HYDROMODIFICATION	193	0	0	193	7
7400 Flow Regulation/Modification	193	0	0	193	7
7550 HABITAT MODIFICATION (OTHER THAN HYDROMOD)	0	85	0	85	0
7600 Removal of Riparian Vegetation	0	85	0	85	0
7700 Streambank Modification/Destabilization	0	85	0	85	41
8100 ATMOSPHERIC DEPOSITION	181	0	0	181	533
8300 HIGHWAY MAINTENANCE AND RUNOFF	0	0	0	0	9
8600 NATURAL SOURCES	9	96	76	181	533

Partial Basin 16 Assessment Information (from Draft Report July 2001)

Nulhegan River Watershed

The Nulhegan River, one of several river waterbodies in Basin 16, originates east of Spectacle Pond in the town of Brighton. It flows in an easterly/southeasterly direction through a wide, flat valley of shrub swamp for much of its 16 mile length. The drainage area of the Nulhegan is 151 square miles. The four major tributaries to the Nulhegan are the East Branch (13 miles long), the Black Branch (12 miles), the Yellow Branch (10 miles), and the North Branch (12 miles).

The streams that were sampled in the Nulhegan River watershed in summer 2000 are fairly dilute with specific conductances of 14-60 μmhos. The total variation in pH among the sites sampled was 5.45-7.68. The three sites on the Yellow Branch of the Nulhegan River had the lowest pH values and alkalinities (pH 5.45 - 5.83, and alkalinity 2- 4.5mg/l). These values represent summer flows and likely are considerably lower during spring snow melt events, which often bring the highest acidities of the year. As a result, the pH values and alkalinity in the Yellow Branch will be limiting to sensitive fish and macroinvertebrate taxa especially in the orders Ephemeroptera, Bivalvia, and Gastropoda. Other stream reaches that also had low alkalinity and therefore probably undergo a period of low pH in the spring are: Tuffield-Willey and Bluff Mountain Brooks. The low pH and alkalinity of these two streams indicates that other, very high elevation (greater than 600 meters) streams with small watersheds, most likely undergo a period of very low pH and alkalinity.

Fish Assemblages

Twelve sites from eight streams and rivers were sampled within the Silvio Conte lands of the Nulhegan drainage. A total of 450 fish from 16 species were collected. The Vermont Department of Fish & Wildlife collected an additional two species and a total of 31 Atlantic salmon, two brook trout, one brown trout and one rainbow trout at river mile 1.8 of the Nulhegan in 2000. The 18 species collected during this survey can be compared to the 30 species actually collected historically from Vermont waters of the Connecticut River drainage. There are seventy-nine species native to Vermont, with potentially 39 occurring in Vermont waters of the Connecticut drainage. All 18 species collected in 2000 had already been recorded in Vermont waters of the Connecticut drainage. Species richness per site ranged from 1-9.

There were no state or federally-listed species collected during 2000, nor have any been reported in past surveys. Sixteen of the species collected were classified with "common or "widespread" distributions. The burbot and lake chub have "uncommon" distributions across the Vermont. Only two species collected, rainbow and brown trout, are non-native to Vermont.

IBI values could be generated from only three of 12 sites in the Silvio Conte Refuge (SCR). The three sites scored 36 (rating of "very good"), 39 ("excellent") and 9 ("poor"). Five of the sites were classified as low gradient . No IBI has been developed as yet for this assemblage type. Two sites supported only brook trout and consequently did not provide enough information to calculate an IBI. Three sites were qualitatively sampled and did not provide data of suitable quality to calculate an IBI.

The "poor" evaluation given the Yellow Branch-Nulhegan site (river mile 7.6) may have been due to natural limitations of that river reach. The site was located immediately downstream from an open-canopied low-gradient section of stream. Summer water temperatures may have been elevated in this area to an extent where coldwater species were excluded . This was not evident, however, in the water temperature recorded at the time of sampling (12 ^{0}C, at 1225 on August 21). A pH of 5.45 is potentially limiting for some species at this site. Brook trout or slimy sculpin, however, are both more resistant to low pH than blacknose dace, which dominated this section. Additional nearby stream sections should be re-sampled to clarify the condition of the fish assemblage of this reach.

Macroinvertebrate Assemblages

A total of 223 taxa were identified from the 17 stream sites sampled within the SCR lands of the Nulhegan River watershed. Aquatic insects were the dominant macroinvertebrate class with 195 taxa, broken down by insect order as follows: 81 Diptera (58 Chironomidae), 44 Trichoptera, 19 Coleoptera, 18 Ephemeroptera, 17 Plecoptera,, 9 Odonata, 2 Megaloptera, and 4 Hemiptera. The remaining taxa were mainly from the class Mollusca, Gastropoda (eight), and Bivalvia (six). This by no means should be considered even close to a complete taxa list of the macroinvertebrate species from running waters within the SCR lands of the Nulhegan River watershed. It is, however, a good representation of the taxa groups found in the stream during the late summer. None of the taxa collected are listed as threatened or endangered in Vermont or the United States. Most of the taxa collected are common in Vermont running waters, and all of the taxa collected are considered native to Vermont. The Trichopteran, *Palaegapetus celsus* is uncommon, found from only 17 other locations in Vermont, and highly associated with small acidic montane streams with liverwort present, which it uses to build its case. The Coleopteran, *Ancyronyx variegata* has only been collected from six other stream sites by the VDEC . This may however be due to its habitat of burrowing under bark of decaying logs, making it difficult to collect with the methods typically employed.

The macroinvertebrate assemblage integrity was evaluated from 12 of the 17 stream reaches sampled for macroinvertebrates. The stream reaches from the SCR were assigned into an assemblage type based on stream size, elevation and alkalinity. Nine of the reaches were evaluated under the Small High Gradient category and three the Medium High Gradient category. The remaining reaches were considered low gradient meandering streams that could not be quantitatively assessed using the above protocols. Eight of the 12 stream reaches were rated as either very good or excellent. These streams would be considered very near reference condition compared to other streams from a similar category in Vermont. The four other streams were rated good condition; moderately altered from the natural condition, but still considered to be meeting their Class B water quality management designation. Two of these streams were comparatively lower in EPT richness, one in density, and one in PPCS-f. Two of these streams had moderately elevated Bio Index values. The low EPT and density values are probably an effect of the low pH stress in Tuffield-Willey and Yellow Alder Brook. The elevated Bio Index and PPCS-f from the North Branch Nulhegan River (river mile10.5) and Yellow Branch Nulhegan River (river mile 7.6) may be due to the extensive wetlands upstream of these sites. It may also be due to the extensive logging that has historically occurred in these watersheds. Overall, all the stream reaches were of good quality or better with no impaired reaches identified within the Silvio Conti National Refuge.

Paul Stream watershed & Wheeler Stream watershed

The stream sites from the Paul Stream watershed and the Wheeler Stream watershed ranged in watershed size from 3.5 to 113 km^2, and at elevations from 286 to 628 m above sea level. The data indicate the waters of these drainages are somewhat soft with specific conductances ranging from 26-41 μmhos, and alkalinities from 6.2- 21.3 mg/l. Measured pH was near neutral and ranged between 6.51-7.52. Within the Paul Stream watershed, the smaller streams generally had lower alkalinities (less than 10 mg/l). Dennis and Notch Pond brooks had significantly higher alkalinity than all the other stream sites.

Fish Assemblages

A total of 1,763 fish from 20 species were collected from the ten stream sites. In addition to this, a collection conducted by the Vermont Department of Fish & Wildlife on lower Paul Stream (river mile 3.1) tallied 124 Atlantic salmon and 10 brook trout and an undetermined number of non-game species. Of the 79 fish species native to Vermont, there is potential for up to 39 species to occur in the Vermont waters of the Connecticut valley. Thirty native species were *actually* recorded, historically from this drainage. All twenty species collected in 2000 had already been recorded in the Connecticut drainage. Species richness per site ranged from 1 to13.

Three non-native species were recorded; two brown trout from two sites and a single bluntnose minnow from one site. For all collections made in 2000, blacknose dace, white sucker and brook trout were the most common species, occurring at nine, seven and seven sites respectively. Other common species included longnose dace and creek chub, recorded at six and five sites each respectively. No state or federally listed species were collected in the West Mountain WMA. No listed species have been historically reported from this drainage. Species state-wide occurrence is categorized here as "abundant", "common", "uncommon" or "rare", based on the 9000-record VT ANR database. No rare fishes were collected. Finescale dace and burbot were the least common species, being rated as "uncommon". Ten species were regarded as "common" and nine were considered as having a "wide-spread"state distribution.

Of the 10 sites sampled in the West Mountain WMA, six could be evaluated for biological integrity using one of the two IBIs. The North Branch Paul Stream site supported only brook trout (to apply the CWIBI there must be at least two species). Two sites on Paul Stream were Type 4 - low gradient- sand bottom sites (no appropriate IBI has yet designed to apply to this type of site). One site was only sampled qualitatively for species presence and therefore the data were not of sufficient quality to generate a score. Where IBI scores could be calculated, scores ranged widely for the six sites: 31 ("good") to 45 ("excellent"). All sites where an IBI was calculated met the State Water Quality Standard biocriteria for fish assemblages of Class B waters.

Macroinvertebrate Assemblages

A total of 147 taxa were identified from the seven stream sites sampled within the West Mountain WMA. Aquatic insects were the dominant macroinvertebrate class with 131 taxa, broken down by Insecta order as follows: 52 Diptera (37 Chironomidae), 31 Trichoptera, 16 Ephemeroptera, 15 Plecoptera, 7 Coleoptera, 6 Odonata, 2 Megaloptera, and 2 Hemiptera. The remaining taxa were

mainly from the Gastropoda (5) and Bivalvia (4). This should be by no means considered even close to a complete taxa list of the running waters from the West Mountain WMA. It is however, a good representation of the taxa groups found in these streams during the late summer. None of the taxa collected are listed as threatened or endangered in Vermont, or the United States. Most of the taxa collected are common in Vermont running waters, and all of the taxa collected are considered native to Vermont. The Coleopteran, *Microcylloepus pusillus* is somewhat uncommon being found in only seven rivers in the VDEC Biomonitoring database. It was found in Dennis Pond Brook and may be somehow connected to streams below ponds or wetlands.

The integrity of the macroinvertebrate assemblage was evaluated from six of the seven stream reaches. The stream reaches from the Paul Stream drainage were assigned into an assemblage type based on stream size, elevation and alkalinity. Three of the stream reaches were considered to be Small High Gradient streams, and three Medium High Gradient streams. The seventh, Paul Stream rm 12.8, is a slow, meandering stream that appears to be of good biological integrity, however it could not be quantitatively evaluated using the protocols in the above document. The biological integrity from two of the Small High Gradient streams was rated as excellent or within the range of natural condition. Dennis Pond Brook was rated as very good or exhibiting only a minor change from the expected condition. This evaluation was due to a lower then expected number of EPT taxa and a slightly elevated Bio Index value and may have been a result of the natural influence of significant wetlands and a pond immediately upstream from the reach sampled. The macroinvertebrate assemblage was also somewhat atypical for a SMT in that a number of warm water taxa were present, including *Chimarra atterima*, and *Stenelmis sp.*

APPENDIX E

September 21, 2001

Section 604(b)
Pass Through Projects Inventory
FFY89 - FFY01
(all projects completed unless noted with completion date)

Addison County Regional Planning Commission

Pass funding through to the Middlebury River Watershed Group to allow them to conduct a study of possible sources of increased E-coli levels on an impaired branch of the Middlebury River. (01/01/02)
Develop, for the region, digitally referenced surface waters. Phase II.
Develop, for the region, digitally referenced surface waters and augment existing surface water data by adding certain attribute information. Phase I
Develop priorities for Little Otter Creek watershed water quality improvement. Phase II
Develop priorities for Little Otter Creek watershed water quality improvement by reducing phosphorus transport from agricultural and other land uses to Lake Champlain. Phase I.
Map on-site septic system info for four towns and support On-Site Sewage Committee proposed legislation.
Report on satellite imagery land cover conditions for certain watershed, conduct additional mapping of conditions in Lewis Creek watershed, continue coordination with USDA, sponsor on-site regional meeting.
Assist New Haven River lay monitoring, continue agricultural NPS mapping efforts in certain watersheds, develop capability to utilize LANDSAT TM technology.
Locations of watershed boundaries for seven drainages, of approved (USDA/SCS) agricultural runoff control systems, watershed pollutant loading reductions (incomplete).
Land use/land cover for watersheds of Lake Dunmore and Fern Lake.
Prepare local planning guides for flood plains, wetlands and special/natural areas.
Land use/land cover for Wellhead Protection Areas throughout the region.
Mapped zoning district boundaries within WHPAs of the region.
Evaluation of potential for development within each WHPA of region.
Assist with Lake Champlain Committee's "Planning Manual & Checklist."
Inventory source, number served and the extent of service areas for community and municipal drinking water systems of the region.

Bennington County Regional Commission

Develop digitally-referenced surface waters and augment existing surface water data by adding certain attribute information.
Review municipal health ordinances and related zoning-subdivision regulations and make recommendations for updating such ordinances so they are current and enforceable and protect the state's waters.
Map ground water source protection areas, overlaid with E911 data for all towns in the region.
Update water resources element of the regional plan, survey conservation commissions to identify conditions which either impact or improve water quality, develop study design and scope of work to prepare comprehensive basin/watershed management plan for region and host a meeting on the proposed on-site sewage rules/regulations.
Locate flood hazard areas (i.e. FEMA lines) for Rupert; integrate flood hazard info with wetlands-related information; enhance town-wide water resources planning efforts.
Characterize existing and projected water consumption and use in region, produce greater awareness of management strategies for source supplies.
Collect data for existing water consumption and use for Bennington County.
Location of flood hazard areas (i.e. FEMA lines) for Dorset.
Location/extent of wetlands in Dorset from NWI maps.
Flood hazard area (ie FEMA lines) for Bennington, overlay with NWI wetlands.
Location of flood hazard areas (ie FEMA lines) for Sunderland & Arlington.
Location of flood hazard areas (ie FEMA lines) for Manchester.
Location/extent of surface water classifications in region. Location/extent of six use restricted waterbodies of the region.
Location/extent watershed boundaries for 14 lakes & ponds in the region greater than 20 acres.
Location/extent of WHPAs in region, attribute information for WHPAs.

Highlight NWI information for region.
Develop a VT Hoosic River Watershed Ground Water Protection Strategy.

Central VT Regional Planning Commission

Continue development of a GIS "Impervious Surfaces" data layer for the Thatcher Brook, Great Brook Shepard Brook and Mill Brook watersheds. (4/25/02)
Initiate development a GIS "Impervious Surfaces" data layer to track growth and evaluate cumulative growth impacts in order support policies that limit or reduce the amount of impervious surfaces, initially in the Mad River watershed.
Review municipal plans and zoning regulations and make recommendations for additional water quality protection in 23 towns in the region.
Map unstable banks on the Mad River to assist with the creation of filter strips (filter strips done by others).
Develop a series of planning maps for each town , showing information developed in previous water quality and surface water inventories.
Enter onto the regional GIS the location of all cascades, waterfalls, gorges and whitewater sections in the Region, assist the Dept. with a regional public meeting regarding the status of the on-site sewage reform legislation.
Develop (for remainder of region) digitally referenced surface waters by Waterbody ID and calculate Waterbody sizes; augment existing surface water data by adding certain attribute info.
Develop (for Duxbury, Northfield & Roxbury) digitally referenced surface waters and attributes, sponsor on-site regional public meeting.
Develop (for Fayston & Warren) digitally referenced surface waters and attributes.
Land use/land cover within WHPAs and watersheds of public surface water supplies throughout region.
Land use/land cover for Town of Woodbury at 1:5000 scale.
Land use/land cover for watersheds of at least 5 lakes and ponds in Woodbury, spatial analysis of 5 watersheds.
Sponsored WNRCD to develop soil erosion control handbook for construction equipment operators.
Location/extent of watershed boundaries for lakes/ponds in region greater than 5 acres.
Sponsored DEC to enter NWI Wetland areas by county.
Mapped land use and zoning districts within WHPAs of Calais and Plainfield.
Mapped land use/land cover within WHPAs of region and watersheds of public water supplies.
Mapped extent of existing and planned service areas.
Location and attributes of waterfalls, cascades and gorges and whitewater segments within Calais and Plainfield.

Chittenden County Regional Planning Commission

Identify and map eroding stream banks, stormwater discharge points, vegetative buffers, wildlife use and land uses within 100' of Indian Brook and tributaries in Colchester & Essex (9/24/01)
Review municipal plans and zoning regulations and make recommendations for additional water quality protection in 17 municipalities in the region with adopted municipal plans.
Continue work on automation of municipal drinking water distribution and sewage collection and treatment systems using ARC/INFO GIS for the Town of Milton.
Complete work on automation of municipal sewage collection and treatment systems using ARC/INFO GIS for the towns of Williston and Essex.
Develop digitally-referenced rivers and streams in Chittenden County by Waterbody ID and calculate Waterbody sizes.
Map all drinking water distribution lines greater than 2" for at least one Chittenden County town.
Digitize approximate location and extent of surface water for region, certain attributes, sponsor on-site regional public meeting.
Outfall location associated with each municipal and industrial wastewater treatment facility in region, assist DEC with spatial analysis of urban/suburban conditions in LaPlatte River watershed for Nonpoint source phosphorus TMDL project.
Watershed boundaries for major surface watersheds (50 in number) within region.

Land use/land cover, parcels (where available) and zoning district boundaries within WHPAs in Charlotte, Colchester and Jericho.
Location/extent of land use, parcels and zoning district boundaries within WHPAs of Hinesburg, Richmond and Underhill, well attribute information (incomplete).
Analysis of potential for development within WHPAs of Hinesburg and Richmond.
Assist with Lake Champlain Committee's "Planning Manual & Checklist."

Lamoille County Planning Commission

Compare municipal plans and ordinances with DEC's *Local Planning and Zoning Options for Water Quality Protection*, making recommendations for additional water quality protection in those documents as necessary; assist 2 municipalities with updating the water quality protection elements of their plans/ordinances; update the Water Resources component of the Regional Plan (4/25/02).
Prepare a comprehensive catalog and spatial inventory of watershed implementation analyses projects that have been carried out and funded by various agencies within the Upper Lamoille and Upper Little River basins; update the Water Resources element of the Regional Plan (12/31/01).
Provide a septic system suitability and land cover analysis for the remaining five watersheds in the county, and continue to collect water resource policies and priorities for the next update of the regional plan.
Provide a streambank and land use inventory along Wild Branch River in Wolcott and Craftsbury; provide Wolcott with recommendations for areas of building restrictions due to past flood damage; provide Wolcott with a septic system suitability analysis in Wild Branch watershed; continue colleting water resource policies for next update to regional Plan.
Provide a septic system suitability analysis for the West Branch River watershed in Stowe; to continue to collect relevant water resource data for the next update of the regional plan, and assist with public outreach regarding any recent on-site sewage reform rule change.
Spatially locate all boundaries of the Green River watershed and overlay the watershed with septic system suitability information and previously-acquired land use/land cover information; complete the update of the Regional Plan to include water resource policies and priorities, and assist the Dept. with public outreach regarding the status of on-site sewage reform.
Prepare town maps depicting the area and extent of each septic system suitability class for the region.
Map the boundaries of the Gihon watershed and locate the extent of septic system suitability soils information and land use/land cover.
Begin update of Regional Plan to include water resource policies and priorities.
Update regional soils information (septic system suitability), illustrate North Branch watershed land use/cover with septic system suitability, sponsor on-site regional public meeting.
Spatially referenced locations and characteristics of sites where hazardous materials (active/inactive landfills, state/local active salt storage sites, state "registered" non-petroleum haz. waste sites & underground storage tanks, on-site sewage disposal systems greater than 6500 gpd) may be used, stored or generated.
Design, develop and deliver certain portions of an education and information program regarding water source protection planning.
Location and extent of distribution and/or collection lines for municipal drinking water, municipal stormwater and municipal sanitary wastewater throughout the region.
Location and extent of surface water classified as Class C.
Location/extent of land use within WHPAs of region, well attribute information.
Mapped zoning district boundaries and extent of existing and planned service area within WHPAs of the region.
Location/extent and attributes of waterfalls, cascades and gorges of the region, evaluate the potential for loss of these features.
Mapped location and attributes of whitewater segments in region. Inventory (for regional plan development) locations of boating access points, use restricted waters, locations of federal*, state* and municipally* owned property along/adjacent to surface water, locations of hydroelectric* and hydro-related facilities*, locations of targeted waters, trophic status and watershed area for lakes/ponds over 20 acres and locations of nutrient sensitive lakes/ponds* and extent of watershed area; (*) denotes to be GIS compatible

Northeastern VT Development Association

Assist with the management of the Nulhegan River watershed by providing technical support for Nulhegan watershed groups, making recommendations for establishment of management goals for the surface waters in the Nulhegan watershed, revising the Nulhegan River watershed map as necessary, and holding a public forum to gather comments (05/01/00).

Assist the building of local water quality planning capacity to protect the waters of the Nulhegan River watershed by reviewing town plans and land use regulations and making water quality protection recommendations for these documents

Assist the Nulhegan River assessment by developing a set of GIS maps of the Nulhegan River watershed showing watershed boundaries, land use/land cover, potential pollution sources, existing uses and hold a public hearing to gather further information about public uses.

Develop (for certain NVDA towns in the Barton, Memphremagog, Coaticook and Clyde River basins, digitally-referenced surface waters and augment existing surface water data by adding certain attribute information.

Develop for certain NVDA towns in the Missisquoi, Black and Barton River basins, digitally-referenced surface waters by Waterbody ID and calculate Waterbody sizes; augment existing surface water data by adding certain attribute info; assist with public information re the on-site sewage reform.

Spatially reference location/extent of large clear-cutting operations in four towns, review certain programmatic aspects of VT AMPs, sponsor 2 on-site regional public meetings.

For the Passumpsic River basin, inventory locations of unique natural areas, locations of existing and potential public access points to surface waters and evaluate the adequacy of existing municipally-based mechanisms for protecting these resources.

Location/extent of distribution and/or collection lines for municipal drinking water, municipal stormwater and municipal sanitary wastewater for Newport City, Canaan, Danville and St. Johnsbury.

Develop model shoreland ordinance for use in N.E.Kingdom. Prepare/distribute undeveloped shorelines report.

Location/extent and characteristics (zoning, size and use of undeveloped sections, parcels) of undeveloped shoreline areas of lakes/ponds of the region larger than 10 acres, assess adequacy of present municipal shoreline ordinances, develop criteria and prioritize lakes in region in need of protection.

Assist with digitization of features associated with CT River Inventory Project.

Assist with mapping and characterization of features associated with CT River Inventory Project.

Mapped land use, zoning districts and extent of service area within the Wellhead Protection Areas of Brighton, Concord, Greensboro and Sutton.

Watershed boundaries for 88 lakes/ponds in region greater than 20 acres, land uses and zoning districts within watersheds of lakes/ponds in at least 4 municipalities.

Highlight NWI maps information for 12 municipalities.

Northwest Regional Planning Commission

Phase II of a project to compare adopted town plans and zoning regulations with DEC's *Local Planning and Zoning Options for Water Quality Protection*, and making recommendations for additional water quality protection in those documents as necessary.

Phase I of a project to compare adopted town plans and zoning regulations with DEC's *Local Planning and Zoning Options for Water Quality Protection,* and making recommendations for additional water quality protection in these documents as necessary.

Mapping of surface waters and waterbodies in Grand Isle County, Lake Champlain direct drainage and Franklin County, and attribute the waterbodies with DEC-designated WBIDs, and generate a tabular summary of water course lengths by VT WBID and stream names.

Conduct a GIS-based land use inventory and analysis of the Missisquoi River watershed and its major sub-basins, and assist the Dept. in sponsoring a regional public form regarding the status of the on-site sewage reform.

Inventory and digitize on GIS maps, streambank erosion along the Missisquoi River within the Region.

Develop, review & present to public basic regional water resource policies for regional plan, spatially reference certain DEC-WQ information, sponsor on-site regional public meeting.

Map and characterize Lake Carmi watershed land use.

Map and characterize undeveloped shoreline areas of St. Albans Bay & Missisquoi Bay.
Prepare/distribute local strategies for ground water protection handbook.
Location/extent of land use and zoning districts within WHPAs of the region.
Develop/expand regionally based matrix which identifies regionally significant water resources and specific abatement measures for land use scenarios.
Assist with Lake Champlain Committee's "Planning Manual & Checklist."
Mapped extent of existing and planned service area within WHPAs of the region.

Rutland Regional Commission

Develop the Water Resources and Quality element of the Regional Plan; continue collecting data and information on the Poultney-Mettawee watershed; coordinate with DEC's watershed planning efforts, and provide logistical support for any public meeting held in the region (06/30/02).
Assist the building of local water quality planning capacity by inventorying, coordinating and consolidating existing water quality planning efforts and developing water quality protection sections for the Brandon and Hubbardton Town Plans.
Using cdroms, transfer water resources information to 26 towns in the region and host informational forums to explain how the towns can use the information to protect water quality.
Update existing water resources information in the Rutland region, develop a waterbody map of the region, attributed with DEC-designated WBIDs, and supply the town of Brandon with a cdrom containing the waterbody information for the town of Brandon.
Study the bedrock influence on water quality and yield for certain public community water systems in the Region and share this information with owners of the systems; assist the Dept. with a public forum regarding the status of the on-site sewage reform.
Map current and proposed land uses (and their areas) within groundwater source protection areas and share info with towns and DEC.
Investigate use of GPS technology in locating private wells and surface water sources in part of region, sponsor on-site regional public meeting.
Develop regional water resource policies for regional plan, present spatially based water resource information using the GIS.
Attribute information associated with 67 community water systems of the region.
Identify and display, for each waterbody in region greater than 20 acres in size (35 waterbodies) the configuration and extent of surface water located within 100' and 200' of shore, identify waterbodies in region under use restrictions enacted by VT Water Resources Board.
Location and attributes of privately owned domestic wells in Brandon and Wallingford.
Location/extent of land use and zoning district boundaries within the WHPAs of Brandon and Wallingford.
Assist with Lake Champlain Committee's "Planning Manual & Checklist."
Location/extent of watershed boundaries for lakes/ponds in region greater than 5 acres.

Southern Windsor County Regional Commission

Determine what additional data is needed to describe how and why Mill Brook and its tribs are changing course over time, and educate landowners in activities that will reduce run-off and erosion on Mill Brook (4/24/02).
Assess stream bank erosion problems on Mill Brook tribs, produce a report and involve landowners in developing plans for bank stabilization.
Assess stream bank erosion problems on Mill Brook, produce a report, and involve riparian landowners in developing plans for bank stabilization.
Assess stream bank erosion problems of tributaries in the Mill Brook watershed, produce a report, and involve riparian landowners in developing plans for bank stabilization.
Complete the first phase of work for the development of a regional water quality plan by preparing regional GIS maps depicting updated surface water uses and values and certain land uses and practices; making recommendations for segments in need of further assessment, and holding a regional public meeting to obtain feedback on surface water uses and threats.

Assist with hosting a Project "WET" workshop and spatially analyze potential impacts of land use activities in the Mill Brook watershed on water quality and water uses.
Assess the potential impact of agricultural activities on nonpoint source pollution in the Mill Brook watershed, and assist the Dept. with public outreach regarding the status of the on-site sewage reform.
Continue developing the Regional Watershed Protection Program and assist local groups involved with water quality protection in the SWC region.
Assist Ascutney Local River Subcommittee in the review of health & sewage ordinances and town plans in 3 towns, increase town involvement associated with Regional Watershed Protection Program, sponsor on-site regional public meeting.
Location and extent of potential pollution sites and current uses of waterbodies in region using GIS.
Land use/land cover and parcel conditions along the CT River, evaluate river protection criteria against land use and parcels, characterize location, type and owner of domestic point sources to CT River.
Initiate phase I of III regarding a Regional Watershed Protection Program.
Forums for local officials regarding the implementation of tools/techniques for surface water quality protection.
Assist with digitization of features associated with CT River Inventory Project.
Assist with mapping and characterization of features associated with CT River Inventory Project.
Location/extent of surface waters and WHPAs in region.
Location/extent of waterfalls, cascades and gorges and whitewater segments in the region, attribute information.
Mapped surface water classifications in region.
Surface water monitoring project on several rivers in region with River Watch & CT River Watershed Council.

Two Rivers-Ottauquechee Regional Commission

Assist three towns along the Second and Third Branches of the White River and the White River main stem with updating the Water Quality protection sections of the town plans and regulations; attend White River Partnership and town meetings regarding the White River Plan, review and comment on the Plan (4/23/02)
Digitize and document streambank erosion points on the main stem of White River, prepare written assessments and reach reports and provide copies to the White River Partnership and towns.
Review municipal plans and zoning regulations and prepare recommendations for additional water quality protection for 23 municipalities in the region.
Assist with the rotational basin assessment, conduct a GIS-based land use inventory and analysis of the Barnard Brook watershed, and involve the public in the process through a public meeting.
Update the water resources element of the Regional Plan, survey town planning and conservation commissions to identify conditions which either impact or improve water quality, and develop a study design and scope of work to prepare a comprehensive basin/watershed management plan for the Ottauquechee River watershed.
Update the Windsor County surface water GIS data sets and assist the Dept with public outreach regarding the status of the on-site sewage reform.
Edit and code surface waters in 16 towns to current VCGI attribute standards, label surface waters with their appropriate VT Waterbody ID number and calculate the length of riverine surface waters by WBID number.
Spatially reference land use/cover conditions in 3 towns, document potential NPSs pollution, sponsor on-site regional public meeting.
Coding of surface waters (VCGI protocol) in towns of region located in Windsor County.
Location of major surface waters and tributaries in Windsor County portion of region (includes 10 towns), location and extent of potential Nonpoint pollution sources (defined as an inventory of land use) immediately adjacent (within 150 feet of shore) to major surface waters and tributaries entered above.
Location, extent and characteristics of land use, zoning district boundaries and parcels found in upper White River towns (Granville & Hancock), identify riparian conservation strategies, complete phase III report.
Assist with digitization of features associated with CT River Inventory Project.
Assist with mapping and characterization of features associated with CT River Inventory Project.
Land use/land cover within WHPAs for the region.
Annotate each surface water segment in region.
Verify and enter all point source locations in region.

Location & attributes of waterfalls, cascades, gorges & whitewater segments of the region.
Location and attributes of hydroelectric and hydro-related facilities of the region.
Highlight information on NWI maps for 3 municipalities.

Upper Valley - Lake Sunapee Council

To assist the Hartford Conservation Commission by digitizing the town's groundwater favorability areas to enable integration of groundwater information with other town natural resource planning activities, and coordinate public meetings and other outreach activities conducted as part of the White River planning process, as funding permits (6/25/02).
Assist with the rotational watershed assessment by hosting public meetings to exchange water quality information for Lull's Brook, revise the watershed map to reflect any new public info, and gather public info regarding other water quality issues in the Harland Area for Town Plan recommendations (12/31/01).
Assist with the rotational water quality assessment by developing a set of GIS maps of Lull's Brook watershed showing land uses and potential contamination sources in the towns of Hartland and West Windsor, and encourage public involvement to identify additional existing uses and potential contamination sources.
Assist with the rotational water quality assessment by developing a set of GIS maps of the Bloody Brook watershed in the town of Norwich, and by co-hosting a public meeting with the Norwich Conservation Commission.
Collect and evaluate information re the status of water supply protection in certain towns and identify each community's needs relative to water supply protection.
Draft an updated and expanded water resources component for the Hartland Town Plan.
Identify, map and enter onto GIS land use/land cover of parcels adjacent to Ottauquechee, White, Ompompanoosuc and West Branch of the Ompompanoosuc Rivers in the region.
Summarize/compare water quality protection features contained in zoning ordinances and subdivision regulations of 10 towns, sponsor on-site regional public meeting.
Identify, map and enter onto GIS land use/land cover of parcels adjacent to CT River in region.
Update/revise maps and data files associated with inventory of formal and informal public access points found on the Ottauquechee, White and Ompompanoosuc Rivers.
Coordinate the CT River Inventory Project - a project which will map and enter many natural resource items found in the 29 VT towns adjacent to the CT River.
Assist with administration of CT River Inventory Project.
Location/extent and characterize public access points to major waterways of region (other than CT River).
Promote bi-state (NH & VT) conference on CT River.

Windham Regional Commission

Assist with the Connecticut River Conservation District Coalition Riparian Forest Ecosystem project that will identify and map eroding stream banks, types of vegetative buffers, wildlife use and land uses within a min. of 100' of the Rock River in the towns of Newfane, Dummerston and Dover, and hold a public forum (09/14/01).
Develop an Action Plan for the West River watershed based on the high priority issues identified in the West River Watershed Alliance forums.
Continue to upgrade the level of detail and accuracy of the GIS surface waters data layer, and provide better base information for watershed planning and the rotational basin assessment.
Assist with rotational watershed assessment by building a regional watershed planning process and by continuing the work of assessing nonpoint source pollution areas on tributaries of the West River.
Initiate a water quality improvement project for the West River Basin, in cooperation with the Bonnyvale Environmental Education Center, and assist the Dept with public outreach regarding the status of the on-site sewage reform.
Continue working with On-Site Sewage Committee to develop plan of action and assist with dissemination of info from Committee to towns in Windham region.
Develop a protected lands map for six Connecticut River towns in the Region, identifying gaps of important resource land protection, including riparian lands.

Summarize/compare water quality protection features contained in bylaws and ordinances of 6 towns, assist with Deerfield River hydro relicensing public participation, sponsor on-site regional public meeting.
Determine condition of individual sewage disposal systems in Dummerston, Newfane and Putney, enhance administration and enforcement of sewage ordinances in region.
Inventory and evaluate local and state septic system control programs, conduct septic system workshops, continue attending Deerfield River Compact meetings.
Assist DEC-WQ with Deerfield River comprehensive river planning, design local implementation strategies, regional plan review.
Assist with digitization of features associated with CT River Inventory Project.
Assist with mapping and characterization of features associated with CT River Inventory Project.
Draft and present to the public policies and action program recommendations regarding recreational greenways adjacent to major rivers/streams in region.
Evaluate Jamaica Town Plan & Regulations with respect to NPS pollution, draft suggested amendments.
Conduct Upper West River Basin "water forums."

In 1989 a cooperative pass through effort involved the **Otter Creek Natural Resources Conservation District** and the VT ANR/GIS. The order in which data were entered onto a geographic information system [for Addison County]....was as follows:

1. surface water classifications
2. public water supply wells
3. aquifer protection areas
4. important water related features - waterfalls, gorges, cascades, whitewater segments
5. wetlands
6. warm and cold water fishery waters
7. important regional swimming areas
8. public surface water supplies
9. electric generating sites

APPENDIX F

URBAN STORMWATER MANAGEMENT IN VERMONT
September 27, 2001

I. Problem Statement

There are approximately twenty-six streams in Vermont that are "impaired" primarily due to urban stormwater runoff. These impaired waters are currently not meeting water quality standards as a result of existing development, not as a result of proposed new projects. The water quality impairments are caused primarily by stormwater discharges which are not receiving adequate treatment, such as projects that pre-date DEC's stormwater permitting program and previously permitted stormwater discharges that are not in compliance with their original permits. DEC believes that these waters are impaired, not water quality limited. This means that when base-level treatment requirements, known as BMPs (Best Management Practices) are in place and working correctly, the water quality impairments should be eliminated.

There is currently a backlog of approximately 1,000 expired stormwater permits and significant numbers of existing stormwater treatment systems which are not providing necessary treatment due to inadequate construction and maintenance. There is also a potential permitting logjam for new projects in impaired watersheds as a result of recent Water Resources Board decisions in the Hannaford/Lowe's appeal.

Awaiting the development of watershed TMDLs (Total Maximum Daily Loads) for these receiving waters is not a viable solution to these problems, due to the time, expense and technical uncertainty involved in developing a fully implementable TMDL. It can take several years to develop a TMDL for a single impaired watershed. The completion of the TMDL development process for the twenty-six stormwater-impaired waters is currently projected to require at least 10 years or more.

II. Vision Statement

DEC is presenting this plan of action which is designed to immediately begin corrective measures within impaired watersheds. This will involve a phased strategy which is cost-effective, can be implemented efficiently, will simultaneously eliminate water quality impairments, reduce the expired permit backlog and address the permitting of new development.

III. Proposal and Rationale

DEC will begin immediately to implement a three-part solution to the problem of impaired waters, implemented through the issuance of watershed-specific general permits, referred to as Watershed Improvement Permits (WIP). A WIP will be individually crafted for each impaired watershed. Three groups of stormwater discharges would be asked to apply for coverage under the applicable Watershed Improvement Permit, including:

1) stormwater discharges to the impaired water that have already been issued a stormwater discharge permit or temporary pollution permit (regardless of whether such permit is currently valid or expired);

2) stormwater discharges that have been designated by DEC as "significant stormwater discharges" to the receiving impaired water; and

3) proposed discharges of stormwater to the impaired water from new development.

A brief description of the Watershed Improvement Permit process for each of these three groups, along with the rationale for their inclusion in this plan, is set forth below:

1. Existing Permittees

Under DEC's plan, all previously permitted stormwater dischargers would be included under the WIP. This includes all discharges that have previously been issued either a stormwater discharge permit or a temporary pollution permit, regardless of whether such permit is currently valid or expired. To obtain coverage under the WIP, these existing discharges would need to provide to DEC a written certification signed by a professional engineer licensed in Vermont, that the existing stormwater management system was built and is currently operating in compliance with the previously issued permit. If such certification cannot be made, the WIP will specify a reasonable timeframe for taking corrective action to construct and/or bring the previously permitted stormwater management system into compliance with the previously issued permit. Once this corrective action is taken, an engineer's certification would be provided to DEC. The WIP will also specify that an engineer will need to periodically recertify that the stormwater management system is properly operating and maintained. Finally, the Watershed Improvement Permit will clearly state that DEC will periodically conduct scientific monitoring in the impaired water to determine if water quality is improving, and if it is not improving to the satisfaction of DEC, additional and more stringent stormwater management measures may be required either through the modification of the WIP, the issuance of a new WIP, and/or through the issuance of individual stormwater discharge permits.

It is DEC's belief that this approach toward existing permittees is fair and reasonable. First, this approach merely requires that a permittee demonstrate they are doing what they originally agreed to do. Second, for those permittees whose permits expired, or for those permittees who did apply for renewed permits, this approach eliminates the time-intensive process of notifying expired permittees or reissuing individual permits. Therefore, this approach helps in eliminating the backlog of expired stormwater permits. Finally, from a technical standpoint, DEC believes that it will only be necessary to require updated and current treatment standards for some previously permitted stormwater discharges in an impaired watershed to improve water quality and meet water quality standards. In general, once a stormwater treatment design is approved and implemented, proper ongoing maintenance should be the principal focus, not periodic re-design and re-construction. It is inevitable that treatment standards will change over time as the science of stormwater management evolves, but it's neither practicable, nor cost-effective to continually retrofit large numbers of these landscape-based treatment systems (e.g. detention ponds, swales, etc.). If DEC determines after future monitoring that certain of these systems are causing significant impacts to the receiving watershed, then DEC will address retrofitting these individual systems on a case-by-case basis either through a WIP or an individual stormwater permit.

2. Significant Stormwater Discharges

Within each impaired watershed there are several entities that, by virtue of their size, location and lack

of adequate treatment, have an inordinate detrimental impact on the receiving water. Some of these may have previous stormwater discharge permits or temporary pollution permits, others may pre-date the permitting program. Regardless of their previous permit status, as significant contributors to impaired waters, and as a result of being dischargers to surface waters, they legally require current permits. DEC will identify all "significant stormwater discharges" to an impaired water covered by a Watershed Improvement Permit using a formula devised by DEC's Stormwater Management Program. This formula will take into account certain factors, including the areal extent of impervious surfaces, efficacy of any existing stormwater treatment, and degree of connectivity to the receiving water. DEC believes that it is necessary to selectively require optimized stormwater treatment for these stormwater discharges in order to improve impaired waters. Requiring optimized treatment for these significant discharges is very efficient with regard to benefits versus costs, particularly when considered on a watershed basis. The top tier of these discharges within a watershed will be required to engineer treatment solutions designed to achieve the water quality, recharge, and channel protection requirements of the Vermont Stormwater Management Manual.

3. New Development

At the same time that improvements to existing stormwater management systems are ongoing, the WIP will minimize water quality impairment from new stormwater discharges by requiring stormwater treatment solutions to meet the requirements of the Vermont Stormwater Management Manual.

IV. Long-Term Monitoring and Amendment of the Watershed Improvement Permit

After substantial implementation of the stormwater management requirements specified in the WIP, scientific monitoring of the impaired water will be performed by DEC. If necessary, additional "significant discharges" to an impaired water will be identified and will be required to upgrade treatment to further reduce stormwater loadings to the receiving water. Additional and more stringent management of stormwater discharges will be obtained through the modification of the WIP, the issuance of a new WIP and/or through the issuance of individual stormwater discharge permits. Sequential iterations of this process will occur until scientific monitoring indicates an elimination of the impairment.

V. Summary

DEC believes that this plan represents the best practical solution to improving impaired waters, is a fair and balanced response and avoids having considerable amounts of money being spent in a less-than-optimum manner. It will improve stormwater-impaired waters, ensure the attainment of water quality standards, systematically eliminate the expired permit backlog, and allow new development to move forward through the permitting process. It is administratively efficient, cost effective, and is a phased, proportionate approach, which can be implemented immediately. Watershed Improvement Permits can be implemented in a timely manner, relative to the classic TMDL approach, and can easily incorporate iterative cycles to ensure elimination of water quality impairments. The TMDL process can proceed simultaneously and finalized TMDLs can be incorporated into a revised or new WIP as required.

LIST OF URBAN - IMPAIRED WATERS & WATERSHEDS

Waterbody ID	Basin	County	Waterbody Name	Problem	Pollutant
VT03-06	3	Rutland	MOON BROOK, MOUTH TO 2.3 MILES UPSTREAM	LAND DEVELOPMENT; EROSION; URBAN RUNOFF; NO MONITORING DATA ON POLLUTANTS	UNDEFINED - TYPICAL (SEDIMENT, NUTRIENTS, PATHOGENS, TOXICS)
VT05-07	5	Franklin	STEVENS BROOK, FROM I-89 DOWNSTREAM FOR APPROX 1.5 MILES	LAND DEVELOPMENT, EROSION/SEDIMENTATION, URBAN RUNOFF, MORPHOLOGICAL INSTABILITY	SEDIMENT, ORGANIC ENRICHMENT, TOXICS (METALS & ORGANICS)
VT05-09	5	Chittenden	INDIAN BROOK FROM LAKE UPSTRM FOR 9.8 MILES TO BUTLERS CRN (RT 15)	LAND DEVELOPMENT, EROSION, URBAN RUNOFF; NO MONITORING DATA ON POLLUTANTS	UNDEFINED-TYPICAL (SED'T, NUTRIENT, TOXICS, METAL, PATHOGEN)
VT05-09	5	Chittenden	DIRECT SMALLER DRAINAGES TO INNER MALLETTS BAY	URBAN RUNOFF, FAILED/FAILING SEPTIC SYSTEMS; INCLUDES SMITH HOLLOW BROOK & CROOKED CREEK	PATHOGENS
VT05-10	5	Chittenden	ENGLESBY BROOK	URBAN STORMWTR RUNOFF, BLANCHARD BEACH CLOSURE	PATHOGENS, UNDEFINED-TYPICAL (METALS, NUTRIENT, TOX, SED'MT)
VT05-11	5	Chittenden	MCCABES BROOK, UPSTREAM FROM MOUTH FOR 3.5 MILES	AGRICULTURAL RUNOFF, URBAN RUNOFF	UNDEFINED-TYPICAL (SED, NUTRIENTS, ORG ENRICH'MT, PATHOGENS)
VT05-11	5	Chittenden	BARTLETT BROOK	LAND DEVELOPMENT, EROSION, URBAN RUNOFF; NO MONITORING DATA ON POLLUTANTS	UNDEFINED - TYPICAL (SEDIMENT, NUTRIENTS, TOXICS, METALS)
VT05-11	5	Chittenden	MUNROE BROOK	URBAN RUNOFF, EROSION, LAND DEVELOPMENT	UNDEFINED-TYPICAL (SED, NUTRIENT, METAL, PATH); UNKNWN TOX'Y
VT05-11	5	Chittenden	POTASH BROOK, FROM MOUTH TO 5 MILES UPSTREAM	URBAN RUNOFF, LAND DEVELOPMENT, EROSION; FREQUENT BEACH CLOSURES (RED ROCKS)	SED'MT, PATHOGENS; UNDEFINED-TYPICAL (METALS, NUTRIENTS, TOX
VT08-02	8	Chittenden	ALLEN BROOK, FROM 1 MILE ABOVE MOUTH UPSTREAM 5.5 MILES	LAND DEVELOPMENT; EROSION; URBAN RUNOFF	PATHOGENS, UNDEF-TYPICAL (SED, TOXICS, NUTRIENTS, METALS)
VT08-02	8	Chittenden	MUDDY BROOK (LOWEST 7 MILES)	LAND DEVELOPMENT; EROSION; URBAN RUNOFF	TOXICS, ORGANIC ENRICHMENT, TEMPERATURE
VT08-02	8	Chittenden	SUNDERLAND BROOK (6.5 MILES)	LAND DEVELOPMENT; EROSION; URBAN RUNOFF	TOXICS; UNDEFINED (SEDIMENT, NUTRIENTS, PATHOGENS, METALS)
VT08-02	8	Chittenden	CENTENNIAL BROOK (2 MILES)	LAND DEVELOPMENT; EROSION; URBAN RUNOFF; NO MONITORING DATA ON POLLUTANTS	UNDEFINED - TYPICAL (SEDMT, NUTRIENTS, TOXICS, METALS, PATH)

VT08-02	8	Chittenden	MOREHOUSE BROOK (1.5 MILES)	URBAN RUNOFF, EROSION; NO MONITORING DATA ON POLLUTANTS	UNDEFINED - TYPICAL (SEDIMENT, NUTRIENTS, PATHOGENS, TOXICS)
VT08-12	8	Lamoille	WEST BRANCH, LITTLE RIVER (5.8 MILES)	INCREASED PEAK STORMWATER FLOWS & RUNOFF FROM URBANIZING AREA; LOSS RIPARIAN VEGETATION; MORPHOLOGICAL INSTABILITY	PHYSICAL HABITAT CHANGES
VT08-20	8	Washington	SLIDE BROOK (0.7 MILES)	EROSION FROM UPSTREAM AREAS IN W/SHED & PARKING LOT; LAND DEVELOPMENT	SEDIMENT
VT08-20	8	Washington	RICE BROOK	EROSION FROM UPSTRM AREAS IN WATERSHED & PARKING LOT; LAND DEVELOPMENT	SEDIMENT
VT08-20	8	Washington	CHASE BROOK, FROM MOUTH UPSTREAM FOR 0.5 MILE	RUNOFF FROM PARKING AREAS	SEDIMENT
VT08-20	8	Washington	CLAY BROOK, INFERNO ROAD AREA (0.1 MILES)	SOIL EROSION CONSTRUCTION ACTIVITIES & GRAVEL PARKING LOT; INCREASED PEAK STORMWATER FLOWS	SEDIMENT, IRON
VT10-06	10	Windsor	EAST BRANCH, ROARING BROOK (0.5 MILE)	LAND DEVELOPMENT, EROSION, ROAD RUNOFF	SEDIMENT, IRON
VT10-06	10	Windsor	ROARING BROOK (LOWEST 1.5 MILES)	LAND DEVELOPMENT; EROSION; ROAD RUNOFF	SEDIMENT
VT11-15	11	Windham	STYLES BROOK (2 MILES)	LAND DEVELOPMENT, HYDROLOGIC MODIFICATION	SEDIMENT
VT11-15	11	Windham	TRIB #1, NO. BRANCH, BALL MTN BROOK, ABOVE GOLF COURSE POND	URBAN RUNOFF, LAND DEVELOPMENT IN STEEP AREA, EROSION	SEDIMENT
VT12-05	12	Windham	NO. BRANCH DEERFIELD RIVER, 0.4 MILE ABOVE SNOW LAKE TO TANNEY BRK RD	LAND DEVELOPMENT & CONSTRUCTION RELATED EROSION	SEDIMENT
VT13-14	13	Windham	WHETSTONE BROOK - BRATTLEBORO	ENCROACHING URBANIZATION; RIPARIAN DEVELOPMENT; POTENTIALLY FAULTY SEWER LINE/SEPTIC SYSTEM	PATHOGENS

APPENDIX G

Pesticides in the Surface Waters of Chittenden County

A Joint Report of:
Vermont Department of Environmental Conservation and Vermont Department of Agriculture, Food and Markets, and the University of Vermont, Rubenstein Ecosystem Science Laboratory

Introduction:

Pesticides are widely used by Vermont homeowners, commercial landscapers, and farmers, but relatively little monitoring data exist to evaluate whether these potentially harmful products are entering our streams and waters. This is especially true for urban and suburban areas where homeowner use is largely unregulated. Available information from surveys and studies conducted by the University of Vermont (UVM), United States Geological Survey (USGS), and the Vermont Department of Agriculture, Food and Markets (VDAFM), has shown that some pesticides are found in streams, edge-of-field surface runoff, and groundwater. In 1999, VDAFM detected turf herbicides in streams adjacent to a residential complex immediately following a commercial landscape application.

The presence of a pesticide in the water does not necessarily indicate environmental risk. The risks will generally be related to the concentrations that the pesticides reach in Vermont waters and the frequency and duration at which those concentrations occur. Currently, there are almost no data to address the significance of these risks for Vermont waters. Determining environmental risks is an essential part of evaluating the success of current pesticide use regulations. This study was undertaken as a first step to develop a database that could be used to evaluate environmental risk and the effectiveness of current pesticide regulations.

Project Description:

Data were gathered from the developed areas of Chittenden County to:

1) summarize commercial pesticide use and patterns, targeting lawn care pesticide products, in this area;
2) characterize targeted pesticides in streams and rivers discharging to Lake Champlain at a number of locations where intensive pesticide use is known to occur;
3) provide estimates of the occurrence of targeted pesticides in storm water discharges to Lake Champlain from a variety of urban/suburban areas where homeowner and commercial pesticide applications are known to occur; and
4) evaluate potential adverse effects from targeted pesticides in surface waters by conducting toxicity tests on water samples in conjunction with pesticide analyses.

Methods and Results:

Lawn care pesticide products and use patterns: The pesticides that were the focus of this survey are commonly found in products used in and around the home by both private homeowners and commercial landscape applicators. Many are also commonly used in agriculture. The initial list was selected based on best professional judgment of VDAFM personnel and reporting data provided by commercial applicators in Chittenden County (**Table 1**). It included the following chemicals:

1) **2,4-D, MCPP, MCPA, and Dicamba** - Broad leaf weed control by commercial applicators and homeowners. Most "weed and feed" products contain these active ingredients.

2) **Pendimethalin** - Used for crabgrass control in turf and corn. Most commonly used product for crabgrass control.

3) **Triclopyr** - Broad leaf weed control used in utility maintenance, turf, and by homeowners for brush control.

4) **Dacthal** - Was commonly used as pre-emergent herbicide for grass control in turf and for weed control in fruit and vegetable farming. Use of dacthal in Vermont is restricted to certified applicators. Homeowners may continue to apply the dacthal they have in hand although no commercial use was reported in Chittenden County in 1999.

5) **Chlorpyrifos** - Commonly used insecticide in turf and for indoor/outdoor pest control. Legal use of this product in and around the home will end December 31, 2001.

6) **Diazinon** - Commonly used insecticide (30% of the homeowner use insecticide market) in and around the home. Most use is by homeowners for ants, and garden and turf insects. No commercial use was reported in 1999. Registrations for home uses of this product will expire in 2004.

7) **Malathion** - Commonly used insecticide for home and garden use.

Table 1. Commercial use of common pesticides in Chittenden County in 1999. Use is reported as pounds of active ingredient. Currently the most reliable data on pesticide use in Chittenden County is based on the required reporting of amount used by commercial pest control companies. The data in this table does not include any pesticides applied by homeowners of private agricultural applicators. 1999 is the latest year for which full data are available.

	turf	golf	structural	ornamental	corn	field and forage	utility	TOTAL
Pendimethalin	2361	33			1266	40		3700
Chlorpyrifos	1432	9	12	0.5				1454
MCPA	748	27						775
MCPP	308							308
2,4-D	135	27			6	0.6		169
Triclopyr	29						120	149
Dicamba	75	4.5			53			133
Malathion	2			3				5
Dacthal	No Reported Use in 1999							
Diazinon	No Reported Use in 1999							

Sample site selection and sampling methods: We sampled during rainfall events after known commercial pesticide applications and following periods of expected maximum homeowner activity (e.g. the first storm event following the Fourth of July holiday). For comparison, some samples were also collected during drier periods between rainfall events.

Samples were collected by hand. For wet weather sampling, grab samples were collected at 30 minute intervals during the period of rising flow in the streams and combined into a single sample for analysis. During dry weather, single grab samples were collected.

Three general use scenarios were evaluated:

1. A multi-family low rise residential development with a unit density of 8-12 units per acre that used a commercial landscaping service. Samples were collected from storm water draining the 42 acre site during the first significant rainfall following an early spring herbicide treatment (May 13, 2000) and during the first rainfall following the Fourth of July weekend (July 9, 2000). Samples were collected by hand at several points where storm water runoff exited the property.

2. Englesby Brook, a small urban stream. Three sites were situated along the upper, middle, and lower portions of the stream. The upper reaches are dominated by a golf course. The middle and lower sections pass through a variety of residential, suburban, and urban settings. The lower reaches drain into Lake Champlain. Samples were collected during storm events on May 13, July 9, and September 12, 2000.

3. Six storm water drains located throughout the City of Burlington and discharging directly to Lake Champlain or the Winooski River. The areas drained included a range of size and land use characteristics. Five and four drains were sampled during the July 9 and September 12 storm events, respectively. Two sites were sampled on September 1 during dry weather conditions.

Analytical methods and results: Both the acid herbicides (2,4-D, MCPP, MCPA, dicamba, triclopyr, and dacthal metabolites) and the neutral pesticides (diazinon, pendimethalin, chlorpyrifos, and malathion) were analyzed in the VDAFM laboratory using modified USEPA protocols (Methods 614 and 512.2) with gas chromatograph and mass spectrometer instrumentation.

A total of 22 samples were analyzed. Five of the ten target analytes - MCPA, dicamba, triclopyr, chlorpyrifos, and malathion, were not detected in any of the samples. The remaining five target analytes were detected at least once during the study. The following table summarizes the findings.

Compound	Type	MDL[1] ppb	Detects	% Detects	Max. ppb	Min. ppb	A-WQG[2] ppb	Detects[3] >A-WQG
2,4-D	H	0.1	3 of 22	14%	162	0.27	120	1
MCPP	H	0.1	4 of 22	18%	115	0.19	1860	0
Dacthal[4]	H	0.1	3 of 22	14%	0.4	0.14	310	0
Diazinon	I	0.06	2 of 22	9%	0.22	0.08	0.30	0
Pendimethalin	H	0.05	2 of 22	9%	2.9	0.21	2.10	1
MCPA	H	0.1	0 of 22	ND	ND	ND	12.0	ND
Dicamba	H	0.1	0 of 22	ND	ND	ND	420	ND
Triclopyr	H	0.1	0 of 22	ND	ND	ND	1860	ND
Chlorpyrifos	I	0.05	0 of 22	ND	ND	ND	0.083	ND
Malathion	I	0.05	0 of 22	ND	ND	ND	1.0	ND

H = herbicide, I = insecticide

1. MDL is the minimum analytical detection limit
2. A-WQG is the Vermont's acute water quality guideline indicating the concentration at which acute effects on sensitive aquatic species may occur when exposure exceeds one hour.
3. The number of detections exceeding the acute water quality guideline.
4. Dacthal metabolites were analyzed for but results are reported as dacthal parent compound.
5. ND = None Detected

Toxicity testing methods and results: Toxicity of samples was evaluated by UVM by measuring the survival and reproduction of *Ceriodaphnia dubia*, a water flea, in a 7-day test according to USEPA protocols (USEPA, 1989). No toxicity tests were conducted on the May 13 samples. Five samples each from the July 9 and September 12 sampling events were tested. One sample from the September 1 dry weather sampling was tested.

No significant acute effects (mortality) were observed in any sample tested. Although most tests showed only moderate inhibition of reproduction, strong reproductive inhibition was observed in three of five samples collected during the July 9 storm event. Pesticides (MCPP, dacthal metabolites and traces of diazinon) were detected at these 3 locations at levels below the acute water quality guidance values. Of the two samples in which a pesticide was detected at a concentration greater than the acute water quality guidance value, one (2,4-D at 162 ppb) was included in the toxicity testing. No acute or chronic effect was observed in that test. Other toxic substances such as trace metals likely present in the samples may have contributed to the reproductive impairment noted.

Discussion:

Pesticides were detected at seven of the ten sites sampled. Three of the four turf herbicides most commonly reported by commercial applicators (pendimethalin, MCPP, and 2-4-D) were detected at least once (a total of 12 detections) at half the study sites. It is likely that these products were used by homeowners as well, although no data were gathered on homeowner use. Two pesticides detected in these samples exceeded applicable acute water quality guidelines: 2,4-D was detected in a storm drain at a level 1.35 times the acute guideline and pendimethalin was found in runoff from the residential units following a commercial application of that product at 1.38 times the acute guideline. All other herbicide detections were significantly lower than acute guidelines. Dacthal metabolites were detected at two storm drain sites, although there was no reported use of this product. Toxicity testing conducted on the sample containing 2,4-D at 1.35 times the acute water quality guideline showed no measurable effect on the survival or reproduction of *Ceriodaphnia*.

The most commonly reported insecticide, chlorpyrifos, was not detected in any sample. Diazinon, with no reported commercial use, was detected at two locations on Englesby Brook during one sampling event. Concentrations detected were 27 and 73 percent of the acute water quality guideline for diazinon. Diazinon is likely to be the most common insecticide used by homeowners.

Four products, accounting for 50 percent of the total project detections, were found in Englesby Brook; however, no detections were above acute water quality guidelines.

There were no acute responses (e.g., no mortality) during the toxicity testing; however, three of five samples collected during the July storm event strongly inhibited reproduction. Pesticide levels in these samples were low, therefore, the response could be the result of other contaminants in the storm water; elevated concentrations of several trace elements were found in these samples.

Summary and Recommendations:

Pesticides were found in 18 percent of the samples collected. Two chemicals were found at concentrations that exceeded acute water quality guidelines on one occasion. These results indicate that pesticides commonly used for turf management are present in some streams in developed areas of Chittenden County at certain times. Because some chemicals appeared at concentrations that were above water quality guidelines, their occurrence may pose some risk to aquatic communities in those waters.

To clarify environmental risks, additional sampling should be implemented in order to determine how long the critical concentrations of these products persist in lakes and streams and how often these concentrations occur. Chronic exposures to lower concentrations of contaminants can also cause harm. In this limited study, at most sites where samples were collected on multiple dates, pesticides were detected on only one of the dates. This suggests that the occurrence of pesticides in these waters may be relatively short lived. Future sampling should focus on determining the frequency of occurrence of these chemicals in surface waters, the amount of time that they remain in the system at critical concentrations, and the potential toxic effects.

Suggested Information Sources:

1. Bailey, HC et al, "Diazinon and Chlorpyrifos in Urban Waterways in Northern CA, USA", Env. Tox. & Chem., 19(1) pp. 82-87, 2000

2. Hoffman, RS, PD Capel,, SJ Larsen, "Comparison of Pesticides in Eight U.S. Urban Streams", Env. Tox. & Chem., 19(9) pp. 2249-2258, 2000

3. http://www.cciw.ca/glimr/data/conc-urban-pesticides/intro.html

4. Lee, GF, "Screening Urban Pesticide Use for Potential Water Quality Impacts", G. Fred Lee and Associates, El Macero, CA, June 1998)

5. USGS. "Pesticides Detected in Urban Streams During Rainstorms and Relation to Retail Sales of Pesticides in King County, Washington". USGS Fact Sheet 097-99. April 1999.

For Further Information Contact:

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Vermont Department of Environmental Conservation
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Waterbury, VT 05671
Tel: 802-241-3784
E-mail: Dougb@dec.anr.state.vt.us

APPENDIX H

Watershed & Lake Associations of Vermont

Watershed Planning & Rivers Programs
Vermont Department of Environmental Conservation
Agency of Natural Resources
2002

Department of Environmental
Conservation
Water Quality Division
103 South Main Street
Building 10 North
Waterbury, VT 05671

Tel: 802.241.3770
Fax: 802.241.3287

Throughout Vermont, there are a number of citizen-led efforts toward watershed restoration, protection, and stewardship. Over the past several years, these groups have engaged in a wide-variety of activities, from river corridor assessments and restoration to land conservation and water quality monitoring. The Vermont Department of Environmental Conservation recognizes these groups as essential components to successful projects in Vermont's watershed.

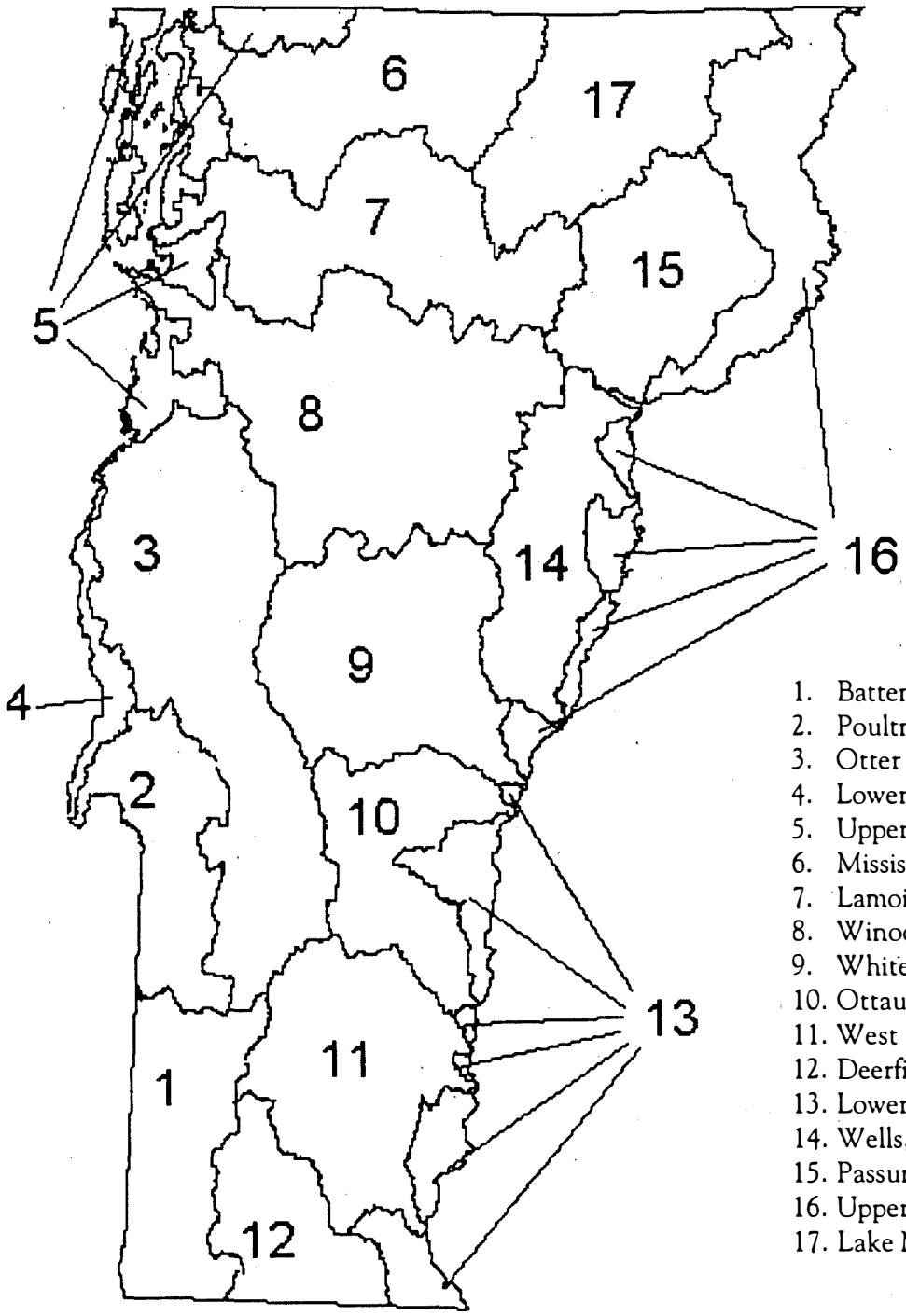
A directory of Vermont's watershed and lake associations is offered to help organizations and agencies build a communications network in support of their protection, restoration, and stewardship programs. An outline of the Water Quality Division's programs is also offered to help direct calls for project assistance.

The terms "watershed & lake associations" are used to describe the wide-range of citizen groups working on river, lake, and land-use issues. The associations are listed under one of the 17 major drainage basins shown on the map on the following page.

Please contact the Water Quality Division with any new information that will help us keep this resource up to date.

Enjoy!

Vermont's Watersheds



1. Battenkill
2. Poultney-Mettawee
3. Otter Creek
4. Lower Lake Champlain
5. Upper Lake Champlain
6. Missisquoi
7. Lamoille
8. Winooski
9. White
10. Ottauquechee
11. West
12. Deerfield
13. Lower Connecticut
14. Wells, Waits, Ompompanoosic
15. Passumpsic
16. Upper Connecticut
17. Lake Memphremagog

	Watershed & Water Conservation Associations of Vermont		Lake Associations of Vermont*	
Basin 1 Batten Kill, Walloomsac, Hoosic	Pownal Hoosic River Watershed Association James Winchester PO Box 22 ☎ 802.823.5258 Pownal, VT 05261 Email:		Woodford Lake Estates Lake Paran Recreation Inc.	
	Vermont Battenkill Conservancy, Inc Martin Oakland 2241 VT Route 313 W ☎ 802.375.0331 Arlington, VT 05250-8923 Email:			
	Battenkill Watershed Alliance Cynthia Browning PO Box 734 ☎ 802.375-9019 Arlington, VT 05250 Email:			
	Bennington County Conservation District Shelly Stiles PO Box 505 ☎ 802.442.2275 Bennington, VT 05201 Fax: 802.447.1934 Email: stiles@together.net			

* For more information on Lake Associations please contact:

Jackie Sprague
Federation of Vermont Lakes and Ponds
245 CB Road
Hinesburg, Vermont 05461
802.482.2885

or

Susan Warren
Lakes and Ponds Section
Vermont Department of Environmental Conservation
103 South Main Street, Building 10 North
Waterbury, Vermont 05671
802.241.3794

Basin 2 **Poultney, Mettawee**	Friends of the Poultney River Joanne & David Calvi 62 Inman Pond Road ☎ 802.773.5811 Fair Haven, VT 05743 Email:		Sunrise/Sunset Lake & Perch Pond Association, Benson Beebe Lake Association Burr Pond Association, Sudbury Echo Lake Property Owners Association, Hubbardton	
	Poultney-Mettawee Watershed Partnership Mary Jeanne Packer PO Box 8541 ☎ 802.287.4284 Poultney, VT 05764 Email: prw@gwriters.com Web: http://www.vacd.org/pmnrcd/index.html			
	Poultney-Mettawee Natural Resource Conservation District Marli Rupe PO Box 209 ☎ 802.287.5841 Poultney, VT 05764 Email:		Lake Bomoseen Association, Castleton Glen Lake Association, Castleton Lake Hortonia Association, Hubbardton St. Catherine Association, Poultney/Wells	
	The Nature Conservancy Mary Droege RR 1 Box 266 ☎ 802.273.3676 Castleton, VT 05735 Email:			

Basin 3 **Otter Creek, Little Otter Creek, Lewis Creek**	Addison County River Watch Collaborative Marty Illick 442 Lewis Creek Road ☎ 802.425.2002 Charlotte, VT 05462 Email: scottpond@aol.com		Lake Dunmore Fern Lake Association, Salisbury/Leichester Cedar Lake Association, Monkton Chipman Pond Association (Tinmouth Pond) Wallingford Belmont Improvement Society (Star Lake), Mt. Holly	
	Otter Creek River Watch Project Heidi Willis PO Box 433 ☎ 802.388.9207 E. Middlebury, VT 05740 Email:			
	New Haven River Anglers/River Watch Pete Diminico 305 Meehan Road ☎ 802.453.3899 Bristol, VT 05443 Email: diminico@sover.net Web: http://nhraa.tripod.com			
	Lewis Creek Association Marty Illick 442 Lewis Creek Road ☎ 802.425.2002 Charlotte, VT 05462 Email: scottpond@aol.com Web: http://www.lewiscreek.org			
	The Watershed Center at Little Otter Creek PO Box 96 Bristol, VT 05443 ☎ Email:			

	LaPlatte River Group Kate Bortz Shelburne Natural Resources Committee Planning & Zoning Department Town of Shelburne ☎ 802.985.5118 Shelburne, VT 05482 Email:			
	Green Mountain Fly Tyers Club Charles A. Whitehair 205 North Church Street ☎ Rutland, VT 05701 Email:			
	Otter Creek Natural Resource Conservation District Route 7 South RD 4 Box 1302 ☎ 802.388.6746 Middlebury, VT 05753 Email:			
	Middlebury River Watershed Partnership Melissa Green 1590 Rte 7 South, Suite 1 ☎ 802-388-6726 ext. 26 Middlebury, VT 05753 Email: melissag@together.net			

Basin 4/5 Lower Lake Champlain, Upper Lake Champlain, LaPlatte, Malletts Bay, St. Albans Bay, Rock, Pike	Lake Champlain Basin Program Michaela Stickney PO Box 204 54 West Shore Road ☎ 802.372.3213 Grand Isle, VT 05458 Email: Web: http://www.anr.state.vt.us/champ/welcome.htm		Lake Carmi Campers Association, Franklin * Also See Sunset Lake/Sunrise Lake under Basin 2	
	LaPlatte River Group Kate Bortz Shelburne Natural Resources Committee Planning & Zoning Department Town of Shelburne ☎ 802.985.5118 Shelburne, VT 05482 Email:		St. Albans Bay, Lake Champlain Lake Iroquois Association	
Basin 6 Missisquoi	Franklin Watershed Committee Pauline Favreau c/o Franklin Town Clerk PO Box 82 ☎ 802-285-2101 Franklin, VT 05457 Email: townfran@together.net		Fairfield Pond Association, Fairfield Metcalf Pond	
	Missisquoi River Basin Association Cynthia Scott 12 Canada Street, Suite 3 ☎ 802.868.5304 Swanton, VT 05488 Email: mrba@together.net Web: http://www.anr.state.vt.us/champ/Watersheds/mrba.htm			

	Missisquoi River Keepers Homer St. Francis Jr. PO Box 276 ☎ 802.868.2559 Swanton, VT 05488 Email: Franklin County Natural Resource Conservation District 1 Valley Crossroads St. Albans, VT 05478 ☎ 802.524.6505 Email:			
Basin 7 Lamoille	Browns River Watershed Council Mark Fasching PO Box 334 ☎ 802.899.4000 Jericho, VT 05465 Email: brwc_vt@yahoo.com Web: http://www.anr.state.vt.us/champ/Watersheds/brwc.htm Lamoille River Anglers Association Sumner Stowe/Daniel Noyes PO Box 960 ☎ 802.253.7346 Stowe, VT 05672 Email: angler@flyrodshop.com Mt. Mansfield River Watch Bill Butler PO Box 31 ☎ 802.899.2088 Jericho, VT 05465 Email: Lamoille County NRCD & Nature Center Position Open 109 Professional Drive, Suite 2 ☎ 802.888.9218 Morrisville, VT 05661-8524 Email: Web: http://www.pwshift.com/lcnature		Greensboro Association Caspian Lake, Greensboro Friends of the Green River Reservoir, Hyde Park Arrowhead Mtn. Lake Association Lake Eden Association Lake Elmore Association South Pond Association NY Institute for the Blind: Lake Wapanacki	

Basin 8 Winooski	Potash Brook Project Carl Engvall PO Box 8541 Burlington, VT 05402-8541 ☎ Email: cengvall@juno.com Friends of the Winooski River Freddie Cousins 153 State Street ☎ 802.223.8080 Montpelier, VT 05602 Email: fwr@sover.net Web: http://homepages.together.net/~dbraun/FWR Friends of the Mad River Mike Blazewicz The General Wait House PO Box 255 ☎ 802.496-9127 Waitsfield, VT 05673 Email: friends@madriver.com Web: http://friendsofthemadriver.org		Sunset Lake Preservation Association Nancy Baker 68 Sunset Lane East Hinesburg, VT 05461 Web: http://www.geocities.com/vtsunsetlake Berlin Conservation Commission Calais Lakes and Ponds Committee North Montpelier Community Club Greenwood Lake Association Peacham Pond Association Woodbury Lake Association	
Basin 9 White	White River Partnership Amy Sheldon 99 Ranger Rd. ☎ 802.767.4600 Rochester, VT 05767 Email: wrpamy@together.net Web: http://home.together.net/~wrpamy Chateauguay-No Town Gerald Fredrickson 546 East Barnard Rd. ☎ 802.763.2314 South Royalton, VT 05068 Email: jerry10310@aol.com		Silver Lake Association, Barnard	

	Two Rivers-Ottauquechee Regional Planning Commission Kevin Geiger 3117 Rose Hill ☎ 802.457.3188 Woodstock, Vermont 05091 Email: kgeiger@trorc.org Web: http://www.trorc.org			
Basin 10 Ottauquechee, Black	Southern Windsor County Regional Planning Commission Becky Basch PO Box 320 The Ascutney Building, Route 5 ☎ 802.674-9201 Ascutney, VT 05030 Email: rbasch@swcrpc.org Web: http://www.swcrpc-vt.org		Lake Rescue Association, Ludlow Wilderness Corporation, Lake Ninevah Amherst Lake Association Scott Terrace Association (Echo Lake), Plymouth	
Basin 11 West, Williams, Saxtons	Stratton Area Citizens Committee Bill & Betsy Uptegrove PO Box 351 ☎ 802.874.4374 West Townshend, VT 05359 Email:			
	Saxtons and West River Watch, Whetstone Monitor Francis Doyle Bonnyvale Environmental Education Center PO Box 2318 ☎ 802.257.5785 Brattleboro, VT 05303 Email: beec@together.net			
	West River Watershed Alliance Jolene Hamilton (Interim contact) Windham County Conservation District 28 Vernon Street Suite 2 ☎ 802.254.5323 Brattleboro, VT 05301 x104 Email: Jolene-Hamilton@vt.nacdnet.org			

Basin 12 Deerfield	Green River Watershed Preservation Alliance Steven Lembke 273 Jacksonville Stage ☎ 802.254.4813 Brattleboro, VT 05301 Email: Web:		Lake Raponda Association	
Basin 13 Lower Connecticut, Mill Brook	Connecticut River Watershed Council Chris Joyell PO Box 206 Saxtons River, VT 05154 Email: crwc@sover.net Web: http://www.ctriver.org/crwc.html			
	Connecticut River Watershed Advisory Commission Nathanial Tripp RFD 3 ☎ 802.748.8406 St. Johnsbury, VT 05819 Email:			
	Connecticut River Joint Commission Sharon Francis or Adair D. Mulligan PO Box 1182 ☎ 603-826.4800 Charlestown, NH 03603 Email: Web: http://www.crjc.org			
	Mill Brook Watershed Association Becky Basch PO Box 320 The Ascutney Building, Route 5 ☎ 802.674.9201 Ascutney, VT 05030 Email: rbasch@swcrpc.org Web: http://www.swcrpc-vt.org			

Basin 14 **Stevens, Wells, Waits, Ompompanoosuc**	Friends of the Ompompanoosuc Linda Matteson PO Box 153 Thetford Ctr., VT 05075 ☎ 802.785.2410 Email:		Harvey's Lake Association, Barnet Swift Water Girl Scout Council, Lake Abenaki Lake Groton Association, Groton Ticklenaked Pond Association, Ryegate Lake Fairlee Association, Fairlee/Thetford	
	SEWER - Save Everyone's Wells River Alice Allen Al-lens Farm 210 Bolkum Road Wells River, VT 05081 ☎ 802.584.4077 Email: kurganbc@together.net			
Basin 15 **Passumpsic**	Caledonia Natural Resource Conservation District Andrea Turner 1153 Main St. Ste 2 St. Johnsbury, VT 05819 ☎ 802.748.3885 Email: andrea.turner@vacd.org Web:		Joes Pond Association, Danville Coles Pond Association Lyford Pond Association South End Neward Pond Association	
	Passumpsic River Network Tim McKay Federal Building Rm. 216 26 Main Street St. Johnsbury, VT 05819 ☎ 802.748.3885 x100 Email:			
	Passumpsic Valley Land Trust Dotty Weinstein P.O. Box 124 St. Johnsbury, VT 05819 ☎ 802.748.8089 Email: dweinst@plainfield.bypass.com			

Basin 16 Upper Connecticut, Nulhegan, Willard Stream, Paul Stream	Connecticut River Watershed Council David Deen PO Box 206 Saxtons River, VT 05154 Email: crwc@sover.net Web: http://www.ctriver.org/crwc.html Connecticut River Watershed Advisory Commission Nathanial Tripp RFD 3 ☎ 802.748.8406 St. Johnsbury, VT 05819 Email: Connecticut River Joint Commission Sharon Francis or Adair D. Mulligan PO Box 1182 ☎ 603-826-4800 Charlestown, NH 03603 Email: Web: http://www.crjc.org		Maidstone Lake Association, Maidstone Halls Lake Association, Newbury Miles Pond Association Lake Morey Protective Association, Fairlee Neil Pond Association, Lunenburg Wallace Pond Association

Basin 17 **Lake Memphremagog,**	Barton River CPP Program Greg Hennemuth Lake Region Union High School 317 Lake Region Road ☎ 802.754.6521 Orleans, VT 05860 Email: ghennemuth@lakeregionhs.k12.vt.us		Westmore Lake Association: Willoughby, Long Pond, Bald Hill Pond, Westmore Seymore Lake Association, Morgan Salem Lake Association, Derby Island Pond Association, Brighton Crystal Lake Association Daniel's Pond Association Echo Lake Association Eligo Lake Association Averill Lakes Association: Great & Little Averill, Forest Lake Memphremagog Conservation, Inc. Lake Parker Association Shadow Lake Association	

APPENDIX I

Vermont Department of Environmental Conservation

Fluvial Geomorphology: a Foundation for Watershed Protection, Management and Restoration

January 16, 2001

FLUVIAL GEOMORPHOLOGY: A FOUNDATION FOR WATERSHED PROTECTION, MANAGEMENT AND RESTORATION

Introduction:

The Vermont Agency of Natural Resources is at a significant milestone in its implementation of public policy and water resource management. Several ambitious, watershed-based initiatives of great potential consequence for the people and natural resources of Vermont are in various stages of formulation and application. These include the Watershed (Basin Planning) Initiative, Stormwater Management, TMDL Implementation, Public Education, Riparian Buffers Policy, Hazard Mapping and Geomorphic River Management and Restoration. Public policy in the area of phosphorus reduction, particularly in the Lake Champlain watershed, is shifting its emphasis toward non-point sources and erosion control as cost-effective investments to achieve phosphorus loading goals. Farm policies are beginning to embrace riparian management practices and programs, such as CREP (Conservation Reserve Enhancement Program), which can effectively protect, sustain and enhance agricultural productivity.

Successful implementation of any and all of these far-reaching initiatives is entirely dependent upon building and sustaining public support. Each program must include four components of equal strength and focus: **Protection, Management, Restoration and Education**. Equally important for achievement of cost-effective results is a science based methodology which can be applied to help prioritize and focus application of the limited resources available under any of these critical initiatives.

The purpose of this Concept Paper is to show how the principles and applied methods of **fluvial geomorphology** can be used to help provide a science based foundation to technically support the State's water resource initiatives and how public support and ultimately public policy can be influenced by measurable, incontrovertible field data that documents resource condition and quality and departure from a natural system's ultimate ecological and economic potential. **Fluvial geomorphology** is one of the essential tools and organizing principles for community-based watershed protection, management, restoration and education.

Facts:

- Fluvial geomorphology is a science which seeks to explain the physical interrelationships of flowing water and sediment in varying land forms. It is a science, the understanding and strength of which, has advanced greatly in the last decade primarily due to an extraordinary volume of rigorously measured and analyzed field data obtained from all over North America.

- The Vermont ANR has made a significant investment in staff training to become proficient in the application of the science of fluvial geomorphology.

- Partnerships between state and federal resource and infrastructure management agencies, watershed associations and individual communities are being formed and supported through shared understanding of the physical processes and geomorphic condition that is described through physical assessments.

- The Vermont ANR and its partners have made substantial progress in developing the necessary application tools including databases of field measurements of Vermont streams supportive of resource protection, management, restoration and education decisions and policies.

- Cost-effective, multi-objective, ecological and economically supportable resource protection, management and restoration decisions are made possible by field data based physical assessments that establish system condition and potential. Field data provides the evidence upon which public support is made possible.

- The principles and applied methods of fluvial geomorphology can be used to:

  - Assess stream channel stability and understand or predict the evolution of channel adjustments that <u>must</u> take place in response to anthropogenic or other external influences. How will the stream system respond to proposed or projected land use changes, riparian corridor encroachments or channel modifications such as flood control projects?

  - Develop lake watershed management plans through sediment and nutrient budgets to develop effective strategies for nutrient reduction. What is the contribution of streambank erosion to sediment and nutrient loadings in relation of surface run-off or wastewater treatment plant discharges?

  - Assure that investments in transportation infrastructure maintain or improve channel stability and resource values and minimize maintenance costs. What are the long term effects on channel stability caused by roadway approaches to bridges or culverts that fill flood plains? Do cost-effective alternatives exist based on lower life-time maintenance costs, enhanced public safety and improved stability and resource quality?

  - Establish the basis for flood plain and riparian corridor management and protection that reduces the potential for flood losses and conflicts with human investments. A science-based methodology is made possible to determine high risk areas for development along all stream corridors; a significant expansion of and improvement over the existing National Flood Insurance Program methodology.

  - Describe the complex spatial and temporal scales of cause and effect and the implications for lake and stream impacts created by watershed land use, flood plain or channel management practices oftentimes conducted far away and in the past. How is the stream system responding today to extensive gravel mining conducted 15 years ago, or the channelization for flood control purposes performed in 1973, or the flood plain encroachments created by the construction of a railroad the entire length of the valley in 1910?

- ✓ Predict the sensitivity of waterbodies to watershed change, channel or flood plain encroachments and how a watershed as a whole will benefit from a geomorphic based management and protection plan and restoration of channel stability. Streams of different physical type and in varying valley settings react to external influences and channel management practices differently. The science enables us to predict system response in virtually any location.

- ✓ Support the resolution of water resource problems on a watershed scale rather than continue the historic approach of reacting to the symptoms of a broader problem, site by site. Armoring 500 linear feet of unstable streambank within a mile long unstable reach invariably exacerbates the problem and represents a wasted investment.

- ✓ Illustrate to and educate the public on physical processes and the imperatives of system response to watershed and riparian corridor management decisions. Field data is a powerful tool to show physical processes and system condition in relation to potential.

- ✓ Provide the data that can support stream buffer and river corridor protection and management decisions.

Discussion:

The Vermont Agency of Natural Resources is embarking on several new watershed initiatives in response to statutory mandates, identified public need and a growing constituency for watershed protection and restoration. The Agency has become equipped and more proficient with the tools necessary to formulate, implement and sustain these initiatives effectively.

Initiatives commenced in the 70's, such as wastewater treatment, were successful because they looked at a specific problem and solved the problem of wastewater assimilation at the watershed scale. Today the problems involve the often competing demands for the use and enjoyment of waters, polluted runoff, exotic species, and the pervasive problem of stream instability. To be effective, basin planning and other initiatives must go beyond the enumeration of symptoms and use the analysis of physical, chemical, biological, and social data to explain the root problems of Vermont's troubled waters.

Watershed assessments in Vermont's 305b Report to Congress have described erosion/ sedimentation and phosphorus as the largest categories of pollution in the state. These two concerns are related, in that eroding stream bank soils may very well be one of the largest sources of sediment and phosphorus entering our watersheds. The root causes for eroding stream bank soils are the removal of riparian vegetation, hydrologic modifications, flood plain and channel encroachments and the channel management practices that have been conducted to address the symptoms of these original causes. These activities have caused stream instability at the watershed scale, wherein bank erosion at one location triggers further stream bed and bank erosion in both upstream and downstream directions.

As a result of intensive staff training in recent years, the Agency has begun to implement the principles and applied methods of fluvial geomorphology in stream alteration permits, river restoration, public

hazard identification, and river education programs. Initial success with explaining complex stream problems and restoring stream reaches using a geomorphic approach presents an important opportunity for resource managers and watershed constituents. Fluvial geomorphology, a science which seeks to explain the physics of flowing water and sediment in different land forms, is an essential tool and organizing principal for community-based watershed protection and restoration. **The field data derived through physical assessments conducted on streams following a rigorous geomorphic-based methodology can be supportive of many other state water resource initiatives and programs.**

Successful initiatives that lead to meaningful actions will be important in explaining the relationship of erosion, aquatic habitats and water-based recreation with channel stability in different watershed land forms. For instance, basin plans that include an assessment of stream type and stability could then effectively explain the sensitivity of streams to land use changes, flood plain encroachments, loss of riparian vegetation and channel management activities. Once completed, these plans would address a large root cause of the erosion/sedimentation and phosphorus loading problems and present specific actions that can be prioritized on a watershed basis.

For decades now, the economic, ecological and recreational values of the majority of our Vermont rivers and streams have been substantially degraded from their true potential. The State has the opportunity now to restore and strengthen the water resource based economy of the state.

Recommended Actions:

To effectively deal with stream channel instability, arguably Vermont's greatest water resource challenge, and to support other on-going critical water resource protection and management initiatives, Vermont's water resource managers, scientists, and policy makers should take actions toward the following goals:

I). Create a multi-objective and geomorphic framework for stream management in Vermont and develop an informed partnership of resource managers and watershed constituents.
Support an approach based on applied fluvial geomorphology which focuses on improving stream stability and function as a central management goal. This approach is effective because it addresses the multiple objectives of various stakeholder groups, and can be understood and applied by such diverse individuals as town planning board members, road foremen, landowners, and local, county, state, and federal resource agencies. This strategy complements more traditional approaches to stream management by creating projects and plans that serve goals of ecosystem restoration in equal measure to human needs of flood risk mitigation, private property protection, water quality improvement and recreational opportunities. The Agency of Natural Resources has begun education, training and outreach programs as well as fostered state and federal partnerships through data collection and river stability demonstration projects.

II). Develop databases to support stream, river corridor and watershed protection, management, restoration and public education programs and to provide indices of program accomplishments and effectiveness.

In order to 1) develop and implement stream and watershed management plans, 2) prioritize stream reaches within a watershed for their relative stability, 3) design and construct geomorphically-based restoration designs, 4) monitor the effectiveness of these projects and 5) monitor the effectiveness of the program, a data collection effort is needed. **The results of this data collection effort will provide physical benchmarks with which to evaluate stream threats and impairments.** Reference data will also provide geomorphically-based design specifications to complement traditional engineering approaches to such projects as streambank stabilization, transportation infrastructure investments, flood recovery or prevention, flood plain management and stormwater controls. In addition, these databases will provide water resource managers with the necessary data to guide stream project assessments and designs throughout the state; refine conditions for stream alteration and stormwater permits; and provide a common framework for assessing the effectiveness of stream management projects in meeting their stated goals. The following four priority data collection areas will be important for completing basin plans (Goal III described below); supporting stream, flood plain and buffer management decisions and policies; hazard mapping; stream restoration designs, and program evaluation:

A). Development of a "stream geomorphic and physical habitat assessment handbook" to include standard monitoring methodologies and a "data management system" to ensure consistency, repeatability, quality assurance and control of data collection and analysis. The handbook will encourage the involvement of watershed groups and municipal officials through a tiered watershed assessment approach.

B). Development of regional relationships that correlate stream drainage area to the channel-forming (bankfull) discharge and corresponding hydraulic geometry for each hydrophysiographic province represented in Vermont using data from USGS stream gaging stations. These relationships define the standard criteria for identifying bankfull discharge and associated channel geometry (width, depth, and cross-sectional area), upon which stream assessments, morphological type, and monitoring methodologies are based for ungaged streams and stream reaches.

C. Development of a data set on the geometry of selected stable stream reaches of the range of stream types which, owing to their morphology, effectively pass flood flows and associated sediment loads and can serve as reference data for stream assessment, protection, and restoration projects.

D. Development of a data set relating stream channel and bank morphology and condition to actual erosion rates. This information will be used to predict sediment loadings, prioritize implementation of channel stabilization BMPs (Best Management Practices), and provide an evaluation tool for monitoring BMP effectiveness.

III). Develop and implement basin plans in priority sub-basins and establish a network of stream stability restoration demonstration projects throughout Vermont which will advance public understanding of fluvial processes and widespread support of protection and management programs at the state and local levels.

Basin plans should identify and prioritize concerns and problem areas and provide a schedule for attaining long-term goals for stream corridors at the sub-basin scale. Each component of a basin plan should directly or indirectly address water quality concerns arising from stream instability. Following remote sensing and targeted field geomorphology assessments (using data outlined under Goal II described above), basin plans should target stream protection, restoration, and management projects using the following set of priorities (in order from highest to lowest priority):

1. Conservation Reaches. First and foremost, we need to protect those reaches that are least disturbed, where river structure and vegetation associations are relatively intact. Remnant or refuge reaches would provide a good base to work out from, into more degraded reaches in the watershed.

2. Strategic Sites. These are highly sensitive sites, or river reaches that are sensitive to disturbance, where impacts may trigger off-site responses. We need to take a pro-active management strategy here with an emphasis on reaches where disturbances may threaten the integrity of Conservation Reaches. If we don't take action at these sites, the adjustments set in motion may lead to watershed-scale changes that would be uncontrollable without inordinate, impractical expense. The key example is the management of nick points or bed level instability. If we don't address bed level issues, we'll see significant upstream and downstream instability develop.

3. Reaches with high recovery potential. These reaches show signs or potential for self-adjustment, in a manner that fits the present-day setting and stream type. Management efforts that work with the current tendencies of the river could achieve quick and visible success. The "do-nothing" alternative may be viable at these sites but minimally invasive approaches will accelerate recovery while meeting the concerns of the landowner. For example, excluding livestock, placing tree revetments or a couple log-vanes, and re-establishing riparian vegetation on a reach that has (or nearly has) the dimension, pattern, and profile appropriate to its valley type has a high likelihood for success at minimal cost. Again, work should concentrate on reaches adjacent to or connecting Conservation Reaches.

4. Moderate to highly degraded sites. These sites may require a more invasive management strategy (consisting of changes to dimension, pattern, and/or profile). Moderately degraded sites could be defined as those with a reasonable potential to recover after reasonably-priced restoration efforts (e.g., narrowing a stream's width/depth ratio). Highly degraded sites would have little near-term (10-20 yr.) natural recovery potential and are typically high-sediment sources or accumulation zones (i.e., a river type that does not fit the valley type). Physical intervention at highly-degraded sites is often expensive with an uncertain outcome. In most cases, restoration should only go forward once upstream (and in some cases, downstream) sites have been dealt with and watershed-wide sediment and vegetation management plans have been implemented. If we pursue invasive restoration projects in isolation we are just as likely to fail as succeed.