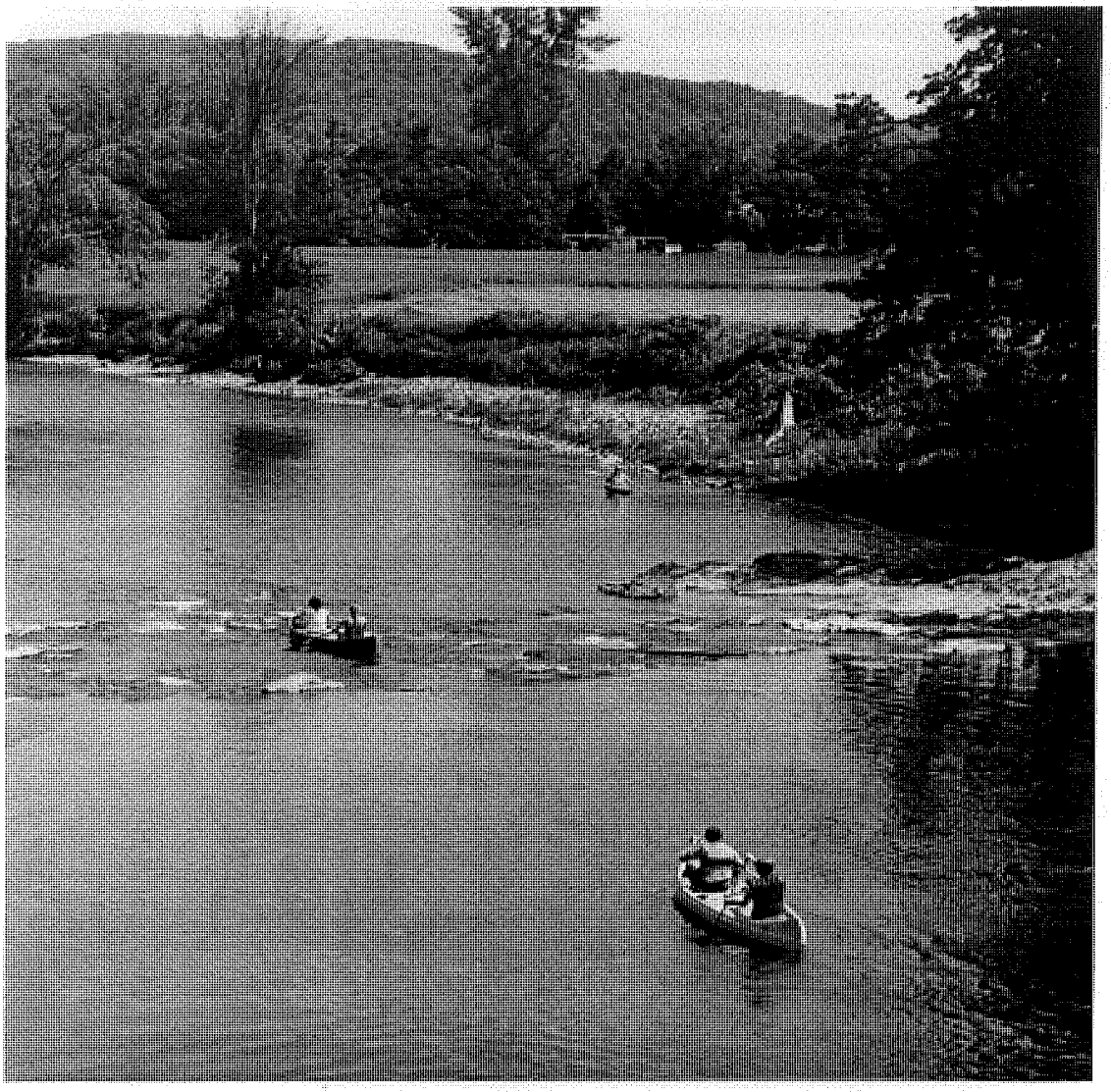
STATE OF VERMONT
2006 WATER QUALITY ASSESSMENT REPORT
(305B REPORT)



Boating the Mighty White River near Royalton. Photo Credit: Vermont Travel Division.

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STATE OF VERMONT

2006 WATER QUALITY ASSESSMENT

CLEAN WATER ACT SECTION 305B REPORT

Vermont Agency of Natural Resources
Department of Environmental Conservation
Water Quality Division
Waterbury, Vermont 05671-0408
www.vtwaterquality.org

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Vermont Department of Environmental Conservation

on the internet at: < http://www.anr.state.vt.us/dec/dec.htm >

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DEPARTMENT VISION

We envision a Vermont where people can live in harmony with diverse and healthy natural systems;
appreciate and enjoy our natural resources;
understand the environment;
work together responsibly to reduce waste and risks to human health and the environment;
and prosper without significant degradation of natural systems.

We envision a Vermont where people breathe clean air;
drink clean water;
eat safe food;
and live in a sustained and healthy environment.

DEPARTMENT MISSION

To preserve, enhance, restore, and conserve Vermont's natural resources,
and protect human health, for the benefit of this and future generations.

2006 Section 305b Report
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Reporting Period: 1/1/04 – 12/31/05

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 report on a biennial basis to the US Environmental Protection Agency (EPA) which provides information about the quality of the state's surface and ground waters. The Year 2006 Water Quality Assessment Report [often called the *305b Report*] summarizes water quality conditions throughout Vermont during the 24-month reporting period (January 1, 2004 through December 31, 2005). Also included is water resources monitoring/assessment program information for rivers and streams, lakes and ponds, wetlands and groundwater. The report contains information on certain costs and benefits, monitoring progress, swimming beach closures and special concerns. The Year 2006 305b Report, similar to reports from earlier years, is meant to provide the reader with an understanding of the programs designed to assess 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 2006 305b Report contains updated water quality information for portions of Round Four and Five of the rotating river basin assessments. These specific basins are Basin 6 (Missiquoi) and Basin 17 (Lake Memphremagog, Barton, Black, Clyde). 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 2006 Water Quality Assessment Report 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 four use support categories used by the Vermont Department of Environmental Conservation are *full support, stressed, altered,* or *impaired.* The four use support categories are described below.

Full Support - This assessment category includes waters of high quality that meet all use support standards for the water's classification and water management type.

Stressed - These are waters that support the uses for the classification but the water quality and/or aquatic habitat have been disturbed to some degree by point or by nonpoint sources of human origin and the water may require some attention to enhance its usefulness or the water quality and/or aquatic habitat may be at risk of not supporting uses in the future. Data or other information that is available confirms water quality or habitat disturbance but not to the degree that any designated or existing uses have become altered or impaired.

Altered - These are waters where a lack of flow, water level or flow fluctuations, modified hydrology, physical channel alterations, documented channel degradation or stream type change is occurring and arises from some human activity, OR where the occurrence of exotic species has had negative impacts on designated uses. The aquatic communities are altered from the expected ecological state. This category includes those waters where there is a documentation of water quality standards violations for flow and aquatic habitat but EPA does not consider the problem(s) caused by a pollutant or where a pollutant results in water quality standards not being met due to historic or previous human-caused channel alterations that are presently no longer occurring.

Impaired - These are surface waters where there are chemical, physical and/or biological data collected from quality assured and reliable monitoring efforts that reveal 1) an ongoing violation of one or more of the criteria in the Water Quality Standards and 2) a pollutant of human or human-induced origin is the most probable cause of the violation.

Water uses include, but are not limited to, drinking, aquatic life, recreation, fish consumption and agriculture. A determination of use support may be made from *monitored*[1] information or from *evaluated*[2] information gathered and provided to the Department of Environmental Conservation (DEC) by water resources personnel, fish and wildlife biologists, aquatic biologists, lake association members and other qualified individuals or groups. The 2006 Water Quality 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 altered or impaired) are considered not to be meeting the Water Quality Standards. 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 2006 list of waters are certain impaired waters that need or would benefit from a pollution budget determination more commonly known as a Total Maximum Daily Load or TMDL determination. The 2006 303d list of waters is being developed concurrently to the 2006 305b Report. As the 303d list needs EPA approval, that information is being prepared separate from the 2006 305b Report.

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 describing the extent of remaining problems. The 305b Report has become increasingly important to support funding award decisions to the state made 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 the last previous biennial Vermont Section 305b Report, can be found through the internet at http://www.anr.state.vt.us/dec/waterq/wqdhome.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.
- Use data of known quality from multiple sources to make assessments

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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, the 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.

[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.

- 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 is eager to see the following goals be addressed in 305b reporting:

- *Adopt 2006 Integrated Water Quality Monitoring & Assessment Report Guidance (7/29/05)*
  For the 2006 Section 305b Report, DEC was able to partially adopt EPA's guidance document. For this report, DEC has not been able to convert its assessment approach to the "assessment unit" type/level of approach advocated by EPA guidance. Rather, DEC has continued to rely upon the well established and functional "waterbody" as its unit of assessment and reporting. DEC has also continued to use its own assessment database rather than converting to EPA's "Assessment Database" (ADB). As a way for DEC to evaluate the utility and functionality of ADB, EPA has agreed to load Vermont assessment information for lakes and rivers within one river basin into ADB. The Department, nonetheless, considers its assessment approach and findings to be largely consistent with the five categorical listings defined in EPA guidance. DEC's assessment process identifies surface waters in full use support (full support and stressed) and less than full use support (altered and impaired). DEC's assessment and listing processes result in the identification of waters considered as "impaired" (consistent with EPA guidance category 4A, 4B and 5) and in the identification of other waters either in need of assessment (category 3). DEC has identified waters altered by exotic species, altered by flow regulation or altered by historic physical channel changes. These are waters altered by a non-pollutant and, except for being labeled as "impaired," could be equivalent to waters for category 4C. DEC will continue to rely on its current assessment and listing approaches into the foreseeable future.

- *Expand use of biological indicators and reporting*
  DEC 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, section 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 on July 2, 2000. These procedures are currently used by DEC 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.

Vermont DEC continues to build upon its biological assessment database. In the last two years, more than 450 biological site assessments have been added to its biological database. 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, DEC 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 EPA, DEC 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 DEC continues to update and make improvements to its web site (http://www.vtwaterquality.org) which includes information on biological monitoring programs and indicators within DEC.

- *Improve data management, increase the documentation of data quality, and increase the use of electronic databases and geographic information systems.*
  DEC's analytical laboratory conducts its business under the auspices of the EPA-approved Quality Assurance/Quality Control Plan (QA/QC) and Quality Management Plan and monitoring is carried out under QA/QC Project Plans. DEC now uses an Access database for improved 305b information management and has increased the documentation of data quality. Regarding electronic reporting, DEC 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. For certain nonpoint source projects, DEC has begun expanding its use of EPA's Grants Reporting and Tracking System.

- *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. During the 2006 305b reporting period, DEC was able to complete and submit to EPA its "Water Quality Monitoring Program Strategy," a document that outlines important monitoring elements over a ten year period. The document can be found as an appendix to this report.

- *Increase assessments of drinking water use support*
  This continues to remain a goal for DEC. Until sufficient resources are available to specifically perform drinking water use source support assessments, they will be performed as part of the DEC'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)*
  DEC uses waterbody identification numbers (WBID) for reporting by hydrologic unit. All waterbodies in the state are assigned waterbody identification numbers and are geo-referenced. 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. In Vermont, there are 609 lake and pond waterbodies (equal to or greater than 5 acres in size) and 210 designated river and stream waterbodies. All 819 designated waterbodies have been spatially referenced onto a GIS at a scale of 1:100,000 as well as onto the 1:5,000 scale afforded by the Vermont Hydrography Dataset. The Vermont Hydrography Dataset (VHD) is based on the National Hydrography Database. DEC has developed a database table to link hydrologic unit codes (HUC-14s) to all WBIDs. This linkage allows DEC to exchange data between three watershed characterization systems: HUC's; 1:100,000 waters; and 1:5,000 VHD waters.

PART ONE: ASSESSMENT EXECUTIVE SUMMARY/OVERVIEW

Overall description

The water quality of Vermont's rivers and streams and lakes and ponds is considered good. This overall water quality rating has not changed from the overall rating level reported in the year 2004 Section 305b Report. The US Environmental Protection Agency (EPA) has requested states to also assess the state's water quality considering the fish consumption advisory for mercury which was issued by the Vermont Department of Health in June 1995 and most recently revised in June 2000. The advisory was issued as the result of fish tissue sampling that showed mercury in the tissue of all fish, particularly in walleye and lake trout, and also PCBs in lake trout[1] in Lake Champlain. Taking the fish consumption advisory into consideration, the overall water quality of all the state's waterbodies would be rated as fair. Deposition of mercury from the atmosphere is the predominant source believed to be responsible for elevated levels of mercury in fish.

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

No comprehensive studies have been completed on the quality of Vermont's groundwater. The quality of this vast resource is believed to meet drinking water standards for most of its consumers. An accurate assessment of groundwater quality, however, requires a program with sufficient staff and other resources to characterize the resource.

Assessment Findings

Water quality assessment reports for two river basins were completed by the Department of Environmental Conservation (hereafter as DEC or the Department) in the two years since the 2004 Section 305b report. An assessment report for Basin 6 (Missisquoi) was completed in 2004; and a report for Basin 17 (Lake Memphremagog, Barton, Black, Clyde) was completed in 2005. Each basin assessment report is available from DEC upon request. The water quality assessment report for Basin 8 (Winooski) is nearing final revisions as of this writing.

DEC continued to conduct its monitoring and assessment and listing of waters consistent with the Assessment and Listing Methodology. The 2006 305b Report showcases the LaRosa Environmental Laboratory - Analytical Services Partnership Program.

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[1] The 1989 advisory issued for PCBs (polychlorinated biphenyls) in Lake Champlain remains in effect.

Rivers & streams

The assessment of Vermont's river and stream surface water quality and aquatic habitat conditions has been updated from the 2004 305b assessment with water quality information and data from waters monitored and assessed during the 1/1/04 to 12/31/05 reporting period. Beginning with the 2004 report and continuing with the 2006 report, DEC instituted a substantially different way to make use support determinations. As described above and in the appendix containing the Assessment Methodology, miles of rivers and streams are placed into one of four categories by degree of support to designated uses – full support, stressed, altered or impaired. This categorization differs from the categories of full support, full support/threatened, partial support, and non-support used in the 2002 and earlier 305b assessment reports. The 2006 biennial report contains rivers and streams that have been re-assigned to the new categories to the extent possible. However, the current assessment categories do not directly equate to the former categories across all rivers and streams within Vermont. The assessment category of these rivers and streams (considered to be in the minority) will be determined as DEC gets to them in the assessment rotation. *The numbers provided in use support categories as well as the miles of rivers and streams affected by different causes and sources need to be considered as transitional until a complete re-assignment and re-assessment has been done.*

Vermont has approximately 7,100 miles of perennial rivers and streams. Of the 5,491 river and stream miles assessed for the 2006 305b Report, overall approximately 88% of those miles are in compliance with the state's water quality standards and support designated uses, and 12% do not meet water quality standards or do not fully support the designated uses. About 1,609 river and stream miles (23% of total miles) were not assessed for this report. These figures do not appreciably differ from those reported in the 2004 305b Report.

Lakes & ponds

Inland lakes & ponds

All lakes and ponds within the borders of Vermont are considered as inland lakes or ponds except for the 11 segments of Lake Champlain. Moore Reservoir and Comerford Reservoir (found along the upper Connecticut River), Lake Memphremagog and Wallace Pond are transboundary waters that are reported as "inland lakes."

Of the 55,347 inland lake/pond acres that were assessed for this report, 37,522 inland lake acres support uses and 17,825 inland lake acres do not support uses. The 2004 305b Report indicated that 35,908 inland lake acres supported uses and 19,434 inland acres did not support uses.

Although all inland lake/pond waters are impacted by mercury pollution and are subject to fish consumption advisories, Vermont's assessment methodology indicates the need for waterbody-specific tissue data to indicate non-support of fish consumption. Accordingly, when assessed following the methodology, approximately 85% of inland lake acres support fish consumption use. This proportion reflects that there are only a relatively small number of Vermont lakes from which actual fish tissue data are available.

Lake Champlain
In Lake Champlain and due to the combined effects of trace metal contamination, nutrient accumulation and non-native species, none of Lake Champlain's 174,175 acres found in Vermont fully support designated uses.

No acres in the Vermont portion of Lake Champlain support fish consumption use due to elevated levels of mercury and polychlorinated biphenyls (PCB) in fish tissue.

In 2005, the Lake Champlain Basin Program issued a report entitled *"State of the Lake - Lake Champlain in 2005 - A Snapshot for Citizens."* The special report contained several important questions frequently asked by the public regarding the lake and its contributing watershed. Answers to the questions concerned water quality, public health and safety, fish and wildlife habitat and aquatic nuisance species. The questions appearing in the report are provided below:

Can I swim in Lake Champlain?
Do blue green algae blooms pose a risk?
Who notifies the public about blue-green algae risks?
Can I drink the water?
Can I eat the fish from Lake Champlain?
Are there any new toxins to be concerned about?
Are phosphorus levels too high in the Lake?
Has water clarity improved?
How do increases in population and land use changes influence water quality?
Is it important to protect and restore wetlands and rivers?
Is the biodiversity of Lake Champlain changing?
Do cormorants have an effect on fish, birds and habitats?
Are fish populations changing?
Do sea lamprey threaten salmon, trout and other fish?
Do zebra mussels affect the ecosystem and human use?
Does Eurasian watermilfoil impair the Lake?
Is water chestnut still a problem?
What aquatic nuisance species pose future threats?
What are some cultural heritage and recreation opportunities in the Basin?
Are educational efforts making a difference?
Are local communities helping the cleanup?

The entire *State of the Lake* report can be inspected at the Lake Champlain Basin Program's web site: www.lcbp.org.

Wetlands

The Vermont Wetlands Program within the Department administers the Vermont Wetland Rules which regulate most palustrine wetlands that have been mapped on the Vermont Significant Wetland Inventory maps. Mapped wetlands have a higher level of protection than unmapped wetlands.

Some years ago, the Vermont Agency of Natural Resources digitized all the National Wetland Inventory (NWI) maps for the state. This effort identified a statewide total of 232,000 acres of palustrine wetlands. These wetland areas are considered significant and are designated as Class

Two wetlands under the Vermont Wetland Rules. Wetland inventories conducted in selected towns around Vermont indicate there is considerably more acres of wetland than identified by the NWI project. The wetlands that do not appear on the NWI maps are considered Class Three by the Vermont Wetland Rules. The area of Class Three wetlands is estimated as 90,000 acres.

The Wetland Section logged in 512 new projects during 2004. In addition to the 512 projects logged in during 2004, approximately 96 projects were continued from previous years. In 2004, the Wetlands Section received 88 new Conditional Use Determination (CUD) applications and 84 CUDs were issued, one was denied, and one was terminated. Of the 84 CUDs issued in 2004, a total of 4.2 acres of Class Two wetland were lost, 0.83 acres of wetland were permanently impaired and 0.45 acres of wetland were temporarily impaired. The CUDs issued in 2004 approved approximately 18.93 acres of permanent buffer zone impairment and 0.9 acres of temporary buffer zone impairment. A number of impacts permitted through the CUD process undergo some form of mitigation. Portions of the wetland and buffer zone may be restored from a previously impacted condition or enhanced through plantings. Wetlands can be created from an area that was not previously wetland, or simply protected through a conservation easement. Wetland gains can be the result of mitigation for permits, restoration for wetland violations, or the voluntary action of willing landowners, or a combination of these factors.

Groundwater

During the reporting period, a variety of groundwater concerns were addressed. These concerns included the occurrence of naturally occurring arsenic and radionuclides. The wastewater disposal issue regarding radionulcides at public drinking water systems is particularly problematic. MTBE (an additive by refiners to gasoline) is also of major concern regarding groundwater and about 75,000 private wells near hazardous waste sites have been sampled for MTBE. More than 250 wells have MBTE detections across the state.

Groundwater is currently used for drinking water by approximately 70% of Vermont's population. About 46% of the population is self-supplied while about 24% is served by public water systems using groundwater. Over the reporting period there were 29 new or modified groundwater sources that required a source permit from DEC.

About 87% of the public community water systems in the State have their corresponding Source Protection Areas or aquifer recharge areas mapped. The remaining public community water systems are using 3,000 foot radius circles as their Source Protection Areas.

In 2002, the on-site sewage statute was reformed to provide universal jurisdiction over all on-site sewage (septic) systems. While this reform may have occurred prior to the 2006 reporting period, it is still considered a major event in the on-going protection and improvement of Vermont's groundwater quality.

Listings of Waters

Development of the Year 2006 List of Impaired Waters in need of a Total Maximum Daily Load (a reporting requirement under Section 303d of the Clean Water Act) is a process that runs

concurrent to the development of the 2006 Section 305b report. Consequently, the final 2006 303d List of Impaired Waters has not been included in this report. The 2006 303d List of Impaired Waters, ultimately needing approval by EPA, will be finalized and made available separately. DEC will also make available separately the several other listings of priority waters which are considered to fall outside the scope of Section 303d.

Vermont's 2004 303d List of Impaired Waters was approved by the New England regional office of EPA during the reporting period (approval on July 19, 2004). The 2004 303d listing identified a total of 155 waters as being impaired (111 river/streams and 44 lakes/ponds).

Vermont's 2004 listing of other priority waters outside the scope of 303d was also finalized in 2004. This consists of a number of listings and includes: impaired waters that do not need a TMDL; waters in need of further assessment; waters with completed and EPA-approved TMDLs; and, waters altered by exotic species, flow regulation and channel alteration.

During the 2006 Section 305b reporting period, the New England regional office of EPA approved seven Total Maximum Daily Load determinations completed by DEC. This brings to fifty (50) the total number of TMDLs that have been approved by EPA since 2001.

Concerns & Recommendations

There are several concerns and recommendations which relate to the management and improvement of Vermont's water quality and water resources. Concerns and recommendations which have been prepared for the following topics are more fully described in Chapter 7:

Atmospheric deposition of pollutants
Hydrologic modifications in lakes and rivers
Exotic aquatic species as pollutants
Eutrophication of lakes
Nutrient criteria
Alteration of littoral habitat & effects of shoreline development on inland lakes
Emerging contaminants
E.coli contamination & mircrobial source tracking
Lack of strategic statewide vegetated buffer requirements
Road salt and water quality
Polluting discharges from large farms
Groundwater

PART TWO: INTRODUCTION & BACKGROUND

A. Introduction: Setting the Stage

Within its borders, Vermont has approximately 7,100 miles of rivers and streams, 300,000 acres of fresh water wetlands and 812 lakes and ponds (those at least 5 acres in size or those named on US Geological Survey maps) totaling about 230,900 acres. Surface waters (not including wetlands) are classified as Class A or Class B. 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. Class B waters, which are managed for high quality, may have minimal, minor or moderate change to aquatic biota or habitat according to the water's management type B1, B2 or B3. Certain Class B waters have an overlay Waste Management Zone for public protection below sanitary wastewater discharges.

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/streams and 229,053 acres of Class B lakes/ponds. Approximately 315 miles of the Class B rivers and about 15 acres of Class B lakes have a Waste Management Zone. The Waste Management Zone, similar in effect to a zoning overlay, is created on a site-specific basis to accommodate the direct discharge of treated sewage effluent to surface waters.

The Vermont portion of the Batten Kill along with the West Branch of the Batten Kill (totaling about 33 miles), the Lower Poultney River (about 22 miles), a 3.8 mile segment of the Ompompanoosuc River and a 1.3 mile segment involving Pikes Falls on the North Branch of Ball Mountain Brook have each been designated by the Vermont Water Resources Board as an Outstanding Resource Water (ORW). The 3.8 mile segment of the Ompompanoosuc was designated ORW in 1996. All other ORWs noted above were designated in 1991.

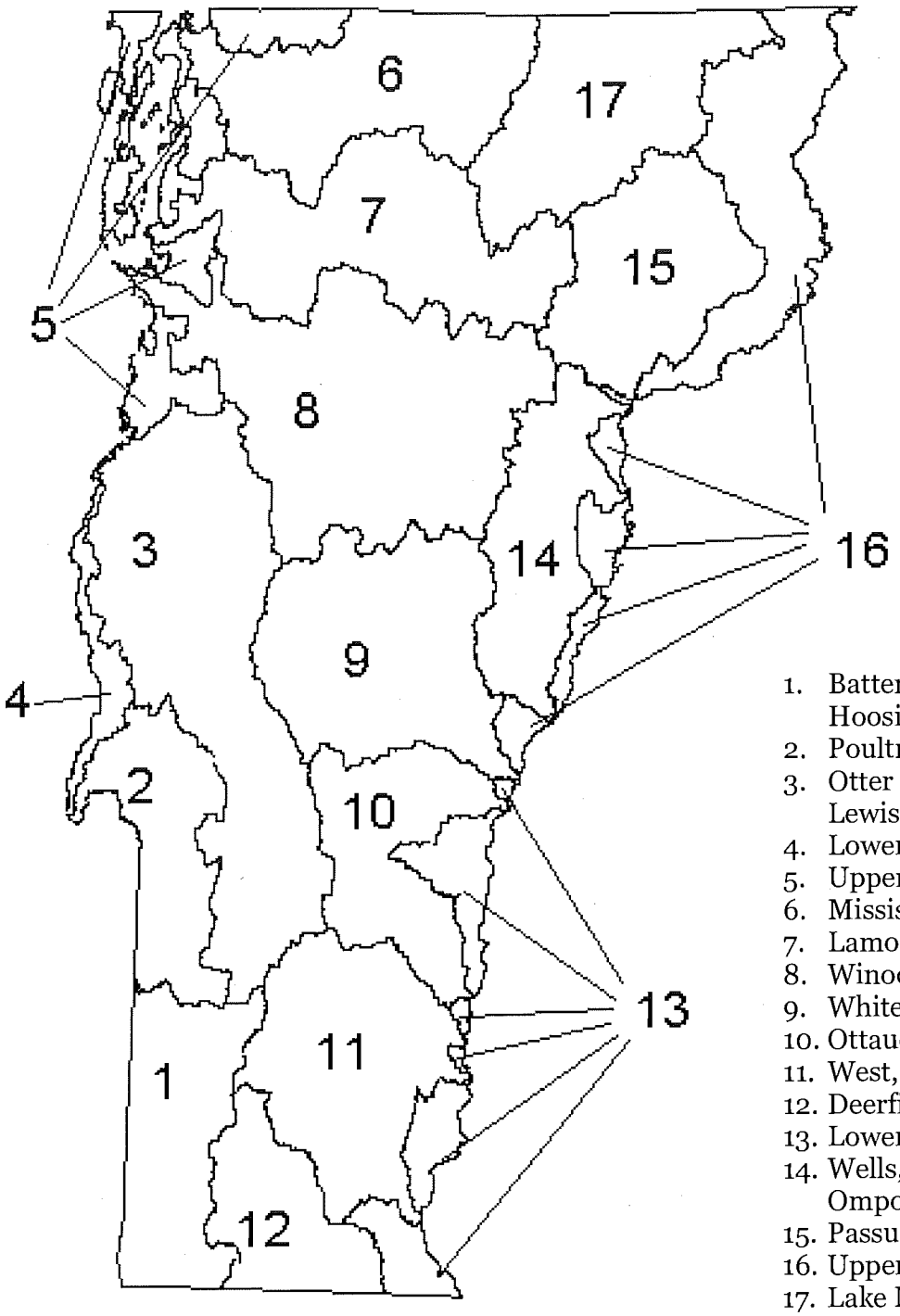
Wetlands within Vermont are classified as Class One, Class Two or Class Three. Class One wetlands are considered exceptional or irreplaceable in their contribution to Vermont's natural heritage and are afforded the highest level of protection. Class Two wetlands are considered significant. Class One and Class Two wetlands are those shown on the National Wetlands Inventory maps. Class Three wetlands are areas that do not appear on the maps. The majority of wetlands within Vermont are Class Two.

Surface water quality monitoring undertaken by the Department during the 2006 305b reporting period (January 1, 2004 through December 31, 2005) 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. DEC 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 Four of the report for a more detailed description of DEC's surface water quality monitoring program and for the results of monitoring and assessment activities. Appendix C and D contain DEC's 2006 Assessment and Listing Methodology and Water Quality Monitoring Program Strategy, respectively.

For the wide range of water quality management and planning purposes, there are 17 major river basins found in Vermont. These rivers drain into one of four large regional drainages: Hudson River,

Lake Champlain, Lake Memphremagog and the Connecticut River. A map illustrating the 17 river basins is provided below.

Vermont's Major Watersheds



1. Battenkill, Walloomsac, Hoosic
2. Poultney-Mettawee
3. Otter Creek, Little Otter, Lewis
4. Lower Lake Champlain
5. Upper Lake Champlain
6. Missisquoi
7. Lamoille
8. Winooski
9. White
10. Ottauquechee, Black
11. West, Williams, Saxtons
12. Deerfield
13. Lower Connecticut
14. Wells, Waits, Ompompanoosuc
15. Passumpsic
16. Upper Connecticut
17. Lake Memphremagog

B. Background: An Overall Description of Vermont's Water Quality & Surface Water Resources

Summary Description of Vermont's Water Quality

The water quality of Vermont's many rivers and streams and lakes and ponds is considered good. This overall water quality rating has not changed from the overall rating level that was reported in the 2004 Section 305b Report. The US Environmental Protection Agency (EPA) has requested states to also assess the state's surface 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 that 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 fish consumption advisory into consideration, the overall water quality of all the state's waterbodies would be rated as fair. A statewide assessment of mercury in sediments, waters, and biota of Vermont lakes was completed during the 2004 reporting cycle. Results of the project are discussed and can be found in Part Four of the 2004 305b Report.

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.

No comprehensive studies have been completed on the quality of Vermont's groundwater. In most cases it is believed that groundwater quality meets drinking water standards. A thorough evaluation of groundwater is needed, however, to provide a factual characterization of this important resource.

Atlas/Total Waters

Vermont has approximately 7,100[2] miles of rivers and streams, 230,900 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 mile area.

Vermont's border waters include the Connecticut River on the east (border with New Hampshire), Lake Memphremagog and Lake Champlain 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 17 major river basins in Vermont (refer to map in Part Two), which drain to one of four large regional drainages: Lake Champlain, the Connecticut River, Lake Memphremagog, or the Hudson River. Additional surface water resource information is contained in Table 2.1 below.

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

[2] Source of 7,100 mile figure is EPA's Total Waters Database. Earlier 305b reports relied upon Don Webster's list of Vermont waters prepared in 1962 that showed a total of 4,936 miles. A number of omissions have been discovered in Webster's listing with many small streams overlooked and the lengths of some rivers and streams significantly underestimated. The total mile figure is likely to change once the Vermont Hydrography Dataset becomes functional.

Table 2.1. 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[3]	7,099
Border miles of shared rivers/streams (subset)[4]	262
Number of lakes, reservoirs & ponds (at least 20 acres)	291
Number of lakes, reservoirs & ponds (at least 5 acres but less than 20 acres)	318
Number of significant, lakes, reservoirs & ponds (less than 5 acres)	203
Acres of lakes, reservoirs & ponds[5]	230,901
Acres of freshwater wetlands[6]	300,000

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), the lake is considered an inland sea by many residents of Vermont, New York and Quebec. The Atlantic Ocean and Inland Waterway are accessible to the south from Lake Champlain via the New York Barge Canal. The Richelieu River, St. Lawrence River and the Atlantic Ocean are accessible to the north through Canada.

Estimated total stream miles and lake acres in Vermont using the Vermont Hydrographic Dataset

During the reporting period, the Vermont Center for Geographic Information developed a new spatially referenced geographic layer and accounting of surface waters throughout the state. This so-called Vermont Hydrographic Dataset (VHD) was derived by photo-interpretation of 1:5,000 scale aerial orthophotographs and through use of the 1:100,000 scale National Hydrographic Dataset (NHD) as a base layer. VHD has been approved by USGS as the NHD dataset for Vermont and, accordingly, all reach addressing is compliant with NHD standards and specifications.

For many years and concerning several previous Section 305b Reports, DEC has provided a statewide estimate of about 7,100 river and stream miles. This estimate is based upon the older EPA Total Waters dataset which was a precursor to the NHD and sized to capture surface waters at 1:100,000 scale. A map scale of 1:100,000 implies that waters visible on USGS 1:100,000 scale quadrangle maps will be captured by the geographic coverage in question. The 1:5,000 scale VHD shows all waters visible on a base layer of that scale, resulting in significantly more waterbodies being mapped.

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[3] Includes the Connecticut River.

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

[5] 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. Figure also accounts for three newly inventoried ponds. These were not previously tracked in Vermont's Lake Inventory Database.

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

The new VHD-based preliminary estimate for total river and stream mileage on a statewide basis is 22,525 miles, an increase of 317% over the older EPA Total Waters estimate. The total number of lake acres captured by VHD does not appreciably change from the current DEC estimates of total statewide lake acreage, as the largest proportion of lake acres in Vermont are already reflected by the current Vermont Lake Inventory.

For the 2006 Section 305b Report, DEC has chosen to continue using the Total Waters estimate. Before the VHD-based estimate is incorporated into its various water quality assessment and reporting efforts, DEC will need to revise the lengths of rivers and streams throughout the state on a systematic basis involving each waterbody. As of this writing, it is not known when that revision process will begin or how long it will take. In order to ensure reporting consistency, the VHD-based mileage values will not be employed until all river and stream waterbodies have been re-evaluated.

Effectiveness of Pollution Control Programs

The Vermont Department of Environmental Conservation (DEC) within the Agency of Natural Resources has been designated as the lead water quality management agency for the State of Vermont. In that role, DEC administers a wide variety of programs that are intended to control, reduce or prevent pollution from point and nonpoint sources to the State's surface and ground water resources. These programs are effective at maintaining, protecting and restoring water quality and aquatic habitat conditions. For the purpose of describing water pollution control program effectiveness, DEC's various water pollution control programs can be summarized into three categories: General, Point Sources and Nonpoint Sources.

Since the 2004 305b Report, a relatively new water quality program has become established in Vermont known as the Clean and Clear Initiative. The Clean and Clear Initiative, which cuts across the three water pollution program categories noted above, is introduced later in this chapter.

GENERAL PROGRAM

Water Quality Standards

The Water Quality Standards are the foundation of the state's water pollution control and water quality protection efforts. The Water Quality Standards (Standards or WQS) have been promulgated by the Vermont Water Resources Board and provide the specific criteria and policies for the management and protection of Vermont's surface waters. The classification of waters (rivers, streams, lakes and ponds) as Class A, Class B or Class B with Waste Management Zone are the management goals to be attained and maintained. The classification also specifies the designated water uses for each class. Class A waters are either A1 (ecological waters) or A2 (public water supplies). Class B waters fall within one of three water management types (B1, B2 or B3) after consideration by the Water Resources Board.[7] The current Vermont WQS (go to www.state.vt.us/wtrboard, click on "Rules") were adopted June 10, 1999 and became effective July 2, 2000.

The Vermont WQS establish narrative and numeric criteria to support designated and existing uses. Designated uses, as established in Sections 3-02(A), 3-03(A) and 3-04(A) of the Standards, mean any

7 A petition for water management typing of all surface waters in the White River basin was submitted to the Water Resources Board during the 2006 reporting period. Deliberations and rule making regarding the petition – now by the Water Resources Panel - are ongoing.

value or use, whether presently occurring or not, that is specified in the management objectives for each class of water. Table 2.2 serves to indicate applicable designated uses.

Table 2.2. Designated Uses for Water Classifications.

Designated Uses	Class A(1) – Ecological Waters	Class A(2) – Public Water Supplies	Class B Waters
Aquatic Biota, Wildlife & Aquatic Habitat	√	√	√
Aesthetics	√	√	√
Swimming & Other Primary Contact Recreation	√		√
Boating, Fishing & Other Recreation Uses	√		√
Public Water Supplies		√	√
Irrigation of Crops & Other Agricultural Uses			√

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 re-classified to Class A since the 1998 305b Report.

Outstanding Resource Waters
An overlay of both Class A and Class B waters is the designation of 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. The following waters have been designated as ORWs: the Batten Kill and its West Branch, Pikes Falls on the North Branch of Ball Mountain Brook, the lower Poultney River and Great Falls on the Ompompanoosuc River. No additional ORWs were designated during the 2006 305b reporting period.

Watershed Approach
Vermont has adopted and is implementing a watershed approach to surface water quality planning. The DEC-prepared document, *Guidelines for Watershed Planning* (refer to the year 2002 305b Report or to www.vtwaterquality.org, click on "planning" then click on "basin planning process") calls for basin surface water plans to be developed on a periodic basis.

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. Nevertheless, 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

Guidelines for Watershed Planning 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.

During the reporting period, the Poultney-Mettowee River Basin Plan was adopted by the Secretary of the Agency of Natural Resources. The basin plan for the White River was adopted in November 2002. For a summary update on progress of activities in the nine river basins where water quality management plans have been or are being developed, the reader should refer to Appendix A. Table 2.3, appearing on the following page, provides a summary overview of the status of basin planning activities as of December 2005.

POINT SOURCE CONTROL PROGRAM

Vermont administers a well-planned and comprehensive direct discharge water pollution control program, consisting of planning loans and advances, construction grants and loans, permitting and compliance monitoring. In March 1974, Vermont received from EPA the delegation authority to administer discharge permits under the National Pollutant Discharge Elimination System. Within Vermont there are 33 wastewater treatment facilities considered as "major" and 132 "minor" facilities.

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 Appendix B, Table B.1), advanced waste treatment, correction of combined sewer overflows (CSO) (see Appendix B, Table B.2), control of toxics, pollution prevention activities and facility enlargements.

During the 2006 305b reporting period, construction commenced on CSO corrections, sewer line rehabilitations and extensions, sewer system improvements, wastewater treatment plant upgrades, and phosphorus reductions. Various new projects, located in all four major drainages within Vermont, commenced construction in 2004 and 2005 using funding from state, federal and local sources, totaling approximately $76 million in ultimate expenditures (refer to Table 2.4 below). Due to the size of some of the projects and limited appropriations, some of the projects received only partial state and federal funding during the reporting period. These projects will receive full funding during succeeding years.

Of the 31 facilities with planned phosphorus reduction projects in the Vermont portion of the Lake Champlain basin, 30 have been or are close to being completed. Of the 33 planned CSO correction projects, 24 have been completed, 5 are underway and 4 are pending.

Vermont's TMDL planning for Lake Champlain, including a new lower tier of phosphorus limits, anticipates over $5 million in new construction projects at existing municipal wastewater treatment plants in the coming years.

Approximately $76.5 million dollars were spent during the 2004 - 2005 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 nine communities. This figure is a substantial increase over the $26.5 million figure reported in the 2004 305b Report.

Table 2.3. Basin Planning Initiative - Status for All Basins (as of December 2005).

	River Basin Identification Number								
Components of the Basin Planning Process	**2**	**3&4**	**5**	**6**	**7**	**8**	**9**	**11**	**14**
Public forums held	C	C	O	I	C		C	C	C
Watershed Council formed	C	C	C		C		C	C	C
Local water quality concerns identified	C	C	C	O	C		C	C	C
Panel discussions on water quality issues held	C	O	O	O	C		N/A	C	C
Strategies for water quality issues formulated	C	O	O	O	C		C	C	O
Review of town plans & zoning regulations	C	I/O	O	I	C		C	O	O
Develop water management type classification proposal	C	I/O	I		C		C	O	O
Meetings with towns on classification proposal	C	I/O			C		C	I	
Watershed plan draft	C	I	I		C		C	I,C	I
Public hearings on draft plan	C						C		
Final basin plan	C						C		
Basin plan adopted by ANR Secretary	C						C		
Outreach to schools and local groups	O	O	O	O	O		C	O	O
Basin Assessment Report	C	C	C	C	C		C	C	C
Phase I Stream Geomorphic Assessments	O/C	O/C	O	O	O	O	O	C,O	O/C
Phase II Stream Geomorphic Assessments	O/C	I/O/C	O	O	O	O	O	C,O	O/C
Bridge and Culvert Inventory	O/C	I/O		O	O	O		O	O/C
Dam Inventory	I				C		C	I	
Biological Monitoring	O	O	I	C	O	O	C	O	O
Restoration Projects	C&O	O	O	O	C&O	C&O	O	C&O	C&O

Key to Table: I = initiated, O = ongoing, C= completed
Basin 2 = Poultney-Mettowee Rivers; Basin 3 = Otter Creek; Basin 4 = Lower/Southern Lake Champlain; Basin 5 = Northern Lake Champlain; Basin 6 = Missisquoi River; Basin 7 = Lamoille River; Basin 8 = Winooski River; Basin 9 = White River; Basin 11 = West, Williams & Saxtons Rivers; Basin 14 = Waits, Wells, Ompompanoosuc & Stevens Rivers.

Table 2.4. Municipal Pollution Control Project Starts.
(January 1, 2004 to December 31, 2005)

Community	Description	Est. Project Cost
****** LAKE CHAMPLAIN DRAINAGE ******		
Burlington	Digester rehabilitation	$3,403,000
Colchester	Individual On-Site Systems	$ 150,000
Milton	Treatment Plant Upgrade	$9,310,000
Richmond	Treatment Plant Upgrade.	$3,907,000
Rutland	Combined Sewer Overflow Reduction	$6,400,000
Shelburne	Sewer Relocation	$1,171,000
****** HUDSON RIVER DRAINAGE ******		
Pownal	New sewerage to serve 3 villages including sewers, pump stations & treatment plant	$27,690,000
****** LAKE MEMPHREMAGOG DRAINAGE ******		
Barton	Sludge Removal	$ 511,000
Newport City	Treatment Plant Upgrade	$4,394,000
****** CONNECTICUT RIVER DRAINAGE ******		
Ludlow	Phosphorus Removal	$1,080,000
Rochester	Treatment Plant Upgrade.	$4,399,000
Saint Johnsbury	New sewerage to serve East St. Johnsbury village	$ 346,000
Saint Johnsbury	Combined Sewer Overflow Reduction	$3,153,000
Springfield	Treatment Plant Replacement and Enlargement	$10,909,000
Springfield	Combined Sewer Overflow Reduction	$2,451,000
TOTAL COST		**$76,500,000**

NONPOINT SOURCE (NPS) CONTROL PROGRAM

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 sixteen years of Clean Water Act Section 319 NPS implementation funding (1990-2006), Vermont has received about $19 million to implement a variety of activities. The goal of the NPS management program is to encourage the successful implementation of best management practices (also referred to as "BMPs") by diverse interests such as farmers, developers, municipalities, lakeshore residents, landowners and riparian landowners in order to prevent or reduce the runoff of pollutants. Effective BMPs can be structural, vegetative or management-based as well as regulatory or advisory.

Some notable activities carried out with Section 319 funding during this 305b reporting period include youth-based watershed restoration efforts, enabling nutrient management services for farm operators and funding assistance targeted at municipalities for reducing sediment runoff from unpaved

backroads. Importantly, the Program was able to assist a variety of locally-led efforts to improve water quality and/or habitat conditions (e.g. Sucker Brook restoration in Williston, the West River planning and management in Windham County and the Missisquoi River assessment and implemtntation in Franklin County).

Because of the diffuse but widespread nature of NPS source pollution, there are several other important programmatic aspects that are prominent features of Vermont's nonpoint program. Some management elements are part of DEC while others elements are conducted outside of DEC. Examples of the former include construction sediment and erosion control, hazardous and solid waste management, responding to spills and leaks and the control of stormwater from construction sites and developed areas. Examples of the latter include logging erosion control carried out by the Vermont Department of Forests, Parks and Recreation and agricultural runoff control by the Vermont Agency of Agriculture, Food and Markets. The US Department of Agriculture is an important nonpoint source management partner in both forestry and agriculture arenas.

Specific details regarding the NPS program and project activities are available from DEC. DEC has maintained a listing of 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 BMPs and programs and in the improvement of water quality.

CLEAN AND CLEAR INITIATIVE

The over abundance of phosphorus in many of Vermont's waterways causes great harm because it nourishes algae blooms, degrades the clarity and overall quality of the water and impacts wildlife. All of these constitute a serious threat to the economic vitality and natural beauty of Vermont. With 2005 being its second year of operation, the Clean and Clear Action Plan is a comprehensive, multi-faceted blue print for reducing phosphorus loading to Vermont's waterways through both point and nonpoint sources. Clean and Clear advances the pollution reduction framework established in the Lake Champlain Phosphorus Total Maximum Daily Load (TMDL) from the year 2016 to 2009, the 400th anniversary of the arrival of the French explorer Samuel de Champlain.

In 2005 Governor Douglas recommended, and the Vermont Legislature appropriated, a nearly twenty percent increase in the Clean and Clear budget for programs in the Vermont Agencies of Agriculture, Natural Resources and Transportation. This increase allowed for: additional stream restoration projects; reduced a greater percentage of the backlog of expired stormwater permits; enabled the development of nutrient management plans on farms and more water quality management financial assistance; broadened the level of public participation in watershed planning; and, provided for more outreach so that the public will become more aware of phosphorus issues. The major components of the Clean and Clear Action Plan Initiative are summarized below.

Agency of Agriculture, Food and Markets (AAF&M)

Best Management Practices & Alternative Manure Management

This program provides significant financial assistance through cost share for structures designed to address discharges from farm production areas because the majority of milkhouse waste, silage and manure is stored there. The total estimate to fix all these major production area structural issues on Medium Farm Operations (MFO) is $15.4 million. An additional $0.88 million is needed to assure all MFO farms have nutrient management plans. This totals to $16.3 million for all MFO farm fixes to meet proposed regulatory standards. AAF&M estimates that to fix all of the manure waste storage,

silage leachate, roof runoff and milkhouse waste issues on all farms would cost over $61 million. Five Alternative Manure Management projects have been approved totaling $233,950.

Conservation Reserve Enhancement Program (CREP)

CREP encourages farmers to voluntarily install conservation buffers in riparian areas by offering rental payments in exchange for taking strips of land out of production. The goal of CREP is to enroll 7,500 acres by the year 2009. After an initial spike in acreage enrolled in 2002, CREP is showing slow, steady growth through 2005. About 1,175 acres have been enrolled with 200 acres enrolled in FY2005. Although there was a significant expansion of education and outreach efforts with additional staff, rental payments over the last few years had been insufficient to draw more enrollment. During 2005, rental payment rates have been increased which should result in higher enrollment.

Nutrient Management Program

Nutrient Management Plans (NMP) are part of the Integrated Crop Management Program (ICMP) and help bring soils to optimum phosphorus levels. Of the 205 MFOs in Vermont, 105 do not have NMPs in place. The cost of implementing NMPs on these farms is about $0.88 million. Some 68 farms have signed up to receive cost share contracts. It is anticipated that as more farmers become aware of water quality issues and regulations, this program will grow rapidly.

Regulatory Programs

Rules regarding Accepted Agricultural Practices (AAP), Medium Farm Operations (MFO) and Large Farm Operations (LFO) comprise the regulatory tiers of the Agricultural Water Quality Program and are designed to prevent discharges containing phosphorus and nitrogen. AAPs are a base level of management required of all farms. Proposed changes to AAPs include a mandatory 10 foot buffer on all riparian cropland. Other proposed changes include criteria for nutrient and pesticide storage, soil testing, riparian pasture management. MFOs will soon be subject to an increased level of management because of the potential impact that greater numbers of animals can have being confined in a single area. LFO revisions for nutrient management and waste storage structures will undergo rulemaking procedures in spring of 2006.

Conservation District Outreach and Technical Assistance Program

Vermont's 14 Conservation Districts provide direct technical assistance to farmers to help: establish compliance with AAPs; apply for help with conservation practices; apply for exemptions from winter spreading bans; conduct assessments of groundwater contamination and; provide agricultural representation in basin planning being conducted by DEC. The Winooski Conservation District hired two technicians who provide land treatment planning services in watersheds targeted by the Federal Watershed Protection Act.

Basin Planning

Agriculture is recognized as a major source of nonpoint pollution in many of Vermont's river basins and watersheds. The Winooski Natural Resource Conservation District has been awarded a grant of $100,000 to write and provide research for agricultural elements of seven basin plans which are required by state law.

Agencies of Natural Resources and Transportation

Wastewater Discharges

Dramatic progress has been made over the last several years in reducing the level of phosphorus in discharges from municipal wastewater facilities. Under Clean and Clear, the reduction of more than 3.3 metric tons per year of permitted phosphorus discharge was funded in FY2005-2006 for the Richford and Troy/Jay facilities. Funding of similar projects in Hardwick and Waterbury in FY2007 will lead to reductions of another 5 metric tons of permitted phosphorus in discharges.

River Management

The Vermont General Assembly provided a major boost to the River Management Program during the 2005 session, appropriating $1.25 million in capital funds for projects. Clean and Clear funds were also used to leverage $1 million in FEMA grants for mapping of erosion hazards which, when addressed, will help prevent transport of phosphorus-laden sediment. More than 3,000 miles of stream have been assessed by River Management staff and our partners since Clean and Clear began in 2004, generating data for more "on the ground" implementation projects in 2005.

Better Backroads

The Better Backroads Program helps control phosphorus runoff by assisting towns with improved road maintenance and construction techniques and grants to implement them. Grants pay for bank and ditch stabilization and culvert upgrades, all of which stem erosion and decrease the transport of phosphorus. More than 30 towns participated for the first time in the Better Backroads Program in 2005 due to a significant boost in Clean and Clear grant awards, which totaled $328,486. Five towns and two organizations were awarded grants for road inventory and evaluation projects. Some 41 towns and 3 organizations got grants to correct an erosion problem. The program stabilized 5.8 miles of roadside ditches in 2005, up from 4.0 miles in 2004. Forty-five culverts were stabilized in 2005; nearly double the 23 from 2004. On-site assistance is crucial to getting towns to participate in the program.

Stormwater Management

Substantial progress in reducing the backlog of expired stormwater permits combined with an increasing number of sites coming under permit control indicates that overall stormwater treatment is improving in Vermont. The number of individual or general permits for new developments or redevelopment projects has increased from 68 in 2004 to 111 in 2005. All new permits require stormwater treatment systems consistent with state standards in the 2002 Vermont Stormwater Management Manual. The first of 17 hydrology-based TMDLs for stormwater impaired watersheds will be submitted to EPA for approval in early 2006, with more expected later in the year. Two sets of stormwater rules have been established with one set governing stormwater management in watersheds of impaired waters; the other set governing how stormwater is managed in non-impaired waters.

Erosion Control at Construction Sites

With additional staff provided by Clean and Clear, there has been considerable improvement in permit processing, education and outreach and permit compliance. The overall rate of compliance is still too low. However, projects in impaired watersheds with Individual Permits have generally shown better compliance records. Despite a significant increase in outreach and education efforts, there were many cases where contractors were not aware of their obligations under Construction General Permits (CGP). After explaining the program, compliance at many of these sites showed improvement. As of November 2005, the number of CGP applications authorized in 2005 was 119, up from a total of 79 in 2004. The number of acres of construction disturbance regulated by the program increased from 998 acres in 2004 to 1,290 acres in 2005. Despite a 50% increase in permit activity, the increase in staff funded by Clean and Clear has allowed for a 92% rate of meeting Permit Expediting Process (PEP) time standards in 2005, up from 66% in 2004.

Local Municipal Actions

This program places a Water Quality Specialist at the Vermont League of Cities and Towns to encourage towns to adopt water quality regulations not covered by state law. The program began in early 2005 with the specialist delivering presentations at the Town Officer Education Conference series.

Wetland Protection and Restoration

Because wetlands are such a valuable resource in the battle against phosphorus loading, this program seeks to restore wetlands damaged or destroyed by development and agriculture. An $80,000 contract to develop a restoration plan for wetlands in the Lake Champlain Basin was awarded in 2005. Working with the Vermont Land Trust, the Hinesburg Land Trust and the Trust for Public Lands, ANR

has committed $120,000 to restore the natural hydrology to approximately 120 acres of wetland along the LaPlatte River. Clean and Clear also contributed $39,000 to a project in Benson. Partnering with The Nature Conservancy, 50 acres of an agriculturally altered wetland along the Hubbardton River will be restored which will eliminate an active source of phosphorus loading.

Forest Management

With forested areas covering over 75 percent of the state and yielding some 900,000 cords of wood per year, there is some concern about sediment discharges from silvicultural practices. Stream crossings are often the most likely to create a discharge, so loggers and landowners are being encouraged to use skidder bridges and other Best Management Practices. A watershed forester has been hired to facilitate these efforts and will begin work in February 2006. In 2004, the last year for which statistics are available, technical advisory teams investigated 34 cases of discharges from silvicultural activities. In all cases, discharges were brought under control and site restoration was achieved quickly in 30 cases.

Monitoring

Monitoring of water quality and land use is necessary to determine whether the goals of the Lake Champlain TMDL implementation plan are being met. Four segments of the Lake are not meeting their in-lake phosphorus standard and six others are borderline. Three segments are seeing increasing phosphorus levels and almost all of the lake's major tributaries exceed allowable limits. Development of land that had been in forested or agricultural use could increase phosphorus runoff which could offset some of the gains from the management activities of Clean and Clear. Citizen volunteers sampled 16 stations in Lake Champlain and 52 other lakes in 2005 as part of the Vermont Lay Monitoring Program, which this year produced a new Vermont Volunteer Surface Water Monitoring Guide. A study of St. Albans Bay has found there is an abundant supply of phosphorus in the sediments of the bay which is likely to nourish algae for many years to come. It is time to consider treatment options to counter this.

Watershed Action Plans

Watershed Planning educates citizens about what they can do to reduce pollution, coordinates pollution reduction activities and invites the public to help establish priorities for management projects. Under Clean and Clear, two additional Watershed Coordinator positions were recruited, giving the program five positions in the Lake Champlain Basin and two in the Connecticut River Basin. Watershed Coordinators, working to develop consensus through Watershed Councils, were the catalysts for dozens of water protection activities in 2005 involving more than 3,500 people.

The above serves to summarize the major components of the Clean and Clear Initiative. For those readers interested in a more complete description of the various elements, including program history, program accomplishments and the various indicators being used to document success, the Clear and Clear Action Plan: 2005 Annual Report should be studied. The report can be seen on the Clear and Clear web site: www.anr.state.vt.us/cleanandclear.

Nature & Extent of Nonpoint Sources of Pollutants

Pollution from nonpoint sources of pollutants 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 nonpoint source pollution. Water quality impacts and the potential for impact from nonpoint sources are apparent in each of Vermont's 17 drainage basins.

The reader is referred to Part Three (Surface Water Monitoring and Assessment) and Part Six (Groundwater Monitoring and Assessment) for further details regarding the causes and sources of NPS pollution within Vermont.

Environmental Impact/Economic & Social Costs/Economic and Social Benefits of Effective Water Programs

Point Sources
The total commitment and expenditure of state, federal and local funds for all municipal wastewater treatment facilities and appurtenances to date has been approximately $630 million. These facilities have improved the quality of 59 rivers and 3 lakes for such uses as swimming, fishing, boating and aquatic life. The $630 million figure includes the $76.5 million in improvements which started construction during the 2006 305b reporting period. Refer to Table 3.4 below for the location and estimated cost of these recent improvements.

Nonpoint Sources
Quantifying the financial resources expended on nonpoint source control of pollutants is not as easy to determine or link to specific river miles/lake acres of improvement as contributions of resources occur from many and various state, federal and local agencies as well as from landowners, volunteer groups, foundations, businesses and even corporations. There are two Clean Water Act (CWA) programs under DEC administration and a single state-funded program that address nonpoint source pollution control which can be highlighted.

The CWA programs are the Section 604b Pass Though Program and the Section 319 Program and the state-funded program is the Vermont Conservation License Plate Program. Funding for the two CWA programs from 1989 through 2006 has amounted to approximately $860,000 (604b) and over $19 million (319). The 604b Program has assisted the 11 Vermont regional planning commissions conduct a wide variety of water quality planning related activities. A portion of the 319 Program has provided funding assistance to a wide variety of governmental and non-profit organizations to carry out nonpoint source implementation efforts.

The notable state funded program is the Vermont Conservation License Plate Program. In the eight years of its existence (1998-2006), the program has awarded over $400,000 in state monies to many diverse groups for a wide variety of projects. Many of the funded license plate projects provide water quality and/or aquatic habitat benefits. Another extremely important state funded program (which addresses point sources as well) is the Clean and Clear Initiative that has been described previously.

As a way to offset some of these cost-benefit uncertainties, the 2004 Section 305b Report mentioned five fairly recent socio-economic evaluations related to recreational water use or water quality conditions. The reader is referred to the 2004 report for the noteworthy findings of those evaluations. In brief, the five surveys that were mentioned in that report include:

> The Center for Rural Studies at the University of Vermont conducted a survey in the fall 2002 of 1,338 Vermont households regarding their opinions of recreation resources. The survey[8] was done for the Vermont Department of Forests, Parks and Recreation as one component for the 2005 Vermont Outdoor Recreation Plan.

8 Center for Rural Studies. 2003. The 2002 Vermont Outdoor Recreation Survey Report and An Analysis of Change Since 1992. University of Vermont. Burlington, VT.

The Year 2000 Vermont Angler Survey[9].

The Year 2001 National Survey[10].

In the fall 2003 issue of *LakeLine*[11], researchers examine property sale prices and water quality relationships of lakes in 3 New England states (ME, NH, VT) to provide some understanding of the social value of environmental quality and the risk of degraded environmental quality.

A report in 2002 was issued describing a study of visitors to Vermont State Parks.[12] The study was conducted to improve current knowledge of the values and functions of the 47-state park system.

Strategy to Achieve Comprehensive Monitoring & Assessment Coverage

In accordance with EPA guidance and during the 2006 Section 305b reporting period, DEC completed a Water Quality Monitoring Program Strategy. The Strategy document consists of ten parts and addresses major elements necessary for monitoring the quality of ambient waters for the purpose of water quality assessment, planning and management. The monitoring strategy is written with a ten-year lifespan and includes annual and mid-term progress evaluations. Implementation of the Strategy began during 2004. The Strategy can be found as Appendix D.

The narrative appearing below is the executive summary that has been excerpted from the EPA-approved Vermont Water Quality Monitoring Program Strategy.

The ambient water quality monitoring program strategy provides a framework describing existing monitoring and assessment efforts in Vermont and elaborates on elements of an ideal monitoring program to meet several objectives. The Strategy has multiple uses and purposes and is organized into EPA's guidance "Elements of a State Water Monitoring and Assessment Program" (March, 2003). The Strategy presents a roster of specific monitoring goals and objectives and a listing of existing and potential monitoring designs for Vermont waters. Recommendations for core and supplemental water quality indicators are provided. Detail is provided on quality control and assurance, data management approaches, a description of data analysis and assessment procedures, and the use of these procedures to support federally required reporting. The final sections of the Strategy address suggestions for periodic review of the monitoring program and provide estimates of necessary resources for full program implementation. Throughout the Strategy, the term "waters" is intended to comprise rivers and streams, lakes, ponds and reservoirs, and wetlands. Groundwater has not yet addressed by this strategy.

Section One serves as an introduction while Section Two provides the goals and objectives to be met. The goals and objectives are as follows:

<u>Goal One: Predict and monitor the condition of Vermont's aquatic and wetland resources to:</u>

- identify emerging problems before they become widespread or irreversible;

9 Vermont Department of Fish & Wildlife. 2000. The 2000 Vermont Angler Survey. Prepared by the University of Vermont, School of Natural Resources. Waterbury, VT.

10 US Fish & Wildlife Service. 2003. 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation in Vermont. Washington, DC.

11 K.Boyle & Bouchard.R. 2003. Water Quality Effects on Property Prices in Northern New England. LakeLine. Journal of North American Lake Management Society. Pages 24-27.

12 A.Gilbert & Manning.R. 2002. Economic and Social Values of Vermont State Parks.

- provide information essential to protecting, maintaining and/or restoring the integrity and use of these resources;
- achieve comprehensive monitoring coverage of all Vermont waters;
- identify water quality conditions, impairments, causes, and sources; and,
- evaluate the success of current policies and programs.

Objectives for Goal One:

A. Identify the status of Vermont's aquatic and wetland resources
B. Identify trends in the condition of Vermont's aquatic and wetland resources, including high-quality waters in need of protection
C. Identify existing and emerging threats to Vermont's aquatic and wetland resources
D. Identify where watershed level activities impact aquatic and wetland resources
E. Provide information to support and evaluate Agency and Department planning, management and regulatory programs, including the development of environmental indicators
F. Respond to citizen complaints and emergency situations regarding Vermont's aquatic and wetland resources (as appropriate)
G. Determine compliance with Vermont Water Quality Standards, and identify where standards may need to be modified to account for natural conditions
H. Provide technical data and information to public water supply operators
I. Obtain monitoring data coverage for all waters such that each significant public water will be monitored directly, or will have its condition estimated based on a statistically unbiased random probability determination

Goal Two: Communicate, collaborate and coordinate with organizations, agencies, and the general public to:

- increase public knowledge of and involvement in aquatic and wetland resource monitoring and assessment (and hence water resource management);
- promote efficient and effective monitoring and assessment programs; and
- collect useful data to supplement state monitoring and assessment programs.

Objectives for Goal Two:

A. Develop a mechanism for identifying and coordinating monitoring and assessment programs in Vermont
B. Identify aquatic and wetland resource data needs and develop mechanisms to enable volunteer monitoring and assessment programs to collect data that are of high quality and relevant to those needs
C. Communicate with other state and federal agencies to assure complementary monitoring programs
D. Encourage volunteer monitoring programs

Section Three addresses monitoring designs. Detail is provided on existing monitoring approaches used in Vermont, including the rotational watershed assessment approach and existing core and supplemental projects, broken into physical, chemical, biological, and volunteer-based categories. A comprehensive listing of potential threats to Vermont waters is provided.

Section Four lists core and supplemental indicators of water quality that are measured by the individual monitoring projects. These indicators spring from the Vermont Water Quality Standards, but also include parameters that relate to ecological and habitat quality. Section Five describes approaches to quality assurance, provides a listing of active quality assurance project plans, and discusses briefly how quality assurance planning relates to quality management planning.

Section Six provides a listing of existing databases that house water quality information generated by the monitoring program. The section also discusses the current status of Vermont's water quality assessment databases, and relates information housed in those data archives to the Vermont Hydrographic Dataset. Section Seven describes how DEC assesses water quality data to arrive at determinations of water quality standards attainment, and further elaborates on approaches to listing waters where uses are not met. The Strategy references Vermont's Water Quality Assessment and Listing Methodology as a standalone document that guides the listing process. Section Eight describes required Federal reporting that is supported in large part by the monitoring program and associated assessment and listing processes. Finally, Sections Nine and Ten of the Strategy describe monitoring program review and institutional needs.

Specific recommendations are provided within each section. The highest priority items requiring funding include securing long-term technician and summer staff support for the biomonitoring and lakes programs, and developing a coordinator position to support volunteer organizations participating in the successful LaRosa Laboratory Services Partnership Program offered by DEC. Other priority items regard increasing consistency in the archiving of water quality assessment findings and expansion of the use of STORET (a national water quality data archive developed by EPA) to hold biomonitoring data.

The Strategy recommends using a hybrid of fixed station and probability-based surveys to assess the conditions of waters statewide. Projects that are developing biological indices of aquatic life use support for large rivers, lakes and reservoirs, and wetlands have identified needs. The Strategy also highlights approaches to developing nutrient criteria and modifying pathogen criteria. With respect to federal assessment methods and reporting requirements, the Strategy specifically recommends that assessment methods be fixed for a period of three assessment and listing cycles and that reporting during those periods be consistent. This will enable DEC to track changes in use attainment with time. From the roster of recommendations and strategies, several higher priority, unmet needs are evident and these are listed in the executive summary section of the strategy which can be seen on the web at: http://www.vtwaterquality.org/lakes/docs/lp_monitoringstrat.pdf.

PART THREE: SURFACE WATER MONITORING & ASSESSMENTS

A) Current Surface Water Quality Monitoring Program

The following section is a description of the Water Quality Division's (WQD) current ambient monitoring program that is comprised of numerous discrete projects. The WQD's monitoring efforts are classified herein as physical/chemical, biomonitoring, volunteer and other. Within each of these classes, monitoring projects are further described as core, or long-term projects; diagnostic studies, which identify the causes of particular water quality problems; and special studies, which provide information and data on specific water quality issues. Other projects coordinated by close partners of the WQD are also included in this listing.

1) Physical and chemical monitoring

Core Programs

The Spring Phosphorus Program collects spring overturn nutrient and physical and chemical data on Vermont lakes and ponds that are 20 acres in size or larger. Parameters include total phosphorus, total nitrogen, alkalinity, calcium, magnesium, hardness, Secchi disk transparency, and multi-probe profiles (temperature, dissolved oxygen, conductivity and pH). Since 1977, 236 lakes have been monitored in conjunction with this program. Forty-eight lakes have 10 or more years of data and 18 of these have 15 years or more. The Spring Phosphorus Database contains over 1,700 records.

The Lake Assessment Program is designed to rapidly assess the extent to which lakes meet designated uses and to gather information to focus lake management and protection efforts. The sampling intensity for assessment lakes varies with the degree to which impairment is evident or 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 water quality. Detailed notes are made regarding the extent and species 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 determine compliance with Vermont Water Quality Standards. Since 1989, close to 280 comprehensive assessments and 60 cursory assessments have been performed.

The River Water Quality and Aquatic Habitat Assessment Program is designed to: assess the extent to which rivers and streams support designated uses; determine the causes and sources of impacts if there are some; to identify special resource features and high quality waters; and to compile all this data and information into a single report. The Ambient Biomonitoring Program (described below) provides most of the information used 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 concurrently with the biological sampling. The stream geomorphic assessment program (also described below) contributes data and information used to determine aquatic habitat condition. Quality-assured lay monitoring data are a growing portion of the information on rivers and streams especially in determining contact recreation use support based on *E. coli* sampling. Rivers and streams in the basins of focus are also visited to look for obvious sources of pollution from the land or indicators of

problems or threats in the water such as sedimentation, heavy algae growth, or water with unnatural color or odor.

The Water Level Monitoring Program monitors lake surface elevations to establish mean water levels for a variety of purposes, most notably to determine the jurisdictional boundary of the State's lakes and ponds under the shoreland encroachment permit program and Vermont's Public Trust Doctrine.

The Lake Champlain Long-Term Monitoring Program surveys the quality of Lake Champlain waters on a biweekly basis from May to November at 13 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; alkalinity; total suspended solids; dissolved oxygen; conductivity; and pH. As of April 2003, this program had assembled a database comprising 6,366 lake and 4,282 tributary sampling events.

The Long-Term Monitoring (LTM) Acid Lakes Program collects chemical and biological data on lakes located in low alkalinity regions to determine the effects of acid deposition on Vermont's lakes. Initially, 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 and are sampled at least eight times every year for 16 chemical parameters related to acidification. These data are used to classify lakes according to their acidification status, evaluate spatial and temporal variability in measured parameters, 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 evaluate impacts of acidification on aquatic communities. As of April 2003, the LTM data archive comprised 1,857 in-lake and 405 lake-outlet sampling records. This project contributed data to a seminal article describing long-term acidification trends across northeast North America, which was published in the journal Nature in 2000.

The Stream Geomorphic Assessment Program collects geomorphologic data on streams throughout the state to assess stream geomorphic condition and develop regime relations for Vermont's streams. Geomorphic assessments enable the prediction of expected rates of river adjustment and an evaluation of the effects of various land and river management practices on geomorphic condition and physical habitat quality. Regime relations guide stream protection, management, and restoration projects and assist 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. Geomorphic assessment protocols have been developed and promoted by the Agency of Natural Resources. Geomorphic assessments are done according to different levels of complexity. The figure on the following page illustrates the location and level of completed or ongoing stream geomorphic assessment efforts.

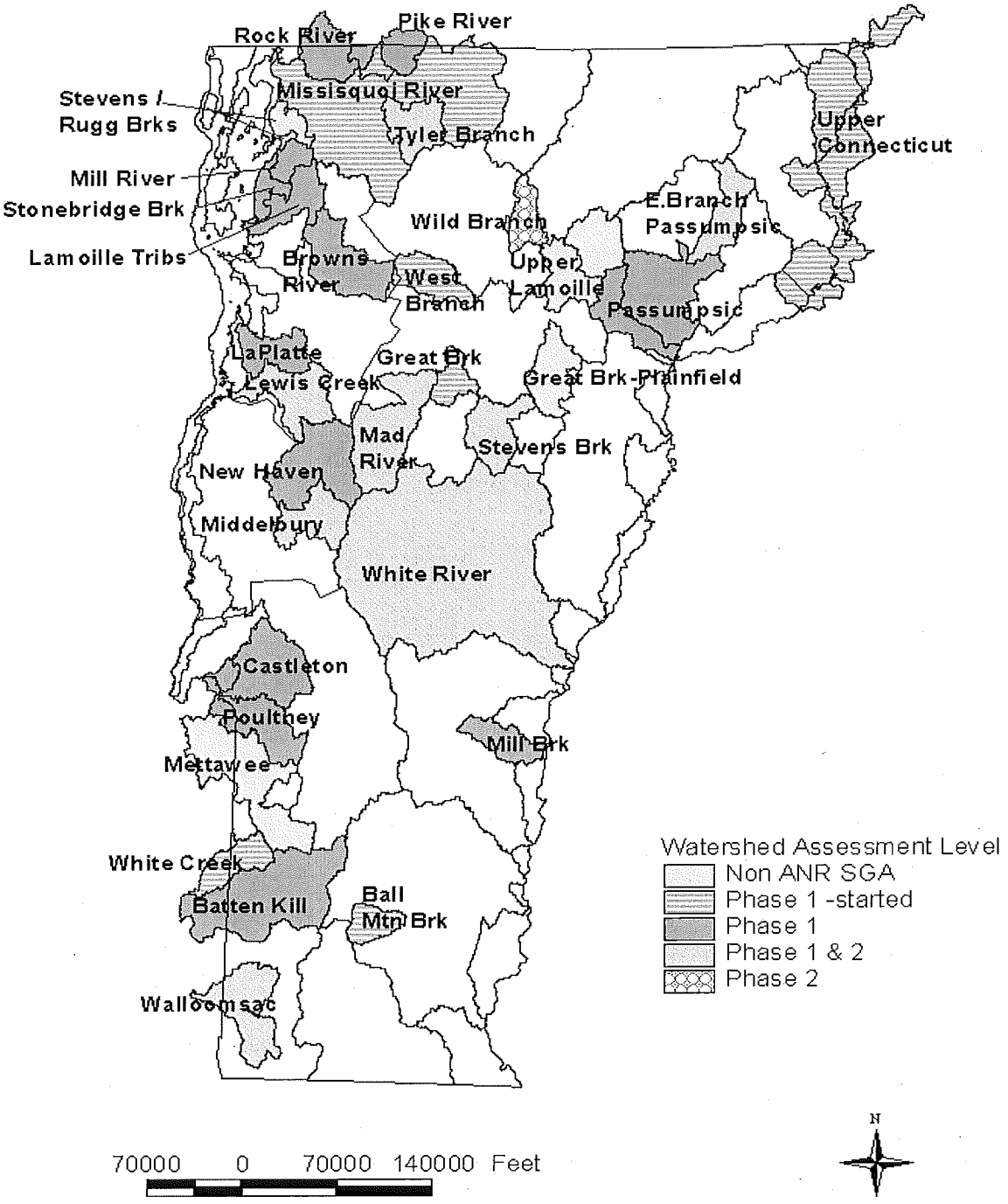


Figure 3.A.1. Location & Level of Stream Geomorphic Assessments (April 2004).

Lake Diagnostic Studies
Diagnostic studies are typically aimed at identifying the cause of eutrophication in Vermont lakes. Over the past 20 years, Vermont has performed numerous such monitoring studies, and the results of these studies have led to remediation steps. Lakes on which diagnostic studies have been performed include Harveys Lake (Town of Barnet), Lake Morey (Fairlee), Lake Iroquois (Hinesburg), Fairfield Pond (Fairfield), Lake Parker (Glover), Lake Carmi (Franklin), and Lake Champlain. Presently, the DEC is investigating the possible initiation of a new diagnostic study for Ticklenaked Pond, a nutrient-impaired lake in the Town of Ryegate.

A wide variety of parameters are sampled in conjunction with lake diagnostic studies, and the actual tests performed are specific to the project. Standard eutrophication parameters (total phosphorus, Secchi disk transparency, and dissolved oxygen) are always measured. Other parameters taken from sediments and the water column can be measured as needed.

Special Studies
Special studies are those performed to gain more information about a particular environmental issue of importance to DEC. There are four special studies noted below.

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 lake types occurring in the two states that have elevated levels of mercury in fish and upper trophic level biota. The parameter list for this integrated collaborative monitoring project is large, and includes standard limnological measurements and mercury in total and methyl phases in sediment, water, and biota. There is also a paleolimnological component that has determined the extent to which atmospherically deposited mercury has entered lakes in the study set. Two peer-reviewed journal articles have been produced from this study that was completed in 2003.

The Best Management Practices Effectiveness Demonstration Project is a long term stream monitoring effort (1999–2007) designed to assess the efficacy of best management practices in controlling pollutants in nonpoint source runoff in tributaries of Lake Champlain.[1] This cooperative DEC-USGS project differs from the project described immediately above in that it uses an upstream-downstream approach to pinpoint reductions in pollutant runoff attributable to specific installed Best Management Practices. The project is being carried out simultaneously on one agricultural and one urban stream in the Lake Champlain basin (Little Otter Creek and Englesby Brook, respectively). Sampling is focused on nutrients and sediment and sampling is conducted monthly and during storm events. Minor BMP structures were installed during 2002 in both watersheds. Larger implementation projects are scheduled for 2004.

In conjunction with the **Paleolimnology of Vermont Lakes Project**, DEC is collaborating with the University of Vermont to develop a set of indicators of present and historical trophic status

[1] During 1994-2001, a similar study was conducted known as **the Lake Champlain Agricultural Best Management Practices Monitoring Project.** This comparative observational study was carried out to evaluate the efficacy of both low- and high-intensity reach specific BMP implementation strategies related to livestock grazing. Parameters measured included total phosphorus, total and Kjeldahl nitrogen, total suspended solids and *E. coli* along with biological assessments. Even though the project has been completed and results published, biological assessments conducted by DEC are continuing.

based on the paleolimnology of carbon and nitrogen stable isotopes ($\delta^{13}C$ and $\delta^{15}N$). Using cores from the sediments of several lakes, DEC is working to identify the extent to which the present trophic condition in these lakes deviates from the historic background. Such information is instrumental in understanding the extent to which productivity (and thus phosphorus) has been elevated since the lake watersheds were first cleared in the early 1800's.

2) Biological monitoring

Core Programs

The **Ambient Biomonitoring Program** was established in 1982 to 1) monitor long-term trends in water quality as revealed by changes in ambient aquatic biological communities over time; 2) evaluate potential impacts on aquatic biological communities from permitted direct and indirect discharges, ACT 250 (10 V.S.A. 151) projects, nonpoint sources, and spills; and 3) establish a reference database to facilitate the generation of Vermont-specific biological criteria for water quality classification and use attainment determinations. Since 1985, DEC 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 several macroinvertebrate metrics. Guidelines have been developed to determine water quality standards attainment 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 April 2003, well over 1,700 stream assessments were completed using macroinvertebrate and/or fish from 1229 stream reaches.

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 177 discrete surveys.

The WQD 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*).

One interesting component of these aquatic nuisance species efforts is the Lake Champlain Zebra Mussel Monitoring Program. For this effort, 13 in-lake and 12 shoreline stations in Lake Champlain are monitored for larval and settler zebra mussel presence and density every two weeks from April through November. In addition, adult zebra mussel surveys are performed at selected shoreline locations during late summer. Notably, this is the only such zebra mussel monitoring project of it's kind in the United States. As of April 2003, there were 2,220 veliger records and 1,013 settler records within this program's nine years of data records.

Special Studies

The Biodiversity Monitoring Program evaluates the status of selected biological species and communities in Vermont. Specific activities include 1) distribution surveys of aquatic plant, fish and macroinvertebrate species listed by the Vermont Endangered Species Committee as rare, threatened, endangered, or of special concern; 2) distribution surveys of communities having species considered likely candidates for future listing (e.g., snails); and 3) monitoring of biological communities or community types, the diversity of which is threatened (e.g., Lake Champlain mussel and cobble/shale macroinvertebrate communities threatened by zebra mussels). Data are used to describe species distribution, identify species/communities at risk, and develop management plans for the protection of identified species/communities.

The Lake Bioassessment Project was initiated in 1995 to begin developing biological criteria for Vermont lakes. This monitoring effort was launched as a cooperative project with the State of New Hampshire. The goal of the project is to develop numeric measurements of the phytoplankton, macrophyte, and macroinvertebrate communities in reference lakes for use in assessing aquatic life use attainment in lakes. Consistent protocols have been developed to measure these biological assemblages, and to date, 12 New Hampshire and 41 Vermont lakes have been included in the project. Statistically-validated multimetric indices have been developed for the phytoplankton and macroinvertebrate communities. To date, data describing macrophyte commbnities have proven insufficiently precise to develop macrophyte criteria.

The **Vermont Wetlands Bioassessment Project** is a coordinated effort between the DEC and the Vermont Department of Fish and Wildlife's 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 has been used to assess and monitor the ecological health of seasonal pools in Vermont. This project was completed in 2002 and efforts at using these data to develop vernal pool biocriteria have seen limited success. DEC plans to modify this project for 2004 by adopting protocols and sampling strategies consistent with the Lake Bioassessment Project, to include more rigorous procedures for monitoring marginal wetland macrophytes.

The Lake Champlain Long-Term Monitoring Program described above also includes biological sampling, which is primarily aimed at assessing phytoplankton, zooplankton, and macroinvertebrate communities. Data from this element of the project resides in the New York State Natural History Museum with copies available only in spreadsheet form in Vermont. These data have been underanalyzed and underutilized as of this writing, but should provide a baseline for evaluating changes in ecosystem structure given implementation of the Lake Champlain TMDL for phosphorus.

The Northern Leopard Frog Surveys in the Lake Champlain Basin Project was initiated in response to reports of malformed frogs in the Lake Champlain basin in Vermont in the summer of 1996. Malformed frogs were reported from 12 sites in five counties within the Lake Champlain basin. Systematic field surveys were initiated in 1997, targeting the northern leopard frog (*Rana pipiens*). These surveys recorded the frequency and morphological characteristics of

gross abnormalities among newly metamorphosed northern leopard frog populations at 20 sites within the Lake Champlain basin. With subsequent support through the USEPA REMAP program, DEC has examined over 6,000 northern leopard frogs since 1996, and external malformations have been detected in 7.5% of the frogs examined. Data characterizing the gross abnormalities and describing the frequency and occurrence of abnormalities within northern leopard frog populations continues to be gathered 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/). DEC also continues to collaborate with the National Institute of Environmental Health and Sciences, the National Wildlife Health Center, and other researchers, providing environmental samples and specimens to help further malformed frog investigations.

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

- monitoring nontarget impacts to aquatic biota in lakes chemically treated with the aquatic herbicide Sonar® (fluridone) to control Eurasian watermilfoil infestations;
- monitoring the effects on both target and nontarget organisms of copper sulfate treatments to small recreational lakes and water supply reservoirs; and
- monitoring impacts to nontarget fish and macroinvertebrates in rivers treated with lampricide (TFM) to control sea lamprey (*Petromyzon marinus*) in Lake Champlain..

The Fish Contaminant Monitoring Program is managed by the WQD and performed in cooperation with the Vermont Department of Fish and Wildlife and the Vermont Department of Health. Edible tissue from game fish acquired throughout the state is analyzed for mercury and other contaminants. These data are then used to set and subsequently refine fish consumption advisories issued by the Vermont Department of Health.

3) Volunteer monitoring

Citizen groups have become increasingly involved in monitoring, education, protection, and restoration projects in Vermont. DEC provides assistance and training to volunteers whenever possible. Watershed and lake associations are presently active on numerous rivers and lakes in the state. In fact, there are over 100 such associations statewide. DEC has developed a directory listing various watershed associations and their activities in "Current Programs of Vermont Watershed Associations – October 2003" with a lake association addendum listing active lake groups. This directory listing can be inspected on the web at:
www.anr.state.vt.us/dec/waterq/lakes/docs/lp_watershedprograms.pdf

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 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. Other lakes are sampled only for Secchi disk 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 84 lakes and

36 Lake Champlain stations. Seventy-two inland lakes and 30 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 Project.

The Citizen Lake and Watershed Survey Program provides survey sheets and technical training to 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.

The Aquatic Nuisance Species (ANS) Watchers Program trains citizen volunteers to monitor for the presence of invasive nonnative aquatic species. The program is currently focusing on monitoring for Eurasian watermilfoil, water chestnut, and zebra mussels. There are presently about 110 ANS Watchers throughout Vermont.

The Volunteer Acid Precipitation Monitoring Program was initiated in 1980 to monitor changes in precipitation chemistry. Dedicated volunteers at six sites around 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. The data are used to assess spatial and temporal variability in the pH of bulk precipitation and 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).

Other volunteer initiatives
The Water Quality Division collaborates with the LaRosa Laboratory (showcased below) on a novel program to assist citizen monitoring groups statewide. Beginning in 2003, the Water Quality Division and LaRosa Laboratory began issuing analytical services grants to volunteer organizations, based on a competitive proposal process. The project was very successful in 2003. Eleven projects were supported. These projects ranged in scope from small, single-lake studies to large, multi-year and multi-parameter watershed assessment initiatives. In 2003, the program produced in excess of 1,800 viable, quality-assured data records across Vermont.

4) Monitoring partnerships

Federal
The US Army Corps of Engineers (ACOE) manages several flood control reservoirs in Vermont. These are monitored routinely for flow and stage, and periodically for a variety of physico-chemical constituents. ACOE reservoirs with designated swimming beaches are also monitored for *E. coli* regularly during the swimming season. ACOE reports on it's monitoring activities annually, and shares these reports with WQD. ACOE sampling results are used in conjunction with Integrated Assessment reporting.

The US Environmental Protection Agency (EPA) coordinates regional water quality monitoring projects of a variety of types. In recent years, projects which WQD has been involved include the REMAP New England Wadeable Streams Project and the National Study of

Chemical Residues in Fish. EPA was also the principal sponsor of the REMAP Assessment of Mercury in Waters, Sediments and Biota of Vermont and New Hampshire Lakes project. WQD plans to participate in the upcoming REMAP New England Lakes Project. Results of these studies are used for a variety of purposes in addition to Integrated Assessment reporting.

The US Fish and Wildlife Service (FWS) sponsors projects across New England dealing with toxic contamination of aquatic biota. WQD has collaborated with FWS on several projects, and data are freely shared. In addition, FWS co-sponsored toe REMAP mercury project discussed above.

The US Geological Survey (USGS) operates a network of gauging stations on Vermont waters, which are supported by a cooperative agreement with DEC. This gauging network provides water flow data that are critical for numerous applications, both within and outside of DEC. USGS also coordinates several water quality studies throughout Vermont in a variety of disciplines, and the results and data are commonly shared with DEC for numerous uses including permitting and integrated Assessment reporting.

State

The Vermont Department of Forests, Parks and Recreation operates a comprehensive beach monitoring program for all of it's public use beaches on State Park lands. Twenty-nine beaches are monitored on a weekly basis following established protocols. Swim advisories are posted based on results of the testing, when *E. coli* sample values exceed the Vermont standard for Class B waters of 77 *E. coli* /100ml. These data are openly shared with DEC. They are used for assessments as well as for identifying beaches subject to chronic, controllable bacterial contamination.

The Vermont Department of Health (DOH) operates a program whereby appointed Town Health Officers are trained to collect water quality samples at designated beaches. This program is suitable for small municipalities with informally-used swim beaches. Data reported back to Town Health Officers from the DOH laboratory take the form "safe for swimming," or "violates Vermont's standard unsafe for swimming." These data are not reported not tracked as numeric results. Town Health Officers commonly use these data to post warnings at swim beaches. Owing to resource constraints, samples collected in conjunction with that program cannot follow the strict quality assurance procedures required by DEC and the Department of Forests, Parks and Recreation in their *E. coli* monitoring projects. As such, this program provides useful and preliminary screening information to determine where swim beach water quality may need further assessment.

The Vermont Monitoring Cooperative (VMC) is a collaborative organization in which scientists collect and pool information and data for the purpose of improving our understanding, protection, and management of Vermont's forested ecosystems. Participating cooperators from government, academic and private sectors, conduct research projects on a variety of topics including forest health, air quality and meteorology, wildlife, aquatic systems and others. The VMC helps make the data and results from these projects available to other scientists, educators, resource managers and the general public. The VMC was initiated in 1990 as a state, university, and federal partnership, with a one-hundred year envisioned lifespan. The centerpiece of the

VMC is the data library and card catalogue system that allow data to be shared, archived, and accessed by scientists and other interested parties via the VMC website. The data archive contains data and ancillary textual material from over 100 projects, and is geographically referenced.

Academic

DEC maintains ties with several academic institutions interested in water quality monitoring. A partial list of these institutions includes Dartmouth College, Middlebury College, the University of Vermont, and member schools of the Vermont State College System. Collectively, these institutions carry out numerous projects and resultant data are commonly used by DEC for assessment purposes. The University of Vermont also carries out several larger-scale research and monitoring projects cooperatively with or of significant interest to DEC. A non-inclusive list of University of Vermont projects includes paired assessments of geomorphic and macroinvertebrate biometrics on streams, research into natural background levels and strategies to mitigate *E. coli* in Vermont waters, assessment of cyanotoxins in Lake Champlain and elsewhere, impacts of non-native species on aquatic food webs.

Local

The Addison County River Watch Collaborative (ACRWC) is a volunteer-based consortium of local volunteer organizations that monitor waters in several watersheds in Addison County. The ACRWC has monitored approximately 45 sites across four watersheds for *E. coli* and eutrophication-related parameters. ACRWC provides data and summary reports to DEC on an annual basis for assessment purposes. These data are also being used to assist in development of the Otter Creek and Lower Direct Champlain Basin Plans. The ACRWC received a LaRosa Laboratory services grant in 2003 (see section 5 below). This organization launched a new monitoring project, during 2004 and in partnership with DEC, to assist in the development of nutrient criteria.

The White River Partnership (WRP) is a private, non-profit organization that has established a monitoring program for the watershed using several volunteer "stream-teams." Activities include geomorphic assessment, priority site mapping, and water quality sampling for a variety of constituents including temperature, turbidity, conductivity, and *E. coli*. WRP's volunteer monitors generate quality-assured data that are used to identify priority reaches for protection or remediation.

The West River Watershed Alliance (WRWA) is another watershed group dedicated to similar goals as the ACRWC and WRP but whose focus is on the waters in the West River watershed. The Alliance has re-established a monitoring program in the West River watershed that for many years was run by the Bonnyvale Environmental Education Center (BEEC). BEEC data were provided annually to DEC for assessment purposes for many years. The WRWA also received a LaRosa laboratory services grant in 2003 and 2004.

The City of Burlington and Town of Colchester collectively monitor several heavily-used swimming beaches, by measuring *E. coli* on a regular basis. These data are made publicly in near real-time via the "Burlington Eco-Info" website (www.burlingtonecoinfo.net).

The Watershed Alliance of the University of Vermont and **River Network** have been active in promoting surface water quality monitoring for elementary and high schools throughout Vermont. Such monitoring is valuable from an educational and student/community involvement standpoint.

The Friends of the Mad River (FMR) is a non-profit organization sharing similar goals to the above noted groups. The FMR has undertaken a number of planning and implementation projects along with a long-standing water quality monitoring program which includes *E. coli* and a number of other parameters. DEC has been periodically provided data for use in assessment reporting.

The LaPlatte Watershed Volunteer Water Quality Monitoring Program was initiated to track changes in water quality over time, identify potential problems and progress in improving water quality and protection the watershed, and to contribute to public understanding of water quality issues. This organization received a LaRosa laboratory services grant in 2004.

The Missisquoi River Basin Association (MRBA) is an active non-profit group of volunteers dedicated to the restoration of the river, its tributaries, and Missisquoi Bay. Bringing together diverse interest groups within the community, MRBA's activities are many and varied, including tree planting for streambank stabilization, trash cleanup, supporting farmers in a nutrient management program, river outings, and education forums. In 2005, MRBA began an extensive volunteer nutrient monitoring program at 19 sites on the Missisquoi River and its major tributaries.

5) Monitoring spotlight on.....

The LaRosa Environmental Laboratory - Analytical Services Partnership Program

The Vermont Department of Environmental Conservation is pleased to use this report to showcase a relatively new and highly successful water quality assessment program - the LaRosa Environmental Partnerships Program. This program, which provides slots for laboratory tests to partner organizations throughout Vermont, furthers the purpose of characterizing surface water quality conditions. The program was enabled owing to an important change in the funding mechanism for the Department's LaRosa Environmental Laboratory.

Historically, the LaRosa facility was funded on a per-test basis, with individual State programs paying a fixed rate per analysis. This limited the Department's ability to monitor sites as, most often, there were but limited State funds available to support water quality testing for waters that were not subject to Federal grant projects. In 2002, the LaRosa facility initiated a three-year trial of an alternate funding strategy, whereby each division of DEC (e.g., Water Quality, Waste Management, etc.) was levied an allocation to support the laboratory, in proportion to prior-years use. In return, each division could request tests on an as-needed basis. The Water Quality Division decided to provide its unused allocation to volunteer lake and watershed organizations to augment water quality monitoring in waters of local importance.

Under the LaRosa Analytical Services Partnership Program, locally-based citizen organizations apply for partnership awards, following an RFP-based competitive process. Volunteer-based associations across Vermont are eligible, including river, lake, and watershed groups, and water quality and conservation committees associated with local municipalities. Post-secondary academic institutions and not for profit non-governmental organizations are eligible provided that one of the following criteria are met: 1) the project is designed jointly with a local association to assess current water quality conditions or diagnose a known water quality problem of interest to the local association; or, 2) the project assesses the extent of or diagnoses the cause of a water quality problem of statewide importance.

Many project types are eligible for the program, so long as waters under evaluation are of joint interest to the local association sponsoring the project and to DEC. Annually, proposals for new or existing multi-year projects are accepted. Continuation of existing multi-year projects is subject to availability laboratory capacity, continuing need for the data, and project performance and reporting during prior years.

The program is novel in that no funds are disbursed. Rather, partners are allocated a specified number of pre-scheduled laboratory analyses, to be performed by the LaRosa Laboratory free-of-charge. The program provides sample bottles and/or preservatives that are required for the intended tests. Transportation of samples to the LaRosa Laboratory in Waterbury, as well as costs associated with sample collection, equipment[2] and other project functions are not covered by the program. As such, the LaRosa Analytical Partnerships Program truly serves to develop partnerships between the State and local organizations.

Each project selected for a LaRosa Partnership award is required to prepare a quality assurance project plan. To accomplish this while minimizing the difficulties of QAPP preparation for partner organizations, a pre-established and pre-approved "generic" QAPP is provided that covers the majority of activities likely to be carried out under the program. This QAPP was initially written by EPA to support small monitoring projects funded by the Lake Champlain Basin Program. For the LaRosa Partnership Program, it was modified to be compliant with the current LaRosa Environmental Laboratory quality assurance plan document. DEC staff and a few highly-trained citizen monitors provide guidance to participants on monitoring program design, parameter selection, monitoring techniques, and data quality assessment. Citizens are also provided copies of the DEC's 2005 *Volunteer Guide to Surface Water Quality Monitoring*, and the DEC's citizens Guide to *E. coli* bacteria monitoring.

Since 2003, 20 separate projects have been supported, yielding just over 14,000 discrete datapoints from 262 geo-referenced sites, occupying seven of Vermont's planning basins (see Figure 3.A.2 below). The most extensively monitored regions capture most of the watersheds draining to Lake Champlain and Lake Memphremagog, and the West, Williams, and Saxtons River basins. Several smaller projects are active in waters that drain to the Connecticut River.

[2] The Department is aware that EPA New England is considering developing a water quality monitoring equipment loan program for citizen-programs. Such an initiative would dovetail well with the LaRosa Partnership Program.

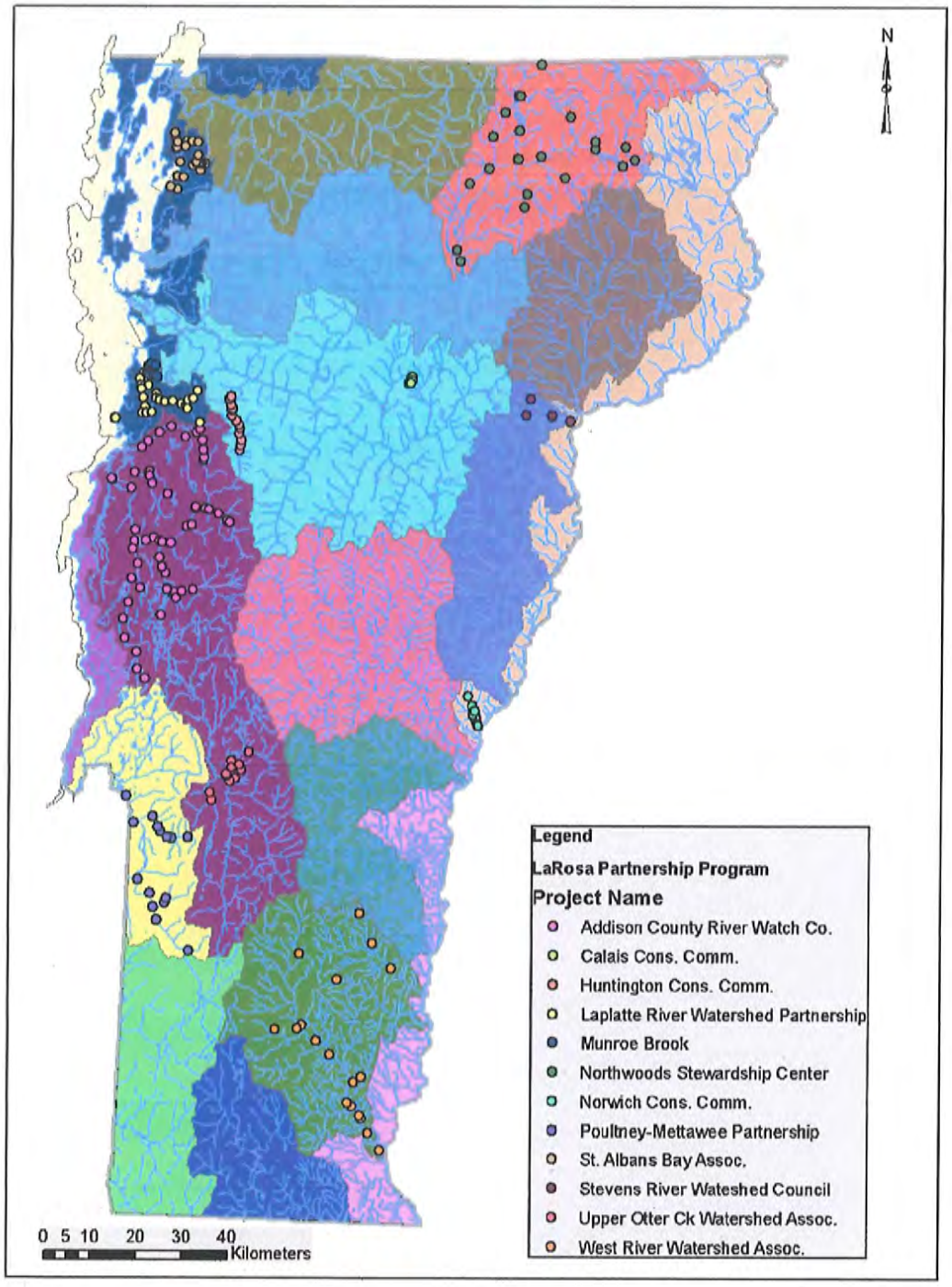


Figure 3.A.2. LaRosa Partnership Program monitoring locations.

While written reporting requirements for LaRosa Partnerships are fairly flexible, the monitoring groups are held to high standards in regards to data quality assessment and data submissions. The laboratory data are freely provided to the groups on an on-going basis through a web-based

reporting system, but are not accepted for assessment and listing until they are re-submitted to DEC using a data submission template, and only after data quality assessment is completed.

The most commonly measured parameters are *E. coli* bacteria, followed by phosphorus, total suspended sediments, total nitrogen, turbidity, and NOx. While monitoring groups are free to request any number of tests from the full suite of analytes offered by the LaRosa Laboratory, annual partnership allocations are balanced to maintain laboratory capacity for Water Quality Division programs, and cannot affect other Department laboratory users.

The partner groups have used the data results in numerous ways, including identifying stressed or potentially impaired locations, monitoring swimming beach suitability, guiding geomorphic assessment reaches, site remediation, and community education. Some examples of data results are provided in the following manner.

Figure 3.A.3 shows *E. coli* measurements from swimming locations measured by the Huntington Conservation Commission. Figure 3.A.4 shows average total phosphorus concentrations, for 2004, from the Addison County Riverwatch Collaborative, the Poultney-Mettowee Partnership, the LaPlatte Watershed Partnership, and the Upper Otter Creek Watershed Council. Total phosphorus increases in the LaPlatte River from upstream to downstream locations are shown in Figure 3.A.5.

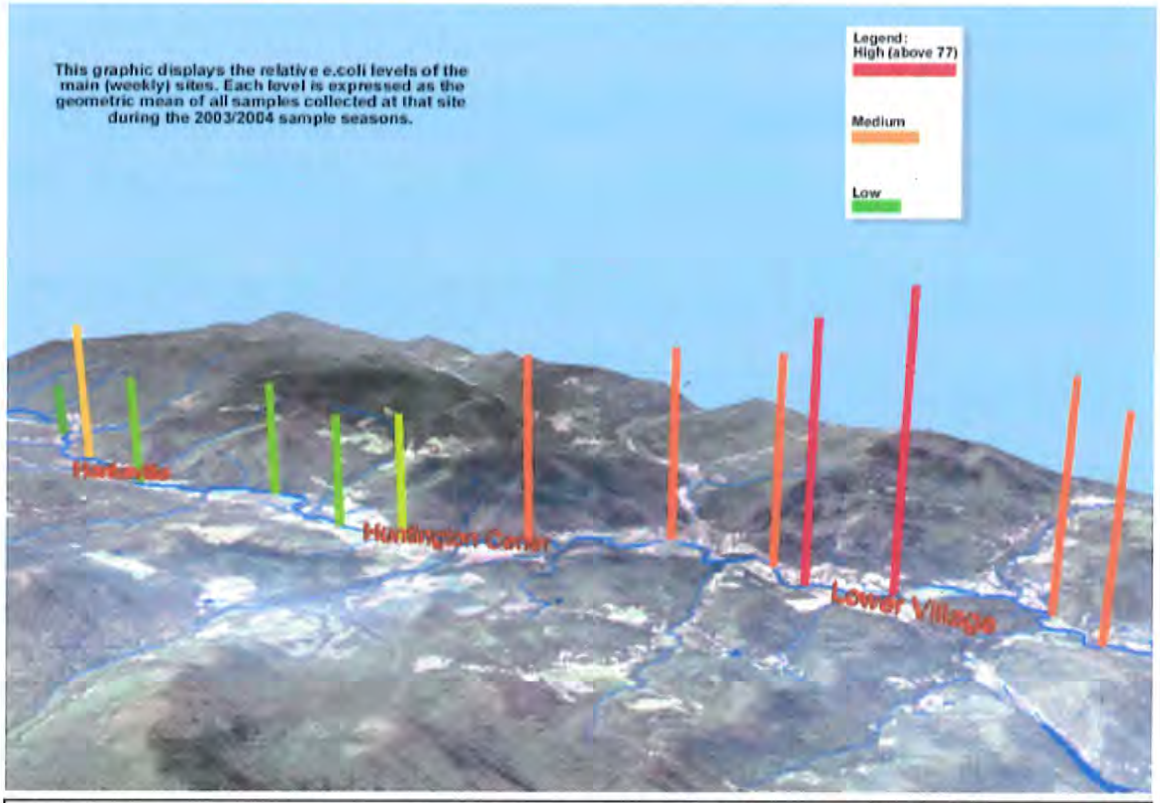
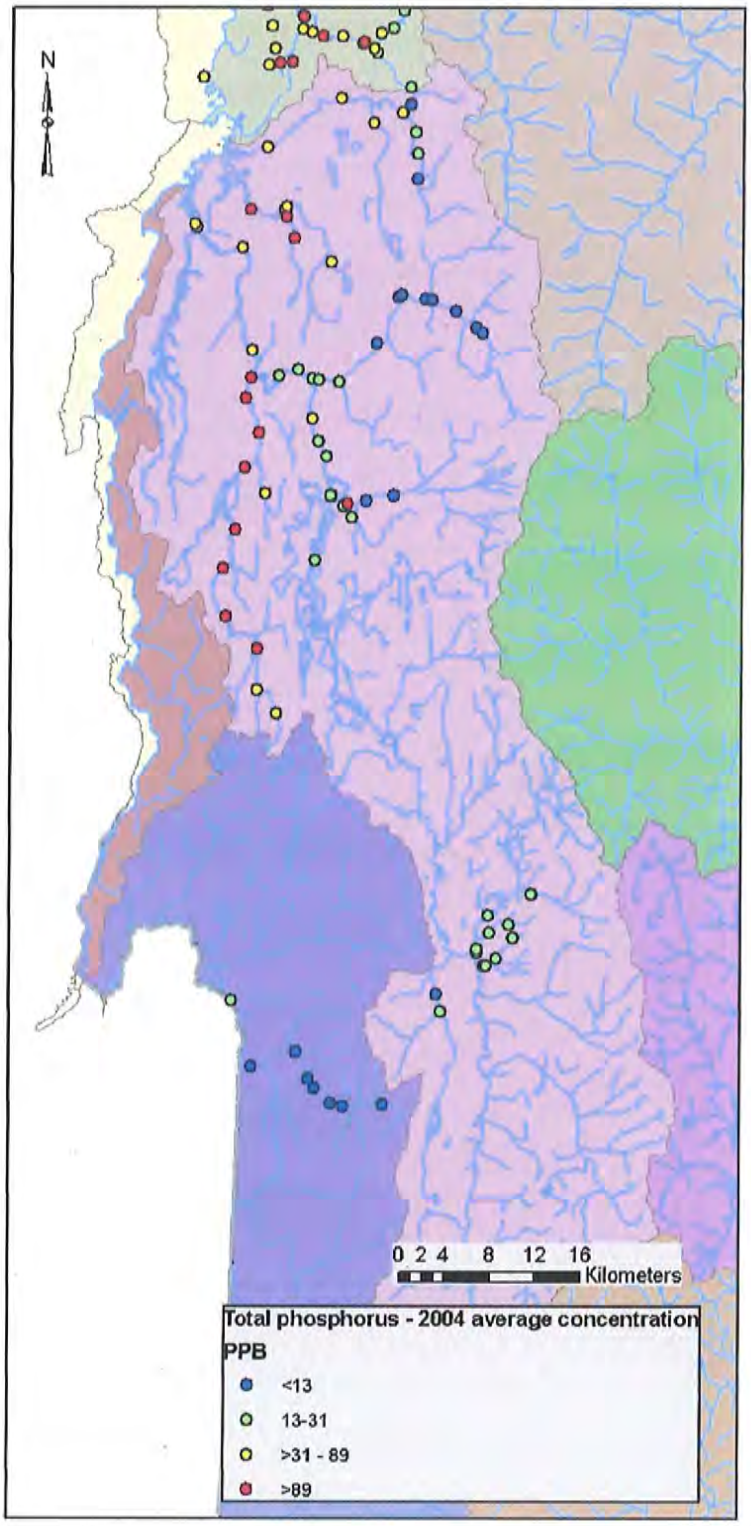


Figure 3.A.3. Geometric mean E. coli concentrations for swimming holes along the Huntington River, 2003-2004.

Partnership participants have provided a wealth of valuable assessment data to DEC and these have been used to support several assessment and listing decisions and to corroborate existing assessments in numerous waters. However, the primary beneficiary of this program is not DEC but rather the watershed organizations that support the monitoring groups. Entering into monitoring partnerships with DEC has resulted in an enhanced level of citizen participation in the basin planning process, resulting in the establishment of more diverse watershed councils and in the implementation of necessary remediation projects.

As groups have become more familiar with monitoring techniques, the watersheds in which they live, and the associated needs for cohesive and coordinated support, they have increasingly sought external grant funding to employ full-time monitoring coordinators. Such coordinators presently exist for four of the largest projects supported by the program. This type of growth within a monitoring organization can transform a small citizen watershed group into an effective watershed-based advocacy organization. The most "mature" groups supported by the LaRosa Partnership Program are independently carrying out coordinated water quality monitoring, geomorphic assessment, and streambank and lakeshore remediation projects, all under the umbrella of Vermont's basin planning process.

This apparent success has not come without growing pains though. In 2005, about 37% of services provided to the Water Quality Division from the LaRosa Laboratory were for Partnership projects. While this level of support is admirable, it has placed a strain on Water Quality Division staff who administer the program, and on the LaRosa staff.



During 2006, the Water Quality Division will be carrying out an internal planning process to determine the level of support that can be allocated to the LaRosa Partnership Program. While it is unlikely the program will cease, it is reasonable to expect that boundaries will be established on individual partnership project sizes and durations. This is expected to maximize effectiveness and geographic coverage, while helping to build basin planning capacity throughout the State.

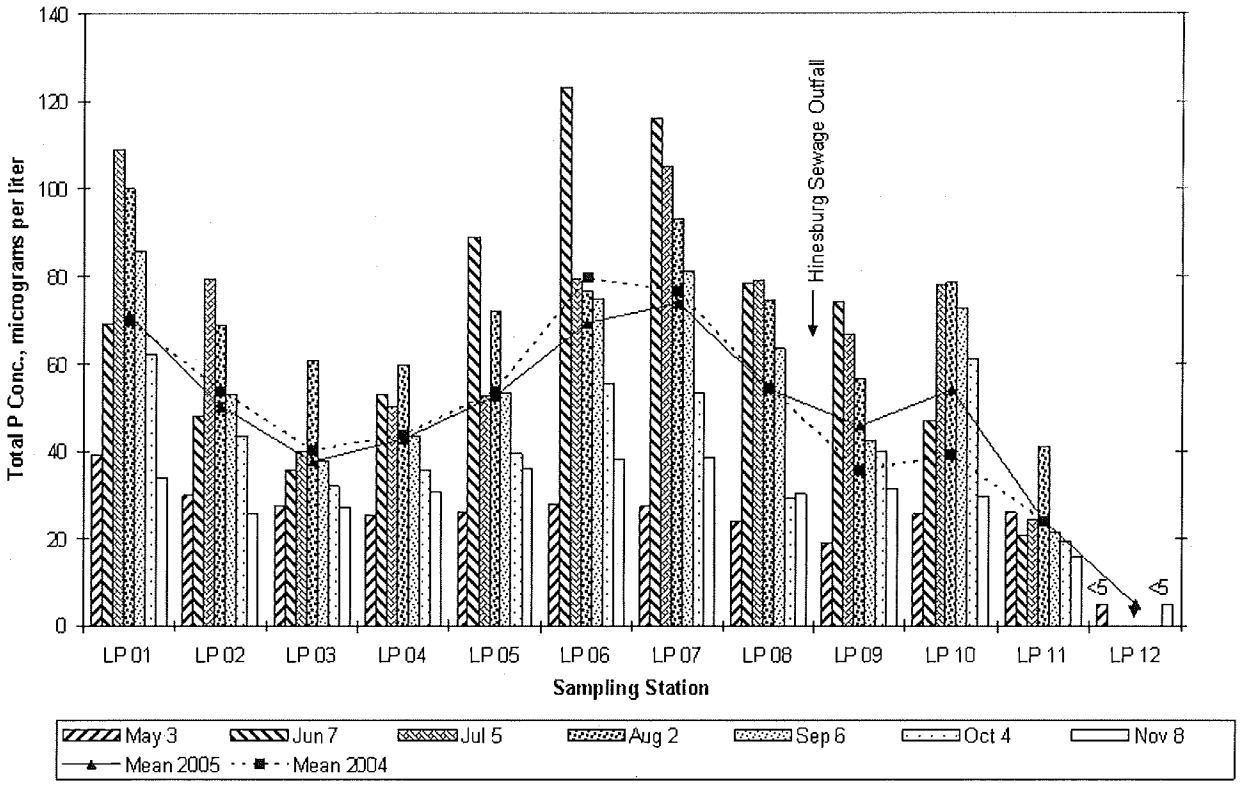


Figure 3.A.5. Total phosphorus measured at eleven stations in the Laplatte River mainstem, for 2005, with means for 2004 and 2005.

B) Assessment Methodology

The following section describes the manner in which the WQD regularly gathers data and other information to make informed decisions about the status, integrity or condition of surface waters.

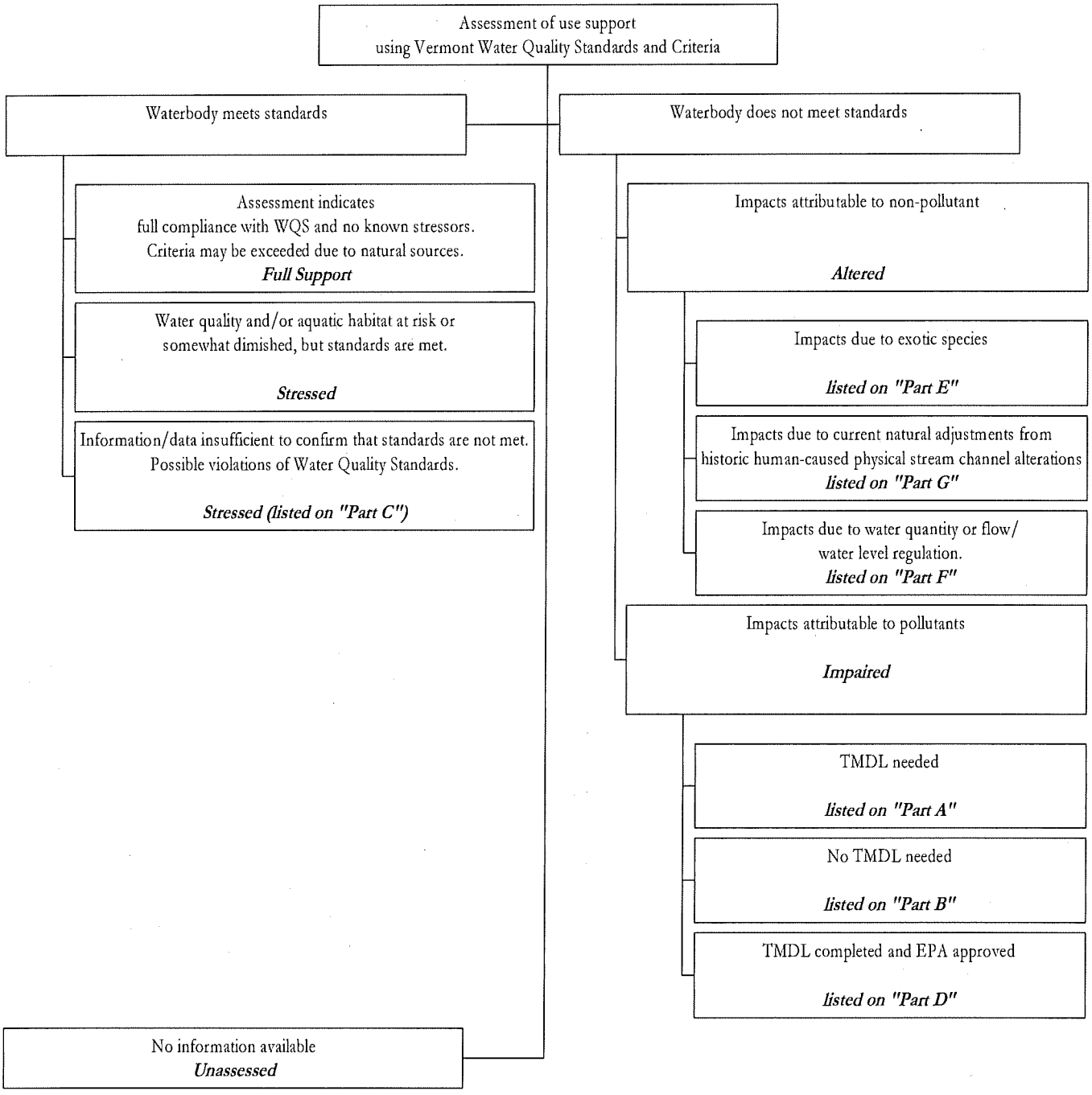
The collection, analysis and evaluation of water quality monitoring data and other information represent the assessment of a water's condition. The assessment of a water is most accurate when judgements about the water's condition are made using chemical, physical and/or biological data of known reliability collected through monitoring. While not as definitive as data collected though monitoring, an assessment of a water's condition can also take into account field observations or other qualitative information.

The Vermont Water Quality Standards, periodically revised and promulgated by the Vermont Water Resources Board[3], provide the basis used by DEC in determining the condition of surface waters including whether the water meets (attains) or does not meet (exceeds or violates) certain criteria. The assessment of a water's condition within the context of the Water Quality Standards requires consideration of the water's classification and management type, a variety of designated or existing uses, and a series of criteria which can be numerical or narrative. The outcome of an assessment conducted by the DEC is to categorize Vermont's surface waters as either "full support," "stressed," "altered," or "impaired." Waters determined to be "impaired" or "altered," and certain "stressed" waters are presented for water quality management purposes on one or more listings. Over time, DEC is gradually reducing the number of waters characterized as "unassessed." The organizational chart appearing on the following page illustrates the major components of DEC's surface water assessment and listing process.

The reader is referred to Appendix C for the entire 2006 Assessment and Listing Methodology.

[3] In 2004, and associated with Act 115 (an act pertaining to permit reform), the Environmental Board and the Water Resources Board were abolished. The Act, which became effective on January 31, 2005, replaced the Environmental Board with the Natural Resource Board which consists of a full-time chair and two citizens panels - the Land Use Panel and the Water Resources Panel. The Water Resources Panel assumed rulemaking functions previously held by the Water Resources Board.

Chart Depicting Organization of Vermont's Water Quality Assessment & Listing Methodology.



C) Rivers & Streams Water Quality Assessment (Statewide)

Two river basin water quality assessment reports were completed and a third was nearing completion in the two years since the 2004 305b Report. A report for Basin 6 (Missisquoi River basin) was completed in 2004 and a report for Basin 17 (Lake Memphremgog basin) was completed in August 2005. A report for Basin 8 (Winooski River watershed) is due for completion in 2006. Each completed assessment report noted above and those completed previously are available from DEC on request. The more recently completed river basin assessment reports can be found on the DEC Water Quality Division web site (www.vtwaterquality.org, click on "planning" then click on "specific basins"). The data and information gathered prior to production of these reports are incorporated into the rivers and streams and lakes and ponds discussions and reporting numbers which follow below.

1) Assessment of use support

The assessment of Vermont's statewide river and stream surface water quality and aquatic habitat conditions has been updated from the 2004 305b statewide assessment with water quality information and data from waters monitored and assessed during the last two years. There is a substantial difference, however, between the use support determinations in this statewide assessment summary and those of 305b reports prior to 2004. As described above and in the appendix containing the Assessment Methodology, miles of river or stream are placed in one of four categories by designated use – full support, stressed, altered or impaired. This categorization differs from the categories of full support, full support/threatened, partial support, and non-support used in all earlier 305b assessment reports. This biennial report contains rivers and streams that have been re-assigned to the new categories to the extent possible. However, the current assessment categories do not directly equate to the former categories and there are a number of waters where the data and information are too old to permit a decision about the proper assessment category for the river or stream miles. The assessment category of these rivers and streams will be determined as Vermont DEC gets to them *in the assessment rotation and as such, the numbers given below in use support categories as well as the miles of rivers and streams affected by different causes and sources need to be considered as transitional.*

Determination of use support is based on data and information from biological monitoring, chemical monitoring, physical assessments, modeling results, and known sources of problems such as channelization work, combined sewer overflows (CSOs), or flow fluctuations, non-singular incidences of fish kills or spills.

According to EPA and its Total Waters database, Vermont has approximately 7,100 miles of perennial rivers and streams. Of the approximate 5,491 river and stream miles assessed for this report, overall approximately 88% of those miles are in compliance with the state's water quality standards and support designated uses, and 12% do not meet water quality standards or do not fully support the designated uses. Of the 88% meeting standards, approximately 14% are considered stressed by some pollutant or activity.

Table 3.C.1 below is a summary of the number of miles of rivers and streams throughout Vermont which support or do not 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,

stressed, altered, or impaired are determined. For example, river miles that are 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 supported for swimming have no or very few known high levels of *E. coli*, a bacterium that is used as an indicator for the presence of pathogens from warm-blooded animals. Overall use support, expressed as proportion of miles meeting/not meeting uses, by waterbody, is shown in Figure 3.C.1 on the following page. Figures in the table appearing in parenthesis are those from the 2004 305b Report.

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

Table 3.C.1. Statewide Overall & Individual Use Support Summary (miles) for Rivers & Streams.

Designated Use	Full support	Stressed	Altered	Impaired	Total assessed
Overall	4055.2 (4003)	790.7 (848)	294.8 (317)	354.8 (311)	5495.5 (5479)
Aquatic biota/habitat	4148	835.1	294.7	217.7	5495.5
Contact recreation	4743.5	430.2	6.5	142.1	5322.3
Secondary contact recreation	4592.1	605.4	126.3	53.5	5377.3
Aesthetics	4479.3	687.2	173.4	134.6	5474.5
Drinking water supply	253.9	10.3	10.4	11.5	286.1
Fish consumption	0	6036.7	0.1	86.8	6123.6

2) Summary of Causes and Sources

A cause is a pollutant or condition that results in a water quality or aquatic habitat impairment, alteration or stress; a source is the origin of the cause and can be a facility, a land use, or an activity. Tables 3.C.2 and 3.C.3 below summarize the miles of rivers and streams affected by various causes and sources, respectively.

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.C.2 and 3.C.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 an idea of the relative size of the impact from different pollutants or conditions on Vermont's waters and from which land uses or activities they may originate.

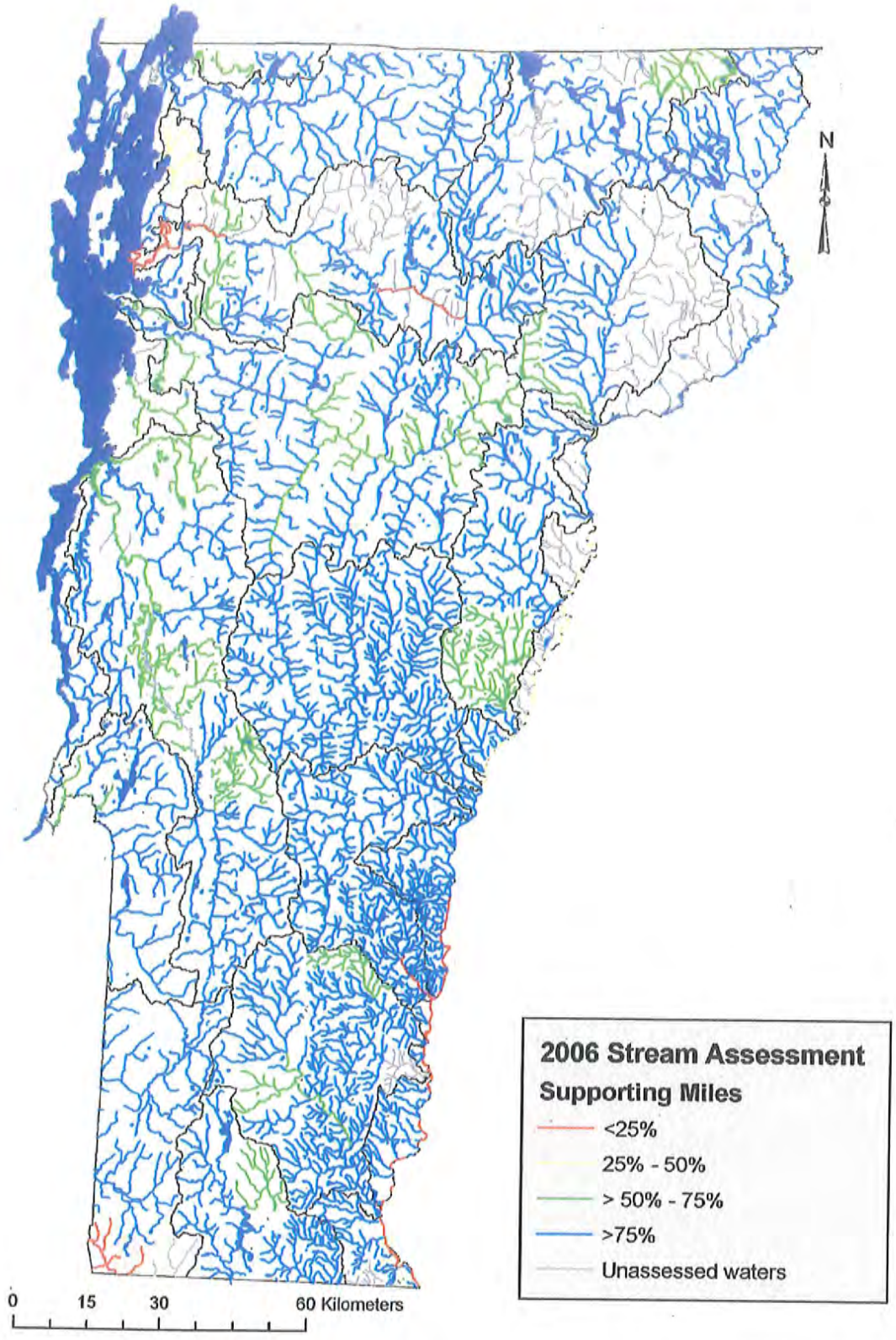


Figure 3.C.1. Overall Use Support for Vermont Rivers and Streams.

Causes

Sedimentation/siltation is the largest cause of stresses 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 results in approximately 332 miles of river and stream not meeting standards and stresses another 723 miles based on the information available at this time.

The second largest documented cause of impacts and impairments is flow alteration. This problem affects about 249 miles and stresses another 68 miles.

Physical habitat alterations affect the third largest number of miles of river and stream having an impact on 209 miles and stressing another 442 miles.

The cause affecting the fourth largest number of miles in terms of pollutants or conditions is nutrient loading to waters. Nutrients contribute to 200 miles of river and stream not meeting standards and to over 440 stressed river or stream miles.

The other substantial causes identified include: metals affecting about 132 miles and stressing another 131 miles; turbidity affecting 131 miles and stressing 142 miles; pathogens affecting about 118 miles and stressing over 280 miles; and thermal modifications affecting 97 miles and stressing over 470 miles (the second largest stressor identified)..

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 noted in the 2004, 2002, 2000, 1998 and 1996 305b Reports. The eight most significant causes of river and stream impairments, alterations, or stresses are given in Table 3.C.2.

Table 3.C.2. Total River and Stream Miles Affected by Cause Category.

Cause of impairment, alteration, or stress	Magnitude (miles)	
	Not meeting standards	Meeting standards but stressed
Sedimentation	332.4	722.7
Flow alterations	249.1	68.2
Physical habitat alterations	208.7	441.9
Nutrients	200.3	442.2
Metals	132.4	131.2
Turbidity	131.1	141.6
Pathogens	117.5	284.9
Thermal modifications	97.4	474.6

Sources

The five sources of pollution identified as having the greatest impacts or causing the greatest stresses on miles of river and stream are flow alteration from hydroelectric facilities, snowmaking water withdrawals and other sources; streambank erosion; agricultural land uses and activities; atmospheric deposition; and removal of riparian vegetation. In some situations, the three sources of streambank erosion, agricultural land activity, and riparian vegetation removal could be interrelated and affecting one given stretch of river and stream at the same time. A second tier of significant sources of impacts includes urban/developed land runoff, flood impacts resulting from human structures or activities, and channel instability again that due to human activity

Flow fluctuations or reductions alter about 245 miles and stress another 66 miles. The number of miles attributed to flow modification as a source are less than in the 2004 305b assessment due to licenses issued at hydroelectric facilities and snowmaking withdrawal changes.

Streambank erosion has been identified as the cause of about 244 miles of impact and 560 miles of stresses. 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.

Agricultural land uses and activities have an impact on 198 miles and stress another 501 miles of river or stream. As mentioned above, the interrelationship between agricultural activities, riparian vegetation loss, streambank erosion, and channel instability as sources makes the attribution of miles stressed, altered, or impaired to each of these sources an imprecise task. The relative contribution of each source should be the focus.

Atmospheric deposition 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. Atmospheric deposition has an impact on 141 miles of river and stream and stress about 17 miles.

Approximately 136 miles of impact and 531 miles of stress have been attributed to the removal of riparian vegetation. 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, but the loss of riparian vegetation also increases a stream's vulnerability to channel changes in an unstable system.

Urban/developed land as a source 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. Urban/developed land runoff affects about 85 miles of river and stream and stresses about 178 miles as determined in this assessment.

Flood impacts and channel instability are the seventh and eighth largest sources of impacts to rivers and streams as currently documented. The flood impacts are those that result from poorly sited or designed human structures (road, bridges, culverts), which blow out during a flood resulting in more damage to the river or stream habitat than would be otherwise. Flood impacts have affected about 77 stream miles and stressed another 76 miles. Channel instability can be a result of flood impacts, flood "repair" work, instream gravel mining, stormwater runoff, watershed hydrology changes. A variety of human activites can cause channel instability but channel instability is a source of sedimentation and habitat alteration. Channel instability contributes to at leas 74 stream miles not meeting standards and stressess another 144 miles.

Other sources specifically tracked include: land development, upstream impoundments, onsite wastewater systems, hazardous waste sites, and resource extraction among others.

Table 3.C.3. Total Miles of Rivers & Streams Affected by Source Category.

Source of impairment	Magnitude (miles)	
	Not Meeting Standards	Meeting standards but stressed
Flow modification	244.9	65.5
Streambank erosion	243.7	560.0
Agriculture	198.2	501.4
Atmospheric deposition	140.9	17.0
Removal of riparian vegetation	136.2	531.1
Urban/developed land runoff	85.1	177.9
Flood impacts	77.0	75.9
Channel instability	74.2	143.6

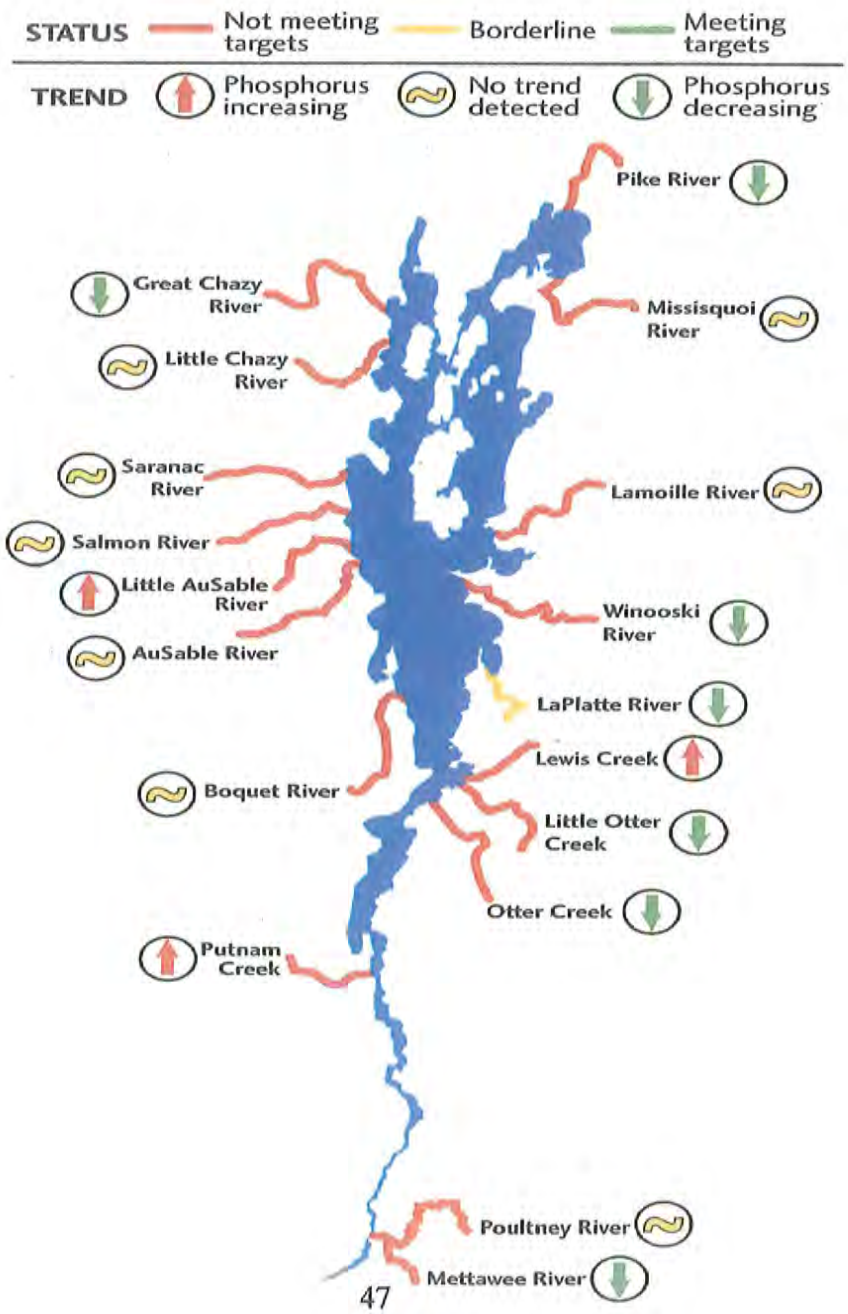
3) Status & Trends of Phosphorus Loading to Lake Champlain from Monitored Tributaries[4]

Tributary rivers carry most of the phosphorus to Lake Champlain. Great progress has been made in reducing phosphorus from point sources, such as [municipal] sewage treatment and industrial discharges. Today, less than ten percent is from these sources. Runoff from nonpoint souces, such as roads, developed land, lawns, riverbanks and agricultural land, contributes over ninety percent. Of the nonpoint sources, 56% of the phosphorus comes from agricultural lands, 37% is produced by developed land and 7% is from forests.

[4] Information for this particular section of the 305b Report has been taken from: The 2005 State of the Lake Report. Lake Champlain Basin Program. Grand Isle, Vermont.

The Lake Champlain Basin Program has funded water quality monitoring for phosphorus and other indicators since 1992. [For the report], monitoring data were examined to see if there have been increasing or decreasing phosphorus trends between 1990 and 2004. Data from monitoring at the mouths of the Lake's 18 major tributaries (9 of which are in Vermont) indicate that only the LaPlatte River is close to meeting its target phosphorus load [defined in the Lake Champlain phosphorus-based Total Maximum Daily Load]. Seven tributaries, however, show an improving trend (6 are in Vermont) and three show worsening trends for phosphorus (1 is in Vermont). The remaining 8 tributary rivers have no trend (3 of these are in Vermont). A figure representing the status and trends of measured tributary phosphorus loading is shown below.

STATUS AND TRENDS OF TRIBUTARY PHOSPHORUS LOADING, 1990-2004



D) Lakes & Ponds Water Quality Assessment (Statewide)

1) Assessment of use support for inland lakes

A statewide summary of inland lake use support is provided in Table 3.D.1. All lake/pond waters within the borders of the State are considered as "inland lakes" except for the eleven segments of Lake Champlain. Moore and Comerford Reservoirs (along Connecticut River), Lake Memphremagog and Wallace Pond are transboundary waters reported as "inland lakes." Figures appearing in parenthesis in the table are those reported in the 2004 305b Report.

Overall, 37,522 inland lake acres support uses, and 17,825 acres do not support uses. Proportionally, aesthetics use is most highly supported in inland lakes (89% of acres), followed by swimming (88%). Improvements in these numbers relative to those published in the 2004 305b Report relate largely to reductions in Eurasian watermilfoil populations on several lakes after chemical treatments.

Although all waters are impacted by mercury pollution and are subject to consumption advisories, Vermont's assessment methodology indicates the need for waterbody-specific tissue data to indicate non-support of fish consumption. Accordingly, when assessed following the methodology, 85% of inland lake acres support fish consumption use. However, based on research conducted specifically in Vermont, all waters are subject to atmospheric mercury contamination, and many waters have the potential be impaired for fish consumption, were data available to support such assessments. More information regarding fish mercury monitoring is available in Part Four.

Table 3.D.1. Acres of Vermont Inland Lakes Supporting or Not Supporting Uses.

Use	Full Support	Stressed	Total Meeting WQS	Altered	Impaired	Total Not Meeting WQS	Not Assessed
Overall Uses	21012 (15026)	16510 (20882)	37522 (35908)	8015 (8874)	9910 (9910)	17825 (19434)	245 (162)
Aesthetics	37882	11593	49475	3443	2529	5872	245
Aquatic Life Use Support	23624	17455	41079	7389	6979	14268	245
Drinking Water Supply	1268	0	1268	0	123	123	123
Fish Consumption	47025	0	47025	0	8115	8115	452
Secondary Contact Uses	37091	9839	46930	4946	2559	7405	1257
Swimming Uses	38461	10616	49077	3358	2559	5234	1281

Note: All Vermont waters are subject to contamination by atmospheric mercury.

Overall use support, expressed as proportion of lake/pond acres supporting/not supporting uses, by assessed waterbody, is shown in Figure 3.D.1 on the following page.

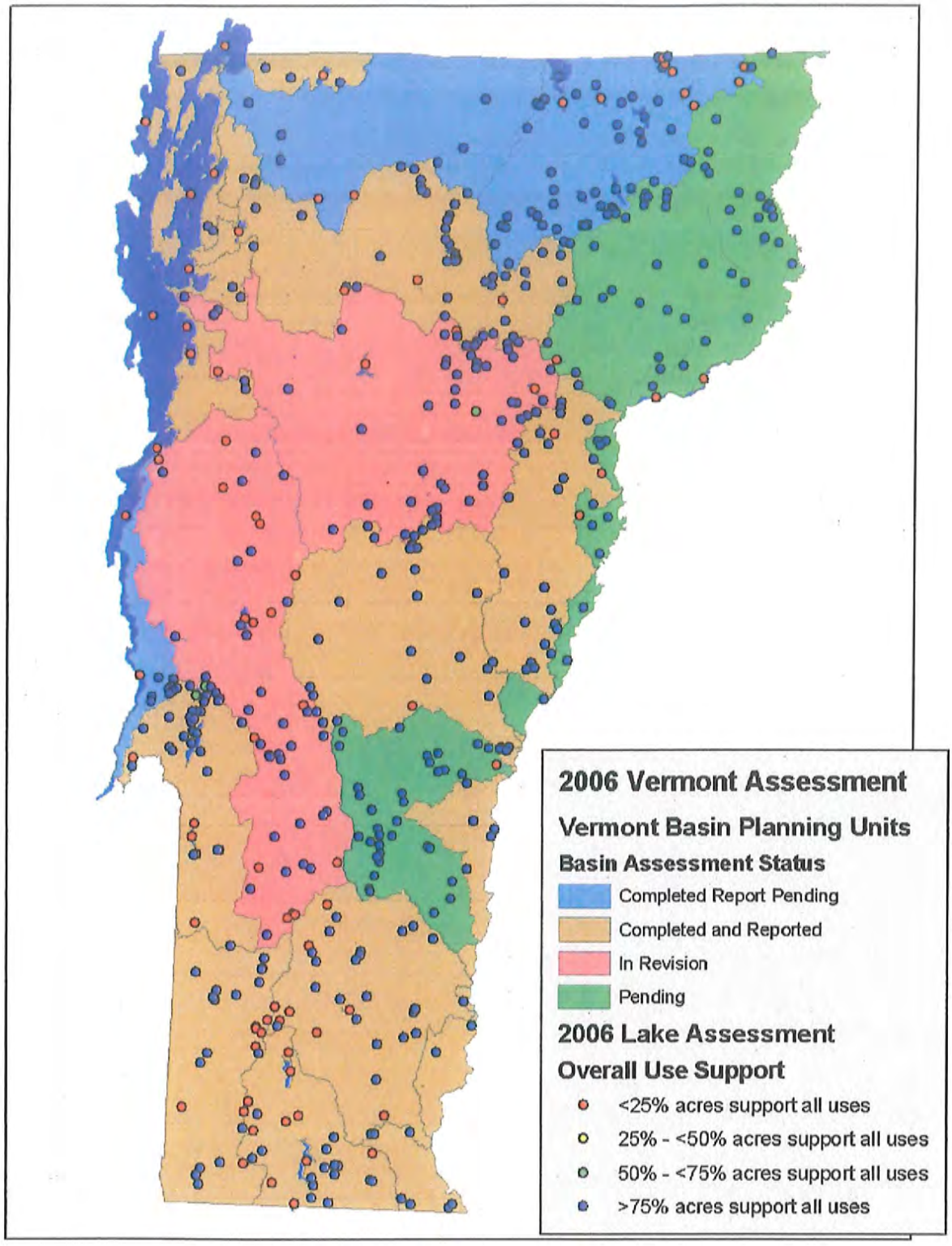


Figure 3.D.1. Overall Use Support for Vermont Lakes and Ponds.

2) Summary of causes and sources for inland lakes

The causes and sources of impairments, alterations, and stresses to Vermont inland lakes are shown simultaneously in Table 3.D.2. Metals and mercury remain the greatest cause of impairment to Vermont inland lakes, causing 8,115 acres not to meet fish consumption uses. This is due to the fact that mercury (Hg) contamination is quite elevated in fish tissues of the component reservoirs within the Fifteen Mile Falls (Connecticut River near St. Johnsbury, VT – Littleton, NH) and Deerfield River hydroelectric projects. Atmospheric deposition is the most important source of Hg to Vermont's landscape and, accordingly, is listed as the most important source category. Flow alteration is the second most important cause of alterations to aquatic life and other uses in Vermont inland lakes, resulting in loss of use to 6,615 acres, due to hydromodification. These flow-altered acres have been reduced by over 1,000 acres during the 2004-2005 reporting period due to operational and/or structural changes in several hydroelectric and flood control projects. Lake acidification, caused by low pH, is the third most prevalent cause of impairment to Vermont inland lakes and the source of this low pH is atmospheric deposition of acid precursors, along with natural factors such as low catchment buffering capacity. In Vermont, 4,420 lake acres are impaired by cultural acidification and an additional 6,999 acres are stressed. Total Maximum Daily Load determinations addressing acid deposition to all 37 of Vermont's acid-impaired lakes have now been approved by EPA.

Phosphorus and nutrients are the fourth most important cause of impairment to Vermont inland lakes, limiting or precluding uses on 2,515 lake acres and stressing approximately 4,700 acres. Siltation is tracked separately from phosphorus, but is the result of similar sources. Siltation impairs 1,723 acres and stresses an additional 3,023. Several sources simultaneously account for nutrients, phosphorus, and siltation, including agricultural, silvicultural, and developed land, road runoff, unstable streams, and residential property management. Finally, non-native species alter several uses and are spread by recreational uses or natural spread vectors. The most important non-native species on Vermont's inland lakes are the Eurasian watermilfoil *Myriophyllum spicatum*, the zebra mussel (*Dreissena spp.*), water chestnut (Trapa natans), and most recently, alewife (*Alosa pseudoharaengus*). Non-native species currently alter 1,214 acres and stress an additional 6,896 acres. Further discussion regarding aquatic nuisance species is provided in Section 5 of this chapter.

Table 3.D.2. Causes & Sources of Impacts to Inland Vermont Lakes.

Causes and sources are ranked in decreasing order of total acreage impaired/altered.
(Note: listed causes and sources are not linked)

Cause of impact	Magnitude of **Cause** (acres)		**Source** of impact	Magnitude of **Source** (acres)	
	Not meeting WQS	Use stressed		Not meeting WQS	Use stressed
0500 Metals	8115	0	8100 Atmospheric Deposition	10212	5702
0560 Mercury	8115	0	7400 Flow Regulation/Modification	8627	4781
1500 Flow alteration	6615	4695	7000 Hydromodification	6615	4741
1000 pH	4420	6999	8600 Natural Sources	4420	7848
0900 Nutrients	2515	4728	1000 Agriculture	2413	2120
0910 Phosphorus	2515	4672	9070 Vt-Unspecified Nonpoint Source	2151	825
2210 Noxious aquatic plants – Algae	2515	3245	1100 Nonirrigated Crop Production	1908	858
1100 Siltation	1723	3023	1400 Pasture Grazing-Riparian And/Or Upland	1908	962
2600 Exotic Species	1214	6896	1800 Vt-Animal Holding/Management Area	1456	796
1200 Organic enrichment - DO	1187	1035	7900 Marinas And Recreational Boating	1314	6911
2200 Noxious aquatic plants – Native	502	1326	7910 In-Water Releases	1314	6872
0000 Cause unknown	0	7	7550 Habitat Modification (Other Than Hydromod)	612	409
0800 Other inorganics	0	6	7700 Streambank Modification/Destabilization	612	448
1300 Salinity - TDS - chlorides	0	9	0200 Municipal Point Sources	521	0
1700 Pathogens	0	808	6000 Land Disposal	452	10
2300 Filling and Draining	0	49	6400 Industrial Land Treatment	452	0
2400 Total Toxics	0	1	3000 Construction	200	3099
			3200 Land Development	200	3079
			7600 Removal Of Riparian Vegetation	85	1107
			8530 Internal Nutrient Cycling (Lakes)	54	72
			8300 Highway Maintenance And Runoff	51	3102
			2000 Silviculture	35	1345

Cause of impact	Magnitude of **Cause** (acres)		**Source** of impact	Magnitude of **Source** (acres)	
	Not meeting WQS	Use stressed		Not meeting WQS	Use stressed
			2100 Harvesting, Restoration, Residue Management	35	1050
			4000 Urban Runoff/Storm Sewers	1	1015
			0100 Industrial Point Sources	0	6
			1410 Pasture Grazing-Riparian	0	5
			3100 Highway/Road/Bridge Construction	0	12
			4300 Other Urban Runoff	0	148
			4500 Highway/Road Bridge Runoff	0	166
			4600 Erosion And Sedimentation	0	3
			5000 Resource Extraction	0	21
			5100 Surface Mining	0	21
			6300 Landfills	0	14
			6500 Onsite Wastewater Systems (Septic Tanks)	0	54
			7300 Dam Construction	0	37
			8520 Debris And Bottom Deposits	0	20
			8700 Recreational And Tourism Activities (Not Boating)	0	156
			8950 Other	0	140
			9000 Source Unknown	0	1040

3) Assessment of use support for Lake Champlain

A summary of Lake Champlain use support is provided in Table 3.D.3 on the following page. In Lake Champlain, due to the combined effects of mercury contamination, nutrient accumulation and non-native species, none of Lake Champlain's 174,175 acres in Vermont fully support all designated uses. Proportionally, aquatic life use is most highly supported (88% of Champlain waters), followed by secondary contact use (83%). Due to phosphorus concentrations in excess of Vermont Water Quality Standards in most areas of the lake, only 23% of Lake Champlain fully supports swimming uses, and only 20% supports aesthetics. No acres support fish consumption use due to mercury and polychlorinated biphenyls (PCBs) in fish tissue that result

in no-consumption advisories for children and women of childbearing age. Figures for overall uses do not differ from those reported in the 2004 305b Report.

Table 3.D.3. Lake Champlain Acres Supporting or Not Supporting Uses.

Use	Full Support	Stressed	Total Meeting WQS	Altered	Impaired	Total Not Meeting WQS	Not Assessed
Overall Uses	0	0	0	13201	174175	174175	0
Aesthetics	35290	0	35290	11394	132053	138885	0
Aquatic Life Use Support	152672	0	152672	21503	5388	21503	0
Drinking Water Supply	121872	0	121872	15673	0	15173	18183
Fish Consumption	0	0	0	0	174175	174175	0
Secondary Contact Uses	144300	0	144300	12994	0	29875	0
Swimming Uses	35290	0	35290	15595	132063	138885	0

4) Summary of causes and sources for Lake Champlain

The causes and sources of impairments, alterations, and stresses to Lake Champlain are shown simultaneously in Table 3.D.4 below. Mercury is the greatest cause of impairment to Lake Champlain, precluding fish consumption use on the entire lake for a subset of Vermont's citizens. Priority organics (PCBs) also impair fish consumption use on the majority of Lake Champlain acres. Atmospheric deposition is the most important source of mercury to Vermont's landscape and is listed as the most important source of mercury to Lake Champlain. The source of PCBs in lake trout was identified in 1994 as a residual "dump" of PCBs in the vicinity of the Wilcox Dock in Plattsburg Bay, New York. The PCB source and contaminated sediments were cleaned up in the late 1990s by the New York State Department of Environmental Conservation. Fish tissue data from Vermont sections of Lake Champlain are undergoing analysis to verify that fish tissue PCB levels have declined.

Nutrients, phosphorus, and associated algal growth impair 132,053 acres of Lake Champlain, and related siltation contributes to that impairment, by stressing uses on 5,388 acres. Unspecified nonpoint sources of nutrients are the largest source of the nutrient pollution, although a suite of sources also contribute nutrients to Lake Champlain, as discussed above (Section 3.D.2). Urban runoff, including stormwater, is also an important nutrient and sediment source in certain segments of Lake Champlain. The Lake Champlain phosphorus-based TMDL continues to serve as the centerpiece of Vermont Governor Douglas' *Clean and Clear Water Action Plan*, which is being implemented as of this writing. Exotic species are a significant problem in Lake Champlain, impairing several uses on 21,503 acres. In Lake Champlain, there is a mix of Eurasian watermilfoil, water chestnut (*Trapa natans*) and zebra mussel (*Dreissena polymorpha*) infestations which all impact aquatic life, aesthetics, swimming, boating, and drinking water uses.

Table 3.D.4. Causes & sources of impacts to Lake Champlain (acres).
Causes and sources are ranked in decreasing order of total area impaired/altered.
(Note: listed causes and sources are not linked)

Cause of impact	Magnitude of Cause (acres)		Source of impact	Magnitude of Source (acres)	
	Not meeting WQS	Use stressed		Not meeting WQS	Use stressed
0500 Metals	174175		8100 Atmospheric deposition	174175	
0560 Mercury	174175		9070 VT-unspecified nonpoint source	132053	
0300 Priority organics	163678		0200 Municipal point sources	73869	
0900 Nutrients	132053		1000 Agriculture	31859	
0910 Phosphorus	132053		7910 In-water releases	24803	
2210 Noxious aquatic plants - algae	132053		7900 Marinas and recreational boating	21503	
2600 Exotic Species	21503		0100 Industrial point sources	21362	
1700 Pathogens	19	222	4000 Urban runoff/storm sewers	13744	
1100 Siltation	0	5388	3000 Construction	13725	
2200 Noxious aquatic plants - native	0	500	8300 Highway maintenance and runoff	13725	
			8600 Natural sources	5388	6
			9000 Source unknown	0	216

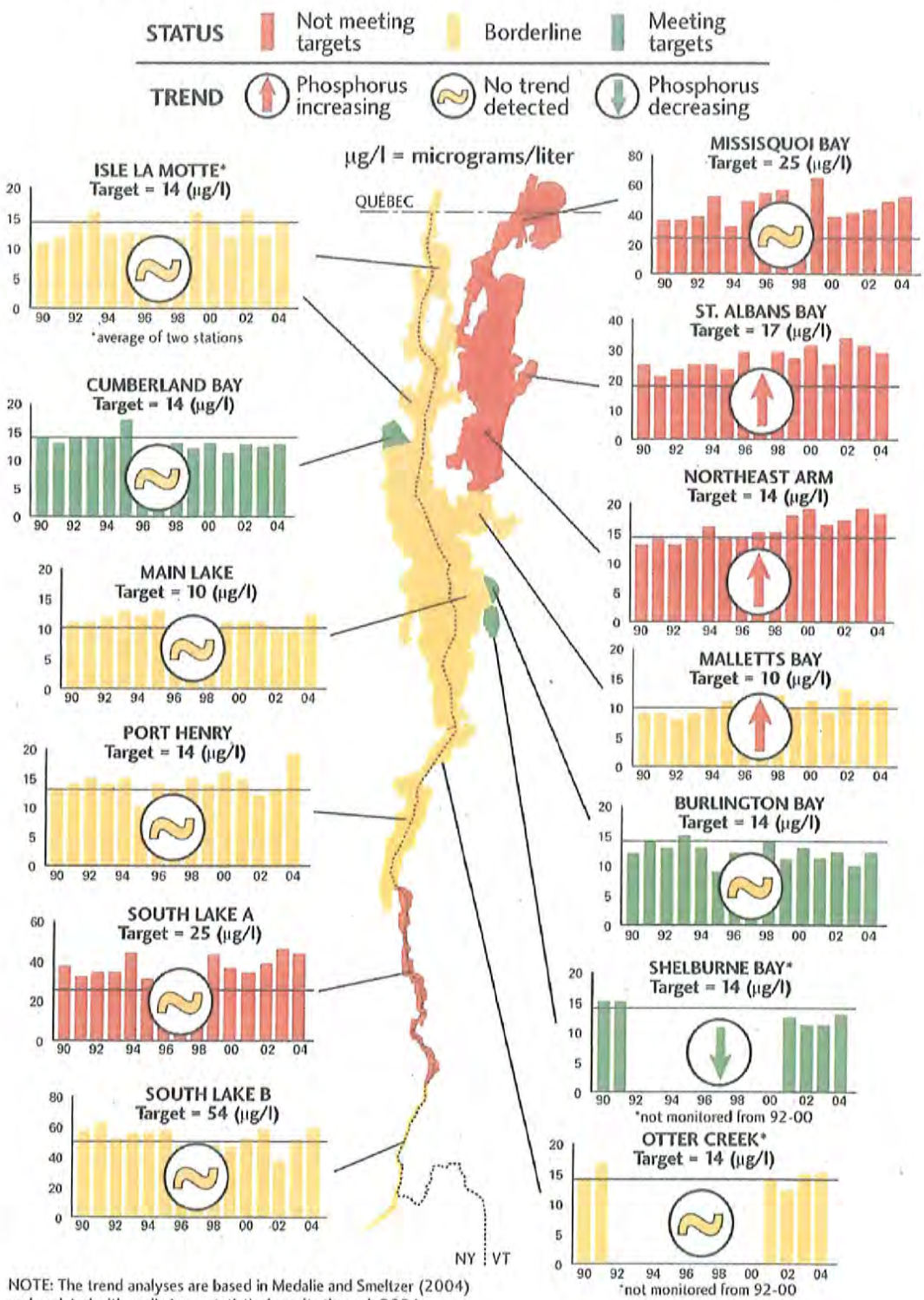
5) Status and Trends of Lake Champlain Phosphorus Concentrations[5]

Human activities, such as sewage treatment, farming, lawn care and urban living, produce and concentrate the nutrient phosphorus. Although phosphorus is not harmful to people, too much of it in Lake Champlain is a problem because it promotes algae growth and causes a deterioration of water quality. The increased algae affect many other organisms and interfere with recreational enjoyment.

The Lake Champlain Basin Program has funded water quality monitoring for phosphorus and other indicators since 1992. Monitoring data were examined to see if there have been increasing or decreasing phosphorus trends between 1990 and 2004. Four lake segments (3 of which are in Vermont) have consistently failed to meet their target water quality standard concentrations. Two of these three Vermont segments plus another Vermont segment are showing trends towards increasing phosphorus concentration. Five other lake segments which sometimes meet the concentration target are not showing any phosphorus trend. Three lake segments (two of which are in Vermont) consistently meet the target water quality standard. The figure appearing on the following page illustrates the status and trends of measured Lake Champlain phosphorus concentration.

[5] Information for this section of the report has been taken from: 2005 State of the Lake. Lake Champlain Basin Program. Grand Isle, Vermont.

STATUS AND TRENDS OF LAKE CHAMPLAIN PHOSPHORUS CONCENTRATIONS, 1990-2004



NOTE: The trend analyses are based in Medalie and Smeltzer (2004) and updated with preliminary statistical results through 2004. Based on LCBP/VTDEC Long-Term Monitoring Program data.

Source: Lake Champlain Basin Program 2005 State of the Lake Report

6) Aquatic Nuisance Species

At least 48 aquatic non-native plants and animals are known from Vermont. Fortunately, most of these species have not become invasive. Those that have become invasive - Eurasian watermilfoil, water chestnut, purple loosestrife, zebra mussels - have had significant economic and ecological impacts. Current management efforts in the state seek to slow or stop the spread of aquatic nuisance species (ANS) to new waterbodies and reduce the density of nuisance populations in infested waterbodies. By their very nature, non-native ANS tend to be easily spread between waterbodies. An ounce of prevention is truly worth a pound of cure, as the cost of preventing an infestation in an uninfested waterbody is significantly less than the annual cost of managing an infestation once it occurs.

Eurasian watermilfoil, currently Vermont's most problematic nuisance non-native aquatic species, was first discovered in Vermont in St. Albans Bay of Lake Champlain in 1962. In the next two decades, the plant population spread to only three additional lakes. However, watermilfoil began to quickly spread to new lakes in the early 1980s, after it had infested and become established in a few of the larger, heavily used recreational lakes. Water chestnut has been in Lake Champlain since at least the 1940s, but it was not found elsewhere until 1994. Early detection of new infestations of watermilfoil and water chestnut is critical if there is to be any opportunity to successfully prevent lakewide spread and the resulting impairment to the ecology and recreational uses of the infested lakes. Water chestnut has actually been successfully eradicated from one lake where a small population was found in the mid-1990s.

Zebra mussels were first found in Lake Champlain in 1993. Currently, there are no effective control methods to reduce or eliminate zebra mussel populations. Zebra mussel veligers found in several lakes since 1993 apparently were unsuccessful in establishing viable populations as no adult zebra mussel populations have been found. The exception to this statement is Lake Bomoseen.

Vermont is fortunate to have relatively few problematic species in the state, but many more nuisance species are found in neighboring states, so constant vigilance and a quick response to the introduction of a new species are imperative to protect our water resources from new invaders. Purple loosestrife, a serious pest of wetlands, lake shores, stream banks and pastures, has a significant foothold in the state. Purple loosestrife has now been identified in 175 Vermont towns.

As of October 2005, Eurasian watermilfoil was confirmed in at least 60 lakes or ponds and 20 other waters (wetlands, rivers, streams) in Vermont. Water chestnut has been confirmed in 8 lakes and ponds and 6 other Vermont waters. Zebra mussels have been confirmed in two Vermont lakes (see figure below).

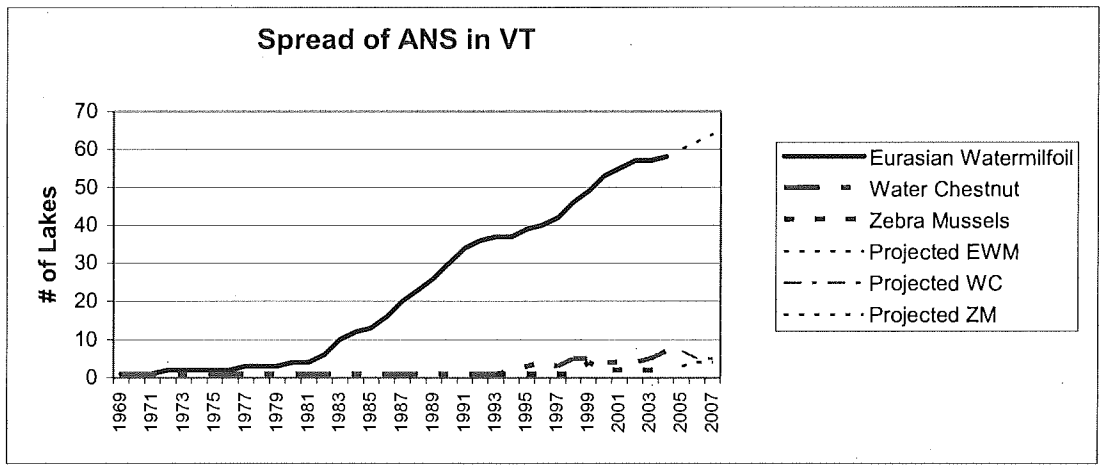


Figure 3.D.5. Spread of aquatic nuisance species (ANS) in Vermont.

Water chestnut is particularly problematic in southern Lake Champlain. Fortunately, it is an annual plant that can be effectively controlled through mechanical harvesting and handpulling if mature plants are harvested prior to dropping their seeds. Since chestnuts can remain viable in the sediment for up to ten years before germinating, areas must be harvested or handpulled annually for many years before total control is achieved. After control is achieved, vigilance is needed to assure re-infestation does not occur. In the late 1960s, a two-person handpulling crew was effectively managing the water chestnut population in Lake Champlain, with only eight bushels of chestnut plants handpulled in 1967. However, the annual control program was stopped in 1971, and over the next ten years, the population in the lake exploded to the point where dense plant beds covered 270 acres in 1980. One chestnut seed can produce 10 to 15 rosettes, each of which can produce 15 to 20 seeds, resulting in up to 300 chestnut seeds from a single seed in one year. Missing just one year of control means the chestnuts produced that year are available to continue the infestation for years to come. On Lake Champlain, the impact of inadequate funding for water chestnut control for even one year can dramatically expand the range of dense water chestnut populations (see Figure 3.D.6 below). Many years of sustained funding levels are then needed to regain the lost ground. The Department of Environmental Conservation seeks to maintain a sustained level of funding that supports a water chestnut control program in Lake Champlain which annually reduces the extent of water chestnut in the lake and will ultimately result in the population in the lake being manageable again by handpulling only.

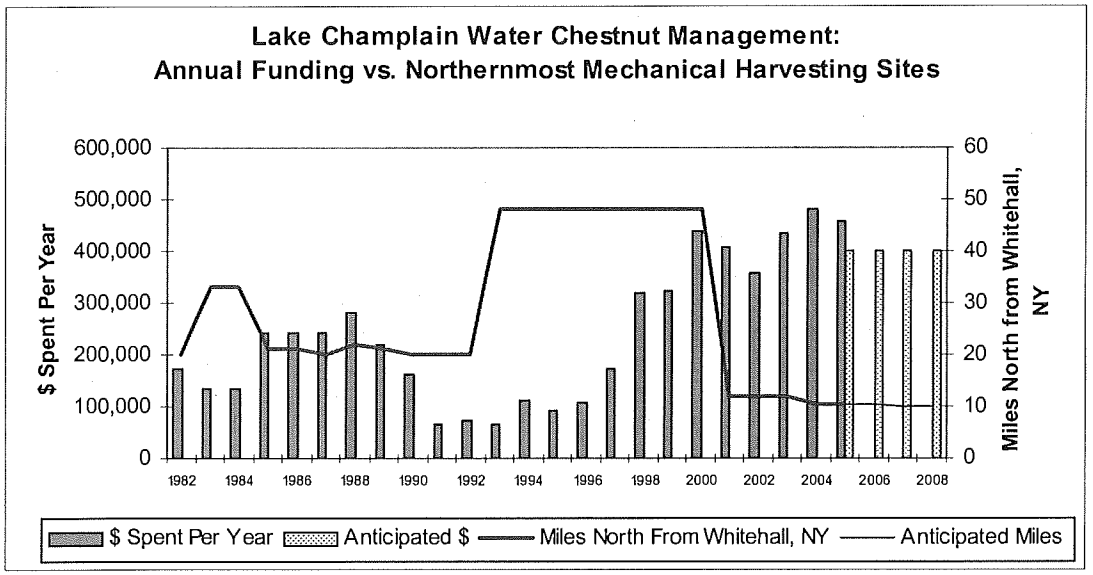


Figure 3.D.6. Lake Champlain Water Chestnut Management: Annual Funding vs. Northernmost Mechanical Harvesting Site.

E) Wetlands Assessment (Statewide)

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 primary function of the Vermont Wetlands Program within DEC is to administer the Vermont Wetland Rules, which regulate most palustrine wetlands that have been mapped on the Vermont Significant Wetland Inventory maps, and therefore have a higher level of protection than unmapped wetlands. The Wetlands Program also provides comment on Act 250 applications that involve wetland issues and conducts pre-Act 250 determinations to assist potential developers in meeting the requirements of the Act. Wetlands Program staff provides comment and advice to other state agencies and they are called upon as wetland experts wherever testimony is deemed appropriate. DEC 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

The Vermont 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 are depicted on the maps. Mapped wetland areas are considered significant and are designated as Class Two wetlands under the Vermont Wetland Rules. Wetland inventories conducted in selected towns around Vermont indicate there are considerably more acres of wetland than identified by the NWI project. A comparison of NRCS mapped hydric soils versus Class Two wetlands in the Lamoille River Watershed found that hydric soils covered approximately 3% more of the landscape than VSWI mapped wetlands, bringing total coverage of total wetland acreage in the watershed to 7%. The wetlands that do not appear on the NWI maps are considered Class Three by the Vermont Wetland Rules. Extrapolating the soil information in the Lamoille Watershed to the rest of the state indicates there may be approximately 90,000 acres of Class Three wetlands in Vermont. Class One wetlands are considered exceptional or irreplaceable in their contribution of Vermont's natural heritage and are therefore are afforded the highest level of protection under the Vermont Wetland Rules. In order for a wetland to be given Class One status, it must be petitioned for reclassification through the Water Resources Board.

Four wetland complexes, totaling 2,138 acres, have been evaluated and given the status of Class One since 1990. Dorset Marsh in Dorset is a 200 acre wetland complex that was successfully petitioned to Class One by the Dorset Citizens for Responsible Growth in 1991, and was also given a 100 foot buffer zone. The North Shore Wetland in Burlington is a 15 acre wetland complex on Lake Champlain that was petitioned by the Vermont Natural Resources Council (VNRC) and given Class One status and a 300 foot buffer zone in 2000. Tinmouth Channel in Tinmouth was reclassified to Class One in 2001. This 1,473 acre wetland complex was petitioned by VNRC, and in addition to Class One status, now contains a buffer zone that is 300 feet on the North End and 100 feet on the southern end. The Lake Bomoseen Wetland was successfully petitioned to Class One by VNRC in 2003. This 450 acre wetland complex in Hubbarton was given a 100 foot buffer in most places but retained a 50 foot buffer zone in one heavily developed area.

Wetlands Section Activities During the 2006 Reporting Period

Clean and Clear Initiative

In order to implement the phosphorus-based Total Maximum Daily Load for Lake Champlain, the Governor allocated funds towards an accelerated clean-up schedule for the lake. As part of that initiative, $250,000 was allocated for wetland restoration and protection. Two projects were identified for funding in 2004 and the funds were recently awarded. Also, money was allocated to develop a Wetland Restoration and Protection Plan for the Vermont portion of the Lake Champlain watershed. For the coming year a full-time position will be funded that will focus on this initiative in the Agency of Natural Resources Lands Division. The *Clean and Clear Wetland Protection and Restoration 2004 Progress Report* can be viewed on the web at: www.anr.state.vt.us/cleanandclear/rep2004/wetlands50-52.pdf.

As part of its FY'06 Clean and Clear legislative appropriation, the Department of Forests, Parks and Recreation received supplemental funding for a new position to coordinate wetlands

protection and restoration activities under the Agency's Clean and Clear program. Major duties will include coordinating/implementing restoration and protection of impaired wetlands and related planning efforts, public education and outreach on Vermont's wetland restoration and protection program, grant administration, and other associated activities. A Request for Proposals was issued by the Agency in the Spring of 2005 to solicit proposals for the development of a Wetlands Restoration Plan for the Vermont portion of the Lake Champlain watershed. When completed, this plan will identify impaired wetlands within the Vermont portion of the Lake Champlain Basin and will prioritize these wetlands for restoration. This information will, in turn, provide the basis for a watershed-wide wetland restoration implementation plan for guiding future wetland restoration and protection activities.

Two sites were funded for restoration projects by Clean and Clear in 2006: the Bissonette Farm Wetland Restoration Site (850 acre property) and the Benjamin-Wing Wetland Restoration Site (65 acre property). These sites will be restored with partners such as the Hinesburg Land Trust, in cooperation with the Trust for Public Land and the Vermont Land Trust, and the Nature Conservancy. The restoration of hydrology for these two properties may result in a net gain and improvement of 170 acres of wetland.

For readers interested in learning more about the Clean and Clear program initiative, one should go to the following web site: www.anr.state.vt.us/cleanandclear/wetlands.htm.

Vermont's Purple Loosestrife Biological Control Program

During the 2004 season, the Purple Loosestrife Biological Control Program released a total of 106,826 *Galerucella* spp. beetles throughout 29 towns and 50 sites totaling nearly 167 acres of new purple loosestrife affected area treated. The total number of beetles released in 2004 increased by 34,623 beetles (or nearly 48%) over 2003. This was due to the establishment of a spring redistribution program and an increased yield of beetles per plant. While the number of plants was reduced from 222 to 186, the number of beetles on each plant increased from an average of 325 to over 544 beetles.

In 2005, the Purple Loosestrife Biological Control Program released a total of 127,807 *Galerucella* spp. beetles throughout 38 towns and 52 sites totaling about 185 acres of new acres treated. The total number of beetles released in 2005 increased by 20,981beetles (or nearly 20%) over 2004. The increase in beetles was due to an expansion of the volunteer beetle-rearing program, which resulted in a 44% increase in the number of plants raised from 186 to 269. Though there was an overall increase in the number of beetles raised, there was a decrease in the number of beetles raised per plant from 544 beetles to 450 beetles between 2004 and 2005. The 2005 annual report regarding the Program can be inspected on the web at:
www.vtwaterquality.org/wetlands/docs/wl_loosestrife-report.pdf.

Education and Outreach Activities

A workshop for contractors was held during April 2004 with approximately 35 contractors in attendance. This group was targeted as they are the people who actually do work in wetlands. The Wetlands Section coordinated with the Stream Alteration Program, the Shoreline Encroachment Program and the Construction Erosion Prevention Program to present a well rounded view of water quality regulations as they pertain to construction. The half day training

was well received, and the contractors are interested in continuing their education in this area. Three workshops around the state were given to municipal officers in October 2004. The workshops offered an opportunity to provide municipal officers with an overview of wetland regulations at the local, state and federal levels. The Municipal Officers Training was offered by the Vermont League of Cities and Towns. Other education and outreach activities included the ongoing logging workshops, field days with conservation commissions, presentations to towns and municipalities, educational workshops for teachers, lectures for universities and other school groups, and regional conservation field days. Most of these efforts were undertaken in response to specific requests for the participation of the Vermont Wetlands Program. The purpose of these education and outreach activities was to provide information about Vermont's wetlands and the regulations that pertain to these wetlands.

Natural Resources Board

In the 2004 legislative session, Act 115 which pertained to permit reform was enacted. This act consolidated and clarified existing environmental permitting appeal routes so that acts or decisions of the nine District Environmental Commissions and the Secretary of the Natural Resources Agency are subject to appeal by the Environmental Court, as are decisions by local development review entities. The Act replaced the Environmental Board with a Natural Resources Board to consist of a full-time chair and two citizen panels, one being the Land Use Panel; the other being the Water Resources Panel. The Land Use Panel assumed the rulemaking functions previously exercised by the Environmental Board and manages the process by which Act 250 permits are issued, may initiate enforcement action, and may petition the Environmental Court for permit revocation. The Water Resources Panel assumed the rulemaking functions previously exercised by the Water Resources Board as well as outstanding resource waters designation and wetlands reclassifications, both of which were revised by the Act so as to take place by rulemaking. The Act gives the Land Use Panel party status before the Environmental Court and the ability to appeal to the Supreme Court in all matters related to Act 250 permits. The Act gives the Water Resources Panel party status before the Environmental Court as well as the ability to appeal to the Supreme Court in all matters related to water rules. The Act became effective on January 31, 2005. The Vermont Wetland Rules were examined by the new Water Resources Panel in 2005 and options for changing the Rules to incorporate changes in Act 115 are being explored.

Vermont Significant Wetland Inventory Maps Updates

A large effort to incorporate all of the changes to the Vermont Significant Wetland Inventory Maps made by reclassification and declassification since the inception of the Vermont Wetland Rules was undertaken in 2004. This included updating both the physical maps and the digital maps. Once the changes were incorporated, the Wetlands Section worked with the GIS Section of ANR to produce maps for each town. These maps are easier to read and more up-to-date than previous versions. In addition, the maps are in Adobe Acrobat format, which are easy to send, print and read for most computer users. The maps were printed in a large scale format in 2005 and will be distributed to the Natural Resources Board and to the towns throughout Vermont in winter of 2006.

New England Biological Assessment of Wetlands Working Group
Staff from the Wetland Section continued to participate in this workgroup. The annual meeting was held in conjunction with the New England Association of Environmental Biologists. A grant proposal was not funded this year but plans are underway to seek other funding in the future to develop a wetland bioassessment program. (Note: a grant was approved in 2005 to re-start the wetland bioassessment project.)

New Data Collection System
In 2004, the Wetlands Section began a new method of gathering data used for the annual report. This new system helps to clarify what types of wetland impacts are being permitted, such as temporary versus permanent impairments, and wetland loss through fill. The system also better tracks wetland restoration, enhancement, conservation and creation. A previous parameter for measuring the success of the program, "acres of wetlands saved," has been dropped as this was not considered a hard number by the program. Instead, the new data system records "staff interactions," which measures situations where the customer has avoided or minimized impacts as a result of interacting with the staff. The new data system has the potential to more clearly provide information which can be used drive program goals, educational efforts, and enforcement focus.

Meetings, Trainings & Conferences
Members of the Vermont Wetlands Program were able to attend a number of meetings and conferences this year for the purposes of keeping up to date on wetland science and regulation. These meetings, trainings, and conferences included:

- The Annual NEBAWWG (March 2004)
- The New England Wetlands Workgroup meetings at NEIWPCC headquarters in Lowell, Massachusetts.
- Basic Environmental Crimes Investigations Training by the Northeast Environmental Enforcement Project
- NRCS Soils Workshop
- NEIWPCC wetland delineation training

Regulatory Activities
The Vermont Wetlands Section is called upon to review a variety of projects including residential developments, commercial and industrial developments, roads, public works, utilities, agricultural projects, silvicultural projects and others. In more than 88% of the projects, our clients are private citizens, 9% are local governments, 2% of the projects our client is state government, and less than 1% is with federal government. The primary function of the Vermont Wetlands Section is to administer the Vermont Wetland Rules, which regulate most palustrine wetlands that have been mapped on the Vermont Significant Wetland Inventory maps. The Wetlands Section also reviews projects under the jurisdiction of Vermont's Act 250 Land Use Permits and Section 401 of the Federal Clean Water Act. Some projects are reviewed under each of the above authorities. Figure 3.E.1. represents a breakdown of the project categories the Vermont Wetlands Section reviewed in 2004.

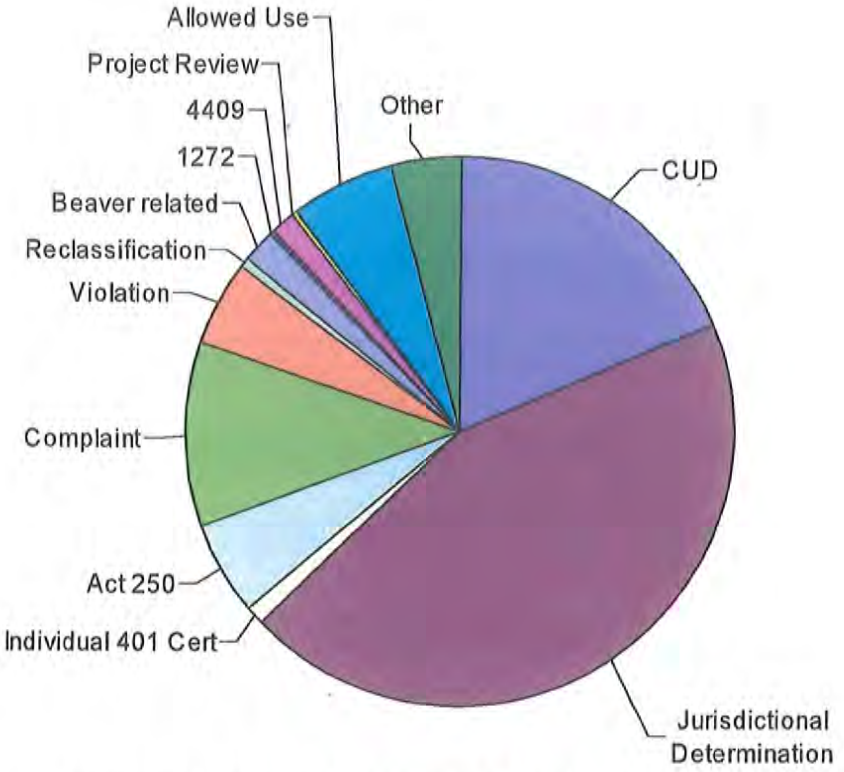


Figure 1: Review Categories for Wetland Projects 2004

The Wetlands Section logged in 512 new projects for the 2004 calendar year. A total of 2.44 acres of wetland were lost for projects started in 2004. Of the projects that were both started and completed in 2004, 1.61 acres of Class Two wetlands were lost, and 0.22 acres of wetland were permanently impaired, and 1.23 acres of Class Two wetlands were temporarily impaired. Of those projects reviewed by the Wetlands office in 2004, a total of 0.83 acres of Class Three wetlands were lost, and 0.36 acres were permanently impaired, and 0.32 acres of Class Three wetlands were temporarily impaired. A breakdown of Class Two and Class Three wetland and buffer zone impacts for projects started and completed in 2004 is summarized in Table 3.E.1.

Table 3.E.1. Wetland & buffer zone loss and impairment (in acres) for projects started in 2004.

Wetland Type	Wetland Loss	Permanent Wetland Impairment	Temporary Wetland Impairment	Permanent Buffer Zone Impairment	Temporary Buffer Zone Impairment
Class Two	1.61	0.22	1.23	6.00	0.70
Class Three	0.83	0.37	0.32	N/A	N/A

Vermont Conditional Use Determinations

The Vermont Wetland Rules designated all palustrine wetlands identified on the VSWI maps and contiguous wetland areas as significant (Class Two) wetlands. Any activity in a Class Two wetland or associated 50-foot buffer zone, other than the allowed uses specified in §6.2 of the Wetland Rules, requires a Conditional Use Determination (CUD) from the Agency of Natural Resources. The Agency may only grant such a determination if the applicant demonstrates that the proposed activity will not have an undue adverse impact on the protected wetland functions.

Wetland Loss through the CUD Process

In addition to the 512 project logged in during 2004, approximately 96 projects were continued from previous years. In 2004, the Wetlands Section received 88 new CUD applications, and 84 CUDs were issued, one was denied, and one was terminated. The following data was compiled from projects that were issued CUDs in 2004, even though many projects may have been started in previous years. The data was compiled from the CUD database, and represents the most accurate measurement of wetland impacts as regulated by the Vermont Wetland Rules. Of the CUDs issued in 2004, a total of 4.2 acres of Class Two wetland were lost, 0.83 acres of wetland were permanently impaired, and 0.45 acres of wetland were temporarily impaired. The CUDs issued in 2004 approved approximately 18.93 acres of permanent buffer zone impairment and 0.9 acres of temporary buffer zone impairment.

Wetland Gain through the CUD Process

A number of impacts permitted through the CUD process undergo some form of mitigation. Portions of the wetland and buffer zone may be restored from a previously impacted condition or enhanced through plantings. Wetlands can be created from an area that was not previously wetland, or simply protected through a conservation easement. Wetland gains can be the result of mitigation for permits, restoration for wetland violations, or the voluntary action of willing landowners, or a combination of these factors. Table 3.E.2. summarizes wetland gains from projects that went through the CUD process.

Table 3.E.2. Wetlands gain (in acres) for projects that received CUDs.

Gain as a Result of:	Restoration	Creation	Conservation	Enhancement
Mitigation and Voluntary	0 ac Wetland 0.106 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone	21.24 ac Wetland 20.78 ac Buffer Zone
Mitigation and Violation	1.67 ac Wetland 0 ac Buffer Zone	0.37 ac Wetland 0 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone
Mitigation	0.002 ac Wetland 0.05 ac Buffer zone	0 ac Wetland 0 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone	4.32 ac Wetland 8.06 ac Buffer Zone
Voluntary	0 ac Wetland 0.56 ac Buffer Zone	0.13 ac Wetland 0 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone
Violation	0.06 ac Wetland 0.20 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone	0 ac Wetland 0 ac Buffer Zone

CUDs by Project Types

Table 3.E.3. breaks down the number of CUDs and associated loss of Class Two wetlands by project type. Residential projects accounted for the greatest number of projects in 2004 (21 CUDs issued in 2004 for single family homes, and 31 issued for residential subdivisions). The Program is also able to break down what type of activity proposed within the project results in the most wetland and buffer zone impact. For single family homes, most of the impact occurs as a result of a combination of the construction of driveways and utilities (0.43 acres of wetland loss). For residential subdivisions, eight of the 32 projects have impacts from both roads and utilities. The largest amount of impacts in the residential subdivision category came from a single project that resulted in 0.57 acres of wetland loss, and 3.13 acres of permanent buffer zone impact. These impacts were the result of driveways, buildings, utilities, parks, and yards. Please note that a number of road projects received CUDs this year, but are not yet in the database.

Table 3.E.3. CUDs & associated loss of Class Two Wetlands broken down by project types.

Project Type	Number of CUDs Issued	Acres of Wetland Loss	Acres of Perm. WL Impair	Acres of Temp. WL Impair	Acres of Perm. Buffer Impair	Acres of Temp. Buffer Impair
Residential Single Family	21	0.68	0.10	0.02	1.76	0.15
Residential Subdivision	31	1.70	0.05	0.34	9.80	0.75
Industrial Commercial	10	0.34	0.30	0.00	2.43	0
Parks/Recreation	9	0.30	0.12		1.92	
Agriculture	0	0	0	0	0	0
Forestry	0	0	0	0	0	0
Transportation	1	0.01	0	0	0.09	0
Institutional	2	0	0.22	0	0.86	2

Technical Assistance

Technical assistance is provided to interested landowners, applicants, District Environmental Commissions, municipal conservation and planning commissions, the Natural Resources Conservation Service, and other Vermont Departments and Agencies. Projects range from consultation on Superfund natural resource damages and remediation to determining the boundary of a wetland for a landowner. The amount of technical assistance that is provided is reflected in the number of site visits made (937), phone calls (6,935), and letters sent (884) during the year. An important value of this technical assistance is communication and the opportunity for education and outreach. Program involvement with individual projects gives program staff an opportunity to educate the stakeholder about the value of wetlands and the particulars of wetland regulation. Through technical assistance and project involvement, wetland impacts were minimized by approximately 12 acres and buffer zone impacts were minimized by approximately 2 acres. At least 33 projects that initially proposed impacts to the wetland and buffer zone were completed with no impact whatsoever to these resources due to staff interaction.

Enforcement & Complaint Investigations

There were 80 complaints made to the Wetlands Section in 2004. Of these complaints, only 26 were actual violations. Ten additional violations were received by some other means than a complaint (referral from the enforcement division, or personal observation). It is practice to respond to all complaints, which could involve resolution over the phone, referral to another program, or to a thorough investigation with enforcement action through the Enforcement Division. Because these cases tend to be more complicated, violations usually take multiple years to resolve. Table 3.E.4. breaks down the acres of wetland and buffer lost and impaired due to violations. Of those projects involving a Wetland Rules violation, approximately 0.36 acres of Class Two wetlands were restored, 0.12 acres of buffer zone were restored, and 0.04 acres of Class Three wetlands were restored.

Table 3.E.4. Wetland & buffer zone loss and impairment as a result of violations.

Wetland Type	Wetland loss	Wetlands impairment (permanent)	Wetlands impairment (temporary)	Buffer impairment (permanent)	Buffer impairment (temporary)
Class Two	7.75	0.03	0.25	0.61	0.26
Class Three	0.32	0.60	N/A	N/A	N/A

The Vermont Wetlands Section continues to work and meet with the Environmental Enforcement Division to follow up on complaints and enforcement actions. Significant progress was made in 2004 on both an enforcement policy and protocol for the Wetlands Section and a protocol to ensure CUD compliance.

PART FOUR: PUBLIC HEALTH RELATED ASSESSMENTS

Size of Water Affected by Toxicants

With the exception of fish consumption advisories described in Appendix D, there are no waterbodies where toxicants are known to be impairing uses related to public health. Nonetheless, NPDES monitoring by permit holders and water supply monitoring by suppliers continue to provide data and other information related to environmental occurrences of toxicants in permitted municipal and industrial discharges and public water supplies, respectively.

Fish Consumption Monitoring

During the reporting period, an additional ~150 individual fishes beyond those reported during the 2004 305b Report were acquired from Lake Champlain waters for the purpose of revising fish consumption advisories. Analysis of mercury (Hg) from these fish samples has been completed by the DEC LaRosa Laboratory in Waterbury. Testing of these fishes for PCB's is not complete as methods previously used by the LaRosa Laboratory are no longer compliant with currently accepted methods, and the laboratory is no longer sufficiently staffed to carry out method development. DEC remains interested in testing a subset of fishes for polybrominated diphenyl ether flame retardants. DEC will determine whether EPA may provide potential assistance in this regard.

In addition, DEC scientists have provided testimony to Vermont legislative committees regarding formalization of fish tissue monitoring approaches, and subsequently prepared a comprehensive fish-tissue monitoring plan, which was delivered to the Vermont Legislature just following the close of the reporting period. The structure of this plan, which is easily extended to other contaminants, is articulated in the following.

The plan answers the charge established by 10 V.S.A. Chapter164, Section 7114, to prepare a plan addressing fish mercury contamination, and how it changes in response to management actions over time. The resulting proposed freshwater fish tissue monitoring program is specifically designed to document the occurrence of, and trends in, mercury contamination in freshwater fishes of Vermont, for lakes and rivers, and relate observed changes to management actions. This plan has been developed by the Fish Contaminant Monitoring Committee which consists of members from DEC and the Vermont departments of Fish and Wildlife (DFW) and Health (VDH).

The proposed freshwater fish tissue monitoring program is comprised of three biennially-recurring "rounds" of tissue sampling. In sampling round one, target fishes in specified size ranges are tested from Lakes Champlain and Memphremagog, Vermont's largest freshwater resources. In round two (two years later), a similar suite of fish species within target size ranges are tested from a suite of 15 inland lakes, and 15 inland third-order or larger rivers. These so-called indicator waters are those which, along with Champlain and Memphremagog, will be used to assess trends in fish mercury, accounting for factors that impact mercury bioaccumulation. In round three (two years following round two), fish mercury testing in a 15-lake and 15-stream randomized selection of waterbodies will be carried out, to provide a statistical assessment of Statewide fish mercury contamination levels. The assessment cycle then begins anew with Champlain and Memphremagog at the next biennium.

In the plan, information is also provided regarding where mercury emissions, deposition, and product recycling figures are tracked and maintained. These figures form the basis for overall tracking of the management of mercury. Discussion is provided on how fish mercury changes can be related to management actions, and an example figure is provided showing changes in fish mercury in Lake Champlain to date.

In order to transition from the existing fish monitoring approach to the more rigorous program described above, resources are needed in terms of field support and analytical chemistry. Under the current fish monitoring program, DEC, DFW, and VDH jointly manage the program and some of the analytical chemistry costs of the proposed program are already accommodated by DEC under its current budget. The total cost for the program, per biennial sampling round, is estimated at approximately $63,000. A considerable portion of these costs are analytical and at present a portion of these are already accommodated by the Department.

A series of recommendations are provided for implementation of this plan. These include: charging the existing ad-hoc Fish Contaminant Monitoring Committee with management of the program; adoption of the proposed program design; and dedication of resources for field efforts and analytical chemistry. Two specific recommendations regard adding a DMA Mercury Analyzer to the DEC laboratory, and transitioning from fillet sample types to biopsy-plugs. Implementation of these important recommendations would significantly reduce sample processing time, analytical chemistry costs, and the numbers of fish sacrificed for contaminant testing.

Mercury (Hg) Monitoring

The following text summarizes monitoring and analytical activities related to Hg contamination in Vermont during the 2006 305b reporting period. Some of these items are not specifically from Vermont but all bear on Vermont's future approach to dealing with the Hg problem. Vermont remains interested in seeing a final issuance of EPA's long-anticipated fish contaminant report for the Connecticut River.

Release of Ecotoxicology *studies and* Mercury Connections *report*

The issue of environmental Hg contamination received a considerable boost in profile in March 2005 with the release of the studies on Hg contamination across northeast North America and published in the journal *Ecotoxicology* and summarized in the report entitled *Mercury Connections.* These studies quantified the extent and magnitude of Hg contamination of all types of biota, including fish, loons, other aquatic biota, and even terrestrial birds. The House Committee on Fish, Wildlife and Water Resources was briefed on the content of *Mercury Connections* in April 2005.

Forthcoming important synthesis studies by Hubbard Brook Research Foundation

The Hubbard Brook Research Foundation has convened a team of scientists who have further analyzed the northeastern Hg database summarized by *Mercury Connections.* The Foundation has written two new important publications that will stand as statements on the overall footprint of the Hg problem in the northeast. The first study describes the mechanisms by which Hg moves from emissions source to northeastern biota, and projected improvements based on

reductions in air emissions under several scenarios. The second study identifies the locations and causes of biological Hg "hotspots" on the landscape. There are two such hotspots formally identified in Vermont. These studies will be published during early-mid 2006 in the journal *BioScience.*

New measurements of dry deposition at the Underhill mercury monitoring station
The Hg monitoring station at Underhill, Vermont was shut down temporarily when a major windstorm toppled the tower on which many physical sensors were attached. The tower was restored during the fall of 2005 and measurement of wet and dry mercury deposition continue thanks to appropriations from Vermont's congressional delegation. Using new techniques, researchers at Underhill have developed stronger evidence than ever before that certain Hg deposition events measured at Underhill are directly attributable to Hg emissions from Midwestern sectors.

The first accounting of mercury inputs and outputs to Lake Champlain
A team of regional scientists recently published a comprehensive accounting of Hg inputs to Lake Champlain. This project quantified mercury loads to the lake from river inputs as well as from direct atmospheric deposition to the lake surface. Tributary inputs of Hg accounted for 56.4% of the total annual load, followed by direct deposition at 38%, and directly-discharging wastewater treatment at 5.6%. As part of this project, the team reconstructed the history of Hg deposition to the lake at several locations. Mercury accumulation to lake sediments is presently 2.8 times the pre-industrial background. The Lake Champlain project is continuing, with additional focus on improving wastewater release estimates, and on the biological pathways that control Hg accumulation into fish and fish-eating wildlife.

Mercury emissions from the northeast region have been reduced tremendously
The Northeast States for Cooperative Air Use Management (NESCAUM) has finalized a new emissions inventory for the region. As compared to a similar inventory developed in 1998, Hg emissions from the northeast have been reduced from 15,900 kg to 4,700 kg, representing a 71% reduction. Point emission sources of Hg comprise 76% of the current total emissions and releases from products and bulbs, home heating, dental discharges, and other minor sources comprise the remainder. Presently, out-of-region emission sources comprise 85% of the Hg deposited to the northeast and in-region sources comprise 15%.

Terrestrial mercury contamination is becoming more evident
Researchers at the Vermont Institute of Natural Science (VINS) are continuing to identify the mechanisms by which the Bicknell's thrush and other upland songbirds are contaminated with mercury. VINS carried out field testing on Stratton Mountain, Mount Mansfield, and East Mountain in East Haven on several species of birds along with the food that is consumed.

Continuation of mercury monitoring by USGS and the Loon Recovery Project
The United States Geological Survey (USGS) is continuing to support studies of Hg cycling in Lake Champlain and in the Sleepers River watershed. Additional results from the Lake Champlain project beyond those discussed above suggest that stormwater may be a significant source of Hg export from urban areas. Discussions are currently underway to make Hg monitoring a routine element of the overall water quality monitoring activities of DEC and the

Lake Champlain Basin Program. In addition, a steady stream of abandoned loon eggs and feathers from Vermont lakes continues to be analyzed for Hg in conjunction with the Loon Recovery Project.

Field sampling of northeastern reservoirs is complete
In an effort to understand the role played by water-level management on the bioaccumulation of Hg in fish, researchers have recently completed a two-year field project on northeastern reservoirs. This project is aimed at understanding to what degree fish-mercury concentrations are enhanced by the management/fluctuation of reservoir water levels.

Cyanobacteria
Monitoring for cyanobacteria continued on Lake Champlain in 2004 and 2005 as funded by the Lake Champlain Basin Program and the University of Vermont. The tiered sampling and analysis program first implemented in 2003 expanded to include citizen monitors in the southern Vermont and northern New York portions of the lake. The University of Vermont (UVM) continues to manage the program, collect samples, conduct taxonomic assessments and analyze for the presence of microcystin. The DEC Lake Champlain team collects algae samples from stations around the lake each week during its routine sampling and sends them, along with pertinent observations, to UVM for analysis. Monitoring emphasizes identification and rapid enumeration of potentially toxic cyanobacteria, with testing for microcystin and anatoxin occurring as conditions warrant. Results are distributed weekly to stakeholders, including health agencies in Vermont, New York and Quebec. Health alert notices remain the responsibility of each respective agency and are posted when algal counts or toxin levels reach a defined threshold[1]. Microcystin remains the focus of the monitoring program on Lake Champlain because it is the most frequently detected cyanotoxin and rapid assessment capabilities exist at several facilities. In 2005, the Vermont Department of Health (VDH) implemented a new recreational standard of 6 µg/L microcystin. VDH also updated its cyanobacteria webpage to include the Lake Champlain weekly monitoring results in a map format, a photo gallery to assist in identifying cyanobacteria, and general information about cyanobacteria and toxins.

Cyanobacteria were present in many areas of the northern lake by early July, with accumulations of *Microcystis* in Missisquoi Bay. Detectable microcystin, below the new recreational level, was found by July 14th. Microcystin concentrations of 10 - 20 µg/l were present in Missisquoi Bay by July 22nd. In late July, algal cell densities remained high, but microcystin had dropped below 6 µg/L and remained low for the rest of the summer. While moderate densities of cyanobacteria were found in other areas of the lake during the summer, microcystin levels were not a concern.

Small Community Untreated Waste Discharges
Several small communities throughout the state have been discharging untreated wastes to waters of the state due to lack of treatment facilities. The discharges from these areas constitute threats to public health. The Village of East St. Johnsbury constructed several individual and shared non-discharging, soil based sewage treatment systems in 2005. Warren Village completed construction of a sewerage project including sewers, pump stations and a large soil based, non-

[1] One may contact the Vermont Department of Health within Vermont by dialing 800-464-4343 or visiting their web site: www.healthyvermonters.info.

discharging leachfield in 2005. In 2005, three villages in the Town of Pownal began construction of their sewer systems in 2004 and on their direct discharging treatment plant.

DEC is providing direct funding and technical assistance to several other communities to help them evaluate and plan for their wastewater needs. It is anticipated there will be a steady demand by several small communities for wastewater evaluations and planning in the coming years. These communities have not been identified in the past as being the sources of surface water pollution, but residents are now realizing that they may have problems with their small lot and older on-site sewage systems. Part of the impetus for this interest appears to be a change in state law which will require designs and permits for all failed septic system repairs beginning in 2007. Currently, repairs at single family houses require no permitting or compliance with design standards. Another factor is the economic viability of small communities which cannot have commercial or residential growth due to limiting soil conditions for septic system leachfields.

Sites of Known Sediment Contamination

The removal of contaminated sediments from Lake Memphremagog at the Lake Memphremagog-South Bay railyard site in Newport, Vermont is complete. On-site composting to reduce contaminant levels in removed sediments is on-going.

Risk assessment activities are being conducted by EPA in regard to elevated contaminant levels found in sediments in and around the confluence of the Ompompanoosuc River with the Connecticut River. Contaminants are thought to be related to historical mining activities (but no longer occurring) at certain locations within the Ompompanoosuc watershed. EPA has completed a Baseline Environmental Risk Assessment (BERA) for the Superfund site known as the Elizabeth Mine site on the West Branch of the Ompompanoosuc River in Strafford, Vermont. The BERA is currently undergoing final review. Additional CERCLA risk assessment activities are in the preliminary planning and implementation phase for other historical mining sites in the watershed.

Sediment testing in the Hoosic River has found PCB concentrations up to 0.041 mg/kg. The sediments tested are in the vicinity of the former Pownal tannery. Sediment sampling on the Hoosic River upstream in Massachusetts also found PCBs as well as a number of metals.

Hewitt Brook and Pond B at the old Bennington landfill site were analyzed for metals and PCBs. Twenty sediment samples were taken. Five metals were found at concentrations above the Low Effects Level (LEL). Arsenic was found at three sample locations above the Severe Effects Level (SEL). PCB concentrations were above the LEL in 14 of the 20 sediment samples. Monitoring is continuing at this site.

A number of compounds have been found in the sediments of Stevens Brook in St. Albans. Near the former St. Albans Gas & Light Property, one volatile organic compound, eight semi-volatile organic compounds, and four inorganics (cadmium, cyanide, barium, and zinc) were found in the sediments at three times or more the reference value. Monitoring is continuing at this site.

Arsenic has been found in the sediments of Jewell Brook, a tributary to the upper Black River in Ludlow. Further investigation of the Jewell Brook Mill site is being conducted by DEC and others.

Restrictions on Bathing Areas During the 2006 Reporting Period

Lake Champlain

Bayside Beach (Colchester) was closed on several occasions during the reporting period due to the presence of indicator bacteria in excess of Vermont's standard of 77 *E. coli* / 100ml. In the Burlington area, two beaches were closed once during the reporting period (North Beach and Oakledge).

Blanchard Beach (Burlington) continues to remain closed to swimming due to continuously high *E. coli* concentrations.

The following Lake Champlain State Park beaches were closed (number of closures in parentheses) for short periods then reopened. These four Lake Champlain State Park beaches were re-opened for bathing when follow up monitoring revealed safe levels of indicator bacteria. In every case, re-sampling taken the day that high results were received by the beaches revealed *E. coli* concentrations below the Vermont standard.

Knight Point (4) Sandbar Beach (3) Kingsland Bay (3) Alburg Dunes (3)

Inland Lakes

These seven inland lake State Park beaches, located at the respective Vermont State Park, were closed during the reporting period (number of closures in parentheses). In every case, re-sampling taken the day that high results were received by the beaches revealed *E. coli* concentrations below the Vermont standard.

Half Moon Pond (1)	Maidstone Lake (2)	Lake Carmi (1)	Crystal Lake (1)
Lake Dunmore (1)	Lake Elmore (1)	Ricker Pond (1)	

The following 3 inland reservoir beaches, located at facilities owned and operated by the US Army Corps of Engineers, were reported as closed for swimming (expressed as estimated number of days) during the reporting period:

Facility Name	10/1/03-9/30/04
Ball Mountain Lake	8
Townsend Lake	4
Union Village Dam	30

These figures are identical to those reported in Vermont's 2004 305b Report. Newer data for the 2005 swimming season are not yet available from the Army Corps of Engineers.

Rivers and streams – citizen monitoring-based closures.

Of the eleven groups currently participating in the LaRosa Environmental Monitoring Partnership Program, two groups (Huntington Conservation Commission/Huntington River and

West River Watershed Partnership/West River) carry out *E. coli* bacteria monitoring efforts at swimming holes and post the results of their sampling efforts. The Friends of the Mad River also monitor and post *E.coli* results obtained at swimming locations (posted online at www.friendsofthemadriver.org). Table 4.1 identifies the rivers and counts of sites, monitored by the Huntington Conservation Commission and the West River Partnership, that were posted for elevated *E. coli* levels during the last three summers.

Table 4.1. Count of weekly samples greater than 77 E. coli/100ml.

Project Name	Site Location	2003	2004	2005
Huntington Cons. Comm.	7 Falls	1	1	5
Huntington Cons. Comm.	Audubon Hemlock	3	19	9
Huntington Cons. Comm.	Audubon Horseshoe	7	5	9
Huntington Cons. Comm.	Brace Bridge	2	4	
Huntington Cons. Comm.	Brent Field	2	3	8
Huntington Cons. Comm.	Bridge Street	6	5	9
Huntington Cons. Comm.	Carse Bridge	3	5	7
Huntington Cons. Comm.	Cemetary	4	5	9
Huntington Cons. Comm.	East Street	3	5	6
Huntington Cons. Comm.	Rec. Field	2	3	15
Huntington Cons. Comm.	Shaker Mountain	2	3	7
Huntington Cons. Comm.	Sheldrake	5	6	6
Huntington Cons. Comm.	Spence Bridge	2	5	7
West River Watershed Assoc.	Bartonsville Covered Bridge	5	5	*
West River Watershed Assoc.	Brookline Bridge	5	2	*
West River Watershed Assoc.	Deyo's	1	2	*
West River Watershed Assoc.	Dummerston Cvd. Bridge	3	2	*
West River Watershed Assoc.	Gassets/Talc Mine	1	2	*
West River Watershed Assoc.	Jamaica State Park	3	2	*
West River Watershed Assoc.	Milkhouse Meadows	6	5	*
West River Watershed Assoc.	Newfane Swim Hole	4	4	*
West River Watershed Assoc.	North Bridge (Chester)	4	4	*
West River Watershed Assoc.	Pikes Falls	2	1	*
West River Watershed Assoc.	Quarry Rd	2	1	*
West River Watershed Assoc.	Scott Covered Bridge	3	2	*
West River Watershed Assoc.	West Rock Confluence	1	2	*

Restrictions on Surface Drinking Water Supplies During the 2006 Reporting Period

There are no standing boil-water notices to report for the 2006 reporting period. While numerous smaller community or private non-transient systems were subject to short-term boil notices due to minor exceedances of Safe Drinking Water Act criteria for finished water, none were of such a magnitude as to trigger a long-term notice. In addition, none of the boil-water situations warranted enforcement actions.

Chronic or Recurring Fish Kills

There were no known chronic or recurring fish kills in Vermont during the 2006 reporting period, save the commonly observed, natural mortality associated with post-spawning stress. Such fish mortality often occurs on lakes and ponds in Vermont during late spring and early summer. The Vermont Department of Fish and Wildlife maintains a fish pathology laboratory which responds to reports of fish kills and maintains records of the events.

During the 2006 reporting period, there were a total of eight fish kills documented by the fish pathology laboratory that were more than incidental in magnitude and exceeded typical mortality associated with post-spawning stress. Two of the events were attributable to discharges for which enforcement actions by the Agency of Natural Resources were taken. The remaining six events were attributed to natural causes. These eight reported fish kills are as follows:

2004:

1) February – a large-scale but natural kill of carp occurred on the upper Dead Creek, due to prolonged ice cover and complete freeze of the waterbody. This killed thousands of carp, and attracted a wide variety of piscivorous waterfowl including osprey and several bald eagles.
2) July - A major complete kill of 0.62 miles of the Dog River was attributed to a chlorine spill from an upstream wastewater treatment facility. Over 20K individual fishes were estimated to be lost.

2005:

1) June - Lake Rescue – evidence of a minor fish kill attributed to post-spawning stress.
2) June - Silver Lake (Leicester) – evidence of a minor fish kill, with very few fish evidenced.
3) July – Wolcott Pond - evidence of a minor fish kill attributed to rapid water warming.
4) July – Lake Eden - evidence of a minor fish kill attributed to rapid water warming.
5) July – South Bay of Lake Memphremagog - evidence of a minor fish kill attributed to rapid water warming.
6) July – A major complete kill of five miles of the upper Winooski River resulted from an ammonia spill at a cheese and yogurt processing plant.

PART FIVE: SUMMARY OF IMPAIRED WATERS

Total Maximum Daily Load (TMDL) Program

Under Section 303d of the Clean Water Act, all states are required to develop lists of impaired surface 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 Part A 303d List of Impaired Waters in Need of a TMDL. The Clean Water Act requires that a Total Maximum Daily Load (TMDL) be developed for impaired waters on Part A of the list and the list provides a schedule as to when TMDLs will be completed.

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. 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.

Follow-up Monitoring ▪ additional monitoring may be needed to ensure the TMDL is effective in restoring the waters.

Table 5.1 appearing on the next page is provided as a summary update of overall TMDL progress since 2001. During the 2006 305b reporting period, TMDLs were completed and approved concerning 7 low pH impaired waters (due to atmospheric deposition). Also during the 2006 reporting period, one draft TMDL was prepared concerning a stormwater impaired waterbody. Table 5.1 is also an expression of future TMDL direction for Vermont. Readers of this report are referred to the 2004 305b Report which contained a brief summary of two significant developments regarding previously approved TMDLs (Lake Champlain-phosphorus and 30 acidified lakes).

Table 5.1. Update on Vermont TMDL Projects.

Segment	Pollutant & Waterbody ID number	Project Status	Projected TMDL Submittal
Acid Impaired Waterbodies	pH 7 ponds	TMDLs Complete	EPA Approved (9/04)
Acid Impaired Waterbodies	pH 30 ponds	TMDLs Complete	EPA Approved (9/03)
Lake Champlain	Phosphorus 9 segments	TMDL Complete	EPA Approved (11/02)
Styles Brook (Stratton)	Sediment 11-15	TMDL Complete	EPA Approved (6/02)
Trib #1, N. Branch Ball Mtn. Brook (Stratton)	Sediment 11-15	TMDL Complete	EPA Approved (6/02)
Black River (Ludlow)	Phosphorus 10-14	TMDL Complete	EPA Approved (5/01)
Winooski River (Cabot)	Pathogens 08-09	TMDL Complete	EPA Approved (3/01)
Stormwater Impaired Waters	Approx. 17 segments	Developing TMDL protocols based on setting hydrological targets versus relying solely on pollutant loading targets	Initial draft TMDL submittal occurred in 11/05 (Potash Brook); other TMDLs to follow in 2006

Development of Stormwater TMDLs

For the last two and a half years, the Water Quality Division of DEC has been working collaboratively to develop TMDLs for the 17 stormwater impaired waters identified on the Vermont 303d List of Impaired Waters. The genesis of the current approach came about when the Vermont Water Resources Board initiated a docket hearing process to explore the scientific uncertainties in remediating stormwater-impaired waters. The docket hearings drew a large number of participants from the business community, consulting groups, EPA, state agencies, environmental groups and the general public. The Board's conclusions are set forth in a document entitled *"A Scientifically Based Assessment and Adaptive Management Approach to Stormwater Management"* (Stormwater Cleanup Plan Framework, 2005). The primary outcome of the docket proceedings was general agreement regarding the scientific uncertainties involved in remediating stormwater-impaired waters.

Additionally, a design was formulated using hydrology and sediment as surrogates to predict how the aquatic biota in impaired waters will respond to stormwater controls, making it feasible for ANR to develop and implement TMDLs for stormwater impaired waters.

This Framework identified a reference watershed approach whereby hydrologic targets are developed by using similar "attainment" watersheds as a guide. The agreed upon concept was that if the hydrologic and sediment dynamics of the impaired streams are brought into closer alignment with attainment streams, the aquatic biota will respond positively to the resulting better habitat conditions.

The first step in using this attainment stream approach was to select appropriate attainment streams, which, ideally, are as similar to the impaired watershed as possible in physical makeup, such as slope, soils, climatic patterns, channel type, and land use/cover, etc. Since all of the lowland stormwater-impaired streams are located in the Lake Champlain Valley, a collection of similarly located streams were identified as a pool from which the most representative attainment watersheds could be selected for each stormwater-impaired watershed.

Next, modeled hydrologic regimes of existing conditions for both the impaired and attainment streams were developed; achieved by applying the P8-Urban Catchment Model to all the streams. Flow output from this model was utilized to develop flow duration curves (FDC) which give a picture of the long term hydrologic conditions in any given watershed. The differences in particular measures within the FDCs (i.e. high and low flows) between impaired and attainment streams provides insight as to the extent of stormwater controls necessary to bring the impaired waters into compliance.

With the FDCs for all attainment and impaired streams in hand, a statistical approach was developed cooperatively by researchers at the University of Vermont and DEC that allowed the selection of the most appropriate attainment streams for each stormwater-impaired stream. Using this approach, watersheds were grouped based on intrinsic similarities that effect flow, resulting in attainment streams being grouped with the most similar stormwater-impaired streams. Within each group, the attainment stream FDCs represent a hydrologic regime that will likely support healthy aquatic life and thus the attainment of the Vermont Water Quality Standards.

From the extensive efforts involved in the above steps, the necessary information was derived allowing the development of hydrology-based TMDLs for the stormwater impaired streams in Vermont. Upon completion and approval by EPA, these TMDLs will provide the targets necessary to develop stormwater implementation plans for each individual watershed. These plans will specify stormwater control actions necessary to meet the TMDL derived hydrologic targets and, therefore, ultimately attain the applicable Vermont Water Quality Standards.

Overview of the Vermont 2006 Priority Waters List - including Section 303d List of Waters

Development of the 2006 Section 303d List of Impaired Waters is a process that is ongoing and concurrent to the development of the 2006 Section 305b Report. Consequently, neither the draft nor final 2006 303d listing have been included in this report. The 2006 303d list will assume a content and format similar to the 2004 list. Appendix C describes Vermont's 2006 Listing Methodology.

The 2004 303d List of Impaired Waters was approved during the 2006 305b reporting period (EPA approval on July 19, 2004). The 2004 303d List of Impaired Waters has been made available separately and can be inspected on the Water Quality Division's web site: www.vtwaterquality.org.

A brief summary of the Vermont Priority Waters List, which identifies and tracks both impaired and non-impaired waters is given in Table 5.2. It should be noted that the Section 303d List of Impaired Waters is only a portion of the overall Vermont Priority Waters List. Much of the Priority Waters List process occurs outside the scope of Section 303d. It is important to be aware of the overall listing process because it is indirectly involved with and directly referred to in the 303d listing process. Table 5.2 gives an overview of all the sections of the Priority Waters List. Part A, the single component of the 303d List of Impaired Waters, has been highlighted.

Table 5.2. Overview of Vermont Priority Waters List.

Vermont Priority List Section	Description	Included as Part of 303d Listing?
Part A	Impaired Waters in Need of a TMDL	***Yes***
Interim List	Candidate Waters for Section 303d De-listing	Yes, until EPA approval; after approval these waters are removed from 303d; EPA approved 303d list does not include de-listed waters
Part B	Impaired Waters - No TMDL Required or Needed	No
Part C	Surface Waters in Need of Further Assessment	No
Part D	Waters with Completed and EPA Approved TMDL	No
Part E	Surface Waters Altered by Exotic Species	No
Part F	Surface Waters Altered by Flow Regulation	No
Part G	Surface Waters Altered by Physical Channel Changes/Adjustments	No

A summary of the number of waterbody segments listed as impaired on the year 2004 listings is given in Table 5.3. The Vermont Year 2004 303d List of Impaired Waters (i.e. Part A) was approved by EPA on July 19, 2004.

Table 5.3. Number of Impaired Segments (taken from Year 2004 listings).

Impaired Segments	Lakes & Ponds	Streams & Rivers	Total
Listed in Part A – impaired waters needing a TMDL (newly listed waters in 2004 are given in parentheses)	44 (1)	111 (5)	155 (6)
Listed in Part B – impaired waters not needing a TMDL (newly listed waters in 2004 are given in parentheses)	0	13 (1)	13 (1)
Total number of impaired segments	44	124	168

PART SIX: GROUNDWATER MONITORING & ASSESSMENT

It is the policy of the State of Vermont to protect its groundwater resources (Chapter 48: Groundwater Protection). To this end, the Secretary of the Vermont Agency of Natural Resources is responsible for the development of a comprehensive groundwater management program and has established a Groundwater Coordinating Committee with representation from the private sector as well as other departments and agencies. The Committee's role is to advise the Secretary regarding the development of the groundwater program and its corresponding implementation. Also, the Secretary shall, after review by the Groundwater Coordinating Committee, adopt rules for the protection of public water source protection areas (Chapter 56: Public Water Supply). The administrative arm of the Committee is the Water Supply Division (WSD) of DEC.

The purpose of the groundwater program is to protect the quality of groundwater through a variety of mechanisms. Such mechanisms include the development of a strategy for the management and protection of the state's groundwater. This strategy is to be integrated with other regulatory programs administered by the Secretary. Continuing studies and investigation of groundwater, identifying and mapping groundwater, and classifying groundwater per technical criteria and standards, are also components of the program. Cooperation with the federal government in the development of groundwater protection programs along with cooperating with other government agencies in collecting and compiling data on the quantity and quality of groundwater and location of aquifers are yet additional aspects of the groundwater program. Finally, the strategy also includes developing public information and education materials along with providing technical assistance to municipalities for the purpose of protecting the groundwater resources.

Groundwater Strategy & Management

During the 2006 305b reporting period, the WSD and the Groundwater Coordinating Committee (GWCC) focused on the classification of groundwater as specified in the Groundwater Rule and Strategy (GWR&S). The GWR&S is required under Title 10 VSA Section 1392(d) of the Groundwater Protection statute. This same statute establishes the GWCC in Title 10 VSA Section 1392(c).

The Groundwater Protection Statute along with the GWR&S defines four classes of groundwater in Vermont. Vermont's groundwater classification systems defines Class I groundwater as suitable for a public water supply with character that is uniformly excellent and is not exposed to any activities that pose a risk to its use. Currently, there are no Class I groundwater areas classified in Vermont.

Vermont's groundwater classification system defines Class II groundwater as suitable for public water supply with character that is uniformly excellent but exposed to activities that may pose a risk to its use. At present, there are no Class II designated groundwater areas in Vermont.

Other than the Class IV designated groundwater areas, the remaining groundwater in Vermont is classified as Class III. Class III groundwater is defined as suitable as a source of water for individual water supply, irrigation, agricultural use, and general industrial and commercial use.

Vermont's groundwater classification system defines Class IV groundwater as not suitable as a source of potable water but suitable for some agricultural, industrial, and commercial uses. There are nine areas classified as Class IV groundwater areas in Vermont, including the Burgess Brothers Landfill (Bennington), Parker Landfill (Lyndon), Transitor Electronics (Bennington), Pine Street Barge Canal

(Burlington), Maska Inc. (Bradford), Windham Solid Waste District Unlined Landfill (Brattleboro), the Bennington Landfill located in Bennington, and the Unifirst Sites inBrookfield and Randolph. The Unifirst Site inWilliamstown along with the Hartford Landfill (Hartford) are currently being proposed as Class IV groundwater areas.

Class IV Groundwater is groundwater that has been mapped and classified by the Secretary of the Agency of Natural Resources (ANR) as non-potable. Groundwater may be non-potable due to its natural chemical characteristics, or it may have been rendered non-potable by land use activities. All of the above Class IV areas have been contaminated as a result of land use activities.

While it is not suitable for drinking, Class IV Groundwater may be suitable for some agricultural, industrial, and commercial uses. The Class IV designation serves as a warning to present and future landowners and to governmental permitting agencies that groundwater beneath a Class IV Groundwater Area should not be used for potable water supplies. The State of Vermont will not issue permits for drinking water sources within a Class IV Groundwater Area. All new ANR-regulated activities proposed within these areas are required to show that the activity will not further degrade groundwater quality or cause the contamination to spread.

Although there are no Class II designations in the state, the GWCC updated the Class II Groundwater Mapping Procedure. The intent of updating the procedure was in part to provide a broad awareness of the procedures and an opportunity to obtain comment regarding the procedures. In addition, the GWCC thought sections of the procedures needed clarification. The purpose of the document was to detail the technical procedures used to delineate the geographic boundaries of Class II ground waters and determine whether or not the proposed ground water area meets the criteria for Class II designation.

The methods used to define a Class II area are similar to those required to designate a public water supply Source Protection Area (SPA). One difference between a Class II area and a SPA is that the water supply need not be fully developed and permitted for a Class II area. Therefore, a municipality can, with sufficient planning and forethought, protect the recharge area of a future water supply without immediately incurring the expense of full development of that supply. A second difference is the requirement for uniformly excellent character of water in a Class II area. This requirement means that some SPAs, which contain groundwater with impurities (which could be treated prior to consumption), are not eligible for Class II designation. To adopt the procedure, the GWCC must obtain approval from the Secretary.

The GWCC has set a number of goals that include creating a greater awareness of groundwater and maintaining a close association with the Agency of Natural Resources Secretary. To that end, the GWCC spent a considerable amount of time writing a biennial report that provides the Secretary with status of groundwater in Vermont for 2003 and 2004.

The GWCC concluded in the report that groundwater is fundamental to the ecosystem and as a drinking water resource. It recharges wetlands, streams, rivers, lakes, and ponds, which is critical to wildlife. It is a source of drinking water for most of the State's population. While groundwater is addressed through the Safe Drinking Water Act, this Act's prime focus has been on monitoring, treatment, operation, and infrastructure needs of public water systems. Additional regulations that address groundwater are often in reaction to contamination. Yet, the quantity and quality of groundwater which define its use remain largely unknown. Characterizing the groundwater resources

is overdue relative to the continuing threats of contamination, the pressures and pace of economic development, and the importance of this resource. Specifically, the GWCC recommends the following:

A) The GWCC should review and comment on proposed legislation to provide technical review of its implications by a broad range of Agency representatives;

B) Institute water conservation incentives to proactively prepare for the next drought cycle along with expanding the drought monitoring capabilities of ANR; and

C) Fully implement the Groundwater Protection Statute, Chapter 48, with adequate resources for a comprehensive groundwater program that identifies and funds groundwater research.

During 2004 and 2005 legislative sessions, legislation has been proposed that would place groundwater in the public trust. In addition, the proposed legislation would require permits for certain types of groundwater withdrawals. Fees generated from permits would potentially fund groundwater mapping.

Cooperation & Coordination

Under the provisions of Title 10 VSA Section 1392(c), the GWCC has the responsibility of advising the Secretary on groundwater issues. The Committee consists of representatives of all state agencies whose programs impact groundwater, plus members of outside organizations interested in groundwater issues. During the 2006 reporting period, the Committee provided significant coordination with the Waste Management Division (WMD) of DEC regarding the classification of groundwater. In particular, members of the Committee provided technical review and administrative support for the groundwater areas identified by the WMD as contaminated. Subsequently, the GWCC has advised the Secretary on those groundwater areas that were proposed to be reclassified.

State and federal regulations govern drinking water, wastewater, and waste disposal as related to groundwater. The GWCC provides input to these regulations and has focused on a number of recent regulations. Included in this review is the *Groundwater Rule and Strategy.* This rule has been updated to include198 primary groundwater quality standards and 14 secondary groundwater quality standards. These standards are listed with Enforcement Standards and Preventative Action Levels in the 2003 revised rule. Other regulations recently revised, with input from the GWCC, include the Environmental Protection Rules, Chapter 1, *Wastewater System and Potable Water Supply Rules*: Chapter 1 and the *Water Supply Rule*: Chapter 21. Updates to Appendix A, Parts 11 and 12, *Small Scale Water Systems* and *Construction & Isolation Standards for Wells,* of Chapter 21 are also being considered.

It is expected that the federal Groundwater Rule is to be promulgated by EPA as early as the spring of 2006. DEC anticipates this rule will require that sanitary surveys be conducted every three years for community water systems and every five years for the remaining systems. The Rule will likely increase state efforts to identify sources of fecal contamination, require source water microbial sampling for non-disinfecting systems, and require the state to conduct hydrogeological sensitivity assessments for non-disinfecting public water systems that are vulnerable to contamination.

The Vermont Geological Survey (VGS) coordinated with the WSD and the Vermont Agency of Agriculture, Food, and Markets regarding the nitrate contamination of groundwater near a farm in East Montpelier. Elevated nitrate has been found in several private residential wells near some of the cropland fields used by the farm. In April 2003, VGS and WSD submitted a nonpoint source pollution control grant proposal and obtained $30,000 in Clean Water Act Section 319 funding for VGS to

continue its work. This work has now continued through 2005. Work has included using a borehole camera down 10-12 residential wells to look at the well construction and identify fractures, bedding, and water-bearing zones. A subset of wells was sampled for major and trace elements, nitrogen and oxygen isotopes, and chlorofluorocarbons. A tracer study using fluorescent dyes was performed. In addition, groundwater water levels were determined along with the direction of groundwater flow.

The Vermont Legislature enacted amendments to the Agricultural Water Quality Law during the 2005 session. The Vermont Agency of Agriculture now has expanded authority to regulate agricultural practices that have the potential to impact groundwater. To implement this new regulatory and technical assistance responsibility, the Agency of Agriculture has revised the regulations that define Accepted Agricultural Practices (AAPs) and the permitting requirements for Large Farm Operations (LFOs) and has created new regulations for the permitting of Medium Farm Operations (MFOs). The Agency of Agriculture also conducts groundwater sampling to establish baseline water quality conditions on farms that receive state cost share grants and USDA-NRCS cost share funds for the construction and installation of barnyards, waste storage structures and field management practices designed to prevent groundwater and surface water contamination exceeded the MCL or Health Advisory.

The GWCC has examined its own roles and responsibilities and determined that to be an effective committee it must have a stronger relationship with the Secretary of the Agency of Natural Resources. To strengthen its role in protecting groundwater the Committee provided the Secretary with an assessment Vermont must better coordinate groundwater concerns and design an educational strategy.

Groundwater Investigations

Investigations during the 2006 305b reporting period were pursued by WSD's Water Resource Management staff. The WSD staff provides input to land use development and particularly to development that may not be compatible with the groundwater resource. New development that is flagged by Vermont's Act 250 Land Use and Development Process is assessed for its potential impact on groundwater. A wide range of land uses are evaluated in response to the development. Septic systems, underground storage tanks, stormwater systems, quarries, and landfills are a few examples of some of the land uses that have been evaluated. Protection measures such as groundwater monitoring or well construction controls are often put in place. These protection measures are not aimed at precluding development, rather the emphasis is placed on groundwater awareness and protection.

To protect groundwater an understanding of the resource is needed. To this end, the WSD receives and reviews a considerable amount of invaluable groundwater data. In part, this information consists of approximately 100,000 well completion reports. This information is submitted by water well drillers. Well drillers submitted approximately 3,600 well completion reports to the Division for each year of the 2006 305b reporting period. The well completion reports describe the geology, well depth, and well yield of wells drilled. This information is vital to characterization of this resource. With an understanding of the groundwater resource the potential impacts of a given development can be assessed and corresponding protection measures can be put in place.

Groundwater data is also obtained from a cooperative arrangement with the United States Geological Survey (USGS). The WSD and the USGS have recorded groundwater level data measured at thirteen monitoring wells for years. Some of this data goes back to the 1950s. Comparing these data over the years is particularly vital to the development of a drought management program.

The staff of WSD permitted 6 public water systems in 2004 and another 23 in 2005. As part of the permitting process each proposed public water source is hydrogeologically assessed. Data examined includes well completion reports, pump tests or aquifer analysis data, water quality data, bedrock and surficial geology information, along with orthophoto and topographic maps. In addition, a site visit is conducted at the proposed water source with a focus on potential sources of contamination. Once the above information is assessed, a Source Protection Area (SPA) is delineated for the water source.

Information & Public Education

Each of the above SPA delineations includes a public notice. The town, residents or property owners in the SPA, and officials of the water system were contacted. An opportunity for a hearing regarding the SPA was also provided. In addition to the 29 public water source that were permitted during the 2006 reporting period, another 58 non-transient non-community water system were publicly noticed during this period. Until 2005, non-transient non-community water systems were not publicly noticed. This process is also provided in the reclassification of groundwater. The outcome of both processes includes the identification of the groundwater resources along with an excellent rapport developed with concerned citizens at the town level. Groundwater planning at the local level can be better afforded through such efforts. It is believed that such processes will go a long way with respect to educating the public and protecting the resource.

Each year the WSD publishes and distributes several newsletters entitled *"The Waterline."* While the newsletter has focused mostly on public water systems, most water systems use groundwater. With this in mind the newsletter has a direct bearing on groundwater. Hard copies of *The Waterline* can be obtained directly from WSD and can also be found on the WSD's website: www.anr.state.vt.us/dec/watersup/wsd.htm.

The WSD annually sponsors Drinking Water Day at the Statehouse. The event provides a number of exhibits that explains the importance of drinking water and its protection. Attendance often includes students, the general public, interested parties, and members of the legislature.

The remainder of this chapter is devoted to a summary discussion of both specific and general aspects of groundwater characteristics in Vermont.

State of Groundwater Quality

The quality of Vermont's groundwater varies due to both natural and human influences. No comprehensive studies have been completed on the quality of the resource. The WSD requires water quality monitoring at public community and non-transient non-community water systems[1]. Below are results of the monitoring as it pertains to water systems on increased monitoring:

> In 2004, about 93 groundwater supplied public water systems received boil-water notices mostly due to bacterial contamination. Boil-water requirements were also due to leaks in the distribution system, water system infrastructure deficiencies, lack of water, or other reasons. In 2005, this number increased slightly to 97.
>
> Seven public water systems were on increased monitoring conditions in 2004 and 5 systems were on increased monitoring conditions in 2005. The need for increased monitoring was due to arsenic levels being above the Maximum Contaminant Level (MCL) concentration.

[1] A **Public Community System** means a water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents. A **Non-transient System** means a system that regularly serves at least 25 of the same persons daily for more than 6 months per year (e.g. schools, factories, office buildings).

Eight public water systems were on increased monitoring conditions in 2004 because gross alpha particle radiation was above the gross alpha MCL and 5 water systems exceeded this MCL in 2005. There were 6 water systems above the MCL for radium in 2004 and 2005 with one water system exceeding the uranium standard in 2004 and 2005.

There was only one water system that exceeded the nitrate MCL concentration in 2004 and 2005.

In 2004, 17 water systems exceeded the MCL concentration for disinfection byproducts with 14 systems exceeding the standard in 2005.

In 2004, forty-five public water systems were required to perform increased monitoring because these systems have had volatile organic chemical detections over the 5 ug/l limit. In 2005, there were 38 water systems on increased monitoring schedule due to detections over the 5 ug/l limit.

Four water systems in 2004 and 3 in 2005 exceeded the detection limit for atrazine, a synthetic organic chemical (SOC). These water systems were required to perform increased monitoring for this SOC.

The Vermont Agency of Agriculture, Food, and Markets oversees agricultural activities and promotes best management practices with respect to groundwater protection. As part of this effort, the Agency conducts an Agricultural Water Quality Program and found that:

The groundwater monitoring program has tested a total of 1,430 private drinking water wells. About 944 (66%) are farm wells and 486 (34%) are non-farm, neighboring wells. For the 2004-2005 reporting period, 408 well sites were tested. The majority of sampling continues to focus on the investigation of sites with elevated nitrate. The number of sites with positive detections of herbicide is limited. At the conclusion of 2005, there were 59 wells (4.1%) with nitrate concentrations that exceeded the MCL for nitrate-N of 10 mg/l. While there were 30 wells with positive detections of herbicide, no wells exceeded a state or federal drinking water standard or health advisory.

The Waste Management Division (WMD) of DEC regulates and manages a wide variety of hazardous waste along with the groundwater clean-up that occurs regarding this waste. The WMD reports that:

In Vermont, about 75,000 private wells located near hazardous waste sites have been sampled for MTBE. More than 250 wells have detections across the state.

There are approximately 1,400 petroleum or hazardous waste sites in Vermont which have degraded or have the potential to degrade groundwater to the point where it is non-potable. There are approximately 1,600 sites where the WMD has addressed the existing potential release of hazardous substances and completed site management.

There are about 2,500 underground storage tanks (UST) in Vermont that could each individually pose a threat to groundwater quality in the event of a leak.

State of Groundwater - Assessment & Use

Public groundwater sources are expected to supply sufficient water quantities. However, other than those regulated as public water sources, groundwater withdrawals are not regulated. Likewise, the significance of groundwater to the ecosystem is not routinely evaluated. Groundwater assessments are driven by the rules mentioned above and by several interested parties such as the USGS. Information

from these assessments provides the basis for characterizing groundwater in the State. The following provides some facts regarding Vermont's groundwater resource:

About 50 million gallons of groundwater is withdrawn on a daily basis in Vermont. Withdrawals from public and private groundwater sources account for 33 million gallons per day. Agricultural withdrawal accounts for 2 million gallons daily, another 12 million is used for commercial and industrial purposes, and the remaining groundwater withdrawals are used for mining and the generation of thermoelectric power.

Groundwater is currently used for drinking water by approximately 70% of Vermont's population. About 46% of the population is self-supplied while about 24% is served by public water systems using groundwater. Over the reporting period there were 29 new or modified groundwater sources that required a source permit from WSD.

Of the 2,078 active farms within Vermont, 85-90% rely on groundwater for agriculture use.

It is estimated that 320,000 of Vermonters get their drinking water from about 100,200 private wells. This number does not include dug wells or springs. Approximately 3,600 new private wells were drilled and reported to the WSD in both 2004 and 2005.

It is estimated that 80% of the private wells are completed in bedrock and 20% in gravel aquifers. The mean well depth is about 200 feet and the mean yield is about 6 gallons per minute.

Groundwater levels in Vermont are measured at 13 monitoring wells located throughout the state. In 2004 water levels were above normal for January, August, September, and December, for April the water levels were below normal, and normal water levels were reported for the remaining months. For the year 2005, groundwater levels were below normal in May, above normal in November and October, and normal for the remaining part of the year.

Six public water supplies currently lack sufficient water quantity to meet their water demands. Water shortages have occurred at Jericho Heights (Jericho), Magic Village (Londonderry), Albany Water System (Albany), Alpine Haven Water System (Westfield), Montgomery Center Water System (Montgomery) and the Barnet Water System (Barnet).

About 87% of the public community water systems in the State have their corresponding Source Protection Areas or aquifer recharge areas mapped. The remaining public community water systems are using 3,000 foot radius circles as their Source Protection Areas (WSD, 2003).

Existing aquifer maps include the *Groundwater Favorability Maps* (1966 to 1968) which cover the entire state, the *Geology for Environmental Planning* series (1975) that covers 66% of Vermont and was primarily based on data from the *Surficial Geologic Map of Vermont* (1970) and the *Centennial Geologic Map of Vermont* (1961). In the 1980s, ANR provided aquifer maps to 20 towns for planning purposes. VGS has produced an aquifer map for Arlington and is working on a map for the town of Manchester. These maps illustrate the depth to groundwater map, the thickness of overburden and potential aquifer yield.

Groundwater is a critical resource for the State of Vermont and continues to be vulnerable to numerous man-made and natural risks. It supplies a significant portion of the drinking water to Vermont's population. While drinking water is a top priority environmental concern in the State, the clear connection between drinking water and groundwater is lacking. Groundwater efforts, however, are most limited regarding its interaction with surface water. Specifically, the contribution groundwater makes to wetlands, streams, rivers, ponds and lakes receives little attention. Its importance to sustaining the drinking water needs of the State along with Vermont's flora and fauna appears to be

taken for granted. The lack of attention given to groundwater, when compared to the attention given to surface waters may be due, in part, to the lack of public education regarding groundwater and the associated costs required to comprehensively evaluate this resource.

PART SEVEN: CONCERNS & RECOMMENDATIONS

There are several concerns and recommendations which relate to the management and improvement of Vermont's water quality and water resources. Concerns and recommendations have been prepared for the following topics:

Lakes & Ponds

Atmospheric Deposition of Pollutants

Deposition of pollutants to the Vermont landscape from the atmosphere is principally responsible for the impairment of fish consumption uses on 8,115 inland lake acres, all of Lake Champlain and all river and stream miles, and aquatic life uses on 4,420 acres. Atmospheric deposition is the principal source of two major causes of use loss in Vermont: mercury and low pH. The two causes are linked, since in many instances, lakes that are vulnerable to acidification are also those which transfer atmospherically deposited mercury to the aquatic food web in the toxic methyl- form. However, many lakes that are not at risk of acidification exhibit elevated mercury levels in fish and wildlife.

Atmospheric deposition of mercury has resulted in the issuance of fish consumption advisories for many Vermont lakes and rivers, particularly those containing walleye. Specific advisories are in place for the five Deerfield River reservoirs, and for Moore and Comerford Reservoirs within the Fifteen Mile Falls Project (Connecticut River). The impacts of mercury deposition are not, however, limited to loss of fish consumption uses. Reproductive and behavioral impacts to wildlife that feed on fish are common to a subset of New England lakes, including the reservoirs along the Deerfield River and Connecticut River (Fifteen Mile Falls). Potential impacts to upper trophic level biota continue to be monitored by the Vermont Institute of Natural Sciences, in collaboration with the Biodiversity Research Institute.

The mercury that affects Vermont's watersheds is largely derived from mid-Atlantic or mid-Western sources: principally coal-fired electric generating units; non-regulated waste combustors; and smelters. In the past several years, mercury emissions from within New England have declined by 71%, largely due to regulation of waste incinerators within New England. Regional and long-range emissions of acid-forming precursors cause acidification of Vermont waterbodies. The atmospheric deposition of nitrous oxide (NO_x) and sulfate (SO_4) from Midwestern sources (and NOx from regional and mid-Atlantic mobile sources) has resulted in acidification of 34 lakes and eight 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, although evidence of alkalinity increases and de-acidification is very limited in Vermont. All of the acid-impaired lakes are subject to an approved TMDL addressing sources of the acid-forming precursors.

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, DEC has recently completed a revised mercury emissions inventory, and participated in the publication of an important volume of the scientific journal *Ecotoxicology*, which describes in detail the overall impact of the mercury problem in the northeast. DEC continues to

participate in several regional mercury monitoring, research, and assessment projects including a mass-balance modeling effort for mercury in Lake Champlain; participation in a regional modeling and TMDL analysis of mercury fate and transport in New England; and a regional study to ascertain the covarying influence of water level fluctuation and trophic state on mercury bioaccumulation in fluctuated reservoirs. With significant assistance and support from DEC, the Vermont Advisory Committee on Mercury Pollution continues to identify areas in Vermont where mercury use and emissions can be reduced, and is active in advising the Vermont General Assembly on the efficacy of newly-passed mercury-related legislation for Vermont. Finally, DEC staff continue to interact with Vermont's congressional delegation to address this issue from a national perspective.

Despite these many efforts, there remains a significant need to properly assess inland Vermont waters for mercury contamination. During the reporting period, and in response to a legislative directive, the Vermont Fish Contaminant Monitoring Committee prepared a comprehensive fish mercury monitoring plan which, if adopted by the Agency of Natural Resources and Department of Health, will significantly increase the availability of fish-tissue mercury measurements statewide. Funding is needed to implement this program, which has been designed based on findings from the many regional projects, to better estimate mercury levels in fish tissue in particular lakes and to estimate overall statewide levels of contamination for indicator species. Under the newly described fish-tissue monitoring plan, Vermont would implement a six-year rotating tissue assessment program that would yield a stream of new fish tissue data on a biennial basis. In order to enable this project, there exists the need to add a new direct mercury analyzer to the LaRosa Laboratory, or to develop a regional mechanism whereby fish tissue sampled can be processed by the EPA Regional Laboratory using their direct analyzer.

Hydrologic Modifications in Lakes

Water level manipulations are another important source of use impact to lakes. There are 24 lakes and ponds (about 9,000 acres) in Vermont for which one or more uses are altered 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.

During 2004 and 2005, DEC's Lake Bioassessment Program sampled several reservoirs in order to obtain more precise and quantitative estimates of aquatic life use impairments in flow-altered lakes and reservoirs. These data have not been comprehensively evaluated as of this writing, but will provide the information necessary to develop bioassessment guidelines for reservoir systems. This analysis is planned for early 2006. Presently, the Assessment and Listing Methodology contains a decision-making tree to make preliminary assessments of use support in fluctuated lakes and reservoirs in a uniform fashion.

Exotic Aquatic Species as Pollutants

Non-native aquatic plants and animals are established in Vermont - at least 48 non-native aquatic species are known – and many Vermont waters, especially lakes, have a history of impacts related to these invasions. While the number of new introductions of species already known into Vermont lakes continues to increase, no new aquatic invasive species were identified in Vermont waters during the 2006 reporting period.

During the 2006 305b reporting period, Eurasian watermilfoil (*Myriophyllum spicatum*) was discovered in one new lake, Gale Meadows Pond in Londonderry. Water chestnut (*Trapa natans*) was discovered in two private waterbodies (one in Benson and one in Bennington) and at the mouth of the

Missisquoi River. Management efforts (physical removal by hand) were implemented on all four of these waters. The Missisquoi River water chestnut occurrence is of particular concern. The river flows into Missisquoi Bay of Lake Champlain, which is suitable habitat for water chestnut and at significant risk of invasion. At the present time, zebra mussels are pervasive in Lake Champlain and Lake Bomoseen, but have not emerged elsewhere. The mussels also threaten aquatic life and swimming uses in a small set of inland lakes. Most alarming is the positive identification of the nuisance alewife (*Alosa pseudoharaengus*) in Lake Champlain, which has the potential to seriously alter trophic conditions and food chain dynamics, as it has in the Great Lakes and in New York's Finger Lakes.

On a more positive note, sustained hand pulling efforts appear to have eliminated the water chestnut populations in Rood Pond (Williamstown/Brookfield) and Lake Bomoseen (Castleton). Continued surveillance efforts, however, are critical to future success. Other water chestnut sites are continually held in check by a management partnership between the DEC and The Nature Conservancy, which is funded by State, Federal, and Lake Champlain Basin Program sources. It is essential that DEC receive continued funding for water chestnut control at or above existing levels in order to maintain the ground gained in the battle over the last eight years against water chestnut in Lake Champlain and associated waters, and in inland waters.

During the 2006 reporting period, the Permittees/Co-Permittees for the three waterbody systems treated with the aquatic herbicide Sonar A.S. in 2004 (the Lake St. Catherine, Little Pond and Lily Pond system in Wells and Poultney; Star Lake in Mt. Holly; and the Burr Pond/Lake Hortonia system in Hubbardton and Sudbury) have provided year two information regarding the level of Eurasian watermilfoil control achieved/maintained, impacts to non-target species, and the most effective strategy to be implemented in the next phase of their five-year integrated management plans (IMP). While treatments in all systems were deemed successful, Eurasian watermilfoil levels post-treatment were higher than anticipated in Burr Pond and Permittees for two of the three treated waterbody systems have submitted applications for the use of the aquatic herbicide, Renovate 3 in spot/partial-lake treatments in 2006.

This is the first time that the DEC has received a proposal for a second chemical treatment in the five year IMP. Previously, only non-chemical control methods were proposed for the duration of a five year IMP. Requests for follow-up treatments may be a developing trend in aquatic invasive species control in Vermont (and elsewhere). DEC has concerns regarding the effectiveness and longevity of control from the chemical treatments, the effects of cyclical chemical treatments on the non-target environment and the ability of the volunteer groups (lake associations) to sustain the funding and manpower needs associated with this type of regime. In addition, DEC has received numerous inquires from the lake associations and affected citizens regarding these concerns with the main issue focusing on the need for adequate funding. Currently, state dollars available to fund herbicide treatments and other non-chemical controls are inadequate to meet demand. The burden of funding management programs, primarily Eurasian watermilfoil, is on affected shoreline property owners and municipalities. In addition, there is minimal funding for other aspects of invasive species management (monitoring and education and outreach efforts) and for preventing the spread of existing as well as new introductions statewide.

Developing and implementing a Rapid Response Plan is crucial to prevent the introduction of new invasive species populations. Efforts to develop such a plan were initiated during the reporting period for the Lake Champlain Basin and are expected to follow for the non-Basin portion of the state in the future.

Eutrophication of Lakes

DEC commits significant resources to the management of cultural eutrophication that affects Vermont lakes. Vermont has relatively unproductive lakes as compared to other parts of the country. Indeed, only four lakes appear on Vermont's draft 2006 303d list as impaired due to excessive eutrophic conditions (Lake Carmi, Franklin; Shelburne Pond, Shelburne; Ticklenaked Pond, Ryegate; and, Lake Memphremagog, Newport). Of these lakes, the first three are actively subject to TMDL or pre-TMDL analyses. Lake Memphremagog is subject to a two-year comprehensive trophic re-characterization; a joint project with the Province of Quebec. The purpose of this sampling is, in part, to determine if the lake is no longer impaired due to elevated phosphorus levels. A number of years ago the Newport WWTF was upgraded, although the lake was never properly re-assessed following the upgrade in locations that are relevant to the existing numeric nutrient criteria for that lake.

Eutrophication can simultaneously affect aesthetics, 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.

Implementing protective actions to reduce human impacts on lake trophic state before impairments develop is more efficient and effective than waiting until restoration is needed. Toward this end, several lake protection projects have been carried out in Vermont, with successes in some waters. For example, even though the Lake Carmi TMDL is remains in preparation, there have already been notable improvements in the summer nutrient concentrations, transparency, and algal populations in the lake owing to significant watershed restoration efforts already underway there (see Figure 7.1). Another important lake protection and monitoring project is described in the following.

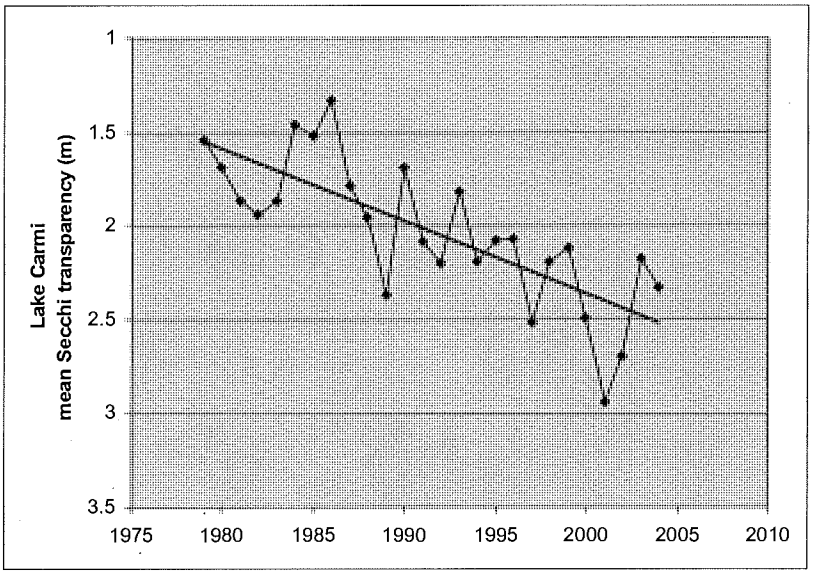


Figure 7.1. Lake Carmi water transparency measured by the Vermont Lay Lakes Monitoring Program.

Nutrient Criteria

During the reporting period, DEC implemented the field phase of its nutrient criteria development plan, having received two EPA grants under the national nutrient criteria program. Vermont's nutrient criteria development plan focuses on developing quantitative relationships between nutrient parameters and designated uses such as recreation, aesthetics, aquatic habitat, and public water supply, in lakes and rivers. At present, all data necessary to carry out the analyses articulated in the Nutrient Criteria plan are catalogued, quality assured, and ready for further analysis.

While DEC is uncertain whether strict numeric nutrient criteria can stand alone as assessment or listing tools, the preliminary signals from the Vermont project dataset do suggest there are threshold nutrient limits for rivers and lakes beyond which impacts to biological communities and water uses are evident. DEC has presented the initial results of this project at several regional meetings, most recently at the

national EPA-States nutrient criteria meeting in Dallas, Texas. A comprehensive analysis of all nutrient criteria analyses will be completed during 2006. The results of these analyses will be provided in a technical document to EPA and the Vermont Water Resources Panel near the end of 2006.

Lake Champlain and Lake Memphremagog and all Class A(1) waters are already subject to segment-specific numeric nutrient criteria for phosphorus. All waters are also subject to numeric criteria for nitrate.

Alteration of Littoral Habitat and Effects of Shoreline Development on Inland Lakes

A well vegetated lakeshore protects the soil from erosion, filters runoff keeping nutrients from overfertilizing the lake, and provides essential wildlife habitat to both terrestrial and aquatic organisms. A developed lakeshore lot with lawn contributes seven times more phosphorus per year to the lake than a forested site. Recent data collected in Vermont show that developed shores have an average of 96% less trees and greater than 10 fold increase in grass than undeveloped shores. In addition, developed lots had 61%, 87% and 69% less of fine, medium and coarse littoral woody debris, respectively, than undeveloped lots. Woody debris provides important habitat for fish, turtles, amphibians and other wildlife. In addition, fish nests tend to be found along undeveloped shores.

Twenty-four percent of all the species identified in Vermont as "Species of Greatest Conservation Need" by Vermont Fish and Wildlife in 2005 rely on inland lakes (< 1% of the Vermont lake area) for most of their habitat needs; habitats that co-occur with vermont's areas of greatest population densities. Of the 304 lakes in the Lakes Inventory database with land use calculations completed for their watersheds, 85% of them have undeveloped land use percentages of 90 % or greater. Many times in Vermont, there is little development in a watershed, but concentrated development along the lakeshore.

Alteration of lakeshore habitat is not simply a Vermont phenomenon. Between 70% to 90% of natural riparian vegetation nationwide has already been lost or is degraded due to human activities. A 2002 recreation survey of Vermont residents revealed that more than 84 percent were concerned with the destruction of fish habitat and indicated that this was a problem.

Under Section 3-01(D) of Vermont's Water Quality Standards relating to Numeric Biological Indices, DEC is authorized to determine full support of aquatic biota and aquatic habitat uses through other appropriate methods of evaluation. In 2005, DEC undertook a study to examine different possible littoral habitat parameters that may be measured and form the basis of a quantitative assessment of littoral habitat condition.

Questions addressed by this study were whether certain parameters can be used to assess littoral condition and whether differences in these parameters occur between developed and undeveloped sites. Ultimately, DEC hopes to determine what level of alteration of littoral habitat a lake can sustain and develop strategies to protect and maintain lakes within the sustained level and remediate lakes with unsustainable levels of littoral habitat alteration. This assessment is intended to dovetail with the lake bioassessment indices that have been developed as part of the Lake Bioassessment Project.

DEC plans to continue its efforts to develop a scientifically based and Vermont-specific evaluation methodology to aid in the determination of full support of aquatic biota and aquatic habitat uses in the littoral zone of inland lakes.

Rivers & Streams

Emerging Contaminants

A host of new generation contaminants are being measured and described from waters throughout the United States. During the reporting period, DEC, in partnership with EPA, was able to obtain measurements of several of these wastewater-derived contaminants. The project confirmed that six pharmaceuticals and personal care product (PPCP) target analytes are present in Vermont wastewater treatment facilities (WWTFs) at detectable concentrations. For the most part, concentrations were in the low part-per-trillion range. The treatment facilities represent a range of potential inputs and treatment technology. It can be concluded that some analytes, particularly 4-nonylphenol and triclosan, are relatively ubiquitous in the environment around WWTF discharges. 4-Nonylphenol was detected most frequently and at the highest concentrations (up to 3 ppb). These findings constitute an initial screening of PPCP occurrence in WWTF effluents and receiving waters in Vermont. Concentrations were low and below known adverse effect thresholds. However, given the uncertainty about the potential environmental effects of long-term exposure to individual PPCPs and combinations of PPCPs, these findings indicate that additional characterization of the occurrence of PPCPs in Vermont's surface waters would be appropriate.

Beginning in 2006, the Lake Champlain Basin Program is sponsoring a more comprehensive screening of PPCPs in surface waters to be implemented in 2006 by the United States Geological Survey. The design of this project is such that effluents, receiving waters, ambient lake and river waters, sediments, and control sites will be tested. While a complete analyte list is beyond the scope of this summary, the project will assess the presence and ranges of several classes of contaminants, including: endcrine disruptors; persistent organics; new organic pesticides; antibiotics and pharmaceuticals; personal care products; and, other industrial-chemical solvents.

New generation contaminants are not limited to waters and wastewater effluent. DEC remains interested in developing the capability to analyze fish tissue for residues of the flame-retardant poly-brominated diphenyl-ethers, and would be pleased to work with the EPA New England should these analyses become available at the New England Regional Laboratory.

E.coli Contamination and Microbial Source Tracking

Vermont is entering a triennial Water Quality Standards (WQS) review process with EPA. Vermont's current criterion for *E.coli* in Class B waters (all Water Management Types) is 77 *E. coli* /100ml. This is the most stringent criterion in the nation and equates to a 75% likelihood illness rate of 3.4 swimmers in 1000 over the course of a season. This level of risk assumes swimmers are exposed to waters subject to heavy use and to wastewater treatment facility discharge. Few beaches in Vermont come close to this kind of situation. Vermont's Class A(1) criterion is 33 *E. coli* /100ml or 18 *E.coli*/100ml expressed as a geometric mean. DEC expects that existing *E. coli* criteria, particularly the one associated with Class B waters, will be re-evaluated as part of the triennial review process.

Research from Vermont watersheds indicates that the Class B criterion is exceeded 34% of the time in completely forested and undisturbed watersheds during wet weather. As such, exceedences of the Class B criterion are very common and can as easily be attributed to natural sources during wet weather conditions. When strictly interpreted, Vermont's criterion results in numerous cases where waters may be identified as unsuitable for swimming. This presents a very difficult situation for water resource management. Waters may be incorrectly identified as potentially unsuitable for swimming, and there may be unwarranted public stigma cast upon the waters in question. For this reason, there

exists the need to modify the Vermont standard to be compliant with the currently accepted, scientifically defensible criteria options now being promoted by EPA.

The development of the LaRosa Laboratory Services Partnership Program has significantly augmented the quantity of swimming water quality assessment data based on *E. coli* bacteria. Certain waters, when assessed using Vermont's Assessment and listing Methodology, become identified as either impaired or in need of further assessment. There are about 280 stream miles and 1030 lake acres identified as stressed due to elevated *E. coli* levels and about 120 miles and 19 acres identified as impaired due to repeatedly high levels of *E.coli*. These measures, and the enhanced attention accorded to swimming water quality monitoring by LaRosa Partnership participants, elevates the need for microbial source tracking (MST) tools in Vermont to determine the extent to which sources are or are not of a natural origin. At present, MST technology remains largely a research-level activity, although a growing number of MST projects in New Hampshire, Maine, and Massachusetts have made this technology more common and precise. There are several waters in Vermont where MST would be highly-relevant, including segments of the Huntington and West Rivers, as well as other Section 303d listed segments impaired by *E. coli*. In Vermont, as with other States, the need exists for regionally-available microbial source tracking facilities at an accessible cost. Vermont recommends that EPA's New England Regional Laboratory strongly consider developing this technology as a service to Vermont and the other New England states.

Lack of Strategic Statewide Vegetated Buffer Requirements

Undisturbed vegetation along rivers and streams (as well as along lake shorelines) is effective at reducing 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 and acres of Vermont's surface waters are negatively influenced by urban runoff, sediment, increased temperature, 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 created in October 1999. The Team was charged with developing a revised Agency buffer policy and procedure, including general and site specific standards. The Buffer Procedure, finalized in 2005, will be used by the Agency in the Act 250 and Act 248 processes and as guidance to riparian landowners, including public and quasi-public agencies.

DEC continues to make some strides in the educational effort to inform the public and municipal planning commissions about the environmental benefits of riparian vegetation. DEC and Regional Planning Commissions (and in some cases local watershed groups) have been working with municipalities to strengthen their municipal plans and zoning regulations to maintain streamside vegetation. Workshops for town officials and the general public have been conducted regarding strategies to encourage the maintenance of existing riparian vegetation as well as promoting the planting of riparian areas lacking vegetative buffers. DEC, the Vermont Youth Conservation Corps, the various Natural Resources Conservation Districts, 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.

A new position, supported by Clean and Clear funding and hosted by the Vermont League of Cities and Towns, has been created and will focus on municipal zoning. The position will be able to provide

planning assistance on local water quality protection strategies one of which will include vegetated buffers.

It is recommended that the Agency continue to make more use of the print media, TV and radio to draw the public's attention to the benefits of maintaining riparian vegetation.

Road Salt and Water Quality

Sodium chloride (also known as table salt) is the de-icing agent of choice in much of the Northeast. It is applied in large amounts to most paved roads throughout Vermont by the Vermont Agency of Transportation, by the 250 municipalities and by an unknown number of private contractors. Application rates are typically measured in tons per lane mile. Exposure to high concentrations of road salt has been shown to have detrimental effects on terrestrial and aquatic ecosystems. In the past, research found that impacts are greatest directly adjacent to roadways and uncovered salt storage piles. The general conclusion was that salt concentrations were unlikely to reach levels of concern in other locations because of dilution or that exposure to high concentrations (1000 mg/L chloride or higher) would be brief and therefore not of concern.

Recent data may be challenging these conclusions. In 2001, Environment Canada completed an assessment of road salt and the potential for harmful effects on the environment. They concluded that, based on available data, road salt was toxic as defined by the Canadian Environmental Protection Act and entering the environment in potentially harmful amounts. In the fall of 2005, Kauschal et al (Proc. Nat. Acad. Sci. 102:13517) documented chloride concentrations reaching 25% of seawater (up to 5 gr/L) in some streams in New York, Maryland and New Hampshire. In Vermont, data from the Lake Champlain Long-term Monitoring Program indicates that chloride concentrations in the main lake, though well below levels of concern, have been rising steadily since 1998. Several of the major tributaries in both Vermont and New York show similar trends. Data collected from areas of high density development throughout Vermont indicate that summer base flow chloride concentrations are elevated in some streams, which may, in turn, point to elevated groundwater concentrations.

These new data suggest that current assumptions of the movement and concentrations of road salt in the environment may need revision. There is limited recent data on chloride in aquatic systems in Vermont and little information on the chronic effects on biota of exposure to sub-lethal levels. Because de-icing is an integral part of maintaining safe winter roads and sodium chloride is the current de-icer of choice, it is presumed that road salt is the culprit and that large amounts of chloride will continue to enter the environment. DEC is assessing available data to identify aquatic environments at the greatest risk from elevated chloride in Vermont and the implications this may have for resident biota. There is also an investigation underway to determine whether conductivity can serve as a useful surrogate for chloride measurements. In the Northeast region, it would be beneficial to add chloride to existing routine groundwater and surface water monitoring to gain a better understanding of current concentrations, loading, and sources. Additionally, investigations into effects of chronic sublethal exposure to chloride on aquatic communities are needed to better understand the environmental response to these concentrations.

Polluting Discharges from Large Farms

From a water quality perspective, concerns continue to exist regarding 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 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 between farm operators and state and federal agencies. The Large Farm

Operation Rules, regulating about 20 farms in Vermont with greater than 950 animals and administered by the Vermont Agency of Agriculture, Food and Markets, will help ensure animal wastes on these larger facilities are managed effectively.

Changes at the federal level are soon to affect the Concentrated Animal Feeding Operation permit program, currently administered by DEC under the National Pollutant Discharge Elimination System. Farms that have between 200 and 700 dairy animals, known as Medium-sized Farm Operations or MFO, will soon need a General Permit and will need to demonstrate compliance with nutrient management requirements. There are close to 200 MFO dairy farms in Vermont. Farms with greater than 700 animals will soon need an Individual Permit.

Improvements and changes to the Accepted Agricultural Practice (AAP) rules are recommended to keep pace with the changing nature of Vermont agriculture. Revisions to the AAPs have been prepared by the Vermont Agency of Agriculture and, once promulgated, will provide an important set of requirements which all farms throughout the state will adhere to.

In order to achieve the greatest possible environmental protection benefit while supporting an important ingredient of Vermont's landscape and way of life, it is recommended these permit programs be developed or modified in a coordinated manner with various technical and financial assistance programs to address waste and nutrient management.

Groundwater

Groundwater is fundamental to the ecosystem and as a drinking water resource. Groundwater recharges wetlands, streams, rivers, lakes, and ponds, which is critical to wildlife. It is a source of drinking water for most of the State's population. While groundwater is addressed through the Safe Drinking Water Act, this Act's prime focus has been on monitoring, treatment, operation, and infrastructure needs of public water systems. Additional regulations that address groundwater are often in reaction to contamination. Yet, the quantity and quality of groundwater which define its use in Vermont remain largely unknown. Characterizing the groundwater resources is overdue relative to the continuing threats of contamination, the pressures and pace of economic development, and the importance of this resource. Specifically, the Vermont Groundwater Coordinating Committee (GWCC) recommends the following:

A) the GWCC should review and comment on proposed legislation to provide technical review of its implications by a broad range of Agency representatives;

B) institute water conservation incentives to proactively prepare for the next drought cycle along with expanding the drought monitoring capabilities of ANR; and,

C) fully implement the Groundwater Protection Statute, Chapter 48, with adequate resources for a comprehensive groundwater program that identifies and funds groundwater research.

To appropriately address groundwater and elevate its standing to a level that other natural resources enjoy will require a continuous commitment. Requisite in this commitment is a groundwater program with personnel that would define the State's groundwater resources. Central to this mission is a proactive approach to aquifer mapping. This mapping would identify potential future aquifers and also

update existing Source Protection Areas that were insufficiently delineated. This approach would establish the connection between surface water and groundwater that is so often ignored. In addition, there is a need for education and technical assistance at the state level and, most importantly, at the local level.

The above approach is based on the policy, as stated in Chapter 48, Groundwater Protection, that comprehensive groundwater management is needed to provide effective preventative strategies to protect the resource. Without this basic understanding of the resource, assumptions regarding groundwater will remain ill conceived and the resource will be under-appreciated. Such an approach results in inadequate groundwater protection efforts. Conversely, a groundwater program based on data that describes the resource can appropriately protect the resource for present and future needs.

Appendix A

Progress Report on Basin Planning During 2005 To the House and Senate Committees on Agriculture and Natural Resources and Energy

January 2006

Vermont Agency of Natural Resources Department of Environmental Conservation

Table of Contents

Introduction

In 2005, the Vermont Agency of Natural Resources, Department of Environmental Conservation (DEC) and its municipal, regional and watershed partners were fully engaged in the basin planning process in eight of Vermont's17 basins.

The overall goal of each plan is to establish strategies that will:

- maintain, improve, or restore the surface waters of the basin,
- ensure full support of uses of the waters, and
- engage the many diverse parties in a watershed who are needed to reduce or eliminated pollution and protect high quality waters.

The Vermont DEC Watershed Coordinators (or Basin Planners) have engaged members of the public, non-profit organizations, landowners, farmers, foresters, loggers, local officials, government agencies and others in the basin planning/watershed initiative process.

The Challenge

The Lake Champlain Phosphorus TMDL, for example, established phosphorus load allocations for each major lake watershed and included an implementation plan describing the major, basin-wide program efforts that will be needed to achieve these allocations. Through the DEC Watershed Planning Initiative strategies are developed by a public process to achieve goals and objectives identified for each major river basin statewide.

Translating TMDL load allocations and river basin plans into real, "on-the-ground" actions requires a locally coordinated implementation process. Watershed Coordinators play a critical role in turning these plans into reality. Their job in a watershed is not finished until the goals derived through the public consensus process are implemented and water quality is improved.

Watershed Coordinators lead the development of individual basin plans based on a public involvement process. They serve as a vital communication link between all the various state and federal agencies and local organizations that are contributing to water quality improvement efforts. They help educate and persuade individual landowners and business owners to prevent or abate nonpoint source pollution from their property. They facilitate the completion of projects, large and small, that correct locally identified problems and restore water quality. Watershed Coordinators are needed in each major basin as a long-term local presence to ensure successful follow-through and implementation of the Lake Champlain Phosphorus TMDL and other water quality plans throughout the state.

The planning process and associated watershed projects are in varying stages in the different basins: one basin plan is in a restoration phase and a typing and classification petition is under consideration by the Water Resources Board (White River); a second basin plan has been approved by the Secretary and is awaiting instructions by the Water Resources Board on the correct manner in which to propose typing and classification petitions (the Poultney Mettowee basin); another basin plan is in final draft form with numerous specific river and stream assessments and restoration projects underway (the Lamoille basin); four basin plans are in development with the respective councils and watershed coordinators holding meetings and prioritizing issues (the Otter Creek, Northern Lake Champlain Basin, West, Williams, Saxtons and the Ompompanoosuc, Waits, Wells Rivers basins); one basin plan is underway with the introductory meetings completed and remedial projects planned (Missisquoi River).

DEC's watershed initiative involves two parallel tracks of work, based on published Guidelines for Watershed Planning. The first is the planning process track. Watershed planning activities use the grass roots approach and include: holding public forums to identify issues and concerns; forming a Watershed Council and facilitating Council meetings; ranking issues in order of priority; holding panel discussions on watershed topics of interest; formulating strategies to address the issues with the public and the council; developing surface water management goals; and with the public, collaboratively writing the watershed plan. The process also lays the groundwork for implementing projects by: raising public awareness of issues and solutions so that people are engaged and willing to act; bringing potential project partners together; identifying projects; determining funding sources; and coordinating the implementation. Although time-consuming, the planning track is essential to effective project implementation in the second track.

The second track of the watershed initiative involves on-the-ground watershed assessment, protection, and restoration projects to improve water quality. Examples of assessment projects include Phase I and II geomorphic assessments that identify physical conditions and health in rivers and streams; bridge and culvert inventories that review the adequacy of these structures for both road and stream protection; dam inventories; and the overall watershed assessment that integrates known physical, biological, and chemical information. Protection and restoration projects can include: riparian buffer re-establishment, stream channel restoration and habitat improvement; selective dam removal; stormwater and agricultural best management practice implementation; securing easements; educating landowners; and working with municipalities on local protection strategies.

Difficulties Encountered

The Watershed Initiative has made significant improvements to the water quality of rivers, their tributaries and lakes in the initial years that three watershed coordinators have served the people of the state. Today we have six state funded watershed coordinators and one part-time contractual coordinator who are able to accelerate the initiative and put more remedial and protective projects in place. Many dollars have been leveraged directly by grant writing and by the rationale and weight of the adopted basin plan.

To date, two noteworthy problems have been encountered in the watershed planning process.

#1. The biggest challenge encountered in the watershed planning process is that it takes more time than anticipated to carry out an inclusive process involving the many stakeholders in a watershed to produce a watershed plan that the public will identify with and implement. This truly grassroots effort in some watersheds starts from square one with no existing watershed organization in place. The watershed coordinator forms a diverse and inclusive watershed council, holds many public forums, conducting numerous panel discussions to provide the Council with the technical information necessary to formulate water quality remediation strategies, the "typing and classification" process, and the information needed for drafting of the plan. Although this takes a far greater amount of time than originally scheduled, it is absolutely essential to have the participation of all stakeholders and land owners who are all responsible for reaching solutions that contribute to the larger goal to restore our waters. The January 2006 deadline required by statute to complete basin plans for the entire state will not be met at the current DEC staffing level. Our best estimate for the time of completion of the plans at the projected staffing will be 2010 to 2011.

#2. Typing and classification involves multiple meetings with towns, draft proposals and mediation where the typing or classification between towns are inconsistent. The White River Plan was completed in November 2002. The petition for typing and classification was forwarded to the Water Resources Board on June 6, 2003. It was not until June 30, 2005 that the Board forwarded its approved final rules with the Legislative Committee on Administrative Rules (LCAR). LCAR remanded the approved final rules back to the Water Resources Board. At the time of this report, December 2005, the rule for the typing and classification of the waters of the White River basin has not been finalized.

Despite being the single most time consuming element in completing basin plans, the water management typing process is important as it brings the watershed coordinators into a close contact with each municipality, its select board, planning commission and municipal officials. As a result of this goal-setting requirement, there are discussions ranging from how municipal ordinances can be enhanced to improve water quality to problems experienced on local tributaries and public treatment works.

The Agency of Natural Resources believes that it is important to give communities the opportunity to establish goals, as described in the 2000 Water Quality Standards, for managing the waters in their environment. Some communities are enthusiastic and rise to the occasion and others do not.

V. S. A. 10 Section 1250 states clearly "It is the policy of the State of Vermont to: "protect and enhance the quality, character and usefulness of its surface waters and to assure the public health;" Within the classification B there is a clear process, Water Management Typing, to set a higher goal that enhances the water quality. Thus, it is important to maintain the typing process to enable the State and others to speak to the goal of enhancing the quality, character and usefulness of our surface waters and to assure the public health.

Finally, it would be helpful if all municipalities considered including guidelines for future water management typing or equivalent goal statements for the management of waters as they revise their Town Plans. This would facilitate the watershed initiative and engage the regional planning commissions, many of whom have now become familiar with Water Management Typing and the watershed initiative.

Details of each Planning Process

The table on the next page lists the components of the basin planning process and their current status by basin as of the first week of December 2005. Following this summary table are eight progress reports, one for each basin. Plans for 2006 are also briefly described for each basin. Basin plans and the basin planning process are required by the Vermont Statute 10 V.S.A. Section 1253(d), the Vermont Water Quality Standards Section 1-02D, and the U.S. EPA 40 CFR Part 130, Section 130.6 – Water Quality Management Plans.

Watershed Initiative Status for All Basins as of December 2004

Current Status by Basin

Components of the basin planning process	Basin 2	Basin 3	Basin 5	Basin 6	Basin 7	Basin 8	Basin 9	Basin 11	Basin 14
Public forums held	C	C	O	I	C		C	C	C
Watershed Council formed	C	C	C		C		C	C	C
Local WQ* concerns identified	C	C	C	O	C		C	C	C
Panel discussions on WQ issues held	C	O	O	O	C		N/A	C	C
Strategies for WQ issues formulated	C	O	O	O	C		C	C	O
Review of town plans & zoning regulations	C	I/O	O	I	C		C	O	O
Develop water management type classification proposal	C	I/O	I		C		C	O	O
Meetings with towns on classification proposal	C	I/O			C		C	I	
Watershed plan draft	C	I	I		C		C	I,C	I
Public hearings on draft plan	C						C		
Final basin plan	C						C		
Outreach to schools and local groups	O	O	O	O	O		C	O	O
Basin Assessment Report	C	C	C	C	C		C	C	C
Phase I Stream Geomorphic Assessments	O/C	O/C	O	O	O	O	O	C,O	O/C
Phase II Stream Geomorphic Assessments	O/C	I/O/C	O	O	O	O	O	C,O	O/C
Bridge and Culvert Inventory	O/C	I/O		O	O	O		O	O/C
Dam Inventory	I				C		C	See below	
Biological Monitoring	O	O	I	C	O	O	C	O	O
Restoration Projects	C&O	O	O	O	C&O	C&O	O	C,O	C&O

Key: I = initiated, O = ongoing, C= completed, WQ = water quality, Basin 2 = Poultney-Mettowee Rivers; Basin 3 = Otter Creek; Basin 5 = Northern Lake Champlain; Basin 6 = Missisquoi River; Basin 7 = Lamoille River; Basin 8 = Winooski River; Basin 9 = White River; Basin 11 = West River; Basin 14 = Wells, Waits and Ompompanoosuc Rivers

Poultney Mettowee Basin Progress Report – Basin 2

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Introduction

The Poultney-Mettowee Basin Plan was completed in February, 2005 in accordance with 10 V.S.A. Section 1253(d), the Vermont Water Quality Standards, the Federal Clean Water Act and 40 CFR 130.6. Distribution of the plan was postponed pending an expected decision from the Vermont Water Resources Panel of the Natural Resources Board relating to typing of waters in the White River Basin. The plan will serve as a roadmap to guide projects within the watershed, and it will help to leverage funds to accomplish the goals it sets forth.

Watershed Initiatives

Activity	Status	Comments/Information
Public forums held	C	Public forums were held in 2001 and 2002 to identify water quality issues and concerns and also actions in which the participants were most interested
Watershed Council formed	C	The Poultney Mettowee Watershed Partnership was expanded to serve the role of watershed council.
Local water quality (WQ) issues identified	C	Through public forums, focus group discussions, public attitudes surveys, and other media outreach.
Panel discussions on WQ issues held	C	Many formats were used to explore water quality issues, including focus groups, public forums, surveys, and panel discussions.
Strategies for WQ issues formulated	C	Strategies were formulated with extensive public input and are in the Poultney Mettowee Basin Plan.
Draft white papers for WQ issues	C	White papers on specific water quality issues were reviewed during the basin planning process.
Review of town plans and zoning	C	The Rutland Regional Planning Commission reviewed town plans and zoning regulations in the Poultney Mettowee Basin as part of an EPA 604(b) pass-through grant.
Develop water management type (WMT) classification proposal	C	A water management typing and classification proposal for the basin is part of the draft plan.
Meetings with individual towns on the WMT classification proposal	C	The watershed coordinator, with assistance from the Poultney Mettowee NRCD and the Watershed Partnership met with representatives from each town in the basin (planning commissions, conservation commissions, and select boards).
Draft basin plan	C	Draft released on July 12th for 80-day comment period.

Public hearings on draft plan	C	3 public hearings were held on the draft plan – Aug. 5, Aug.10, and Sept. 13, 2004
Final basin plan	I	Adopted in February 2005 by Secretary of ANR
Outreach to area schools and local groups	O	Partners engage in continued outreach and involvement with schools and colleges in the basin (Fair Haven Elementary, Poultney Elementary, Mettowee Community School, Castleton State College, and Green Mountain College – Watershed Planning class).
Basin Assessment Report	C	Last assessment report completed in 1999.
Phase I Stream Geomorphic Assessments done	O	ANR Phase 1 geomorphic assessments completed for Poultney, Mettowee, Hubbardton, and Castleton Rivers.
Phase II Stream Geomorphic Assessments done	I	Castleton River phase 2 assessment completed 2005. Phase 2 underway for Poultney, Mettowee, and Hubbardton Rivers.
Bridge and Culvert Inventory	O/C	Culvert assessment in-progress or completed for each town in the Poultney Mettowee basin. Castleton assessment completed via ANR protocols 2005.
Dam Inventory and Assessment	O	Associated with dam removal in Fair Haven
Biological Monitoring	O	There are approximately 60 biomonitoring sites that are sampled on a rotational basis throughout the basin.
Restoration/Protection Projects Underway	O	Most are agriculturally related streambank restoration sites on farms in the Mettowee and Poultney River basins

Key: I = initiated, O = ongoing, C= completed

River and Stream Restoration Projects

Waterway	Water Quality Concern	Current Actions
Mettowee River	Thermal modification, sedimentation, nutrient enrichment, geomorphic instability, fish kills	Bio-engineered streambank restoration, buffer planting, water quality monitoring. 3 projects completed 2005.
Poultney River	Sedimentation, nutrient enrichment, geomorphic instability, elevated levels of pathogenic bacteria	Bio-engineered streambank restoration, buffer planting, ongoing water quality monitoring
Hubbardton River	Sedimentation, nutrient enrichment, geomorphic instability	Riparian corridor restoration through buffer planting, livestock exclusion, conservation easements
Castleton River (Fair Haven)	Ongoing concerns over flooding, stormwater runoff, nutrient enrichment, and sedimentation.	Phase 2 geomorphic assessment, river corridor planning underway.
Castleton River Gully Brook (Castleton)	Geomorphic instability causing flooding, sedimentation, nutrient enrichment	Passive geomorphic restoration project completed summer 2004. Riparian corridor restoration completed 2005.

Conclusion and Plans for 2006

Overall, partners in the basin planning process have indicated that collective efforts have been quite successful in implementing high priority projects that have required enhanced technical and financial resources. Many of the goals and corresponding strategies identified in the plan have been, or currently are being, implemented in the areas of nutrient management, water quality monitoring and education, and streambank assessment and restoration. Resources have been allocated to provide additional nutrient management education and outreach services to farmers including education about new technologies and practices, and individual assistance for record keeping and nutrient management plan implementation.

This was the third year of a project to monitor and evaluate the water quality in the Poultney River, which has now been expanded to include the Mettowee River. The primary interest for expanding this project to the Mettowee River Basin specifically relates to phosphorus loading contributions to the sourhtern part of lake Champlain. Students from Green Mountain College helped with water quality sampling and geomorphic assessment of nearby streambank conditions. This information is publicized on the Poultney Mettowee Watershed Partnership website and in the summer series of articles in the *Lakes Region Free Press*.

For 2006, the partners involved in the basin planning process are committed to the ongoing implementation of strategies identified in the basin plan. There will be expanded water quality assessment and monitoring activities, including additional water quality monitoring and geomorphic assessment of the Mettowee River. Agricultural cooperators will see an increase of nutrient management technical assistance, resources, and funding throughout the basin. Coupled with this will be the development of a pilot program to look at performance based measures and incentives for nutrient management. A high priority will be ongoing restoration projects and public education activities, including the potential dam removal in the Castleton River, where failing dams pose a threat to aquatic biota and habitat. Also, high priority will be given to ongoing education and awareness of water quality issues.

One significant outreach program was expanded this past summer on Lake St. Catherine - the Lake Education and Action Program (LEAP). Funded through the University of Vermont's Sea Grant Program, the primary goal of the LEAP program is to protect lake watersheds from nonpoint source pollution by giving stakeholders the knowledge and skills they need to maintain their property in a non-polluting manner. While the eventual goal of this program is to reach several watersheds, it was decided that the second year should focus on one lake watershed area to modify the program and delivery mechanisms. The following years of the program will expand to other lake watersheds in the basin including Lake Bomoseen and Lake George (in the New York portion of the Poultney Mettowee Basin).

Finally, the basin planning process allowed partners to prioritize and implement several streambank restoration projects throughout the basin this year. We have many other potential restoration projects in the works for future restoration efforts. All of these will improve the water quality locally and reduce the phosphorus that reaches Lake Champlain.

Otter Creek Basin Progress Report – Basin 3

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Introduction

During 2005, the Rutland Natural Resources Conservation District (RNRCD) and the Vermont Agency of Natural Resources (ANR) continued to sponsor the meetings and activities of the Upper Otter Creek Watershed Council (UOCWC) from the headwaters downstream to the vicinity of the Neshobe River. The Council continues to identify the existing and potential causes and sources of pollution that can influence surface waters of the Otter Creek basin. During the 2005 calendar year, the UOCWC organized meetings and facilitated discussion on basin issues such as dams and water level fluctuation, wildlife management, water quality monitoring, stormwater runoff with respect to impaired waters, wetlands, river corridor management (with final presentations on geomorphic assessments), riparian buffers, which included buffer planting projects, and future funding and administrative support for the long-term sustainability of the Council.

Most of the topics discussed at the meetings had been top-ranked issues raised at public forums in 2002 and 2003. The UOCWC is now in the process of developing goals, objectives, and strategies that will be incorporated into the Otter Creek Basin Plan.
Some projects currently underway, or still in the planning stages, include:
Water quality monitoring of the Otter Creek and its tributaries;
Assessment of riparian conditions and geomorphology of the Otter Creek and its tributaries;
Developing watershed improvement projects;
Working with towns to conduct erosion inventories of their back roads;
Collaborating with the Rutland City Department of Public Works and municipal officials on an outreach and awareness project for the stormwater-impaired Moon and Mussey Brooks.

Highlights for 2005 include a Phase 1 geomorphic buffer assessment of the Otter Creek mainstem, water quality monitoring of major tributaries to the Otter Creek, and coordination with stakeholder groups in the Addison County portion of Otter Creek to initiate a basin-wide coordinating committee to oversee basin planning for the Otter Creek. Active water quality groups in Addison County include the Addison County River Watch Collaborative, the Lewis Creek Association, the Watershed Center in Bristol, the New Haven River Anglers Association, the Middlebury River Watershed Association, and the Lake Dunmore – Fern Lake Association.

The Otter Creek Advisory Committee, which continues to serve as the umbrella group for the basin planning process throughout the watershed, has been meeting on a quarterly basis. In addition, an agricultural work group has been formed and meets periodically to discuss water quality issues as they pertain to agricultural land use within the basin. Recently, the Advisory Committee and the agricultural work group have met to review and discuss a draft white paper regarding riparian buffer management practices, as well as to review progress made in addressing impaired surface waters where the problem has been attributed to runoff from the working landscape.

The Watershed Coordinator continues to participate in the meetings and activities of these organizations as a way to support this existing stewardship and to incorporate strategies related to these efforts into the Otter Creek Basin Plan.

Watershed Initiatives

Activity	Status	Comments/Information
Public forums held	C	A series of public forums were held in Rutland County in the winter of 2003 and in Addison County during the spring of 2004.
Watershed Council formed	C	The Upper Otter Creek Watershed Council was formed in the spring of 2003. Existing watershed groups are established in the Addison County portion of the basin. A basinwide advisory committee has been meeting quarterly.
Local water quality issues identified	C	Major WQ issues have been identified through public forums. Recently, a public attitudes survey was developed and will be implemented in Addison County in 2006.
Panel discussions on water quality issues held	O	Several panel discussions were held throughout the basin in 2004 and several more are planned for 2006.
Strategies for water quality issues formulated	O	The UOCWC, basinwide advisory committee, ag work group, and various stakeholders have begun to develop and review draft strategies to address WQ issues.
Draft white papers for water quality issues	O	Issue papers for priority WQ concerns identified thus far are currently being drafted and reviewed.
Review of town plans and zoning	O/C	Completed for Rutland County. Anticipated as a grant project for Addison County RPC for 2006.
Develop water management type (WMT) classification proposal	O	The Rutland RPC is helping to develop a draft WMT proposal for the Rutland County portion of the Otter Creek basin. A partnership with the Addison RPC may assist with this process in 2006.
Meetings with towns on the WMT classification proposal	O	The Watershed Coordinator has been meeting with towns in the basin during 2005 and will continue to meet with towns in 2006. The RPCs are assisting in this effort.
Draft basin plan	O	The Watershed Coordinator intends to develop a comprehensive draft basin plan during 2006.
Public hearings on draft plan		
Final basin plan		
Outreach to area schools and local groups	O	Partners engage in outreach and education with schools and colleges in the basin (Smokey House Center, Currier School, Success School, Rutland High School, Stafford Tech Center, North Branch School, Middlebury High School, Middlebury College, Mount Abraham Union HS, Champlain Valley Union HS, The Watershed Center, UVM, and Patricia A. Hannaford Career Center).
Basin Assessment Report	C	The last assessment report was completed in 1998. An updated assessment report is anticipated.

Phase I Stream Geomorphic Assessments	O/C	Phase 1 completed on the mainstem of the Otter Creek, Neshobe River, Leicester River, and Little Otter Creek. Phase 1 assessments completed for Lewis Creek, the New Haven River, and the Middlebury River in 2005.
Phase II Stream Geomorphic Assessments	I/O/C	Phase 2 assessments completed for the Lewis Creek, New Haven River, Moon Brook, and Middlebury River. A Phase 2 assessment has been initiated on the Neshobe River.
Bridge and Culvert Inventory	O/C	AOT culvert assessments have been completed for most towns in the Rutland County portion of the Otter Creek basin and about half the towns in Addison County.
Dam Inventory		
Biological Monitoring	O	There are approximately 100 biomonitoring sites that are sampled on a rotational basis throughout the basin.
Restoration/Protection Projects Underway	I/O/C	See table below.

Key: I = initiated, O = ongoing, C = completed

River and Stream Restoration Projects

Waterway	Water Quality Concern	Current Actions
Otter Creek mainstem	Sediment from bank erosion and nutrients	Numerous agriculturally-related streambank and buffer restoration projects on farms in the watershed.
Moon and Mussey Brooks East Creek (Rutland)	High levels of pathogenic bacteria, sedimentation, nutrient enrichment, urban (stormwater) impairment due to runoff	Watershed improvement projects planned with Rutland City DPW – 2006 Phase 2 geomorphic assessment completed. Public outreach and awareness initiated for residents of the Moon/Mussey watershed.
Middlebury River	High levels of pathogenic bacteria, sedimentation, nutrient enrichment, impairment due to agricultural runoff	Phase 2 geomorphic assessment has indicated areas of instability. Riparian corridor restoration through buffer planting, livestock exclusion, ag land taken out of production along riparian corridor.
New Haven River	Geomorphic instability, flooding, historic channel modification threatens transportation infrastructure	Phase 2 geomorphic assessment completed, floodway determination, bridge and culvert assessment associated with transportation upgrades. FEH development underway with Lincoln town.
Lewis Creek	Nutrient enrichment, sedimentation, geomorphic instability, historic channel modifications	Phase 2 geomorphic assessment completed, water quality monitoring, riparian corridor protection project, outreach with towns in the watershed, CREP.

Little Otter Creek	High levels of pathogenic bacteria, nutrient enrichment, historic channel modification	Outreach to agricultural cooperators for buffer planting, livestock exclusion, NRCS cost-share programs

Conclusion and Plans for 2006

Overall, the planning process has provided many opportunities for collaborative problem solving among stakeholders that we anticipate for future, successful restoration efforts throughout the Otter Creek Basin.

For 2006, stakeholders and water quality issue groups will continue drafting different sections of the Otter Creek basin plan vis-a-vis white papers for major issues and corresponding strategies. Major topics that will be addressed by working groups will include agriculture, transportation infrastructure (bridge and culvert effects on streams and gravel road erosion), riparian corridor protection, and suburban and urban runoff (stormwater). The Upper Otter Creek Watershed Council as well as existing watershed groups in Addison County will pursue ongoing watershed improvement projects, water quality monitoring, geomorphic assessment, municipal planning opportunities, and public outreach, education, and awareness. Based on assessment, monitoring, and public participation, the highest-ranking projects and activities will be pursued for funding and implementation.

Northern Lake Champlain Basin Progress Report – Basin 5

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Introduction

A watershed council met for the first time on April 29, 2003. The Watershed Coordinator and the watershed council committed themselves to developing the watershed plan and assisting in the implementation of watershed restoration projects. The council supported the coordinator's proposal to hold three public meetings to identify the communities' most prominent concerns. The council also agreed that local groups would develop the first draft of strategies for each of the community's concerns.

The watershed council agreed to the Agency's proposal that the watersheds of the Rock and Pike Rivers would be included in the Missisquoi River Basin planning process and not in that of the Northern Lake Champlain Basin. The Franklin County Natural Resource Conservation District also met with the Missisquoi River Basin Association to discuss this option and the group agreed with this approach. The Rock and Pike Rivers' communities are more closely tied with the communities of the Missisquoi River watershed and landscape than those along the Lake.

During 2004, the Watershed Coordinator began to work with local groups to develop strategies for restoring and protecting water quality along tributaries to Lake Champlain. In 2005, the coordinator continued working on projects and began drafting the basin plan.

Watershed Initiatives

Activity	Status	Comments/Information
Public forums held	C	Forums were held in Shelburne, Colchester, North Hero, and St. Albans
Watershed Council formed	C	A diverse task force was formed and is assisting in the development of a draft watershed plan
Local water quality issues were identified	C	Top issues in the basin include: nuisance aquatic species, urban/suburban runoff, drinking water supply quality, farming issues, streams, causeways
Panel discussions on water quality issues held	C	Presentations and roundtable discussions were held in different parts of the basin in the spring and summer of 2003
Strategies for water quality issues were formulated	C	Strategies were developed with local groups and then reviewed and revised by the watershed council. Strategy development took place during 13 meetings.
Review of town plans and zoning	O	Town plans were completely reviewed for Chittenden and Franklin counties

Develop water management typing (WMT) and classification proposal	I	A proposal will be developed over the next year based on existing, reasonably attainable, and desired water quality
Meetings with individual towns on the WMT classification proposal		
Draft basin plan	I	The draft basin plan is nearing completion and a completed draft plan is expected to be available for public review in 2006.
Public hearings on draft plan		
Final basin plan		
Outreach to area schools and local groups	O	Groups with which we are working include La Platte River Partnership and St. Albans Area Watershed Association. Letters have been sent to all town officials in the basin. Articles have appeared in local newspapers.
Basin Assessment Report	C	The basin assessment report was completed in December 2003.
Phase I Stream Geomorphic Assessments	I/C	These assessments are completed for the LaPlatte River mainstem and major tributaries, and Jewett, Stevens and Rugg Brooks, parts of Mill Brook, Stonebridge Brook, and several small tributaries on the Georgia shoreline.
Phase II Stream Geomorphic Assessments	I/C	These assessments are completed for segments of the LaPlatte River, Bartlet Brook, Englesby Brook, Indian Brook, Munroe Brook, Potash Brook and Stevens and Rugg Brooks.
Bridge and Culvert Inventory		
Dam Inventory		
Biological Monitoring	C	Additional waters have been identified and macroinvertebrates sampled to determine long-term water quality trends of specific waters.
Restoration/Protection Projects Underway	I	Numerous protection and restoration projects are underway throughout the watershed (see below).

Key: I = initiated, O = ongoing, C= completed

River and Stream Restoration Projects

Waterway	Water Quality Concern	Current Actions
Shelburne Bay	Nutrients	Four rain gardens were installed on residential lots as demonstration projects to encourage people to reat stormwater as close to its source as possible. Related educational projects in in the planning stages.

Chittenden County waterways	Nutrients, toxins	A lake friendly urban lawn practices education event was held in April 2005 and a 2006 event is being organized.
Shelburne Bay via the LaPlatte River	Nutrients, sediment	The use of bioinfiltration structure to reduce stormwater flows to an adjacent stream is in the planning stages.
Main lake near Alburg	*E. coli*, nutrients	A water quality monitoring study with volunteers was initiated to determine the water quality impact from a hobby farm.
St. Albans Bay via Stevens and Rugg Brooks	Nutrients, sediment, geomorphic instability	A water quality monitoring study with volunteers continued and the sampling of large rain storms was included. Stormwater treatment projects are being developed with EPA funding. A streambank planting project was completed and two additional plantings were designed for implementation in 2006.
St. Albans Bay via Stevens Brook	Nutrients	An education and outreach program for homeowners that includes a survey of lawn and garden practices, free soil tests, educational meetings wwas completed. A grant application was written to educate businesses that sel lawn care products about lake friendly practices.
St. Albans Bay	Nutrients, sediment	Soil management workshop (erosion reduction techniques were included) was held in Franklin County and attended by farmers from St. Albans Bay. A Better Backroads workshop was held in Franklin County and invitations were sent to town officials in the county.
Northeast Arm	Nutrients, *E. coli*	An article was written in the Agricultural Review to encourage farmers to reduce agricultural runoff that could end up near water supply intake pipes.
St. Albans Bay	Aquatic nuisance species	Eurasian watermilfoil and nuisance native species were harvested.

Conclusion and Plans for 2006

In 2005, the watershed coordinator focused on developing projects with local groups and municipal, state, and federal staff, and on preparing a draft of the basin plan.

In 2006, the focus will be on completing the basin plan for public review and continuing project implementation. The chapter on establishing water management goals, including the typing and classification proposal, may not be included in the 2006 draft. The Agency of Natural Resources is waiting for the Vermont Water Resources Board to develop new guidelines for typing and classifying waterbodies. In addition, the watershed coordinator will continue outreach with

watershed groups, towns, regional planning commissions and other stakeholders in a basin planning process; continue to secure grants and mover forward on projects in the basin; continue collaboration with all partners on priority issues; and conduct ongoing education and outreach with residents of the watershed.

Missisquoi Bay Basin Progress Report-Basin 6

Note: Although the Rock and Pike River watersheds are considered to be part of the Northern Lake Champlain Basin (Basin 5), these areas have been included into the Missisquoi Bay basin planning process along with the Missisquoi River because all three flow to and affect Missisquoi Bay.

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Introduction

There is intense public concern over water quality in Missisquoi Bay, with potentially toxic algae blooms limiting the use and enjoyment of the bay for much of the summer. Many basin residents have been active in the basin planning process since it began formally with six public forums early in 2005. Over 75 people attended the forums, voicing both their concerns for water quality and their suggestions on how to improve it. Not surprisingly, the greatest concerns centered around excessive phosphorus and the resulting algal blooms in Missisquoi Bay. The related issue of soil erosion from streambanks, cropland, construction, and roads was also cited. Residents were also concerned about the lack of public awareness and the need for a coordinated approach to restoring water quality.

Based on the results of the forums, a watershed council consisting of a diverse mix of stakeholders from within the watershed was formed with the initial meeting attracting more than 40 residents and agency representatives. Four issue teams have been formed to focus strategy development and implementation in the following areas: reducing phosphorus pollution, protecting human health, conserving fish and wildlife resources, and increasing public awareness of how everyone contributes to good water quality. These teams have been meeting to address topics such as septic systems, agricultural nonpoint source pollution control, and education. From these discussions, draft strategies are being developed for the basin plan, and several project ideas have been put forward for funding. The watershed coordinator has been working closely with the local newspapers, resulting in numerous articles informing the general public about water quality issues and what is being done to address them.

In addition to basin planning meetings and projects, the watershed coordinator has been supporting local watershed groups in their efforts to garner greater attention to their concerns and funding for their highest priority projects. The coordinator has helped these groups in meetings with the regional legislative delegation, a daylong display at the State House for all legislators, and meetings with the Lake Champlain Basin Program Steering and Private Funding Committees. The exchange of information has allowed state, regional, and federal agencies to be more responsive to local water quality concerns.

Watershed Initiatives

Activity	Status	Comments/Information
Public forums held	C	Six forums held in January and February 2005.
Watershed Council formed	C	First meeting in April 2005.
Local water quality (WQ) issues identified	C/O	Identified at public forums, discussion ongoing.
Panel discussions on WQ issues held	O	Panel discussions held on septic systems, education, and agricultural phosphorus sources.
Strategies for WQ issues formed	O	Draft stategies under development.
Review of town plans and zoning	O	With assistance from the Northwest Regional Planning Commission.
Develop water management type (WMT) classification proposal		On hold due to deliberations of the Water Resources Panel of the Natural Resources Board.
Meetings with individual towns on the WMT classification proposal		
Draft basin plan	O	Sections underdevelopment.
Public hearings on draft plan		
Final basin plan		
Outreach to area schools and local groups	O	Working closely with existing organizations.
Basin Assessment Report	C	Basin assessment report completed November 2004
Phase I Stream Geomorphic Assessments	C/O	Completed in all of Franklin County streams, beginning in Orleans County.
Phase II Stream Geomorphic Assessments	O	Underway in select rivers and streams.
Bridge and Culvert Inventory	C	Completed in all of Franklin County
Dam Inventory		
Biological Monitoring	O	Included in 2004 rotational program
Restoration/Protection Projects Underway	C/O	Local groups continue projects, often in partnership with state and federal agencies.

Key: I = initiated, O = ongoing, C= completed

River and Stream Restoration Projects

Waterway	Water Quality Concern	Current Actions
Missisquoi River	Excessive phosphorus and erosion	Technical support and laboratory analysis (DEC partnership) for year one of MRBA volunteer water quality monitoring
Rock River	Excessive phosphorus and erosion	Technical support for town of Highgate's River Corridor Management grant application and implementation

Saxe Brook (trib to Rock River)	Excessive phosphorus in impaired reach	Field work with UVM international interns to expand assessment information
Missisquoi Bay Basin	Erosion from roadways	Assisted with Better Backroads workshop for town officials and road crew members
Missisquoi Bay Basin	Phosphorus from agricultural sources	Supported multiple efforts to fund a farmer to farmer outreach program

Conclusion and Plans for 2006

Basin planning in the Missisquoi Bay basin has attracted significant attention from the public. As such, addressing water quality problems in the region has become a greater priority at the local, state, and federal levels. Issues that have been raised and discussed in the planning process are beginning to influence policy at all of these levels, benefitting water quality activities both in the basin and beyond.

In 2006, work will continue toward developing a draft plan for the Missisquoi Bay basin. Draft strategies will be discussed at issue team meetings and with the full watershed council. Wherever possible, implementation will continue or begin on those strategies having sufficient interest and resources. As the results of Phase 1 and 2 geomorphic assessments become available, additional river restoration projects will be identified and pursued. In cooperation with the Agency of Agriculture, work will continue to support and expand farmers' efforts to protect water quality. Education and outreach will continue through the local media and through open watershed council meetings.

Lamoille River Basin Progress Report – Basin 7

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Introduction

DEC's Watershed Coordinator and watershed partners have developed a draft water quality improvement plan for the Lamoille River watershed. The draft plan outlines the top water quality priorities for the watershed, the sources of pollution, and the specific actions to address these issues including planning, monitoring and assessment, protection, and restoration strategies.

Additional physical, chemical, and biological monitoring and assessment activities in the Lamoille's lakes, ponds, and streams occurred because of the watershed initiative. Several geomorphic assessments were conducted in the upper Lamoille watershed, Browns River watershed, and Lamoille main stem.

Numerous watershed restoration projects were identified and implemented during the 2005 field season. The watershed coordinator assisted several municipalities in identifying road-related erosion problems and formulated solutions to remediate these causes. Funding has been secured for nine separate projects. Two projects were implemented in 2005. The coordinator led a Youth Conservation Corps crew to implement streambank stabilization, streambed stabilization, garbage cleanup, canoe trail development, and lakeshore erosion control projects. A new stormwater-related large gully erosion project was mapped. Funding and remediation plans are being developed to stabilize this site. The coordinator assisted the town of Morristown and Vermont River Conservancy in securing the protection of an access to one of the Lamoille's most scenic and popular gorges and swimming holes, Terrill Gorge. The coordinator is working closely with state and federal agencies to selectively remove floodplain encroachments and enhance instream and riparian habitat along several miles of the Lamoille River on state-owned land. Potential culvert replacement and dam removal projects to improve fish passage have been identified and funding secured. The Cambridge Conservation Commission and Smugglers Notch Resort implemented a crushed limestone treatment to address iron seepage that is impairing a tributary to the Brewster River. The coordinator assisted the Caledonia and Lamoille NRCDs in the establishment of riparian buffers at seven sites along the Lamoille River.

A comprehensive watershed assessment, restoration, and protection plan for the Browns River watershed in Chittenden County is being done by DEC and its watershed partners. The Browns River has been negatively affected by significant channel alteration and severe streambank erosion. The development of a river corridor management plan is well underway.

The watershed coordinator and partners have been working closely with the Director of Lamoille Watershed Association (LWA) to build watershed interest and capacity for this new organization. The LWA is the first watershed-wide watershed organization that is a direct result of DEC's Watershed Initiative. The LWA has been actively involved in several watershed assessment, restoration, and outreach activities.

Watershed Initiatives

Activity	Status	Comments/Information
Public forums held	C	Eight public forums were held at the onset of basin planning
Watershed Council formed	C	A diverse task force was formed and assisted DEC in the development of a draft watershed plan
Local water quality (WQ) issues identified	C	Top local water quality issues include stormwater, streambank erosion and flooding, agricultural runoff, loss of working farm and forestland, lake and pond issues, and dam-related issues
Panel discussions on WQ issues held	C	A series of panel discussions was held for each of the top water quality issues
Strategies for WQ issues formed	C	The strategies are written.
Review of town plans and zoning	C	Completed
Develop water management type (WMT) classification proposal	C	A WMT proposal was developed based on existing, reasonably attainable, and desired water quality.
Meetings with individual towns on the WMT classification proposal	C	The watershed coordinator has held over 40 meetings with select boards, planning commissions, and conservation commissions.
Draft basin plan	C	A draft basin plan has been developed
Public hearings on draft plan	I	Planned for 2006
Final basin plan	I	Planned for 2006
Outreach to area schools and local groups	O	Educational programs presented at Johnson State College, Sterling College, watershed schools, angler groups, lake associations, landowners, and utilities
Basin Assessment Report	C	Completed in February 2001.
Phase 1 Stream Geomorphic Assessments	C/I/O	Phase 1 geomorphic assessments completed or scheduled: the upper Lamoille, the entire Lamoille mainstem, the Wild Branch, Elmore Branch, Gihon River, Browns River, North Branch and many smaller tributaries.
Phase 2 Stream Geomorphic Assessments	C/O	Phase 2 geomorphic assessments have been completed in the upper Lamoille, Browns River, and Wild Branch sub-watersheds.
Bridge and Culvert Inventory	C	Bridge and culvert surveys have been completed in the entire upper Lamoille watershed and Browns River, Wild Branch, and Elmore Branch watersheds.
Dam Inventory	C	A dam inventory has been completed for the entire Lamoille watershed.
Biological Monitoring	C/O	Additional macroinvertebrate and fish sampling to better bracket possible sources of pollution and determine long term water quality trends including a focus on Rodman Brook downstream of a closed landfill.
Restoration/Protection Projects Underway	C/O/I	Numerous projects are underway watershed wide (see below).

Key: I = initiated, O = ongoing, C= completed

River and Stream Restoration Projects

Waterway	Water Quality Concern	Current Actions
Deer Brook, Georgia	Deer Brook is impaired from excessive sediment and nutrients	A new significant source of gully erosion has been mapped. Funding is being secured to address this erosion through Clean and Clear. A VYCC crew has removed trash in the gully ahead of the restoration project.
Unnamed Tributary to Brewster, Jeffersonville	The unnamed tributary to the Brewster River is impaired from metals (iron)	Smugglers Notch Ski Area, VTrans, and DEC working to remediate iron problem with lime injections. Also, stormwater treatment, small impoundment removal, and stream restoration project will improve this stream. Projects implemented in 2005.
Browns River, Chittenden County	The Brown River is adversely impacted by severe streambank instability and erosion	A river corridor management plan is being prepared for the towns of Essex, Jericho, Underhill, and Westford. A title search has been completed to identify the owner of a dam where a dam removal feasibility study will be done. The Vermont Composting Association and DEC are initiating composting projects to aid in nutrient load reduction to this subwatershed.
Unnamed tributary to the Gihon River, Johnson	A failing dam was discharging significant amounts of sediment downstream	A stream restoration project with Johnson State College staff and students, State Buildings staff, and Lamoille County NRCD was designed and permitted. It included establishment of a buffer and removal of the dam. Further work to address headcutting erosion above the former pond has been completed.
Jacob Brook, Morristown	Several water quality problems and opportunities affecting the town have been identified	A fish passage improvement project has been identified. The town of Morristown has signed up for the WHIP to replace this structure.
Riparian Buffer Establishment, watershed wide	Lamoille County NRCD's successful *Trees for Streams* program is being expanded	Watershed Coordinator is working closely with NRCDs and Lamoille Watershed Association to expand the successful stream buffer program to other counties and to include lakes and pond shorelines.
Lamoille River, Hardwick	Streambank erosion	Coordinator and VYCC stabilized 300 feet of streambank using tree revetments
Drainageway to Lamoille River, Johnson	Headcutting erosion	Coordinator and VYCC installed two hand-placed stone weirs to stabilize channel bed erosion
Lamoille River, Morristown	Canoe access trail	Coordinator and VYCC developed a trail to the Lamoille for canoes on F&W land

Lake Lamoille, Morristown	Erosion at boat access area	Coordinator and VYCC stabilized erosion at a canoe access ramp with rock, gravel, and drainage ditches
Roads in Walden, Hardwick, and Morristown	Erosion and sedimentation from town gravel roads	Developed designs and cost estimates for 3 towns and 7 separate projects to address erosion related to municipal road systems. Two projects were implemented in 2005.
Terrill Gorge, Morristown	Access nearly lost to development	The town, Vermont River Conservancy, and DEC protected a parcel so that access to the gorge and swimming hole is protected.
Various projects in the watershed	Floodplain encroachment removal, instream and riparian habitat improvement, dam removal, and streambank stabilization.	Watershed coordinator, Vtrans, F&W, and NRCS have been working closely to secure funding through the WHIP program.

Plans for 2006

Plans for 2006 include completing a final draft of the Lamoille watershed plan and adoption of the surface water management typing petition by the successor to the Water Resources Board. Public hearings will precede the adoption of a final watershed plan. DEC will continue to proactively identify water quality concerns, initiate watershed improvement projects, and protect high quality sites with help from our watershed partners. The watershed coordinator will work especially closely with the fledgling Lamoille Watershed Association in its capacity building progress.

Watershed restoration projects are planned for: a culvert replacement on JacobBrook in Morristown, a re-connection of floodplain access on the Gihon River in Johnson, the completion of a river corridor management plan and secruing riparian easements for the Browns river, the development of a fluvial erosion hazard map for the town of Underhill, developing bridge and culvert crossing capital budgets for Jericho, Underhill, Westford, and Essex, the removal of floodplain encroachments associated with the Lamoille Valley Rail, instream and aquatic habitat improvement of F&W owned lands along the Lamoille River, establishment of riparian buffers along lakes and streams throughout the watershed, road erosion best management projects at 7 sites in 3 towns, assist additional towns in securing funds for road runoff issues, and the implementation of stormwater best management practices in the Deer Brook watershed. Watershed partners include regional planning commissions, natural resource conservation districts, angler groups, the agricultural community, state and federal government agencies, landowners, and municipalities.

Winooski River Basin Progress Report – Basin 8

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River and Stream Restoration Projects

Waterway	Water Quality Concern	Current Actions
Dog River, Berlin	Streambank erosion	Coordinator and VYCC installed 300 feet of tree revetments to reduce erosion. Identified additional erosion sources within the watershed.
Winooski River, Williston	Streambank erosion at a culturally sensitive site	Coordinator and VYCC installed 400 feet of hand-placed rock riprap to reduce the erosion
Winooski river, Marshfield	Loss of riparian buffer	Coordinator planted 100 large stock hardwood trees along 500 feet of streambank with VYCC and Trout Unlimited
Winooski River, Cabot and Marshfield	Ammonia spill in Cabot	Watershed coordinator and partners are developing a watershed protection, restoration, and education/outreach plan for the upper Winooski to remediate effects of the spill.
Tributary to Great Brook in Plainfield	Significant headcutting gully erosion and sedimentation	Coordinator working with the Plainfield Conservation Commission to remediate erosion in this ravine. Clean and Clear and 319 funding will be used to remediate this site.
Kingsbury Branch, Calais	Watershed wide erosion and sedimentation	Coordinator and staff from Lakes and Ponds and River Management Sections worked with the town of Calais to map numerous sources of erosion and undertake watershed assessments.

Plans for 2006:

Additional riparian buffer plantings along the Winooski river in Marshfield, implementation of restoration, protection, and education measures along the Winooski in Cabot and Marshfield, additional streambank protection on the Winooski in Williston, remediation of a significant gully headcutting problem on a tributary to Great Brook in Plainfield, Phase 1 and 2 Geomorphic Assessments in the upper and middle watershed, and assist towns in securing funding to address road runoff issues.

Watershed partners include regional planning commissions, natural resource conservation districts, angler groups, the agricultural community, state and federal government agencies, landowners, and municipalities.

White River Basin Progress Report – Basin 9

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Introduction

The Agency of Natural Resources has adopted the plan and the Vermont Water Resources Board (Board) held public hearings in February 2005 and subsequently approved the Agency's water management typing and classification proposal for the basin. The Legislative Committee on Adminsistrative Rules (LCAR) reviewed the Board's proposed rule, but has not approved them. At LCAR's request, parties opposing the proposal, the Agency and the Board are all in discussions to develop a revised proposal, including a process for developing future typing and classification proposals.

The White River Basin Plan differs from other plans in that the Vermont DEC did not form a watershed council in the White River Basin, but instead, based the plan on its collaborative work with the White River Partnership and other entities in the watershed. The concept of a separate watershed council guiding the planning process in each watershed did not develop until after the work on the White River Basin Plan was well underway.

The White River Partnership formed in 1995 as a group of local citizens interested in preserving the quality of life in the White River Basin. It has become a forum for bringing together the community, local, state, and federal government agencies, and their resources to protect common interests.

Watershed Initiatives

Activity	Status	Comments/Information
Public forums held	C	Four public forums were held in 2000.
Watershed Council formed	C	The White River Partnership and others served this function.
Local water quality issues identified	C	Top local water quality issues included stream channel instability and streambank erosion, lack of awareness of water quality problems, public access, impacts to fisheries
Panel discussions on water quality issues were held	C	Technical staff participated in development of strategies, gave presentations during public hearings.
Strategies for water quality issues formed	C	Strategies were developed to resolve each priority water quality issue.
White papers on WQ issues	C	Eight water quality issue fact sheets were developed.
Review of town plans and zoning	C	All town plans and regulations were reviewed.
Develop water management type (WMT) classification proposal	C	A water management typing proposal was developed based on existing, reasonably attainable, and desired water quality.
Meetings with individual towns on the WMT classification	C	Information about the typing proposal went to all watershed towns. DEC met with 17 selectboards and

proposal		planning commissions, 1 conservation commission.
Draft basin plan	C	Working Draft Fall 2001.
Public hearings on draft plan	C	September 2002.
Final basin plan	C	Signed and published November 2002.
Outreach to area schools and local groups	C	DEC did outreach throughout planning process. Ongoing outreach by the White River Partnership.
Basin Assessment Report	C	An updated report was done in November 2002.
Phase I Stream Geomorphic Assessments	C	Completed on upper White, First, Second, Third Branches and numerous tributaires.
Phase II Stream Geomorphic Assessments	C	Completed on many of the rivers and streams for which Phase I was done (see above).
Bridge and Culvert Inventory		
Dam Inventory	C	Field inventory done.
Biological Monitoring	C	Additional waters sampled (biological monitoring) to bracket possible sources of pollution and determine long-term water quality trends.
Restoration/Protection Projects Underway	O	Numerous watershed and restoration projects are underway watershed wide (see below)

Key: I = initiated, O = ongoing, C= completed

River and Stream Restoration Projects

Waterway	Water Quality Concern	Current Actions
Ayers Brook	Stream bank stability	DEC river management program assisted the White river Partnership in writing a grant application to begin a river management planning process to identify unstable streambanks where stabilizing vegetation should be planted
Watershed-wide	Unstable Streams	The DEC river management program is working with the White River Partnership to implement river restoration/protection projects in fulfillment of numerous basin plan strategies.
White River	Stream bank stability and runoff	DEC continued assisting the Hartford Conservation Commission in developing a draft buffer protection ordinance.
Smith Brook	Metals (iron)	The Solid Waste Division and the Water Quality Division identified an old, unpermitted landfill as the source of iron leachate.
Watershed-wide	Aquatic Nuisance Species	The DEC biomonitoring section assisted the White River Partnership in monitoring for Rusty Crayfish and harvesting.

Plans for 2006

Plans for 2006 include adoption of the surface water management typing petition by the Water Resources Panel. The Watershed Coordinator will continue to proactively initiate watershed

improvement projects, and protect high quality sites with watershed partners, state and federal government agencies, landowners, and municipalities in accordance with the adopted White River Basin plan. The Watershed Coordinator will also follow the guidelines or rules adopted by the Water Resources Panel to revise the petition for Typing of waters within the basin.

West, Williams, Saxtons Rivers Basin Progress Report – Basin 11

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Introduction

The West River Watershed Alliance (WRWA) and its partners, the Windham County Natural Resources Conservation District (WCNRCD), the Windham Regional Commission (WRC) and the South Windsor County Regional Planning Commission (SWCRPC), since 2003 have been conducting their own locally-driven and supported basin planning process in the West, Williams, and Saxtons River watersheds – state-designated Basin 11. The planning initiative has been a cooperative effort with the Vermont Agency of Natural Resources, specifically its Department of Environmental Conservation (VT DEC), the WRWA and its partners, following state basin planning guidelines, that involved agencies, organizations and the public in developing a document designed to help maintain and improve surface water quality for the three watersheds.

The concept of watershed planning is not new to southeastern Vermont. In November 1998, a group of citizens, including representatives from over twenty state and local agencies and community organizations, met to develop ideas for community-based actions in the West River watershed. By 2000, the group had created an action plan describing an ambitious role for the new grassroots organization that included stream habitat improvement, stream bank restoration, community watershed education, and river advocacy in the watershed. The WRWA then began to implement several projects identified in its action plan.

In 2002 WRWA and its partners became interested in the State's Basin Planning Initiative. However, as the State's program could not provide a state-employed watershed planner for Basin 11 for several years, the three partners saw this as an opportunity for their organizations to open venues that would help protect and preserve natural resources - a theme explicit in their respective missions. The basin planning process itself would create opportunities to bring water quality issues to the public forefront. The WRWA with its partners collectively took on the responsibility for implementing the planning initiative for the three watersheds as a locally-supported grassroots program hoping to address existing and proactively arrest potential water quality issues that had developed or could develop in these watersheds. With encouragement and technical support from the VT DEC, the WRWA has successfully provided the organizational umbrella to harbor the collaborative partnering effort.

Following State basin planning guidelines, the WRWA sponsored three public forums during 2004. Forum participants and other interested parties formed the Basin 11 Watershed Council which has met regularly since April 2004. In that time, over 30 Federal, State, local agencies and non-profit organizations have committed personnel to serve as technical resource professionals for the Council. Seven issue-based focus groups or Roundtable Discussions have revolved around specific watershed problems such as erosion control, storm water runoff, deforestation and buffer loss, flow regulation and flood control, and swimming holes. Focus groups reports and white papers derived

from Roundtable discussions have been presented to the Watershed Council for proposed inclusion into the basin plan. More details about the Basin 11 are presented in the accompanying tables.

From its beginnings, the goals and objectives defined in the WRWA's original action plan have been consistent with those of Vermont DEC's basin planning initiative. Because of this the WRWA and its partners have implemented certain activities which support both organizational and basin planning objectives. Projects and activities identified by the WRWA that are now being conducted within the context of basin planning are outlined in the tables presented below

The Windham County NRCD, WRC, SWCRPC and WRWA have been enabled in this important project obtaining monies from EPA Section 319 and Section 604B grants, Connecticut River Joint Commissions, New England Grassroots Environmental Fund, Windham Foundation, and Vermont Watershed License Plate Grants. These and other funds have afforded the hiring of a part-time Windham County NRCD Watershed Coordinator, provided for associated basin planning expenses, and funded specific erosion-control project costs, while allowing administrative and program oversight from the Windham County NRCD District Manager, and professional staff assistance, public meeting coordination, writing contributions, and GIS capabilities and technical support from WRC and SWCRPS. In spite of limited financial resources, the dedicated grassroots effort has continued to achieve notable and exemplary accomplishments in supporting basin planning goals culminating with a draft preliminary basin plan scheduled for Watershed Council and Vermont DEC review in January 2006.

Watershed Initiative Status

Activity	Done	Comments/Information
Public forums held	C	One public forum was held in each of three watersheds in 2004. Tech Resource personnel were identified and invited. Letters to town officials sent. Public announcements, newspaper articles, email list-server postings, posters and flyers distributed.
Watershed Council formed	C	First meeting held April 1, 2004. Council meets bi-monthly at various locations to include all three watersheds. RPCs and Watershed Coordinator present regular updates. At each meeting a specific focus area is presented and discussed
Local WQ concerns identified	C	WRWA Action Plan (1999) had previously identified concerns and issues. Forum participants in 2004 have added others to the list. Focus groups have further refined lists of concerns while prioritizing issues
Panel discussions on WQ issues held	C	Members of specific focus groups have presented reports to Watershed Council at each council meeting since April 2004, public is invited to attend and participate in question and answer discussions. RoundTable Discussions (RTD) were inaugurated into the Basin 11 Water Council meeting format to examine issues and solutions – six RTDs were conducted in 2005
Strategies for WQ issues formulated	C, O	Seven focus groups had been designated to prioritize and develop strategies to address identified issues. Swim Hole/Public Access, Stream Action, Dams and Flow

		Regulation, Education, have met regularly in 2004… strategies have been formulated and were presented to the Watershed Council in 2005. Projects planned, some implemented in 2005. A Stream Typing group has met since August 2004 to forward the typing and classification process. Land Use, Water Withdrawal and Roads RTDs were held to address respective issues in 2005.
Draft white papers for WQ issues	C	WCNRCD Watershed Coordinator has incorporated focus group and RTD recommendations into the preliminary draft basin plan
Review of town plans and zoning	O	WRC & SWCRPC, through 604B funding in 2003, 2004 and 2005 have conducted an on-going project to review town plans.
Develop water management type classification proposal	O	A stream typing group, comprised of reps from WRC, SWCRPC, WRWA, WCNRCD, VT Dept of F&W, and other concerned citizens, has met since August 2004 to devise and move forward with the Basin 11 classification process. In 2005 preliminary GIS mapping was completed by both RPCs to show typing determinations.
Meetings with individual towns on WMT classification proposal		Planned to begin Fall in 2005 with preliminary discussion with towns. Final review on hold awaiting WRB decision.
Watershed plan draft	O (C?)	Preliminary Draft Basin Plan in progress, Watershed Council and VT DEC review period for preliminary draft plan anticipated to begin late January 2006
Public hearings on draft plan		Spring 2006
Final basin plan		Scheduled for Summer 2006
Outreach to area schools and local groups	C, O	Outreach to area schools begun through Education Focus group. The WQ monitoring program has expanded to include special grant projects for area middle school and high school students. Macroinvertebrate lab facilities set up at Landmark College. WRWA promotes basin planning initiative to its partners and organizational members. Basin Planning concepts have been presented to VT Legislators and local planning commissions. Letters have been sent to all Town officials in Basin 11. Rock River Focus Group involves town officials, and local organizations. Articles and press releases have appeared in local newspapers and on list serves. Local TV info-mercials have been created to promote river stewardship, the sampling program, and basin planning projects. WCNRCD has developed a Basin Planning website.
Basin Assessment Report completed	C	Information incorporated and referred to in the Basin 11 draft plan

Phase I Stream Geomorphic Assessments done	C, O	All Phase 1 field surveys and SGAT data entry completed for Ball Mountain Brook watershed
Phase II Stream Geomorphic Assessments done	C,O	Connecticut River Joint Commissions grant and Section 319 monies funded Phase 2 assessments in 26 reaches of Ball Mountain Brook – completed November 2005. Report submitted to VT DEC December 2005. The Ball Mountain Brook project has served as a pilot study for further SGA work in Basin 11. The CRJC has approved reallocation of 2005 funds to begin Phase 1 work in the Rock River early winter 2006. WRWA is working with The Nature Conservancy to fund and initiate Phase 1 and 2 of the West River main stem in summer 2006. Grant proposal for Clear and Clear funding will be submitted in January 2006.
Bridge and Culvert Inventory (B&C)	O	Several towns in Windham County have inventories completed as part of each town's GIS initiatives. Result of RTDs concerning road maintenance issues have initiated discussions with VTrans and private consultants to conduct B&C inventories in other Basin 11 towns. SGA Phase 1 survey compiled field data has added to data base.
Dam Inventory	I	State inventory provides information for larger impoundments. Dam Focus group has recommended survey of small dams in Basin 11.
Biological Monitoring	O	In 2003 and 2004 WRWA volunteers conducted macro invertebrate monitoring and habitat assessments at 10 sites in Basin 11. WRWA worked with VT DEC to screen potential sites for State sampling. MacroLab set up at Landmark College, Winter 2005. State biological monitoring is on-going in areas of Basin 11 – as described in the Basin 11 Watershed Assessment 2001.
Restoration/Protection Projects Underway or Completed in 2005	O, C	1) Dummerston Covered Bridge Steps erosion control project and Park & Ride lot (C, 2005) 2)Dummerston Covered Bridge rain garden project planning underway. (I, 2005) 3) Williamsville Station access trail erosion control project (C, 2005) 4) Ball Mountain Brook Stream Geomorphic Assessments Phase 1 and 2 (C, 2005) 5) WRWA Water Quality monitoring program and public reporting (I, 2003, on-going) 6) Macroinvertebrate sampling and processing program (I, 2003,on-going) 7) South Windsor County RPC Williams River Assessment Project (C, 2005) 8) Brattleboro Union High School Water Quality Monitoring Project designed and conducted (C, 2005) 9) Retreat Meadows aquatic invasive species control outings and public education seminars offered by WRWA and

		Town of Brattleboro. 10) WHIP projects – developed collaboratively with USDA-NRCS and Windham County NRCD (O, 2005) 11) Saxtons River bank stabilization and riparian buffer project – USDA- NRCS (C, 2005) 12) Invasive species workshop conducted sponsored by the VT Department of Forests, Parks and Recreation in cooperation with the Windham County NRCD (C, 2005) 13) Town of Jamaica stream restoration project proposed and under consideration (I, 2005) 14) Rock River Inventory conducted (C, 2002) 15) West River Clean-Up day organized in cooperation with the Connecticut River Watershed Council, and conducted by WRWA volunteers.(C, 2005) 16) Watershed Coordinator, WRWA, collaboration with The Nature Conservancy to develop "Sustainable Rivers" project concerning USACE Dam operations in the West River. Leading to a formal agreement between TNC and USACE to conduct stream studies on West River (C, 2005, on-going)

* I = initiated, O = ongoing, C= completed

River and Stream Restoration Projects due to WRWA/WRC/WCNRCD Watershed Planning Initiative*

Waterway	Water Quality Concern	Current Actions
West River, Williams, Saxtons Rivers and their tributaries	1) Sedimentation and thermal modification due to riparian vegetation removal, 2) Flood control dams, erosion and flow alteration 3) High levels of bacteria due to storm water runoff. 4) Stream bank erosion 5) High use of swimming holes and associated environmental, public health and safety impacts in lower West River mainstem.	1) WRWA Implemented Volunteer Basin11 WQ monitoring program, 2003, 2004 2) WRWA Implemented Basin 11 Macro-invertebrate monitoring program 2003, 2004, 2005 3) WRC Public Access/Swim Hole inventory with Section 604B and WCNRCD improvement projects as part of Section 319 Workplan 4) Public outreach concerning, basin planning, bacterial levels, and storm water runoff via articles and letters in local news media. *Rivers of Windham County* brochure developed with WRWA and River Bank Media. 5) WRWA project coordination and partnership with agencies and organizations including the The Nature Conservancy, US Forest Service, Student Conservation Association, US F&W, Trout Unlimited 6) Watershed Council Round Table Discussions

		to present USACE and VT DEC Flow regime and Dam Operations issues and agreements 7) Newly inaugurated NRCS Conservation Security Program to be promoted and initiated in West and Saxtons River watersheds as integral part of basin planning efforts. 8) Educational Kiosks designed, constructed, and installed (C, 2005) – on-going use with upkeep and postings by WRWA volunteers. 9) Swim Hole User Attitude survey 2003 and 2004, Results analysis (C, 2005 10) Landmark College collaboration for Macroinvertebrate lab set up and sample processing (I, 2005) – on-going) 11) WRWA basin planning initiative website development (I, 2005) –on-going. 12) Riparian Landowner workshop curriculum developed for Vermont Coverts (C,2003) 13) Windham County Rivers Brochure developed 14) Annual WCNRCD-sponsored "Envirothon" program offers instruction and friendly competition between area schools. 15) WRC initiated VTrans Traffic Safety Assessment at two local swim hole access areas 16) Annual salmon release presentations by Watershed Coordinator in West River watershed schools in cooperation with the U.S. Forest Service.
West River Main Stem	1) Sedimentation and stream bank erosion 2) High use of swimming holes along Rt 30.	1) Dummerston Covered Bridge erosion control "steps"project and Park & Ride enhancement project. 2) WRC safety assessment project addressing traffic and parking issues along Rt. 30 corridor with VTrans. Outreach to neighboring towns. 3) Dummerston Covered Bridge rain garden project planning underway. 4) Williamsville Station access trail erosion control project completed 5) Educational Kiosks designed, constructed, and installed– on-going use with upkeep and postings by WRWA volunteers. 6) Swim Hole User Attitude survey 2003 and 2004, Results analysis in 2005 7) West River "Clean Up Day" WRWA collaboration with CRWC in 2005 8) Retreat Meadows aquatic invasive species

		control outings and public education seminars offered by WRWA and Town of Brattleboro.
Ball Mountain Brook	1) Geomorphic instability, flooding, historic channel modification and transportation infrastructure	1) Phase 1 and Phase 2 Stream Geomorphic Assessments (SGA) conducted. Phase 2 to completed 2005. 2) Water quality monitoring and review of bridge and culvert surveys. 3) WRWA proposed cooperative restoration project with Town of Jamaica pooling SEP funds 4) Ball Mountain SGA reports and presentations to Jamaica Select Board members 2005.
Rock River	1) Geomorphic instability, flooding, and transportation infrastructure	1) NRCS Stream bank restoration project 2002 as identified in WRWA Action Plan 2) Riparian buffer inventory 2001 3) Watershed Coordinator work with riparian landowners to preserve public access, reduce erosion, and ensure safe conditions at Indian Love Call swim hole. 4) Rock River trail erosion and Roundtable discussions and recreational planning for Indian Love
Williams River	1) Lack of public involvement with water quality issues 2) Nutrient enrichment and high bacteria levels in specific areas	1) Formation of new Chester Conservation Committee to work with the SWCRPC basin planning efforts 2) Brattleboro Union High School WQ Monitoring Project in the Williams River. BUHS WQ results included in WRWA's WQ 2005 monitoring report. 3) South Windsor County RPC Williams River Assessment Project funded by 604B. conducted in 2005
Saxtons River	1) Geomorphic instability, flooding, and transportation infrastructure	1) WHIP projects developed collaboratively with USDA-NRCS and Windham County NRCD 2) Saxtons River bank stabilization and riparian buffer projects with the USDA- NRCS 3) WRC's Route 121 highway construction project completed adjacent to the Saxtons River.

Plans for 2006

With the completion of the preliminary draft plan and the recent hiring of a new State Watershed Coordinator, the Basin 11 program will now follow a new tact into the future. Although the WRWA and its partners will continue to follow the planning schedule as it has been laid out by the Basin 11 Watershed Council, the Windham County NRCD Watershed Coordinator will retire in January 2006. The new State Watershed Coordinator will work with the local partnership, overseeing the Basin 11 Management Plan through the public review process while implementing water quality projects as prescribed in the 5-year plan.

Conclusion

2005 has been an exceptionally productive year in the Basin 11 watershed. The collaboration of local towns in erosion control projects and the cooperation of state and regional agencies in planning and implementation has lead to a number of completed projects. With this support and the new staff support from the Agency of Natural Resources 2006 should bring further improvements to the watershed.

Wells, Waits, Stevens and Ompompanoosuc River Basin Progress Report – Basin 14

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Introduction

A DEC Watershed Coordinator has been actively engaged in the Wells, Waits, Ompompanoosuc, and Stevens Rivers basin for approximately two years. Much of the work this year has been focused on planning and assessment but some watershed restoration projects were completed as well. Watershed Council meetings have been held on average every two months for each of the four subwatersheds to develop strategies to address the major community concerns in each watershed. Draft white papers have been written for a majority of the issues in the basin.

Assessments completed in the watershed in 2005 include: phase 2 geomorphic assessments of the Stevens River watershed and the West Branch of the Ompompanoosuc River; phase 1 geomorphic assessments of the Waits River watershed and for the remainder of the Ompompanoosuc River watershed; a bridge and culvert assessment of the Ompompanoosuc River watershed. Finally a water quality testing program for the Stevens River was initiated by the Stevens River watershed council and the Peacham Conservation Commission.

Projects completed in the watershed this year include two riparian restoration projects done in conjunction with the phase 2 geomorphic assessment of the Stevens River. The Ticklenaked Pond Association also completed its watershed grant - planting riparian vegetation and carrying out a barnyard improvement project. The coordinator has also participated in meetings and site visits regarding the DEC and EPA remediation of the Elizabeth Mine superfund site. Accomplishments include: the completion of the stabilization of the largest tailings pile on the site, the design for the next phase of work to begin next summer with funding of approximately 3 million dollars, and the development of the final remediation plans.

Watershed Initiatives

Activity	Status	Comments/Information
Public forums held	C	Five public forums were held in 2004.
Watershed Council formed	C	Watershed Councils were formed in 2004 in each of the four watersheds.
Local water quality (WQ) issues identified	C	Local water quality issues have been identified in each of the four watersheds
Panel discussions on WQ issues held	C	Panel discussions were held in 2004
Strategies for WQ issues formulated	O	Strategies for a majority of the WQ issues have been formulated

Review of town plans and zoning	O	Town plan and zoning regulations have been reviewed
Develop water management type (WMT) classification proposal	O	Initiated but on hold until the process for WMT is resolved for the White River basin
Meetings with individual towns on the WMT classification proposal		
Draft basin plan	I	The compilation of draft white papers into a draft plan has been started.
Public hearings on draft plan		
Final basin plan		
Outreach to area schools and local groups	O	The Watershed Coordinator made presentations to the Wells River Rotary, the White River Natural Resource Conservation District, and conducted a watershed education workshop for the Wells River Conservation Day Camp.
Basin Assessment Report	C	The basin assessment report was completed in April 1999.
Phase I Stream Geomorphic Assessments	O/C	Phase 1 assessments were completed on the Stevens River and Ompompanoosuc West Branch in 2004, on the Waits River and remaining area of the Ompompanoosuc River in 2005, and are propsed for the Wells River in 2006.
Phase II Stream Geomorphic Assessments	O/C	Phase 2 assessments were completed for the Stevens River watershed and West Branch of the Ompompanoosuc River.
Bridge and Culvert Inventory	O/C	Bridge and culvert surveys were completed in the Stevens River watershed in 2004 and in the Ompompanoosuc River watershed in 2005.
Dam Inventory		A dam inventory has been proposed for all 4 watersheds.
Biological Monitoring		Scheduled for 2007
Restoration/Protection Projects Underway	O	See below

Key: I = initiated, O = ongoing, C = completed

River and Stream Restoration Projects

Waterway	Water Quality Concern	Current Actions
Ticklenaked Pond-impaired	Excessive phosphorus	The watershed coordinator worked with the Ticklenaked Pond Association on buffer plantings and a barnyard improvement project. A TMDL study of the lake and its tributaries has been initiated by the Lakes and Ponds section.

Stevens River, Barnet	Lack of woody riparian buffer and streambank erosion	The Caledonia NRCD planted woody buffers along the Stevens River at two sites and there are proposals for more riparian restoration projects next year. The establishment of woody stream corridors has been identified as a watershed planning priority.
West Branch of the Ompompanoosuc River, Strafford	Significant streambank erosion and lack of woody riparian buffers	The Strafford Conservation Commission has completed a Phase 2 and bridge and culvert survey of the West Branch in Strafford and a rough alternatives analysis of possible restoration sites. An additional proposal for Phase 2 assessment and restoration has been submitted for 2006.
Copperas Brook and the West Branch of the Ompompanoosuc River, Strafford and Thetford	Acid mine drainage	The largest tailings pile on the site has been stabilized and 3 million dollars of funding has been received to continue remediation in 2006 and 2007.

Conclusion and Plans for 2006

In 2005, strategies have been developed to address the major water quality concerns in the basin and compiled into draft white papers. These draft white papers will be compiled into a draft plan in 2006. Numerous assessments of basin watersheds were completed this year and more are planned for next year. These assessments have already led to effective water quality improvement projects in the Stevens and Ompompanoosuc Rivers. Projects already planned for next year include: road improvement and riparian restoration projects in the Stevens River watershed based on phase 2 geomorphic assessments and bridge and culvert surveys, and the restoration and protection of riparian lands on the West Branch of the Ompompanoosuc river. Funding and partners will be sought to complete Phase 1 geomorphic assessments of the Wells River and Phase 2 geomorphic assessments of priority sections of the Waits, Wells, and unassessed portions of the Ompompanoosuc Rivers.

Surface water quality testing will continue at Ticklenaked Pond as part of the TMDL study, and funding will be sought to continue the Stevens River water quality testing program. Outreach will continue to local camps, schools, and community groups. The process of surface water typing will continue through the collection of monitoring and assessment data, the review of town plans and zoning, and presentations to municipalities and the watershed councils.

Conclusion

Overall, the watershed initiative is being received very positively and it is, in several instances, already measurably restoring the waters of the state. Watershed residents are active on Watershed Councils or similar organizations, on stream teams, sub-watershed organizations and on focus groups. By encouraging local citizens to lead discussion of water quality issues about their own waters, people with common interest in clean water have arrived at practical, proactive approaches that bring out the best in Vermonters. People are generous in offering their ideas in forming strategies for their watersheds and they also participate in actions to correct and protect impaired waters in the near and long-term. As a result of this participation we have begun to see restoration in certain impaired waters.

Through the process an enormous amount of "deferred maintenance" has been discovered in our watersheds that will take years of systematic work and years to correct. The groundswell of participation from the Missisquoi Bay in the north to the West River in the south; from the Poultney Mettowee and Otter Creek Watersheds in the west to the White River and Stevens, Wells, Waits, and Ompompanoosuc River Watersheds in the east is very valuable. Many further projects will be guided by citizens with the technical help of Watershed Coordinators as the foundation by which the goals of enhanced water quality will be accomplished. DEC is enlisting the participation of land owners in urban and rural watersheds to control of the flow of phosphorus to Lake Champlain to achieve the water quality goals spelled out in the "Lake Champlain Phosphorus TMDL", the "Opportunities for Action" and the mission of the Vermont Clean and Clear Program. Projects are implemented to address the obvious sources of pollution now and not waiting for the perfect plan. DEC encourages all professions and individuals to join us in examining how our actions can be modified for the benefit of our waters.

We also encourage all involved to arrive at a practical and expeditious process to make typing and classification a useful and timely method to set goals to enhance the waters of the state.

APPENDIX B

Vermont Point Source Control Program Update

Table B.1. Status of Phosphorus Removal/Reduction Projects.

Municipality	Construction Status	Comments
***** LAKE CHAMPLAIN DRAINAGE *****		
Barre City	completed	
Brandon	completed	
Burlington (North)	completed	
Burlington (Main)	completed	
Burlington (East)	completed	
Cabot	completed	
Castleton	completed	
Enosburg Falls (Phase 1 - chem)	completed	
Essex Junction	completed	
Fair Haven	completed	
Hinesburg	completed	
Johnson	completed	
Middlebury	completed	
Milton	Temporary system completed	Permanent system under construction in 2005
Montpelier	completed	
Morrisville	completed	
Northfield	completed	
Poultney	completed	
Richmond	completed	
Rutland City	completed	
South Burlington (Bartlett Bay)	completed	
South Burlington (Airport Parkway)	completed	
Shelburne (Plant #1)	completed	
Shelburne (Plant #2)	completed	
St. Albans City & NW Correctional Facility	completed	
Stowe	completed	
Swanton	completed	
Vergennes	completed	

Municipality	Construction Status	Comments
West Rutland	completed	
Winooski	completed	
***** LAKE MEMPHREMAGOG DRAINAGE *****		
Barton Village	completed	
Newport City	completed	
Orleans	completed	

Table B.2. 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)	completed	
Northfield	completed	
Poultney	completed	
Richford	partially completed	monitoring 2 CSO's
Rutland City (Phase 1)	completed	
Rutland City (Phase 2A)	completed	
Rutland City (Phase 2B)	pending	monitoring Phase 2A
Swanton	completed	
Vergennes	completed	
****** LAKE MEMPHREMAGOG DRAINAGE ******		
Barton	completed	
Newport City	partially complete	monitoring
Orleans	completed	
****** CONNECTICUT RIVER DRAINAGE ******		
Bellows Falls	completed	
Hartford	partially completed	Order issued to abate remaining 2 overflows
Ludlow	completed	
Lunenburg	completed	
Lyndon	completed	
Randolph	completed	
Springfield (Phase 1)	completed	
Springfield (Phase 2)	initiated 2004	completion by 2006 (delay to 2011 due to funding being requested by the Town

Municipality	Construction Status	Comments
St. Johnsbury (Phase 1)	complete	
St. Johnsbury (Phase 2)	initiated 2005	
St. Johnsbury (Phase 3A)	scheduled for 2010	
St. Johnsbury (Phase 3B)	scheduled for 2010	
St. Johnsbury (Phase 4)	scheduled for 2010	
Wilmington	completed	
Windsor	completed	

Appendix C

2006

VERMONT SURFACE WATER ASSESSMENT METHODOLOGY

including

VERMONT LISTING METHODOLOGY

In accordance with
USEPA 2006 Guidance

Prepared by:
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September 9, 2005

Table of Contents

Executive Summary

The federal Water Pollution Control Act, also known as the Clean Water Act, requires the State of Vermont and each of the other forty-nine states to develop and submit to the US Environmental Protection Agency two surface water quality-related documents. The documents, to be prepared every two years, arise out of two sections of the Act. Section 305b of the Act requires submittal of a report that describes the quality of the State's surface waters and that contains an analysis of the extent to which its waters provide for the protection and propagation of a balanced population of fish, shellfish and wildlife. This analysis is also referred to as the extent to which Vermont's waters achieve the Act's fishable and swimmable goals. The biennial Vermont Water Quality Assessment Report is commonly known as the "305b Report."

The second document, developed in response to Section 303d of the Act, is a listing of surface waters that:

1) are impaired or threatened by one or more pollutants; and,
2) are not expected to meet Water Quality Standards within a reasonable time even after the application of best available technology standards for point sources of pollution or best management practices for nonpoint sources of pollution; and,
3) require development and implementation of a pollutant loading and reduction plan, called a Total Maximum Daily Load, which is designed to achieve Water Quality Standards.

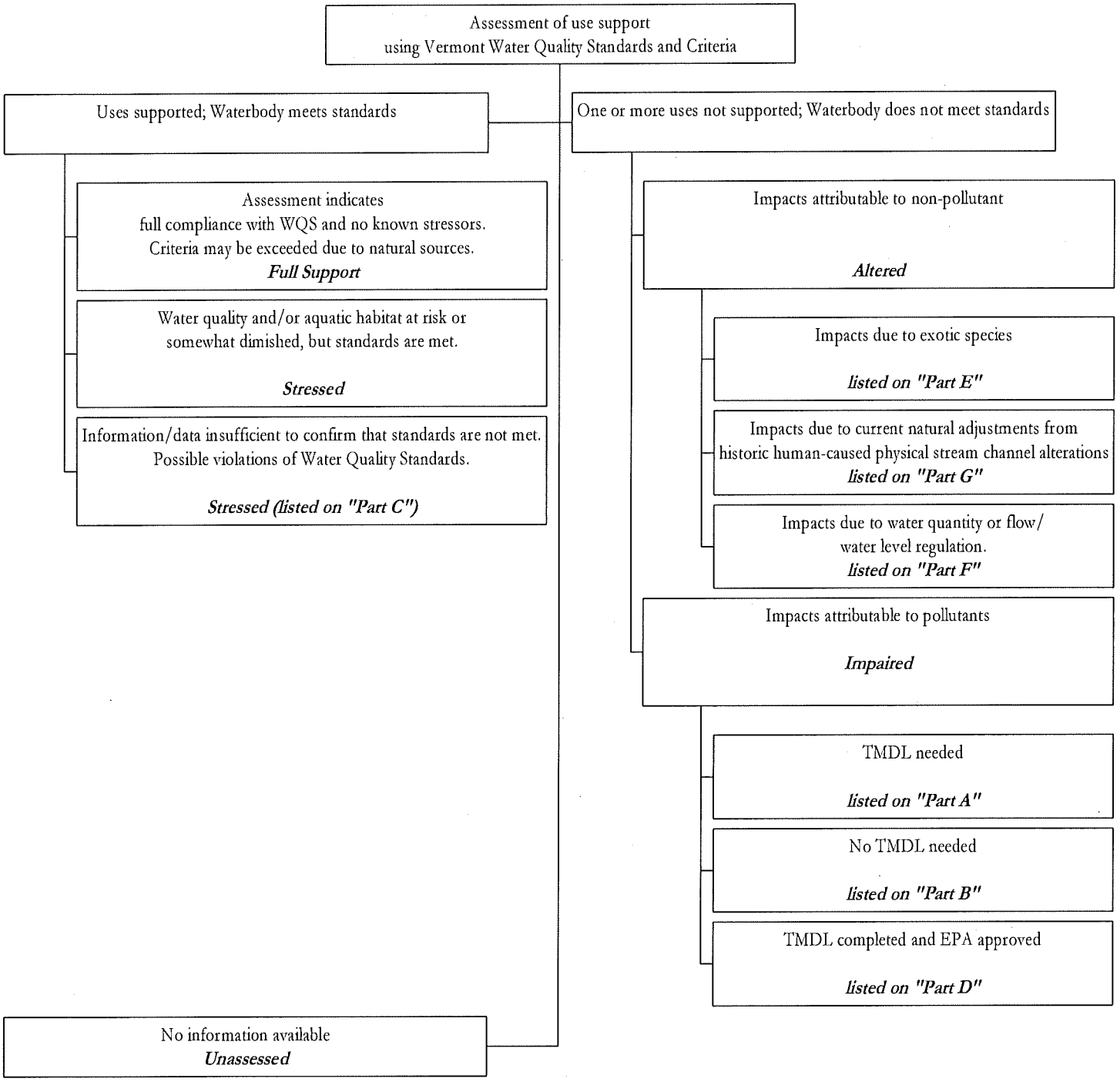
The collection, analysis and evaluation of water quality monitoring data and other information represent the assessment of a water's condition. The assessment of a water is most accurate when judgements about the water's condition are made using chemical, physical and/or biological data of known reliability collected through monitoring. While not as reliable as data collected though monitoring, an assessment of a water's condition can also take into account opinions, observations or other qualitative information.

The Vermont Water Quality Standards, revised and promulgated by the Vermont Water Resources Board, provide the basis used by the Vermont Department of Environmental Conservation in determining the condition of surface waters including whether the water meets (attains) or does not meet (exceeds or violates) certain criteria. The assessment of a water's condition within the context of the Water Quality Standards requires consideration of the water's classification and management type, a variety of designated or existing uses, and a series of criteria which can be numerical or narrative. The outcome of an assessment conducted by the Department is to categorize Vermont's surface waters as either "full support," "stressed," "altered," or "impaired." Over time, the Department is gradually reducing the number of waters characterized as "unassessed."

This document describes the process used by the Department of Environmental Conservation when making water quality attainment decisions to fulfill 305b reporting and 303d listing requirements. The document contains an overview of the Water Quality Standards (Chapter 2); a description of water quality monitoring approaches that are utilized and their linkage to assessment efforts (Chapter 3); the four assessment categories and the factors and decision principles applied when evaluating data and other information to determine if a water meets the Standards (Chapter 4); and, the rationale when deciding where and how to list a particular water (Chapter 5). The chart that appears on the following page illustrates the major components of DEC's assessment and listing process.

Originally prepared as the 2004 Assessment and Listing Methodology, the document was the subject of a public meeting conducted by DEC on March 30, 2004 and held in Waterbury, Vermont. A three-week period for comment followed the meeting and a comment responsiveness summary was developed. The responsiveness summary can be obtained upon request.

Chart Depicting Organization of Vermont's Water Quality Assessment and Listing Methodology



Chapter One. Introduction to Surface Water Assessment Methodology

The Vermont Department of Environmental Conservation is charged with implementing the Vermont Water Quality Standards. As part of this responsibility, the Department must characterize the quality of Vermont's surface waters and determine what factors or stressors may be bringing about observed changes. In Vermont and nationwide, significant emphasis is placed on how the condition of surface waters is determined and whether waters are in compliance with the applicable water quality standards. The methods used for making these determinations are important as the determination of whether the waters meet or do not meet the water quality standards informs and directs water quality management strategies for each waterbody and may lead to significant regulatory consequences. It is essential that determinations are accurate and defensible.

Surface water assessment is part science and part careful observation of the causes of the measured conditions. Assessment begins with an examination of the water's chemical, physical and biological condition, and the causality of the conditions observed. Data is used to estimate the water quality standards "attainment status"of waters. Selecting representative data with known and quantifiable precision is the first step in assessing standards attainment. If a waterbody is determined not to attain one or more criteria of the Vermont Water Quality Standards, then it is first necessary to determine whether or not the impact to the surface water is of natural or anthropogenic origin. Identifying the actual cause of impairment will also have considerable bearing on decisions about what approach to initiate to restore the waterbody. The Department studies what is unique about a waterbody to enable it to rank restoration and protection activities and to understand how waterbodies will respond to management actions. The Department also seeks to provide avenues for Vermont's citizenry to contribute in a meaningful way to the protection and improvement of waters.

This document is part of the year 2006 biennial water quality assessment reporting and listing process. The document explains how the Vermont Department of Environmental Conservation (DEC) carries out surface water quality monitoring and assessment activities and how it makes decisions on a regular basis regarding a water's condition based on the Vermont Water Quality Standards. It also describes how DEC considers certain factors and how DEC makes decisions when interpreting the meaning of samples and observations obtained through monitoring efforts, whether monitoring information is generated by DEC or by others. This document does not describe DEC's broad array of monitoring programs.

Throughout the Assessment and Listing Methodology document, the terms "waters" and "water resources," are used generically and mean lakes and ponds, streams and rivers, wetlands and even watersheds. The Department does not conduct or carry out any systematic monitoring on many types of waterbodies including wetlands, vernal pools, lakes and ponds less than five acres, closed trout waters, rivers and streams not considered "wadeable," ephemeral or intermittent streams. This Assessment and Listing Methodology document is evolving and reflects the ever-improving methods available for water quality monitoring and interpretation. Vermont's citizenry, Federal and academic collaborators, and regulated entities are encouraged to view the Assessment and Listing Methodology with an eye towards where and how they can improve or add to the quality of data and other information used to understand, protect, and improve Vermont's water resources.

Chapter Two. Vermont Water Quality Standards

2.1. Overview

The Vermont Water Quality Standards are the foundation for the state's surface water pollution control and surface water quality management efforts. The Water Quality Standards (Standards or WQS) have been promulgated by the Vermont Water Resources Board (now known as the Water Resources Panel) and provide the specific criteria and policies for the management and protection of Vermont's surface waters. The classification of waters (rivers, streams, lakes and ponds) as Class A, Class B or Class B with Waste Management Zone are the management goals to be attained and maintained. The classification also specifies the designated water uses for each class. The current Vermont WQS were adopted June 10, 1999 and became effective July 2, 2000.

The Vermont WQS establish narrative and numeric criteria to support designated and existing uses. Designated uses, as established in Sections 3-02(A), 3-03(A) and 3-04(A) of the Standards, mean any value or use, whether presently occurring or not, that is specified in the management objectives for each class of water. The following table serves to indicate applicable designated uses.

Table 2.1. Designated Uses for Water Classifications.

Designated Uses	Class A(1) – Ecological Waters	Class A(2) – Public Water Supplies	Class B Waters
Aquatic Biota, Wildlife & Aquatic Habitat	√	√	√
Aesthetics	√	√	√
Swimming & Other Primary Contact Recreation	√		√
Boating, Fishing & Other Recreation Uses	√		√
Public Water Supplies		√	√
Irrigation of Crops & Other Agricultural Uses			√

Existing uses of waters and the level of water quality necessary to protect those uses is to be maintained and protected regardless of the water's classification. 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 and whether or not the use is presently occurring. Determinations of what constitute existing uses of a particular water are made either during the basin planning process or on a case-by-case basis during consideration of an application by the Secretary of the Vermont Agency of Natural Resources (ANR). In making a determination of existing uses, the VTANR shall consider at least the following factors:

a) aquatic biota and wildlife that utilize or are present in the waters;
b) habitat that supports existing aquatic biota, wildlife, or plant life;
c) the use of the waters for recreation or fishing;
d) the use of water for water supply, or commercial activity that depends directly on the preservation of an existing high level of water quality; and,
e) with regard to the factors considered under paragraphs (a) and (b) above, evidence of the use's ecological significance in the functioning of the ecosystem or evidence of the use's rarity.

Chapter Four of this Assessment Methodology describes DEC's approach towards assessing the level of support of these designated and existing uses, in light of the criteria established in the Water Quality Standards.

2.2. Surface Water Classification & Typing

All surface waters in Vermont are presently classified either Class A or Class B. Waters designated as Class A(1) are Ecological Waters, managed to maintain an essentially natural condition. Waters designated as Class A(2) are Public Water Supplies. There may be a change from the aquatic biota, wildlife and aquatic habitat reference condition due to the fluctuations in reservoir water level and in the reduction in streamflow that result from water withdrawals for water supply purposes.

Class B waters comprise approximately 97% of all waters in the State. Class B waters are managed to achieve and maintain a level of quality that is compatible with designated uses. The Standards contain a requirement that all Class B waters shall eventually be designated as Water Management Type B1, Type B2 or Type B3. In designating a Water Management Type, the Vermont Water Resources Board must take into account attainable uses and the level of water quality already existing. Recommendations for Water Management Typing are developed during DEC's basin planning process. Once a basin plan is adopted by the Secretary of ANR, a petition for classification and Water Management Typing is prepared by DEC and submitted to the Vermont Water Resources Panel for their consideration and adoption.

IMPORTANT NOTE: This chapter and its two sections are meant to provide only a summary overview of the Water Quality Standards. Readers seeking additional and more detailed information about the Vermont Water Quality Standards, management objectives, specific criteria, classifications, and water management typing are encouraged to reference the Water Quality Standards. Copies of the Standards may be obtained from the DEC Water Quality Division. Persons may also access the Standards by visiting the web site of the Vermont Water Resources Panel (refer to www.nrb.state.vt.us/wrp/rules.htm).

Chapter Three. Monitoring Designs for Surface Water Assessment Purposes

There is no single way, on a statewide and ongoing basis, to assess the water quality conditions of every Vermont surface water in the context of the Water Quality Standards.[1] Consequently, the DEC water quality assessment methodology relies on a number of monitoring designs and approaches to determine the status of use support. This chapter provides a brief description of the four principle assessment approaches used by DEC. An abbreviated description of monitoring efforts conducted by the Water Quality Division and by its partners is described in Appendix A.

3.1. Rotational Watershed Assessment Approach

For the purposes of water quality management planning and implementation, which includes assessing and reporting water quality information, Vermont has been divided into seventeen major river drainage basins. Each major basin has from four to twenty-two river sub-basins or river mainstem segments. These sub-basins and mainstem segments and the various lakes and ponds are known as "waterbodies." There are a total of 208 river and stream waterbodies (37 as mainstem segments) and 574 lake and pond waterbodies designated throughout Vermont.[2] The seventeen major river basins are located in one of the four large regional drainages: Lake Champlain, Connecticut River, Lake Memphremagog, or Hudson River. The seventeen basins are presented in Figure 3.1 below.

In order to more comprehensively and thoroughly assess the State's surface waters and to take advantage of all existing and readily available sources of water quality information[3], the DEC Water Quality Division has designed and is carrying out a rotational watershed assessment process such that lakes, ponds, rivers and streams of all seventeen major basins are evaluated once every five years. To the extent possible, wetland function and value assessments also follow this rotation schedule. By focusing evaluations on selected basins each year, more systematic and intensive efforts can be made to collect and evaluate information related to the sources and causes of pollution. A focus on a limited number of watersheds also provides the opportunity for DEC to identify water quality trends, involve the general public and provide avenues for interagency coordination.

The rotation and schedule for each basin assessment is shown in Figure 3.1 below. The criteria used to determine which basins would be assessed in each year of the five-year cycle includes:

- Basins from more than one of the four regional drainage areas of the state (Lake Champlain, Connecticut River, Lake Memphremagog, Hudson River) are represented each year with special attention to including at least one Lake Champlain basin and one Connecticut River basin in most years;
- The sum of the basin areas assessed during any given year are roughly equivalent;
- The order of assessments in the next five-year cycle reflects known projects where an assessment is needed or where projects or major assessment studies are occurring (examples of projects needing assessment include hydroelectric facility re-licensing, basin planning with respect to point and nonpoint phosphorus reduction, and municipal wastewater facility upgrades or enlargements); and
- The order of the assessments considers watershed planning taking place in the adjacent jurisdictions of Massachusetts, New Hampshire, New York and the Province of Quebec.

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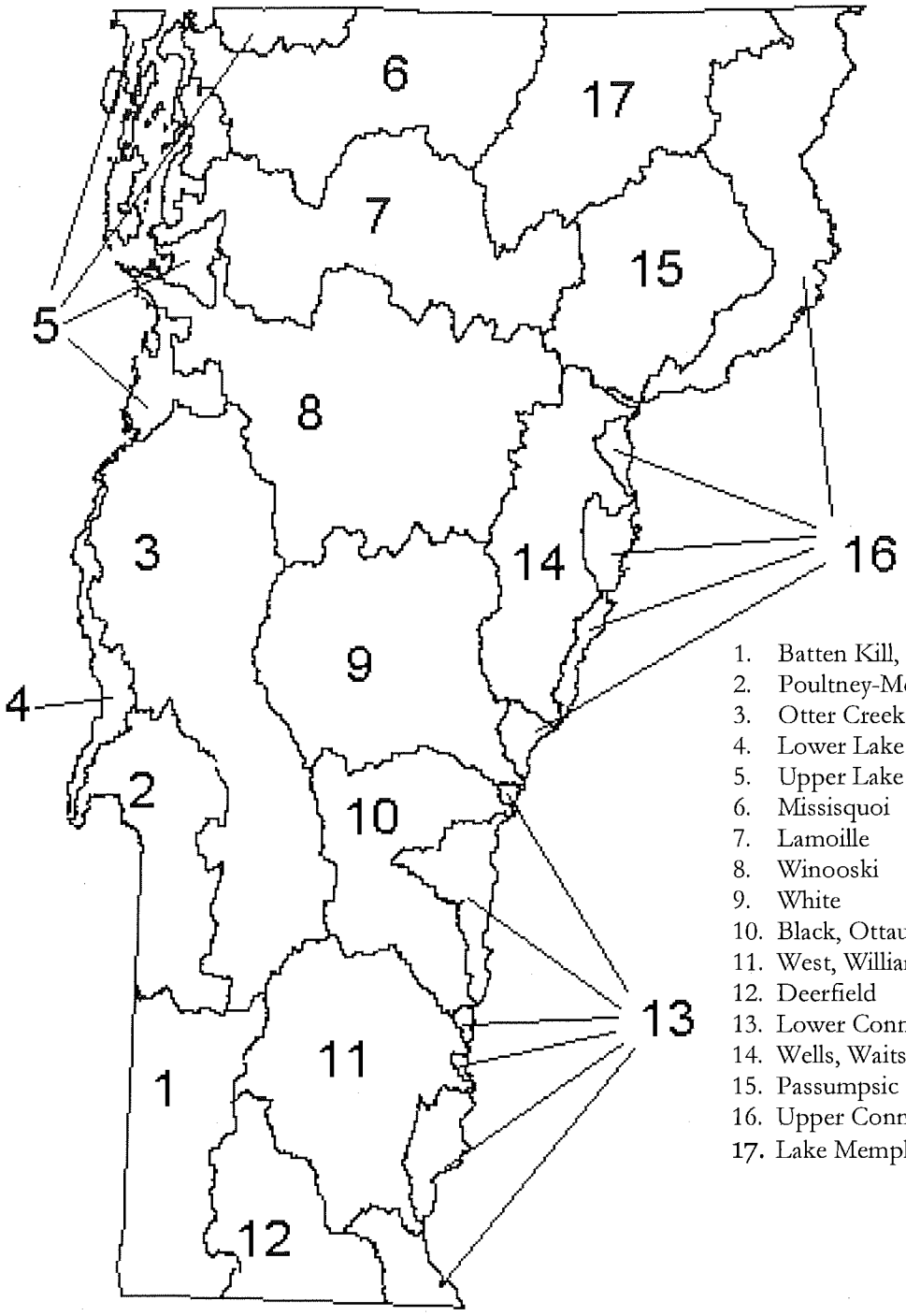
[1] Within Vermont there are some 7,100 miles of rivers and streams, about 230,800 acres of lakes and ponds and over 300,000 acres of wetlands. Many wetlands contain standing water for only a portion of the year.

[2] A 21.5 inch by 16.5 inch map showing river basins with surface waterbodies can be obtained from the Water Quality Division.

[3] For the predominant sources of data used in this regard, refer to the listing appearing on page 12.

Vermont's Major River Basins



1.	Batten Kill, Hoosic, Walloomsac	2003-04
2.	Poultney-Mettowee	2002-03
3.	Otter Creek	2001-02
4.	Lower Lake Champlain direct	2001-02
5.	Upper Lake Champlain direct	2004-05
6.	Missisquoi	2004-05
7.	Lamoille	2002-03
8.	Winooski	2005-06
9.	White	2001-02
10.	Black, Ottauquechee	2002-03
11.	West, Williams, Saxtons	2003-04
12.	Deerfield	2003-04
13.	Lower Connecticut	2003-04
14.	Wells, Waits, Ompompanoosuc	2002-03
15.	Passumpsic	2005-06
16.	Upper Connecticut	2005-06
17.	Lake Memphremagog	2004-05

Figure 3.1. Vermont's 17 major river basin groupings with rotation assessment schedule.

Under the rotational watershed assessment process, DEC staff compile and evaluate all water quality and aquatic habitat data and information and determine impacts to designated and existing uses. This process relies on data and supporting information that is considered to be reliable whether collected from DEC, other water-related agencies, schools/colleges/universities or citizen-based groups. Once the data and other information for each waterbody in a particular basin is assessed, a basin assessment report is prepared. The information contained in each basin assessment report is an early and vital piece of the basin planning process. The assessment results are the first up-to-date overview of the conditions and issues in the basin and its watersheds. Following completion of the basin assessment report, the basin planning process can stimulate more detailed assessments, propose re-classifications and/or typing, or outline protection or restoration activities that could be incorporated in a river basin water quality management plan. As of the date of this document, an assessment report has been prepared for 12 of the 17 basins (refer to Table 3.1 below).

Table 3.1. Drainage Basin Areas with Completed Rotation Assessment Reports.

Basin Number	Basin Name	Report Completion
1	Batten Kill, Walloomsac, Hoosic	August 2002
2	Poultney, Mettowee	December 1999
3	Otter Creek, Little Otter, Lewis Creek	June 1998
5	Upper Lake Champlain direct	December 2003
6	Missisquoi	November 2004
7	Lamoille	February 2001
9	White	November 1997
10	Ottauquechee, Black	June 2000
11	West, Williams, Saxtons	November 2001
12	Deerfield	March 2003
13	Lower Connecticut	April 2002
14	Waits, Wells, Ompompanoosuc	April 1999

3.2. Fixed Station Monitoring Approach

DEC coordinates a large number of fixed-station monitoring projects, incorporating river and lake water quality projects. Projects considered as fixed station in Vermont are long-term, recurring efforts that DEC has operated (or intends to operate) for several years. Some of these projects, such as the Ambient Biomonitoring Network and Lake Assessment Program (both of which incorporate several individual monitoring projects and studies) achieve dense statewide spatial coverage. The total number of river/stream and lake monitoring stations established under these two well-established programs exceed 1,500 and 650, respectively.

Fixed-station monitoring also includes monitoring done by other groups, schools or agencies. To be considered a part of the fixed-station approach, DEC must have knowledge of the particular monitoring plan (e.g. sampling site location, sampling frequency, parameters being collected and tested). Data generated by these other fixed-station monitoring efforts must have a quality assurance plan in order for DEC to characterize the data as reliable.

DEC's and the other fixed-station monitoring networks are designed to assess the status of current water quality conditions and to detect trends or changes in water quality condition. One of Vermont's major lake monitoring programs is a fixed-station, volunteer-based initiative. A listing of fixed station monitoring projects done by the Water Quality Division is provided in Appendix A.

3.3. Probability-based Monitoring Approach

Probability surveys are useful when determining statewide water quality conditions in regard to some uses and are appropriate for statistically estimating use attainment levels on a resource-wide basis (typically statewide or basin-wide). DEC recognizes the value of probability-based monitoring initiatives especially where predictability of use attainability is inherent in the project design. Such designs permit the use of statistically-derived models for inferring use attainment in appropriately selected waters where sampling was not performed. The on-going Regional Environmental Monitoring and Assessment Project (REMAP) assessment of mercury in waters, sediments, and biota of Vermont and New Hampshire lakes is a good example of one such project.

DEC believes, however, that probability-based surveys are of limited utility and of lower value where prediction outside the sample frame is not inherent in the project design, despite the benefits of bias-free, resource-wide attainment information. Accordingly, DEC strives to maximize the benefits of probability-based surveys by working only on those survey efforts in which there is confidence that a predictive system can be part of the outcome. Following this logic, DEC has undertaken four probability-based projects in collaboration with the New England regional office of US Environmental Protection Agency (EPA Region 1) in recent years and is planning to participate in a fifth project in the near future.

The probability-based monitoring surveys DEC has implemented or had some level of involvement with include:

- A REMAP assessment of mercury concentration in sediments, waters, and biota of 46 Vermont lakes and 47 New Hampshire lakes using a spatially randomized design (1998-2003).
- Characterization of use attainment for aquatic life using a spatially randomized draw of existing Ambient Biomonitoring Network data at varying site intensities (2001). The reader is referred to the Vermont 2002 Section 305b Report for a further description of this effort.
- A REMAP assessment of aquatic life use attainment in New England Wadeable Streams (2002-2006).
- Participation in the National Study of Chemical Residues in Fishes (2002-2005).

Other probability-based monitoring surveys that DEC considers appropriate in the future for determining use attainment on a statewide or basin-wide level, where predictability is an anticipated outcome of the project, are as follows:

- Development of a reproducible, indicator-based assessment of fish tissue contaminants (primarily mercury) across Vermont. Using lessons learned from the 1998-2003 REMAP assessment of mercury in waters, sediments and biota project (see below), the sampling units selected for such an assessment should be stratified by trophic state, acidity, and degree of water level manipulation.
- Assessment of aquatic life use support inferred by physical, chemical, habitat, and biological data for lakes across Vermont. (Note: this project is in the planning and development stages as a regional REMAP project, to occur 2004-2006).
- Assessment of sediment-based toxics in large-order rivers and developed lakes.

3.4. Special Studies and TMDL-related Studies

DEC undertakes monitoring associated with special and Total Maximum Daily Load (TMDL) studies as needed, in response to compelling data and information supplied under the rotational assessment and fixed-station and probability-based projects. The number and nature of special studies is commonly dictated by the nature of issues and problems that are reported as needing further monitoring or that may arise as interest or funding permit. These types of studies include detailed sampling to assess use support or standards violations, diagnostic-feasibility studies, effectiveness evaluations of pollution control practices/measures and watershed-based surveys and evaluations. TMDL studies are scheduled as needed consistent with the timeline established in Vermont's 303d List of Waters and dependent on available resources.

Chapter Four. Surface Waters Assessment Methodology

Part I. 2004 Overall Methodology

1. Overview and Data Sources

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

1) DEC Water Quality Division (monitoring data)
2) DEC Wastewater Management Division (National Point Source Discharge Elimination System permit compliance, indirect discharge permit compliance, residuals management)
3) DEC Waste Management Division (solid and hazardous waste sites monitoring data)
4) DEC Geology and Mineral Resources Division (fluvial and surficial mapping, hazard identification)
5) DEC Water Supply Division (surface drinking water supplies water quality data)
6) DEC Laboratory Services at the R.A.LaRosa Laboratory (quality assurance, analytical services, pollutant data)
7) Vermont Agency of Natural Resources Enforcement Division (violations of water quality standards)
8) Vermont Department of Fish & Wildlife (data on game fish and temperature, habitat studies)
9) Vermont Department of Health (beach closure information, fish consumption risk assessments)
10) Vermont Department of Forests, Parks, and Recreation (bacteriological testing, beach closure information)
11) Vermont Agency of Agriculture, Food and Markets (agricultural water quality violations)
12) Vermont Regional Planning Commissions (known locations of problems)
13) US Department of Agriculture, Natural Resource Conservation Service (agricultural nonpoint sources, locations of pollution abatement projects)
14) Citizens and citizen associations (citizen monitoring data, location of sources, complaints)
15) US Geological Survey Water Resources Division (monitoring and research)
16) US Forest Service (fish habitat and water quality data and information)
17) US Environmental Protection Agency (monitoring and research)
18) US Army Corps of Engineers (environmental assessments of project waters)
19) University of Vermont, Vermont State Colleges System and other colleges (monitoring and research)

The DEC River Management and Biomonitoring and Aquatic Studies Sections provide much of the data used in the assessment of monitored river miles. The DEC Lakes and Ponds Management and Protection Section provides much of the data used in the assessment of monitored lake acres. The other sources noted immediately above provide fewer and less widespread, but nevertheless important, data points.

2. Biological Monitoring and 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 considered to be "wadeable" 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 carried out by DEC can be placed into three categories; 1) long-term monitoring of reference level sites, 2) site-specific impact evaluations and 3) statewide probability-based surveys.

Individual site surveys and subsequent processing steps are detailed in *"Methods 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 (WQS) Chapter 3, Section 3-01, as well as those specified in Section 3-02(A1 and B3), Section 3-03(A1 and B3), and Section 3-04(A1 and B4, parts a-d)"* (a.k.a. biocriteria procedure). Using the biocriteria procedure, the integrity of the aquatic biota inhabiting the sites in question is attributed a rank of excellent, very good, good, fair or poor. Rankings are indicative of aquatic life use support status for each water quality classification and water management type.

DEC has no specific protocol for determining what assemblage to sample at a site. DEC attempts to sample both fish and macroinvertebrate assemblages at all sites that it evaluates for biologic condition. However, DEC does not require both assemblages fail to meet aquatic life support expectations in order to declare support or non-support of aquatic life uses. Decisions not to assess one or the other assemblage are most usually based on the availability (or lack) of appropriately representative habitat at the assessment site, although available resources are sometimes a factor as well. In situations where data are available from only one assemblage, DEC uses best professional judgement to determine whether or not those data are representative of the biologic condition at the assessment site prior to making aquatic life support decisions. If yes, a decision is made; if no, additional information or data are gathered.

The biological potential for various sites is established through statewide reference site monitoring. Information from this program element also serves to refine existing biocriteria and detect trends in baseline biological integrity. The long-term goal of reference site monitoring is to gather information on a set of known reference sites on a 5-year rotating basis, so as to generate 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 considered to be minimal relative to other streams in the ecoregion.

Where site-specific impact assessments are conducted (including an evaluation of the appropriate chemical and physical data), potential pollution sources that are not of natural origin are spatially bracketed (i.e. above and below) with sample sites to determine effects 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 (September to October 15) on a five-year rotational watershed basis. DEC has evaluated over 1,200 sites since 1990.

The Department implements biocriteria only when appropriate reference conditions have been described. The Department recognizes differences between biological expectations for different waterbodies including lakes and ponds, wetlands, large and small rivers and perennial and intermittent streams. Biological management decisions are made accordingly.

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. DEC, with cooperative funding from EPA, is now finalizing a multi-metric biological index based on phytoplankton communities, and is also developing a multi-metric index to describe the condition of macroinvertebrate communities within lakes. It is anticipated that future aquatic life use assessments will be more directly based on biological data for phytoplankton, macrophyte, and macroinvertebrate assemblages. Where data are available, results of phytoplankton, macrophyte, and macroinvertebrate community assessments are being incorporated into the assessments of individual lakes. As part of the cooperative agreement with EPA, a lake biological criteria implementation procedure should be finalized as early as 2005. Macroinvertebrate and amphibian community indices are

also currently being evaluated for use as indicators of aquatic life use support for selected types of wetlands.

3. Stream Geomorphic Assessment

Data collected during stream geomorphic assessments according to recognized procedures provide a better understanding of the physical processes and features shaping a watershed; help characterize erosion and flood hazards; help identify high quality habitat; and contribute to understanding the effects of watershed land use activities on stream condition.

The DEC stream geomorphic assessment program objectives are:

1) To create a data collection protocol for the physical assessment of streams and rivers that is scientifically sound and produces repeatable results, so that data can be compared not only within a watershed, but also between watersheds and regions.
2) To create a state Geographic Information System (GIS) and database system of fluvial geomorphic data that is accessible to users inside and outside the Agency of Natural Resources.
3) To create a method for predicting stream channel and flood plain evolution in Vermont that will technically support the resolution of river/land use conflicts and allow for sound land use practices and planning at the watershed scale.
4) To create a geomorphological river assessment methodology that will help lay people understand how human activities over time within a watershed can be conducted in a manner that is both ecologically and economically sustainable.

The Vermont Stream Geomorphic Assessment Protocols (DEC, 2003b) help river planners and managers take the first steps in applying channel form, adjustment process, and channel evolution data by providing a method for assigning a geomorphic and physical habitat condition to stream reaches. The term "departure from reference" is used synonymously with stream geomorphic condition throughout the protocols. The degree of departure is captured by the following three terms:

In Regime – a stream reach in *reference and good* condition that:

- Is in dynamic equilibrium which involves localized change to its shape or location while maintaining the fluvial processes and functions of its watershed over time and within the range of natural variability; and
- Provides high quality aquatic and riparian habitat with persistent bed features and channel forms that experience periodic disturbance as a result of erosion, deposition, and woody debris.

In Adjustment – a stream reach in *fair* condition that:

- Has experienced changes in channel form and fluvial processes outside the expected range of natural variability; may be poised for additional adjustment with future flooding or changes in watershed inputs that would change the stream type; and
- Provides aquatic and riparian habitat that may lack certain bed features and channel forms due to increases or decreases in the rate of erosion and deposition-related processes.

Active Adjustment and Stream Type Departure – a stream reach in *poor* condition that:

- Is experiencing adjustment outside the expected range of natural variability; is exhibiting a new stream type; is expected to continue to adjust, either evolving back to the historic reference stream type or to a new stream type consistent with watershed inputs; and
- Provides aquatic and riparian habitat that lacks certain bed features and channel forms due to substantial increases or decreases in the rate of erosion and deposition-related processes. Habitat features may be frequently disturbed beyond the range of many species' adaptability.

Phase 1 of the DEC protocols is the remote sensing phase and involves the collection of data from topographic maps and aerial photographs, from existing studies, and from very limited field studies. Geomorphic reaches and provisional reference stream types are established based on valley land forms

and their geology. Predictions of channel condition (departure from reference), adjustment process, and reach sensitivity are based on evaluations of watershed and river corridor land use and channel and floodplain modifications.

Phase 2 of the protocols is known as the rapid field assessment phase and involves the collection of field data from measurements and observations at the reach or sub-reach (segment) scale. Existing stream types are established based on channel and floodplain cross-section and stream substrate measurements. Stream geomorphic condition, physical habitat condition, adjustment processes, reach sensitivity, and stage of channel evolution are based on a qualitative field evaluation of erosion and depositional processes, changes in channel and floodplain geometry, and riparian land use/land cover. At least Phase 1 and Phase 2 stream geomorphic data will be used in determining stressed or altered waters due to physical problems.

Phase 3 is the survey-level field assessment phase and involves the collection of detailed field measurements at the sub-reach or site scale. Existing stream types and adjustment processes are further detailed and confirmed based on quantitative measurements of channel dimension, pattern, profile, and sediments. Phase 3 assessments are completed with field survey and other accurate measuring devices.

4. Data Solicitation

In conjunction with the 2006 assessment process, DEC conducted a solicitation for data to further enhance the quantity and spatial coverage of water quality data and other information that is used in assessing surface waters. The solicitation for water quality data was distributed to various watershed groups and was posted on the WQD website (refer to http://www.vtwaterquality.org) and on the web pages of DEC and the Vermont Agency of Natural Resources. The solicitation sought data and information to be submitted on or before November 10, 2005 in order to be considered for the 2006 reporting cycle. Data and other information submitted after that date will be considered for the 2008 reporting cycle. DEC intends to continue similar notices in advance of future reporting efforts.

5. Data Quality

Data employed must be of known quality and should be representative of the water's condition. All data generated by DEC in conjunction with WQD monitoring programs are subject to quality assurance planning using USEPA quality assurance guidance. Moreover, any and all data generated in part or whole using funding from USEPA must be subject to a USEPA-approved quality assurance project plan (QAPP). All data generated in conjunction with any active and/or approved QAPP are considered readily available and reliable data (subject to data limitations identified in the quality assurance/quality control validation and verification process for each project), and are considered in determining use support. Data can be rejected from consideration in the event that it does not meet data quality objectives established by individual QAPPs. DEC's Quality Management Plan and draft Water Quality Monitoring Program Strategy provide listings of project-specific QAPPs. Guidance and assistance regarding quality assurance is also provided from the R.A. LaRosa Laboratory.

For data provided by organizations other than DEC and WQD such as colleges, universities and citizen-based activities, data quality must be assured prior to considering it in the determination of use support. The number of samples, the length of the sampling period, the antecedent weather conditions, degree of compliance or violation and other factors are all considered when evaluating data from other organizations. Where data of unknown or unquantifiable quality are at odds with companion data of quantified quality, the higher quality data will be accorded higher weight in determining use support. Where data of unknown or suspect quality are the only information available, the waterbody is scheduled for additional monitoring prior to determining use support.

6. Statistical Analyses

DEC has expertise in statistical analyses, including non-parametric, parametric, and multi-variate methods. In most instances, it cannot be decided a-priori what type of statistical analysis may be used to assess use support, except for experimentally designed studies. For certain data types, long-term trend detection using linear, non-linear, or non-parametric regression approaches is appropriate. For designed studies aimed at determining the level of use support in an experimental framework (e.g., lakes that are likely to display elevated fish tissue mercury concentrations), parametric analyses of variance, covariance, and/or linear discriminant analysis are most appropriate. To classify waterbodies into meaningful biological groupings to compare biometrics to reference biological communities, linear discriminant analysis, principal components and factor analysis, canonical correspondence and non-metric multidimensional scaling analysis are appropriate. Simple T-tests and ANOVA tests (or non-parametric equivalents) are appropriate where data are being compared to a criterion value or to a set of reference waters. Consequently, these last two tests are more commonly or routinely performed during DEC assessment efforts. Where a statistically parametric method is used to evaluate hypotheses concerning standards attainment, consideration is accorded as to whether "attainment" is established as the null or alternative hypothesis.

DEC does not, on a unilateral basis, subscribe to the notion that a pre-determined proportion of samples exceeding a criterion value automatically equates to impairment, particularly where the total number of samples is low. The proportion of violations or frequency of exceedance in an array of data are treated and used by DEC on an individualized and case-specific basis to determine use support.

In general, DEC believes waters must be proven to be impaired using scientifically defensible methods, and thus statistical hypothesis tests, when necessary, are most often structured in that fashion. In the interest of maintaining solidly defensible and repeatable use support decisions, a decision call resulting in a finding of impairment will be accorded to the null or alternate, depending on which test provides the greatest statistical power while maintaining the type-I error rate (i.e. concluding a water is impaired when in reality it is not) to a pre-established level (typically 5% to 10%).

7. Vermont Surface Water Assessment Categories

Vermont's rivers, streams, lakes, and ponds have been designated into "waterbodies" which serve as the cataloging units for the overall statewide assessment. Waterbodies are typically entire lakes, subwatersheds of river drainages or segments of major rivers. Using data that is quality assured along with other contextual information that is reliable, the Water Quality Division determines whether each waterbody meets or does not meet Vermont Water Quality Standards, and then places waters into one of four assessment categories, taking into account the waterbody classification and water management type. The four categories used in Vermont's surface water assessment are **full support, stressed, altered** and **impaired.**[4] Waters that support designated and existing uses and meet Water Quality Standards are attributed to the full support or stressed categories. Waters that do not support uses and do not meet standards are placed into the altered or impaired category. Waters can also be put into an **unassessed** category. These assessment categories are described below.

7.1. Designated and/or existing uses under the Vermont Water Quality Standards are supported

7.1.1. Full Support Waters

This assessment category includes waters of high quality that meet all use support standards for the water's classification and water management type.

[4] The four assessment categories formerly used by DEC before 2004 were known as full support, full support/threatened, partial support, and non-support. Not all new categories are directly equivalent to the four categories used in former assessments.

In Vermont, there are many waters, such as intermittent streams, that are a lower priority for sampling visits given resource constraints, lack of public access or interest, and competing needs within DEC's water quality monitoring program. DEC therefore makes preliminary assessments, where practical, by considering five factors that address the likelihood that significant stressors exist within the subject watershed. Waters that meet all these factors are then considered to support their uses. The factors DEC uses to develop preliminary, screening-level assessments for these waters are:

- no discharges or contaminated sites in proximity to the waterbody;
- low probability of habitat degradation as evaluated by "Phase One" geomorphic assessments or other remote sensing evaluations;
- nearby sites have biological assessment findings compliant with Vermont Water Quality Standards, for like class and water management type;
- no problems are uncovered during outreach efforts associated with the rotational assessment process and basin planning; and
- no known water level manipulations.

7.1.2. Stressed Waters

These are waters that support the uses for the classification but the water quality and/or aquatic habitat have been disturbed to some degree by point or by nonpoint sources of human origin and the water may require some attention to enhance its usefulness or the water quality and/or aquatic habitat may be at risk of not supporting uses in the future. Data or other information that is available confirms water quality or habitat disturbance but not to the degree that any designated or existing uses have become altered or impaired (i.e. not supported).

Some stressed waters have documented disturbances or impacts and the water needs further assessment.

The stressed waters assessment category includes some of the waters in the formerly used category known as "full support/threatened." The stressed category also captures many of those waters in the formerly used category "partial support – evaluated" where there was evidence of problems and disturbances but current water quality data were lacking.

7.2. One or more designated and/or existing uses under the Vermont Water Quality Standards are not supported

7.2.1. Altered Waters

These are waters where a lack of flow, water level or flow fluctuations, modified hydrology, physical channel alterations, documented channel degradation or stream type change is occurring and arises from some human activity, OR where the occurrence of exotic species has had negative impacts on designated uses. The aquatic communities are altered from the expected ecological state.

This assessment category includes those waters where there is a documentation of water quality standards violations for flow and aquatic habitat but EPA does not consider the problem(s) caused by a pollutant OR where a pollutant results in water quality standards not being met due to historic or previous human-caused channel alterations that are presently no longer occurring.

7.2.2 Impaired Waters

These are surface waters where there are chemical, physical and/or biological data collected from quality assured and reliable monitoring efforts (refer to section 5 of this chapter) that reveal 1) an ongoing violation of one or more of the criteria in the Water Quality Standards and 2) a pollutant of human origin

is the most probable cause of the violation. These are waters that have been in the formerly used "partial or non-support - monitored" category.

7.3. Unassessed Waters

Waters for which DEC has no monitoring data and only limited information and knowledge is available are considered unassessed.

Part II. Assessment Use Support Determinations

The following pages provide specific criteria, principles for making decisions, and other information that DEC applies when making an assessment of water quality conditions and determining whether individual designated and existing uses are fully supported, stressed, altered, impaired or unassessed (described above generally in Part I). Information below is presented by each of the seven designated uses to show how relevant, representative and reliable water quality monitoring data and other information relates directly to the degree of use support for assessment reporting purposes. Additional considerations for lakes are included under aquatic life use where the assessment methodology differs from riverine environments.

1. Aquatic Biota/Habitat (Aquatic Life) Use

In assessing Aquatic Life Use, the DEC Water Quality Division uses several types of water quality and water quantity data and information to determine use support. The specific data types are biological monitoring, habitat assessment, conventional pollutants, and toxicants. For lakes, additional assessment guidelines are used for conventional pollutants, non-native nuisance aquatic species, nutrients, and information regarding water-level impacts. Specific decision-making criteria are as follows:

1.1. Biological Monitoring (refer also to earlier discussion on biological monitoring)

Full Support: Biological assessments for fish and/or macroinvertebrate communities demonstrate compliance with appropriate threshold criteria as described in DEC biocriteria implementation methodologies. In the absence of applicable biocriteria, all available information and data are used to make scientifically defensible weight-of-evidence findings that designated aquatic life uses are fully supported. In most cases, biological condition ratings of *excellent, very good,* and *good* will indicate full support status for Class A(1), Class B(1), and Classes A(2) B, B(2) and B(3) respectively.

Stressed: Biological assessments for fish and/or macroinvertebrate communities and/or habitat assessments indicate that impacts have occurred but are inconclusive with regard to support status determination or demonstrate that the biological condition is at risk of making a transition between support and non-support. In the absence of applicable biocriteria, all available information and data are used to make scientifically defensible weight-of-evidence findings that designated aquatic life uses are stressed. Additional biological assessment may be needed. In most cases, biological condition ratings of *"excellent-to-very good"* will indicate stressed status for Class A(1) waters, *"very good-to-good"* will indicate stressed status for Class B(1) waters and *"good-to-fair"* will indicate stressed status for Class A(2), B, B(2) and B(3) waters.

Altered: Biological assessments for fish and/or macroinvertebrate communities demonstrate non-compliance with appropriate threshold criteria as described in DEC biocriteria implementation methodologies and the cause is not a pollutant (e.g. flow regulation or non-native species). In the absence

of applicable biocriteria, all available information and data are used to make scientifically defensible weight-of-evidence findings that designated aquatic life uses are not fully supported. In most cases, biological condition ratings of *very good or lower, good or lower,* and *fair or lower* will indicate altered status for Class A(1), Class B(1), and Classes A(2), B, B(2) and B(3) respectively. Generally, biological data from a minimum of two hydrological years are necessary in order to determine this condition.

Impaired: Biological assessments for fish and/or macroinvertebrate communities demonstrate non-compliance with appropriate threshold criteria as described in DEC biocriteria implementation methodologies and the cause is due to a pollutant of human origin. In the absence of applicable biocriteria, all available information and data are used to make scientifically defensible weight-of-evidence findings that designated aquatic life uses are not fully supported. In most cases, biological condition ratings of *very good or lower, good or lower,* and *fair or lower* will indicate impaired status for Class A(1), Class B(1), and Classes A(2), B, B(2) and B(3) respectively. Generally, biological data from a minimum of two hydrological years are necessary in order to determine impairment.

1.2. Habitat Assessment

Full Support: Depending on the water's classification and typing {A(1), A(2), B, B(1), B(2), B(3)}, high quality habitat with up to a moderate change from natural or reference condition exists "consistent with the full support of all aquatic biota and wildlife uses."

Stressed: Stream or river physically under stress – in adjustment with stresses greater than as naturally occurs to a "fair" condition derived from a geomorphic assessment completed using recognized protocols.

Altered: Changes to the habitat are greater than minimal to a moderate change from reference, depending on the water's classification and typing. There is an undue adverse effect on the physical nature of the substrate. Aquatic habitat surveys show significant changes from the reference condition due to human origin and/or geomorphic assessment indicated fair to poor conditions. All life cycle functions, including over-wintering and reproductive requirements, are not adequately maintained and protected due to the physical habitat changes.

Impaired: A pollutant of human origin is shown to cause more than the allowable change to aquatic habitat as defined by Vermont Water Quality Standards.

1.3. Conventional Pollutants (defined by USEPA as: temperature, pH, D.O., turbidity, nitrate-nitrogen, phosphorus)

Full Support: Waters that are not stressed or impaired due to conventional pollutants, assessed using the Vermont Water Quality Standards. For example, the total increase from the ambient temperature due to all discharges and activities is not known to exceed 1.0 degree 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).

Stressed: Waters where the level of a conventional pollutant or a combination of conventional pollutants of human origin may be resulting in some disturbance. For example, temperatures are such that in coldwater fishery waters, one or more trout species are reduced in number or biomass as compared to reference condition. Waters with alkalinities between 2.5 and 5.0 mg/l (as CaCO3), and pH values may occasionally drop below 6.5. Coldwater fishery waters where dissolved oxygen may be between 6 and 7 mg/l and 75 to 85% saturation.

Altered: This assessment category is not used in this context.

Impaired: Temperatures are too high as a result of human activities to fully support coldwater fish species in waters designated as a coldwater fishery OR 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).
Reliable, representative monitoring indicates that pH values repeatedly fall below 6.5 standard units or exceed 8.5 standard units across a range of weather conditions, and values are not due to natural sources.
Reliable, representative monitoring indicates D.O. values or percent saturation repeatedly fall below the standard for the water's classification and type except as noted in section 1.5.1 below.
Reliable, representative monitoring shows that turbidity values are more than occasionally above the standard for the water's classification and type as measured across a range of weather conditions and values are not due to natural sources.
Reliable, representative monitoring shows that nitrate-nitrogen and/or phosphorus repeatedly and/or consistently exceeds the standard for the water's classification, type, and elevation except as noted in section 1.5.1 below.

1.4. Toxicants (priority pollutants, metals, chlorine & ammonia)

Full Support: Waters that are not stressed or impaired due to toxicants, as described below.

Stressed: Water quality monitoring or sediment samples reveal the presence of toxics below criteria or there are no relevant criteria and the source of the pollutants has not been remediated. Groundwater data in wells adjacent to the stream shows levels of pollutants above the Vermont Groundwater Enforcement Standards but no in-stream data exists or no sediment samples have been taken.

Altered: Toxicants are considered pollutants, therefore, the category "altered" is not applicable.

Impaired: In most cases, the following exposure presumptions are applicable to compliance determinations: for any one pollutant, an acute aquatic biota criterion is exceeded more than once within a 3-year period, for longer than one hour, above ten-year, seven-day flow minimum (7Q10) flows; or a chronic aquatic biota criterion is exceeded for more than four consecutive days in a three year period, above 7Q10 flows.[5]

1.5. Additional Aquatic Life Use Considerations for Lakes

1.5.1. Lakes - Conventionals (alkalinity, dissolved oxygen, nitrate-nitrogen)

Full Support: Waters that are not stressed or impaired.

[5] DEC recognizes that the literal interpretation of the exposure scenario cited would be difficult to replicate in a field situation. The language cited reflects the exposure conditions used to develop the numerical criterion that is the water quality standard. It is likely that available monitoring data would be collected under a variety of temporal and spatial formats. In evaluating data, DEC uses the exposure assumptions of the criterion development as guidelines in the interpretation of data and uses empirical and judgmental means to assess whether or not there is reasonable potential for those exposure assumptions to be violated. Given the variable nature of available information, evaluations will vary on a case-by-case basis. DEC takes into consideration guidance provided by EPA when evaluating toxicants in surface waters (see "Technical Support Document for Water Quality-based Toxics Control." EPA/505/2-90-001).

Stressed: Reliable long-term monitoring data indicates that a lake's alkalinity routinely drops below 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) 0 mg/l or 0% saturation during peak summer stratification, but macroinvertebrates are present. The area designated as stressed, as a result of human disturbance, is limited to the lake acreage underlain by the hypolimnetic oxygen-deficient area.

Altered: This assessment category is not used in this context.

Impaired: Reliable monitoring data indicates that alkalinity routinely drops below 2.5 mg/l (as acid neutralizing capacity) during the spring runoff period.
Reliable monitoring data indicates that a lake's hypolimnetic dissolved oxygen concentration falls to (or near) 0 mg/l or 0% saturation for a period of greater than 50% of the summer stratification period, **and** the hypolimnetic sediments are devoid of a macroinvertebrate community. The area designated as impaired, as a result of human disturbance, is limited to the lake acreage underlain by the hypolimnetic oxygen-deficient area. However if, in the best professional judgement of DEC scientists, the dissolved oxygen deficit is due to natural causes, aquatic life uses will be considered instead as fully supported.
The epi- and metalimnetic lake waters will be considered impaired if dissolved oxygen concentrations fall below Water Quality Standards in greater than or equal to 10% of samples, and the anoxia is not a natural phenomenon.
Reliable monitoring data indicates nitrates in excess of 5.0 mg/l in 10% or more of samples collected.
A minimum of four evenly-spaced sampling events across the summer stratification period are commonly used to make a determination regarding conventional pollutants in lakes, except for alkalinity, which is most commonly measured in spring, which corresponds to peak acidity loading for lakes.

1.5.2. Lakes Conventionals (phosphorus)

Vermont is working under a cooperative funding agreement with the New England regional office of USEPA to develop scientifically-based nutrient criteria that are relevant to Vermont waters, for inclusion in Vermont's Water Quality Standards. Pending development of these new criteria, the following is used to assess use support for lakes using phosphorus data.

Full Support: Vermont's Water Quality Standards provide that full support lakes have experienced no acceleration of eutrophication or stimulation of the growth of aquatic biota in a manner that prevents the full support of uses.

Stressed: Photic-zone and/or whole column total phosphorus concentrations are elevated in relation to statewide norms, resulting in stimulation of growth of aquatic plant species that results in no more than a minor to moderate change in aquatic biota, depending on water management type.

Altered: Phosphorus is a pollutant, therefore this category is not applicable.

Impaired: Photic-zone or whole column total phosphorus concentrations, as determined by the DEC Spring Phosphorus Monitoring Program, the Vermont Lay Monitoring Program, or other special studies, have increased significantly, or are significantly elevated relative to statewide norms, and resultant algal blooms produce more than a moderate change in the aquatic biota. For Lake Champlain, Lake Memphremagog and South Bay of Lake Memphremagog, summer average phosphorus concentrations exceed criteria expressed in §3-01(A)(2)(c) of the Water Quality Standards.

1.5.3. Lakes – Non-Native Species

Non-native species such as Eurasian watermilfoil (*Myriophyllum spicatum*), water chestnut (*Trapa natans*), alewives (*Alosa pseudoharengus*) or zebra and quagga mussels (*Dreissena spp.*) have significant impacts on existing aquatic plant and animal communities. Information on the extent and distribution of these species is used to assess aquatic life use support in lakes.

Full Support: No established population of an invasive, non-native nuisance species.

Stressed: Non-native invasive species are present but in low densities (e.g. scattered areas of plant growth in limited areas of the littoral zone). In the case of Eurasian milfoil, lakes within a 10-mile radius of an infested lake are considered stressed, unless access to the lake is remote or inaccessible by conventional means.

Altered: Non-native invasive species present in densities sufficient to alter native biological communities. For example, overall plant density is classified as "moderate," indicating locally abundant (50% or greater coverage) growth, or "heavy," (75% or greater littoral cover overall) indicating growth in most shoreline areas.

Impaired: Non-native invasive species are not considered pollutants. Therefore, this category is not applicable.

1.5.4. Lakes - Aquatic Life Use Assessments for Fluctuated Reservoirs

Reservoirs present special cases in regards to assessment of aquatic life use support (ALUS). In the absence of direct biological measurements beyond routine aquatic plant survey data, ALUS can be assessed using the following decision-making 'tree.' In order to use this decision tree, several pieces of information regarding the reservoir are useful. These include bathymetry, maximum and mean waterbody depth, the limnological shoreline development index, and the magnitude and timing of the drawdown. These data can be used collectively to estimate the proportion of the littoral zone likely to be affected by the drawdown regimen. Where available, biological data (in particular the presence and distribution of aquatic macrophytes within the littoral zone) are also useful.

1) Can the level of the waterbody be regulated by an artificial structure (e.g. dam, sluice, weir)?
   Answer is NO: no alteration or stress to ALUS due to water level fluctuation. ***Full Support.***
   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 is NO: a stress or alteration to ALUS could potentially exist, but must be verified by direct assessment before the waterbody can be correctly assessed; go to 4.
   Answer is YES: go to 3.
3) Is the waterbody regulated by a federal Clean Water Act Section 401 water quality certification issued by VTDEC after January 1, 1990?
   Answer is NO: go to 4.
   Answer is YES: ***no alteration or stress to ALUS due to water level fluctuation if operated in accordance with the license.***
4) Is the waterbody in fact subject to periodic fluctuations that are attributable to operation or manipulation of the outflow structure?

Answer is NO: ***a stress 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. Such littoral zone impacts have the potential to cause cascading changes within the trophic web of the waterbody but cause no more than a minor change in habitat or moderate change in aquatic biota from the reference condition. The entire waterbody acreage will be assessed as stressed for ALUS.

Answer is YES: 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, with all expected functional groups, while accommodating the drawdown regimen, **or**, does available biological data suggest that such a community exists within the drawdown zone?

Answer is NO: ***ALUS is altered.*** These alterations create more than a moderate change to aquatic habitat. Littoral zone impacts of this magnitude will have cascading impacts throughout the trophic web, resulting in more than a moderate change in aquatic biota from the reference expectation. Aquatic macroinvertebrate and fish assemblages exhibit more than moderate changes in the relative proportions of tolerant, intolerant, taxonomic and functional components. Accordingly, the entire acreage is assessed as altered.

Answer is YES: ***ALUS is stressed.*** These stresses cause no more than a moderate change to aquatic habitat. Littoral zone impacts of this magnitude could have cascading effects within the trophic web of the waterbody, but these are presumed to create no more than a moderate change to aquatic biota from the reference expectation based on the relative proportions of tolerant, intolerant, taxonomic and functional groups. The waterbody's entire acerage is presumed to be stressed for ALUS.

2. Fish Consumption Use

Vermont interprets the USEPA guidance on fish consumption use attainment to indicate that no waters fully support fish consumption. This is due to well-documented contamination of varying levels of lakes by mercury in waters, sediments, and aquatic biota arising from atmospheric deposition. In the tissues of fish inhabiting Lake Champlain (and elsewhere), other contaminants including polychlorinated biphenyls, polyaromated hydrocarbons, and "DDT" derivatives have been identified.

DEC does not, however, subscribe to the notion that fish tissue consumption is impaired on a statewide basis. This is because most fish species can, indeed, be consumed from most Vermont waters, albeit at a reduced rate. Fish consumption use is considered impaired only in the event that the fish species subject to the consumption advisory is documented to exist in the waterbody and contaminant data exist for that species from the particular waterbody. This approach is consistent with current EPA guidance.

Full Support: No fish consumption advisory in effect.

Stressed: "Restricted consumption" of fish is 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).

Altered: Tissue contaminants are derived from the deposition or release of pollutants into the aquatic environment. Accordingly, this assessment category is not relevant.

Impaired: Fish consumption use is considered impaired only in the event that the fish species subject to the consumption advisory is documented to exist in the waterbody and contaminant data exist for the species from the particular waterbody. For a given fish species present in a waterbody, a 'no-

consumption' advisory is in place for a designated sub-population (e.g., children or women of childbearing age) or for the general population.

3. Swimming/Contact Recreation Use

For assessment of Swimming/Contact Recreation Use, the DEC Water Quality Division uses one or more types of data to determine whether this use is supported. The specific data types are bacterial monitoring and nuisance aquatic species growth. Decision-making criteria are as follows:

3.1. Indicator Bacteria

E. coli (an abbreviation for the scientific name of the bacterium *Escherichia coli*) concentrations are known to vary considerably over space and time in response to natural and human-related factors. In order to assess waters for support of swimming and contact recreation using *E. coli* monitoring data, a minimum number of data points are necessary, and supporting contextual data such as antecedent weather and flow conditions must be considered. DEC considers at least five (5) reliable and quality assured sample results over a swimming season and gathered across a range of weather/flow conditions to be the minimum practical number of samples necessary to document representative conditions and to assess attainment of contact recreational uses. In a practical sense, weekly or more frequent *E. coli* data across the swimming season is most useful to determine impairment and observe weather-related patterns in bacterial concentrations. If there are questions regarding the representativeness of the data, the water is identified as needing monitoring and is recommended for follow-up *E. coli* sampling in the next season.

Very few strains of *E. coli* are themselves pathogenic. Rather, they are indicators of the presence of fecal material of warm-blooded animal origin. This fecal material may contain harmful pathogens. *E. coli*-based criteria are expressed either as geometric mean values, or as one-time, instantaneous single-sample values. These values equate to a likelihood of developing gastrointestinal illness from exposure to waterborne pathogens associated with *E. coli*. EPA originally (1986) derived its freshwater criterion recommendations using a set of statistical relationships relating geometric mean *E. coli* levels to observed gastrointestinal illness rates directly attributable to the *E. coli* exposure. Using these relationships, EPA has recommended that the most conservative *E. coli*-based criterion be a geometric mean of 126 *E. coli* /100ml. At highly populated freshwater beaches (defined as greater than or equal to 2,427 swimmers/day on average) that are subject to direct sewage effluent contamination, exceedance of this criterion means that on a season-wide average basis, 8 in 1,000 swimmers will develop gastrointestinal illness due to *E. coli* exposure. In 2002, EPA reaffirmed it's 126 *E. coli* /100ml geometric mean recommendation considering the most available data and studies.

Vermont's standards have criteria for bacteria that reflect a high level of protection for swimmers and other forms of contact recreation use. The current criteria are far more conservative than those recommended by EPA. Vermont's current criteria are not to exceed a three-sample geometric mean of 18 *E. coli* /100ml (or a single sample maximum of 33) for Class A(1) and A(2) waters, and not to exceed 77 *E. coli* /100ml for Class B waters in all management types. Interpreted using EPA's statistical relationships, a single instantaneous concentration of 77 *E. coli* /100ml equates to a 75% likelihood that a beach closure will prevent swimmers from incurring a 3.4 in 1,000 risk of developing gastrointestinal illness. Such an interpretation must be treated cautiously as any illness rate attributed to *E. coli* exposure less than 8 in 1,000 is below the level quantifiable using EPA's statistical relationships.

Recent research conducted within Vermont indicates that the present Vermont Class B criterion can be exceeded in low to moderate streamflows issuing from forested watersheds due to natural background

sources. Based on calculations using EPA's statistical relationships, 77 *E. coli* /100ml, expressed as a geometric mean of several samples, results in a projected illness rate of 6 in 1,000 swimmers. While this level of risk approaches the EPA minimum recommendation, it is consistent with the intent of current and prior Vermont water quality criteria for bacteria, beginning in 1985. In addition, new EPA guidance (USEPA, 2003b) on the application of water quality criteria for pathogens allows that impairment determinations can be based on geometric seasonal means or some number of single sample exceedances. EPA expresses preference for use of a longer-term indicator (geometric mean) for reporting use attainment. Given these considerations, a common-sense approach must be applied when assessing waters using *E. coli* monitoring data. The following guidelines are applied during the assessment process:

Full Support: Waters are suitable for swimming.

Stressed: Individual samples only occasionally exceed the class-specific single-sample criteria values. The geometric mean does not exceed the criterion value.

Altered: *E. coli* indicator bacteria are considered a pollutant. This assessment category is not applicable.

Impaired: For class B waters in all water management types, the geometric mean of 77 *E. coli* /100 ml is exceeded in a given segment or area and the contamination can be attributed to sources other than natural background. DEC accepts a weight-of-evidence approach to confirm that *E. coli* values are or are not of natural origin. A minimum of five samples collected regularly over the swimming season is needed, and flow and antecedent precipitation are accounted for in this determination. For class A(1) and A(2) waters, the geometric mean of a minimum 3 samples exceeds 18 *E. coli* /100ml, and the contamination can be attributed to sources other than natural background (i.e. human, livestock, domestic animal sources). Generally, data from at least two swimming seasons are needed to assess waters as impaired for swimming.

3.2. Nutrients and Nuisance Aquatic Species

Full Support: Waters are not stressed, altered, or impaired by nuisance aquatic species (includes Eurasian watermilfoil, water chestnut, zebra mussels).

Stressed: Nuisance species are present but not at levels where a nuisance has been documented or in low densities (scattered areas of growth in limited areas of the littoral zone). In the case of Eurasian milfoil, lakes within a 10-mile radius of an infested lake are considered stressed, unless access to the lake is remote or inaccessible by conventional means.

Altered: Nuisance species present in such densities such that swimming uses are not met. For aquatic macrophytes, typically these conditions are characterized by greater than 75% cover of the non-native macrophyte and are designated as "moderate" or "heavy" infestations. For species other than aquatic macrophytes such as zebra mussels, colonies would be present in such densities and at such depths as to impact swimming uses due to potential for injury to bare feet. Nutrients are not applicable in this category.

Impaired: An on-going record of public complaint concerning the algal conditions in the water has been established. For cyanobacteria (blue-green algae), waters display on-going summer blooms of toxin-producing cyanobacteria and have microcystin concentrations at elevated levels in excess of the World Health Organization guideline of 1 ug/l. Nuisance aquatic species are not applicable in this category.

4. Secondary Contact/Non-Contact Recreation Use

For assessment of Secondary Contact/Non-Contact Recreation Use, the DEC Water Quality Division uses information regarding water quantity and water quality, data and other information regarding the game fishery and records of public feedback and complaint to determine levels of support.

Full Support: Water quantity and quality sufficient for boating and fishing.

Stressed: Odor, color, plant growth, low water conditions occasionally discourage boating or fishing.

Altered: Fishing and/or boating are limited due to insufficient or diminished or lack of water, aquatic nuisance species or channel alterations. Boating is not feasible to the degree deemed achievable for the water's Water Management Type.

Impaired: Fishing and/or boating are limited due to water quality or aquatic habitat impairment(s) caused by pollutants from human sources.

5. Drinking Water Supply Use

Drinking water supply use is assessed using data on toxicants and bacteria; information on water treatment plant operation and operating costs; and, data describing cyanobacterial (blue-green algae) toxin concentrations.

Full Support: Water quality suitable as a source of public water supply with disinfection and filtration.

Stressed: This category is not applicable.

Altered: A well-established zebra mussel infestation is known to increase cost or effort to produce water that is suitable for drinking.

Impaired: In rivers, streams, brooks and riverine impoundments the exceedance, due to human sources, of any one human health-based toxic pollutant criteria listed in Appendix C of the Water Quality Standards (or as otherwise determined by the Natural Resources Agency Secretary in accordance with the Toxic Discharge Control Strategy) at flows equal to or exceeding the median annual flow for toxic substances that are classified as "non-threshold toxicants" or at flows meeting or exceeding the 7Q10 flow for toxic substances that are classified as "threshold toxicants." In all other waters, the exceedance, due to human sources, of any one human health-based toxic pollutant criteria listed in Appendix C (or as otherwise determined by the Secretary in accordance with the Toxic Discharge Control Strategy) at any time. (Note: "non-threshold toxicants" are probable or possible human carcinogens and "threshold toxicants" are not known or probable human carcinogens).
Criteria established by the Federal Safe Drinking Water Act can be met only by employing treatment practices that operationally or financially supercede customary practices that include filtration and disinfection.
Finally, waters display on-going summer blooms of toxin-producing cyanobacteria and have microcystin concentrations in excess of the World Health Organization guideline of 1 μg/l.

6. Aesthetics Use

For assessment of Aesthetic Use, the DEC Water Quality Division uses water quality and water quantity information from field surveys and public feedback and complaints to determine levels of support.

Full Support: Water character, flows, water level, riparian and channel characteristics, all exhibit good to excellent aesthetic value consistent with the waters classification. Water clarity and substrate condition is good. No floating solids, oil, grease or scum. Limited or no record of public concern.

Stressed: Aesthetic quality is compromised somewhat. Water unnaturally turbid at times. Moderate levels of plant growth above the expectation for natural communities. Small or disturbed riparian zone. Some record of public concern or complaint.

Altered: Aesthetic quality is poor due to a diminished amount of water to no water in the channel or lake resulting from human activities or due to moderate or heavy densities of nuisance non-native species.

Impaired: Aesthetic quality of water is poor. Water is frequently and unnaturally turbid. Excessive plant growth above the expectation for natural communities covers the channel or lake bottom, rocks or water surface. Substrate is unnaturally silt-covered, mucky, or otherwise changed so as to adversely affect the aesthetics in an undue manner. Presence of solid waste, floating solids, scum, oil or grease occurs frequently and persistently.

7. Agricultural Water Supply Use

There are no EPA definitions for agricultural water supply. Consequently, this use is unassessed and the four assessment categories are not used.

Chapter Five. Listing and De-Listing Methodology

Following the assessment process where waters are determined to be impaired, altered, stressed, or in full support of existing uses or designated uses associated with class and water quality management type, waters may then be categorized and placed onto one or more listings for tracking purposes. The listing of waters is undertaken for Section 303d of the Federal Clean Water Act and, outside the scope of the Act's requirements, DEC maintains several other lists for tracking and management purposes. The sum of listings maintained by DEC is collectively known as the Vermont Priority Waters List. This chapter describes how waters are assigned to the various lists based on their assessment categorization.

5.1. Impaired Waters

All waters determined to be impaired are placed on one of the following listings: Part A-303d List (impaired waters scheduled for TMDL development), Part B (impaired waters for which TMDLs are not required), and Part D (impaired waters for which TMDLs have been completed).

Determination of Pollutant

An important piece of information required in order for a water to be listed as impaired is the determination that the pollutant(s) causing the condition is a result of human activity and not of natural origin. The pollutant becomes the basis for loading determinations and TMDL development or for the control measures to be implemented. DEC attempts to be as accurate as possible as to causal pollutant determination. Where appropriate, DEC subscribes to EPA's Stressor Identification Methodology (USEPA, 2000b). In the absence of EPA's Stressor Identification Methodology or pollutant data, DEC may use biological assessment indicators (refer to previous chapter on biocriteria and biomonitoring) to identify by inference most probable causal pollutants or stressors.

Where there is monitoring data that identifies a violation of a numeric standard, the pollutant may be identifiable. For example, long-term monitoring data may identify a segment of Lake Champlain as exceeding the numeric criterion for total phosphorus as opposed to measured below standard dissolved oxygen which does not necessarily identify a pollutant. Where there is monitoring data that identifies a violation of a narrative standard, the identification of the causal pollutant is more complex. An example of this would be where biological data taken from a stream indicates non-support of aquatic life.

One of DEC's methods of determining compliance with water quality standards is by assessing the biological integrity of the aquatic biota. The benefits of using biocriteria as a *direct* measure of waterbody health are that the approach takes into account the impact of all stressors on a waterbody and provides an overall assessment of the water's health and its ability to support aquatic life. Biological assessment data provide generalized guidance on the nature and extent of the stressor(s) when a problem is detected. The poor condition of a waterbody's biotic community is often related to several factors. Evaluation of the biological data combined with the implementation of stressor identification methodologies can result in the development of a defensible list of most probable stressor candidates or suites of pollutants/stressors of common origin (e.g. stormwater).

In the 2002 version of the Vermont 303d List, and previous years' iterations, the term "undefined" was used under the "Pollutant(s)" column to either suggest a broad suite of potential pollutants or when there was uncertainty about whether the standards violation was caused by a pollutant. For 2006, DEC will use a more rigorous method to determine the causal pollutant. Using current data, knowledge of the specific situations, and best professional judgment, it will be determined whether there is sufficient evidence that the standards violation is caused by the discharge of a pollutant to the water, and if so, the pollutant will be identified. There remain instances whereby the specific pollutant may not be identifiable but a

particular class of discharge, known to contain pollutants, is still determined to be responsible for the impairment. An example of this instance is the discharge of collected stormwater runoff from impervious surfaces. In this example, if the evidence from an on-site investigation suggested that "stormwater" and its associated pollutants was the cause of the impairment, then "stormwater" would be cited as the pollutant on the 303d List. Often accompanying "stormwater" are the instream effects from the altered hydrology stemming from impervious surface runoff. However, since a discharge of pollutants, not altered hydrology, is the primary factor in a water being listed on Part A, there must be some indication of pollutants being discharged. At this time, since it is unknown to what degree either of the problems (pollutants or hydrology) have on these waters, they are listed as impaired by "stormwater" because of the likelihood of pollutants being discharged and that they contribute to the failure to meet water quality standards. Only when there is sufficient evidence that a Standards violation is the result of pollutants discharged to the water will the water be identified as impaired.

In instances where monitoring data identified a water as impaired based on *E. coli* bacteriological data, the causal pollutant in past versions of the 303d List identified "Pathogens" as the pollutant. This procedure was followed because *E. coli* is used and recognized as an indicator of potential illness-causing pathogens. DEC now identifies *E. coli* as the pollutant if there is no monitoring data identifying the existence of other pathogens. The source(s), however, must be confirmed not to be of natural origin.

Part A - 303d List

Part A of the 2006 List of Waters identifies impaired surface waters that are scheduled for total maximum daily load (TMDL) development. Certain impaired surface waters may have TMDLs developed as a group of waters due to the similarity of problems. Part A of the List has been prepared in accordance with current EPA 2006 Guidance and the Environmental Protection Regulations 40 CFR 130.7 ("Total maximum daily loads (TMDL) and individual water quality-based effluent limitations"). A TMDL is deemed necessary for these waters in order to establish the maximum amount of a pollutant that may be introduced into the water after the application of required pollution controls and to ensure the Water Quality Standards are attained and maintained. Waters appearing in Part A are equivalent to "Category 5" waters described in EPA's 2006 Guidance.

In addition to identifying the waterbody, the 303d list identifies the pollutant(s) causing the impairment, the priority ranking for TMDL development and which water use(s) are impaired. DEC has also described the specific water quality problem.

TMDL Scheduling

Priority ranking for TMDL development was developed considering: (1) health issues, (2) the nature, extent, and severity of the pollutant(s), (3) the use or uses that are impaired, (4) the availability of resources to restore the water, and (5) the degree of public interest in problem abatement.

Public Comment Opportunity, Submittal to EPA and EPA Approval

Upon compilation of the draft Part A-303d List, it is made available to the public for review and comment. Notification of availability is at a level sufficient to allow broad coverage of the general public and may include notices in newspapers, State web sites and direct notification through email or mailing lists. In addition to notification, public meetings are conducted to further the public's understanding of the document and to receive verbal comments. Following receipt of public comments, a responsiveness summary is developed that describes how the comments were addressed. Appropriate changes are made to the list. A final version of the Part A-303d List is then sent to the New England regional office of EPA for review and approval.

De-listing - Interim List

During development of the 2006 Part A-303d List there may arise the need to propose for de-listing water(s) previously identified on the year 2004 Part A-303d List. Waters proposed for de-listing will be presented on the 2006 Interim List. This list is termed "interim" because it only exists during the period of Part A-303d List development - the period between release of the 2006 Part A-303d List for public comment and the list's final approval by EPA. The sole purpose of this interim listing is to notify the public and EPA of the de-listing proposals and to provide the rationale and justification for such proposals.

On the Interim List, each entry contains specific information for that particular waterbody as to why it is being proposed for de-listing. The waterbody-specific rationale is intended to provide "good cause" for de-listing. The three scenarios below cover the broad range of circumstances for which waters may be proposed for de-listing in the 2006 list cycle.

- **Scenario 1. Absence of previously known impairment shown by water quality monitoring data.**

  Where there is water quality data confirming the absence of a previous impairment or where a waterbody has been improperly listed due to a lack of sufficient water quality data, DEC will propose to de-list waters that appeared in the EPA-approved 2004 Part A-303d List. The absence of impairment can be substantiated by data of a comparable quantity and quality as the data that was required to assess the water as impaired (for example, 2 years of biological or chemical data needed to establish impairment generally means 2 years of data needed to establish attainment).

- **Scenario 2. Impaired waters that do not need or require a TMDL determination.**
  Current EPA guidance for the 2006 303d List includes a category of impaired waters whereby a TMDL is not required because existing pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future. In light of this, DEC can propose to de-list impaired waters that do not need or require a TMDL. It is important for the reader to understand these waters remain assessed as impaired (until water quality is restored) but will, after EPA approval for de-listing, be shown in Part B of the Vermont Priority Waters List.

  In order to de-list certain impaired waters from Part A (and move them to Part B), DEC must be convinced that other pollution control requirements, such as best management practices, will result in the attainment of Vermont Water Quality Standards. Specifically, DEC needs to show that (1) there are legal requirements in place (e.g. regulations, permits implementing regulations) that apply to the source(s) causing the water quality impairment and (2) that such legally required pollution control practices are specifically applicable to the impairment in question **and** are sufficient to cause the water to meet water quality standards within a reasonable time.

- **Scenario 3. Impaired waters with an EPA approved TMDL.**
  Impaired waters for which an EPA-approved TMDL exists can be de-listed from Part A according to EPA's 2006 Guidance. These waters will then be found in Part D of the Vermont Priority Waters List. Each water covered by an EPA-approved TMDL will continue to be listed in Part D whether the impairment continues to exist or not.

Part B List

All waters listed in Part B are assessed as impaired and do not require development of a TMDL as described in 40 CFR 130.7. Section 303d of the Federal Clean Water Act does not govern these waters. Impaired waters that do not need a TMDL are those where other pollution control requirements (such as best management practices) required by local, state or federal authority are expected to address all water-pollutant combinations and the Water Quality Standards are expected to be attained in a reasonable period

of time. DEC will provide information to show that (1) there are legal requirements in place (e.g. regulations or permits implementing regulations) that apply to the source(s) causing the water quality impairment and (2) that such legally required pollution control practices are specifically applicable to the impairment in question **and** are sufficient to cause the water to meet water quality standards within a reasonable time. Waters shown in Part B are equivalent to "Category 4b" waters of EPA's 2006 Guidance. If, in the future, it is determined that waters are no longer impaired, they will be removed from Part B without formal notice.

Part D List

All waters identified on Part D have appeared on a previous version of the Part A-303d List and also have completed and approved TMDLs in place. If future assessments show the impairment has been eliminated, the waters will remain on Part D as a means of TMDL tracking, however, the current assessment status of the water will be noted. Waters shown in Part D are equivalent to "Category 4a" waters of EPA's 2006 Guidance.

5.2. Altered Waters

All waters determined to be altered are placed on one of several lists that track altered waters. These lists include: Part E List (water altered by exotic species), Part F (waters altered by flow regulation), and Part G (waters altered due to physical channel changes). The listing methodology for each list is given below.

Part E List

Waters appearing in Part E are assessed as "altered." They represent situations to be given priority for management where aquatic habitat and/or other designated uses have been altered to the extent that one or more designated uses are not supported due to the presence of exotic aquatic species. This list currently includes waters altered by the proliferation of Eurasian watermilfoil, water chestnut, zebra mussels or the presence of alewives. Waters shown in Part E are equivalent to "Category 4c" waters of EPA's 2006 Guidance.

Waters will be removed from the Part E List when the population of the exotic species declines and the water is assessed as either "stressed" or in "full support" of the designated uses.

Part F List

Waters appearing in this part of the Vermont Priority Waters List are assessed as "altered." They represent priority management situations where aquatic habitat and/or other designated uses have been altered by flow regulation to the extent that one or more designated uses are not supported. Alterations arise from flow fluctuation, obstructions, or other manipulations of water levels that originate from hydroelectric facilities or other dam operations or from water withdrawals for industrial or municipal water supply or snowmaking purposes. Waters shown in Part F are equivalent to "Category 4c" waters of EPA's 2006 Guidance.

Waters will be removed from the Part F List as corrective actions are implemented.

Part G List

Waters appearing in Part G have been assessed as "altered" where the geomorphic assessment condition (derived from Phase 1 and Phase 2 data) is predominantly the result of in-stream human-induced channel management activities. These waters include stream or river reaches with significant impacts due to physical channel alterations, documented channel degradation or a change in stream type that have resulted from human activities such as gravel mining, dredging, channelization, improper bridge or culvert placement, or floodplain encroachments. In these situations, the aquatic habitat is altered from the stable ecological state due to changes in bedload movement and habitat feature loss so that one or

more designated uses are not supported. In these altered reaches, the changes in bedload and habitat features result from an instability of the system itself as streams naturally realign themselves into a new natural equilibrium. Waters shown in Part G are equivalent to "Category 4c" waters of EPA's 2006 Guidance.

Waters will be removed from the Part G List when the aquatic habitat reaches a stable ecological state naturally or as a result of channel management efforts which reduce bedload transport and the water is assessed as either "stressed" or in "full support" of the designated uses.

The Part G listing is not intended for waters that are subject to myriad discharges or multiple stressors or in watersheds subject to unremediated stormwater discharge(s). Part G is inappropriate for waters that are subject to influxes of washload arising from continuing watershed perturbations.

5.3. Stressed Waters

A subset of waters assessed as "stressed" are listed on the Part C List (waters in need of further assessment).

Part C List

All waters appearing in this component of the Vermont Priority Waters List are assessed as "stressed" and have been identified as needing further assessment to confirm the presence of a violation of one or more criteria of the Vermont Water Quality Standards. A violation has not been documented by sufficient data (i.e. there is an insufficient weight of evidence). Part C waters are considered high priority waters for assessment and monitoring.

In the event a violation is substantiated and determined to exist, DEC will assess the water as "impaired" or "altered," depending on whether or not the cause of the violation is a pollutant, and then assign the water to either Part A (impaired needing a TMDL), Part B (impaired not needing a TMDL), Part E (altered by exotic species), Part F (altered by flow regulation), or Part G (altered by physical channel changes). In the event, however, further monitoring is conducted and the weight of evidence becomes sufficient to show compliance with the Vermont Water Quality Standards, the water will be removed from the Part C listing.

5.4. Full Support Waters

Waters that fully support designated uses are not tracked on the Vermont Priority Waters List.

5.5. Comparison to EPA's Listing Categories

The development of this most recent listing methodology relies upon EPA guidance that outlines a consolidated report regarding the status of all the waters in the state. For comparative purposes, the table below shows how the various DEC listing components correspond to EPA listing categories.

Table 5.1. Comparison between Vermont DEC Listing Components and EPA Listing Categories.

Vermont DEC Listing Components	EPA Listing Categories
Full support waters. Not tracked on the Vermont Priority Waters List	Category 1
Part C waters	Category 2
Unassessed waters. Not tracked on Vermont Priority Waters List	Category 3
Part D waters	Category 4a
Part B waters	Category 4b
Part E, Part F and Part G waters	Category 4c
Part A waters	Category 5

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APPENDIX A

Summary Description of
Vermont Water Quality Division Monitoring Programs

Vermont Department of Environmental Conservation

A Descriptive Listing of Water Quality Division Monitoring Programs

The Water Quality Division (WQD) is responsible for conducting much of the Department's ambient surface water quality monitoring activities. WQD efforts in this regard are comprised of numerous discrete projects and programs. The Division's monitoring efforts can be classified as physical/chemical, biological, volunteer and other. Within each of these broad classes, monitoring projects are further described as core, or long-term projects; diagnostic studies, which identify the causes of particular water quality problems; and special studies, which provide information and data on specific water quality issues. There are, in addition, other projects coordinated by close partners of the WQD which tend to broaden the scope and geographic extent of assessment data collection. Analysis of samples for organic and inorganic compounds and heavy metals would not be possible without the analytical services of the R.A. LaRosa Environmental Laboratory.

A. Physical & Chemical Monitoring

1. Core Programs

The Spring Phosphorus Program collects during the spring overturn (typically late March to May 10) nutrient and physical and chemical data on Vermont lakes and ponds that are 20 acres in size or larger. On average, 50 to 60 lakes are sampled each year. Ten lakes are customarily sampled every year. Parameters include total phosphorus, total nitrogen, alkalinity, calcium, magnesium, hardness, Secchi disk transparency, and multi-probe profiles (temperature, dissolved oxygen, conductivity, and pH). Since 1977, 236 lakes have been monitored in conjunction with this program. Forty-eight lakes have 10 or more years of data, and 18 of these have 15 years or more. The Spring Phosphorus Database contains over 1,700 records.

The Lake Assessment Program is designed to rapidly assess the extent to which lakes meet designated uses and to gather information to focus lake management and protection efforts. The sampling intensity for assessment lakes varies with the degree to which impairment is evident or must be documented. Lakes being evaluated under this program are those found in the basins being examined under the rotational watershed assessment approach. In general and during the summer months, lakes are circumnavigated and detailed assessment observations are made regarding in-lake and shoreline conditions with respect to designated uses and threats to water quality. Detailed notes are made regarding the extent and species 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 determine compliance with Water Quality Standards. Since 1989, 281 comprehensive assessments and 59 cursory assessments have been performed under this program.

The River Assessment Program is designed to assess the extent to which rivers and streams support designated uses to focus management and protection efforts. The assessments themselves involve 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 under the rotational watershed assessment approach. Rivers and streams in the basins of the rotation focus are visited in the spring, summer and fall to look for obvious sources of pollution from the land or indicators of problems or threats in the water such as sedimentation, heavy algae growth, or water with

unnatural color or odor. The Ambient Biomonitoring Program (described on page 5 below) provides most of the information used 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 concurrently with any biological sampling.

The Water Level Monitoring Program monitors lake surface elevations (June 1 to September 15) to establish mean water levels for a variety of purposes, most notably to determine the jurisdictional boundary of the State's lakes and ponds under the shoreland encroachment permit program and Vermont's Public Trust Doctrine. On average, 40 lakes are visited each year.

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. The mouths of eighteen major tributaries are sampled on an event basis as well. The program's large physical and chemical parameter list includes species of phosphorus, nitrogen and organic carbon; chlorophyll-a; base cations; alkalinity; total suspended solids; dissolved oxygen; conductivity; and pH. As of April 2003, this program had assembled a database comprising 6,366 lake and 4,282 tributary sampling events.

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 and are sampled at least eight times every year for sixteen chemical parameters related to acidification. This 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. As of April 2003, the LTM data archive comprises 1,857 lake and 405 outlet sampling records.

The Stream Geomorphic Assessment Program collects geomorphologic data on streams throughout the state to assess stream geomorphic stability and develop regime relations for Vermont's streams. Stability assessments enable 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 guide stream protection, management, and restoration projects and assist in the establishment of Vermont-specific physical criteria for water quality classification and use attainment determinations. Parameters measured in this program, typically during low flow periods, 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 Program has also produced a Stream Geomorphic Assessment Handbook containing recommended protocols and procedures for completing such work. The Handbook's protocols, produced in cooperation with Vermont Department of Fish and Wildlife and VTDEC's Geology and Mineral Resources Division, are for Phase 1, Phase 2 and Phase 3 assessments. The Handbook's protocols are being used by VTDEC and by other groups gathering geomorphologic data.

As of August 2003, the Program has obtained or is aware of geomorphic assessments concerning 17 rivers/streams located in 12 of Vermont's 17 river basins. Phase 1 assessments have been conducted for approximately 1,200 reaches. About 200 reaches have a Phase 2 assessment.

2. Lake Diagnostic Studies

Diagnostic studies are typically aimed at identifying the cause of eutrophication in Vermont lakes. Over the past 20 years, VTDEC has performed numerous such monitoring studies, and the results of these studies have led to concrete remediation steps. Lakes on which notable diagnostic studies have been performed include Harveys Lake (Barnet), Lake Morey (Fairlee), Lake Iroquois (Hinesburg), Fairfield Pond (Fairfield), Lake Parker (Glover), Lake Carmi (Franklin), and Lake Champlain. A diagnostic study was recently completed on Ticklenaked Pond (Ryegate).

A wide variety of parameters are sampled throughout the year in conjunction with diagnostic studies, with the actual tests performed being specific to the project's objectives. Standard eutrophication parameters (total phosphorus, Secchi disk transparency, and dissolved oxygen) are always measured. Other parameters from both the sediment and the water column are measured as needed.

3. Special Studies

Special studies are those performed to gain more information about a particular environmental issue of importance to VTDEC and the Agency of Natural Resources. There are three such projects being cooperatively managed by the WQD. A fourth special study project was completed in June 2001.

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 lake types occurring in the two states that have elevated levels of mercury in fish and upper trophic level biota. The parameter list for this integrated collaborative monitoring project is large, and includes standard limnological measurements and mercury in total and methyl phases in sediment, water, and biota. There is also a paleolimnological component that has determined the extent to which atmospherically deposited mercury has entered lakes in the study set. Two peer-reviewed journal articles have been produced from this study.

The Best Management Practices Effectiveness Demonstration Project is a stream monitoring effort designed to assess the efficacy of best management practices in controlling pollutants in nonpoint source runoff. This cooperative VTDEC-USGS project employs an upstream-downstream approach to pinpoint reductions in pollutant runoff attributable to specific installed BMPs. The multi-year project is being carried out in one agricultural stream (Little Otter Creek) and one urban stream (Englesby Brook) in the Lake Champlain basin.

In conjunction with **the Paleolimnology of Vermont Lakes Project**, the WQD 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 ($\delta^{13}C$ and $\delta^{15}N$). Using cores from the sediments of several lakes, the WQD is working to identify the extent to which the present trophic condition in these lakes deviates 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.

The Lake Champlain Agricultural Best Management Practices Monitoring Project was a seven-year special water quality monitoring project completed in 2001. This comparative observational study used a three-way paired watershed experimental design using a single control and two treatment watersheds. The goal was to evaluate the efficacy of both low- and high-intensity whole-watershed BMP implementation strategies. Parameters measured included total phosphorus, total and Kjeldahl nitrogen, total suspended solids, and *E. coli*. Biological assessments of fish and macroinvertebrate communities were also performed on each of the three watersheds.

B. Biological Monitoring

1. Core Programs

The Ambient Biomonitoring Program was established in 1982 to: 1) monitor long-term trends in water quality as revealed by changes in ambient aquatic biological communities over time; 2) evaluate potential impacts on aquatic biological communities from permitted direct and indirect discharges, Act 250 projects, nonpoint sources, and spills; and 3) establish a reference database to facilitate the generation of Vermont-specific biological criteria for water quality classification and use attainment determinations. Since 1985, VTDEC 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 several macroinvertebrate metrics. Guidelines have been developed to determine water quality standards attainment using both macroinvertebrate community biological integrity metrics and the IBI. Approximately 75 sites per year are assessed, typically during the fall season, 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. This program provides much of the biological data used in the rotational watershed assessment program for rivers. From 1985 to April 2003, well over 1,700 stream assessments were completed using macroinvertebrate and/or fish from 1,229 stream reaches.

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 177 discrete surveys.

The WQD 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*).

An interesting component to these aquatic nuisance species efforts is the longest ongoing zebra mussel monitoring program in the nation, the **Lake Champlain Zebra Mussel Monitoring Program**. In conjunction with this effort, 12 in-lake and 12 shoreline stations in Lake Champlain are monitored for larval and settler zebra mussel presence and density every two weeks (April through November). In addition, adult zebra mussel surveys are performed at selected shoreline locations during late summer. This is the only such zebra mussel monitoring project of its kind in the United States. As of April 2003, there were 2,220 veliger records and 1,013 settler records within this program's nine years of data records.

2. Special Studies

The Biodiversity Monitoring Program evaluates the status of selected biological species and communities in Vermont. Specific activities include: 1) distribution surveys of aquatic plant, fish and macroinvertebrate species listed by the Vermont Endangered Species Committee as rare, threatened, endangered, or of special concern; 2) distribution surveys of communities having species considered likely candidates for future 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 threatened by zebra mussels). Data are used to describe species distribution, identify species/communities at risk, and develop management plans for the protection of identified species/communities.

The Vermont Wetlands Bioassessment Project is a coordinated effort between VTDEC and the Vermont Department of Fish and Wildlife's Non-game 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 has been used to assess and monitor the ecological health of seasonal pools in Vermont. Preliminary efforts at using these data to develop vernal pool biocriteria have seen limited success.

The Lake Bioassessment Project was initiated in 1995 to begin developing biological criteria for Vermont lakes. This monitoring effort was launched as a cooperative project with the State of New Hampshire. The goal of the project is to develop numeric measurements of the phytoplankton, macrophyte, and macroinvertebrate communities in reference lakes for use in assessing aquatic life use attainment in lakes. Consistent protocols have been developed to measure these biological assemblages, and to date, 12 New Hampshire and 38 Vermont lakes have been included in the project. Statistically-validated multimetric indices have been developed for the phytoplankton macroinvertebrate communities, and remain under development for macrophytes.

The Lake Champlain Long-Term Monitoring Program (see also above) includes biological sampling, which is primarily aimed at assessing phytoplankton, zooplankton, and macroinvertebrate communities. Data from this element of the project resides in the New York State Natural History Museum, with copies available only in spreadsheet form in Vermont. These data, which have been underanalyzed and underutilized, should provide a baseline for evaluating changes in ecosystem structure anticipated owing to zebra mussel infestation.

The Northern Leopard Frog Surveys in the Lake Champlain Basin Project was initiated in response to reports of malformed frogs in the Vermont portion of the Lake Champlain basin during the summer of 1996. Malformed frogs were reported from 12 sites in five Vermont counties. Systematic field surveys were initiated in 1997, targeting the northern leopard frog (Rana pipiens). These surveys recorded the frequency and morphological characteristics of gross abnormalities among newly metamorphosed northern leopard frog populations at 20 sites within the basin. With subsequent support through the USEPA REMAP program, WQD has examined over 6,000 northern leopard frogs since 1996, and external malformations have been detected in 7.5% of the frogs examined. Data characterizing the gross abnormalities and describing the frequency and occurrence of abnormalities within northern leopard frog populations continues to be gathered at 10 established sites within the lake basin. All findings are reported to the North American Reporting Center for Amphibian Malformations (http://www.npwrc.usgs.gov/narcam/). VTDEC continues to collaborate with the National Institute of Environmental Health and Sciences, the National Wildlife Health Center, and other researchers, providing environmental samples and specimens to help further malformed frog investigations.

The Fish Contaminant Monitoring Program is managed by the WQD and performed in cooperation with the Vermont Department of Fish and Wildlife and the Vermont Department of Health. Edible tissue from game fish acquired throughout the state is analyzed for mercury and other contaminants. These data are then used to set and subsequently refine fish consumption advisories issued by the Vermont Department of Health.

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

* monitoring non-target impacts to aquatic biota in lakes chemically treated with the aquatic herbicide Sonar® (fluridone) to control Eurasian watermilfoil infestations;
* monitoring the effects on both target and non-target organisms of copper sulfate treatments to small recreational lakes and water supply reservoirs; and
* monitoring impacts to non-target fish and macroinvertebrates in rivers treated with lampricide (TFM) to control sea lamprey (*Petromyzon marinus*) in Lake Champlain.

C. Volunteer Monitoring

Citizen groups are becoming increasingly involved in monitoring, education, protection, and restoration projects in Vermont. VTDEC provides assistance and training to volunteers whenever possible. Watershed and lake associations are presently active on numerous rivers and lakes in the state. In fact, there are over 100 such associations statewide. The WQD has developed a directory listing various watershed associations and their activities in "Current Programs of Vermont Watershed Associations – 2002," with a lake association addendum listing active lake groups which can be inspected at WQD's web site (www.vtwaterquality.org, click on "lakes and ponds," click on directory).

1. 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 based on trophic parameters and monitors approximately 40 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 more limited data are needed, are sampled only for Secchi disk transparency. All sampling occurs on a weekly basis during the summer months. Since development of the Lay Monitoring Program in 1979, data has been generated on 84 inland lakes and 36 Lake Champlain stations. Seventy-two inland lakes and 30 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 Project.

The Citizen Lake and Watershed Survey Program provides survey sheets and technical training to 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.

The Aquatic Nuisance Species (ANS) Watchers Program trains citizen volunteers to monitor for the presence of invasive non-native aquatic species. The program is currently focusing on monitoring for Eurasian watermilfoil, water chestnut, and zebra mussels. There are presently 129 ANS Watchers throughout Vermont.

The Volunteer Acid Precipitation Monitoring Program was initiated in 1980 to assess the impact of the 1970 Clean Air Act (and it's 1990 amendments), which mandated nationwide reductions in SO_4 emissions. Dedicated volunteers at six sites around 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. The data are 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).

2. Other volunteer initiatives

In 2003, the WQD and the R.A. LaRosa Environmental Laboratory launched a new initiative to foster volunteer monitoring by providing laboratory analytical services cost-free to volunteer organizations under a competitive grant program. While this program is just beginning, it does provide an opportunity to significantly enhance the monitoring of waters of joint importance to volunteer organizations and WQD. Grantees under this program are required to prepare, submit, and adhere to an USEPA pre-approved 'checkoff' QAPP prepared by USEPA Regions 1 and 2 in collaboration with VTDEC and New York State DEC, for volunteer-based projects funded by the Lake Champlain Basin Program. These projects promise to provide a wide array of data of known quality and reliability to be used for assessment reporting.

D. Other Monitoring Partnerships

1. Federal

The US Army Corps of Engineers (ACOE) manages several flood control reservoirs in Vermont. These are monitored routinely for flow and stage, and periodically for a variety of physical and chemical constituents. ACOE reservoirs with designated swimming beaches are also monitored for *E. coli* regularly during the swimming season. ACOE reports on its monitoring activities annually and shares these reports with WQD. ACOE sampling results are used in conjunction with assessment reporting.

The US Environmental Protection Agency (EPA) coordinates regional water quality monitoring projects of a wide variety. In recent years, projects that WQD has collaborated on include the REMAP New England Wadeable Streams Project and the National Study of Chemical Residues in Fish. EPA was also the principal sponsor of the REMAP Assessment of Mercury in Waters, Sediments and Biota of Vermont and New Hampshire lakes project and in the survey of pharmaceuticals in certain Vermont waters. WQD plans to participate in the upcoming REMAP New England Lakes Project. Results of these studies are used for a variety of purposes in addition to assessment reporting.

The US Fish and Wildlife Service (USFWS) sponsors projects across New England dealing with toxic contamination of aquatic biota. WQD has collaborated with USFWS on several projects and data are freely shared. In addition, USFWS co-sponsored the REMAP mercury project discussed above.

The United States Geological Survey (USGS) operates a network of gauging stations on Vermont waters which are supported by a cooperative agreement with VTDEC. This gauging network provides water flow data that are critical for numerous applications, both within and outside of VTDEC. USGS also coordinates several water quality studies throughout Vermont in a variety of disciplines, and the results and data are commonly shared with VTDEC for numerous uses including permitting and assessment reporting.

2. State

The Vermont Department of Forests, Parks, and Recreation (DFP&R) operates a comprehensive beach monitoring program for all public use beaches on State Park lands. Twenty-nine beaches are monitored on a weekly basis during the summer (June – August) following established protocols. Swim advisories are posted by DFP&R based on results of the testing when *E. coli* sample values exceed the Vermont criterion for Class B waters of 77/100ml. These data are openly shared with WQD, who uses the data for the purpose of assessment reporting and for identifying beaches subject to potentially chronic bacterial contamination.

The Vermont Monitoring Cooperative (VMC) is a collaborative organization in which scientists collect and pool information and data for the purpose of improving our understanding, protection, and management of Vermont's forested ecosystems. Participating cooperators from government, academic and private sectors, conduct research projects on a variety of topics including forest health, air quality and meteorology, wildlife, aquatic systems and others. The VMC helps make the data and results from these projects available to other scientists, educators, resource managers and the general public. The VMC was initiated in 1990 as a state, university, and federal partnership, with an envisioned one-hundred year lifespan. The centerpiece of the VMC is the data library and card catalogue system that allow data to be shared, archived, and accessed by scientists and other interested parties via the VMC website. The data archive contains data and ancillary textual material from over 100 projects and is geographically and temporally linked.

The Vermont Geological Survey (VGS), also known as the Geology and Mineral Resources Division of VTDEC, conducts research and surveys related to the geology, mineral and groundwater resources of Vermont. VGS serves as a clearinghouse for the State's topographical information.

3. Local

The Addison County Collaborative (ACC) is a volunteer-based consortium of local volunteer organizations that monitor waters in several watersheds in the vicinity of Addison County. Partial funding is typically allocated through the Addison County Regional Planning Commission. ACC has monitored approximately 45 sites across four watersheds for *E. coli* and eutrophication-related parameters. ACC provides data and summary reports to VTDEC on an annual basis. These data are used to assist development and implementation of the Otter Creek and Lower Direct Champlain Basin Plans and in assessment reporting.

The Lewis Creek Association (LCA) is a private, non-profit organization dedicated to protect, maintain and restore ecological health while promoting social values that support sustainable community development in the six-town watershed region as well as other areas of Vermont. LCA is a member organization of the ACC noted above.

The White River Partnership (WRP) is a private, non-profit organization dedicated to helping local communities balance the long-term cultural, economic and environmental health of the watershed through active citizen participation. The WRP, using US Department of Agriculture funding leveraged by private donations, has established a monitoring program for the watershed, comprised of multiple elements and several volunteer "stream-teams." Activities include geomorphic assessment, priority site mapping, and water quality sampling for a variety of constituents including temperature, turbidity, conductivity, and *E. coli*. WRP's active base of volunteer monitors generate quality-assured data that is used to identify

priority reaches for protection or remediation. VTDEC is periodically provided data summaries for use in implementation of the White River Basin Plan, in assessment Reporting, and in other joint special studies.

The West River Association (WRA) is a newly forming group dedicated to similar goals as the WRP and ACC, for waters in the West River watershed. This organization plans to launch a new monitoring project in partnership with WQD during 2003. Project data will be used for several purposes including assessment reporting.

The Friends of the Mad River (FMR) is a non-profit organization sharing similar goals to the above noted groups. The FMR has undertaken a number of planning and implementation projects along with a long-standing water quality monitoring program which includes *E. coli* and a number of other parameters. VTDEC is periodically provided data for use in assessment reporting.

The Watershed Alliance of the University of Vermont and **River Network** have been active in promoting surface water quality monitoring for elementary and high schools. Such monitoring is valuable from an educational and student/community involvement standpoint. When monitoring results are shared with VTDEC, the information can be considered during assessment reporting.

Appendix D

Vermont Department of Environmental Conservation

Ambient Water Quality Monitoring Program Strategy 2005-2015

September 2005

List of Tables

Executive Summary

This ambient water quality monitoring program strategy provides a framework describing existing monitoring and assessment efforts in Vermont, and elaborates on elements of an ideal monitoring program to meet several objectives. The strategy presented herein has multiple uses and purposes, and is organized into USEPA's "Elements of a State Water Monitoring and Assessment Program" (March, 2003). This strategy presents a roster of specific monitoring goals and objectives, and a listing of existing and potential monitoring designs for Vermont waters. Recommendations for core and supplemental water quality indicators are provided. Detail is provided on quality control and assurance, data management approaches, a description of data analysis and assessment procedures, and the use of these procedures to support federally required reporting. The final sections of the strategy address suggestions for periodic review of the monitoring program, and provide estimates of necessary resources for full program implementation. Throughout the strategy, the term "waters" is intended to comprise rivers and streams, lakes, ponds and reservoirs, and wetlands. Groundwater is not yet addressed by this strategy.

Section one introduces the strategy, while Section two provides the goals and objectives to be met, which are as follows:

Goal 1: Predict and monitor the condition of Vermont's aquatic and wetland resources to:

- identify emerging problems before they become widespread or irreversible;
- provide information essential to protecting, maintaining and/or restoring the integrity and use of these resources;
- achieve comprehensive monitoring coverage of all Vermont waters;
- identify water quality conditions, impairments, causes, and sources; and,
- evaluate the success of current policies and programs.

Objectives for Goal 1:

A. Identify the status of Vermont's aquatic and wetland resources
B. Identify trends in the condition of Vermont's aquatic and wetland resources, including high-quality waters in need of protection
C. Identify existing and emerging threats to Vermont's aquatic and wetland resources
D. Identify where watershed level activities impact aquatic and wetland resources
E. Provide information to support and evaluate Agency and Department planning, management and regulatory programs, including the development of environmental indicators
F. Respond to citizen complaints and emergency situations regarding Vermont's aquatic and wetland resources (as appropriate)
G. Determine compliance with Vermont Water Quality Standards, and identify where standards may need to be modified to account for natural conditions
H. Provide technical data and information to public water supply operators
I. Obtain monitoring data coverage for all waters such that each significant public water will be monitored directly, or will have its condition estimated based on a statistically unbiased random probability determination

Goal 2: Communicate, collaborate and coordinate with organizations, agencies, and the general public to:

- increase public knowledge of and involvement in aquatic and wetland resource monitoring and assessment (and hence water resource management);
- promote efficient and effective monitoring and assessment programs; and
- collect useful data to supplement state monitoring and assessment programs.

Objectives for Goal 2:

A. Develop a mechanism for identifying and coordinating monitoring and assessment programs in Vermont
B. Identify aquatic and wetland resource data needs and develop mechanisms to enable volunteer monitoring and assessment programs to collect data that are of high quality and relevant to those needs
C. Communicate with other state and federal agencies to assure complementary monitoring programs
D. Encourage volunteer monitoring programs

Section three addresses monitoring designs. It provides detail on existing monitoring approaches in Vermont, including the rotational watershed assessment approach and existing core and supplemental projects, broken into physical, chemical, biological, and volunteer-based categories. A comprehensive listing of potential threats to Vermont waters is provided. Section four lists core and supplemental indicators of water quality that are measured by the individual monitoring projects. These indicators spring from the Vermont Water Quality Standards, but also include parameters that relate to ecological and habitat quality. Section five describes approaches to quality assurance, provides a listing of active quality assurance project plans, and discusses briefly how quality assurance planning relates to quality management planning.

Section six of the strategy provides a listing of existing databases that house water quality information generated by the monitoring program described in Section 3, discusses the current status of Vermont's water quality assessment databases, and relates information housed in those data archives to the Vermont Hydrographic Dataset. Section seven describes how VTDEC assesses water quality data to arrive at determinations of water quality standards attainment, and further elaborates on approaches to listing waters where uses are not met. Here the strategy references Vermont's Water Quality Assessment and Listing Methodology as a standalone document that guides the listing process. Section eight describes required Federal reporting that is supported in large part by the monitoring program and associated assessment and listing processes. Finally, Sections nine and ten describe monitoring program review and institutional needs.

Specific recommendations are provided within each of the above categories. The highest priority items requiring funding include securing long-term technician and summer staff support for the biomonitoring and lakes programs, and developing a coordinator position to support volunteer organizations participating in the highly successful LaRosa Laboratory Services Partnership Program. Other priority items regard increasing consistency in the archiving of water quality assessment findings, and expansion of the use of STORET (a national water quality data archive) to hold biomonitoring data.

This strategy includes more broadly applicable recommendations that address new monitoring designs: methods for assessment, listing, and reporting; and, to a small degree, water quality criteria development. The strategy recommends using a hybrid of fixed station and probability-based surveys to assess the conditions of waters statewide. Projects that are developing biological indices of aquatic life use support for large rivers, lakes and reservoirs, and wetlands have identified needs. The strategy also highlights approaches to developing nutrient criteria and modifying pathogen criteria. With respect to Federal assessment methods and reporting requirements, this strategy specifically recommends that assessment methods be fixed for a period of three assessment and listing cycles, and that reporting during those periods be consistent. This will enable VTDEC to track changes in use attainment with time. The specific recommendations and strategy items are wide-ranging, and are provided following each monitoring program element as listed above. From the roster of recommendations and strategies, several higher-priority, unmet needs are evident, and these are listed in the following table:

Projected unmet staffing/funding needs to accomplish all elements of the Water Quality Monitoring Program Strategy

Item	Program Area	Need	Start year	Completion target	Resource requirement
1	Monitoring Program	Maintain core monitoring program including State, USGS, and LaRosa components	2005	Ongoing	Consistent base monitoring funding under §106 and other mechanisms (PPA), which increase annually by inflationary costs plus COLA
2		Support/augment core monitoring program	2006	Ongoing	Add 1FTE permanent technician support to biomonitoring program $54.5K*
3			2006	Ongoing	Add ½ FTE permanent technician support to lakes monitoring program - $27.3K**
4			2006	Ongoing	Add 1FTE permanent technician support to wetlands monitoring program $54.5K
5			2006	Ongoing	Augment technician staff by two temporary staff supporting lakes and rivers volunteer programs (April-August) and biomonitoring (Sept-Jan) programs -
6			2006	One time	Purchase a large, laboratory-grade freezer for tissue sample storage $3.5K
7			2006	One time	Purchase a dissecting microscope for aquatic plant identification $3K
8		Initiate wetlands biomonitoring project	2007	2008	$60K operational/technician support in addition to item 4.
9		Incorporate bioassessments into lake assessment program	2007	Ongoing	$1K/lake/assessment
10		Support of the LaRosa Partnership volunteers	2006	Ongoing	Add 1 FTE staff support to coordinate volunteer groups, $27.2K*
10					
11	WQ Indicators and Criteria	Complete nutrient criteria development project	2005	2007	Complete analysis of nutrient criteria project dataset according to VT Plan for Nutrient Criteria Development - $40K****
12		Begin development of wetland biological criteria	See item 7 above		
13	Data management	Data manager	2007	Ongoing	Add ½ FTE technical staff to support data management activities associated with data archiving, and conversion of the Storet biomonitoring database, $27.3K,***

Item	Program Area	Need	Start year	Completion target	Resource requirement
14		Archive biomonitoring data to Storet	2007	Ongoing	Use technical staff associated with items 12 and 14, plus contractor services, to migrate existing biomonitoring data to Storet, and develop a routine data submission system for Storet. $20K of contractor services would assist in this regard.
15		Develop pocket computer-based tools to streamline data management	2006	Ongoing	Using in-house or contracted services, develop a pocket PC-based data collection platform that essentially eliminate paper data collection and entry. 20K
16	Assessment and reporting	Staff support - assessment	2008	Ongoing	Add ½ FTE staff to assist in waterbody assessments and basin report preparation, $27.2K,***

* Calculated as an environmental technician II (VT Pay Grade 18), per FTE basis, plus fringe and indirect costs.

, * these would logically be combined into single positions.

**** funding has been received for this project under §104(b)(3) for 2006.

1. Introduction

This ambient water quality monitoring program strategy provides a framework describing existing monitoring and assessment efforts in Vermont, and describes elements of an ideal monitoring program to meet several objectives. The Strategy presented herein has multiple uses and purposes. It simultaneously:

Provides specific monitoring goals and objectives;
Discusses several types of monitoring designs used in Vermont;
Recommends core and supplemental water quality indicators;
Provides detail on quality assurance procedures;
Provides detail on data management approaches;
Gives data analysis and detailed assessment procedures;
Describes required federal reporting;
Suggests methods for periodic review of this monitoring program; and,
Provides estimates of necessary resources for full program implementation.

Throughout this document, the terms "waters" and "water resources," where used generically, mean wetlands, lakes and ponds, streams and rivers, and even watersheds. The term "monitoring" is intended to address measurement or estimation of ambient water quality conditions. Groundwater is not presently addressed in this strategy, nor are monitoring activities related to permit compliance or in-facility monitoring. This strategy is intended to be evolving, reflecting the ever-improving methods available for ambient water quality monitoring. It provides a range of activities that could be implemented based on availability of resources in any given year. This strategy is intended to have a finite lifespan of ten years, and provides for annual and mid-stream changes to the monitoring program. Vermont's citizenry, Federal and academic collaborators, and regulated entities are encouraged to view this strategy with an eye towards where and how they can participate in understanding, protecting, and improving Vermont's waters.

There are numerous reasons to monitor the quality of Vermont's water resources. Principally, the Clean Water Act requires states to characterize the baseline quality or status of waters, understand the trends or directions in which this baseline is moving, and determine what factors or stressors may be influencing that movement. These are critical components to properly managing any waters. In Vermont and indeed nationwide, significant emphasis is currently being placed on determining whether waters are in compliance with applicable water quality standards and criteria. Such decisions carry significant regulatory repercussions, hence the need for a robust and scientifically defensible framework that describes every step of the assessment, remediation, and protection processes.

The process of assessment begins with the three components listed above: status, trend, and causality. Estimating the status and trends of waters, with known and quantifiable precision, is the first step in assessing standards attainment. Should a waterbody be determined to not be attaining standards, then determining the extent of the water quality impact caused by any number of stressors, again with known and quantifiable precision, is the first step toward remediating a problem.

While the current water quality management climate forces scientists and managers to think about monitoring in the framework of use support, impaired waters listings and de-listings, and TMDL preparation, there are other, equally important goals that must be met by monitoring activities. Chief among these are the understanding of what is unique about a waterbody, and the understanding of how these unique waterbodies respond to management actions. These two objectives provide for protection and efficient remediation of waters. An important corollary objective is to provide, via education and participation, avenues for Vermont's citizenry to contribute in a meaningful way to the protection and/or improvement of rivers, streams, lakes, ponds, and wetlands.

2. Monitoring Objectives

A. Regulatory Justification

The present Strategy has two basic goals: to directly gather information about Vermont's water resources; and to work with partners at all levels to gather additional information while explaining how sound, scientifically-based monitoring data is used to properly manage Vermont waters. Embodied within these goals are specific objectives intended to meet the goals and intent of the Federal and State Law. Specifically, these objectives address several sections of the Federal Clean Water Act, including Sections 106(e), 303(d), 304, 305(b), and others. These objectives also support sections of Vermont Statutes Annotated (e.g., 10 V.S.A. Chapters 37 through 49, 10A V.S.A. Chapter 2). Goal statements and associated objectives are described in the following.

B. Goals and Objectives:

Goal 1: Predict and monitor the condition of Vermont's aquatic and wetland resources to:

- identify emerging problems before they become widespread or irreversible;
- provide information essential to protecting, maintaining and/or restoring the integrity and use of these resources;
- achieve comprehensive monitoring coverage of all Vermont waters;
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- evaluate the success of current policies and programs.

Objectives for Goal 1:

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D. Identify where watershed level activities impact aquatic and wetland resources
E. Provide information to support and evaluate Agency and Department planning, management and regulatory programs, including the development of environmental indicators
F. Respond to citizen complaints and emergency situations regarding Vermont's aquatic and wetland resources (as appropriate)
G. Determine compliance with Vermont Water Quality Standards, and identify where standards may need to be modified to account for natural conditions
H. Provide technical data and information to public water supply operators
I. Obtain monitoring data coverage for all waters such that each significant public water will be monitored directly, or will have it's condition estimates based on a statistically unbiased random probability determination

Goal 2: Communicate, collaborate and coordinate with organizations, agencies, and the general public to:

- increase public knowledge of and involvement in aquatic and wetland resource monitoring and assessment (and hence water resource management);
- promote efficient and effective monitoring and assessment programs; and
- collect useful data to supplement state monitoring and assessment programs.

Objectives for Goal 2:

A. Develop a mechanism for identifying and coordinating monitoring and assessment programs in Vermont
B. Identify aquatic and wetland resource data needs and develop mechanisms to enable volunteer monitoring and assessment programs to collect data that are of high quality and relevant to those needs

C. Communicate with other state and federal agencies to assure complementary monitoring programs
D. Encourage volunteer monitoring programs

C. Existing and Designated Uses

Vermont's Water Quality Standards are promulgated under the legal jurisdiction of the Vermont Water Resources Board (10 V.S.A. Chapter 37, §905), consistent with the intent of the Federal Clean Water Act (40 C.F.R. 131.3). In keeping with C.F.R. 131.10(f), "Existing Uses" are those uses actually attained in a waterbody on or after November 27, 1975. Vermont's standards establish narrative and numeric criteria to support the following designated and existing uses, as established in §1-03(B)(1) for those Standards:

a) Aquatic biota and wildlife that utilize or are present in the waters;
b) Habitat that supports existing aquatic biota, wildlife, or plant life;
c) The use of waters for recreation and fishing;
d) The use of water for water supply, or commercial activity that depends directly on an existing high level of water quality; and,
e) With regard to the factors considered under paragraphs (a) and (b) above, evidence of the use's ecological significance in the functioning of the ecosystem or evidence of the uses rarity.

Thus, water uses protected under Vermont law are more colloquially described as aquatic life, habitat, aesthetics, fishing and swimming, and water supply. Waters of particular ecological significance in regards to aquatic biota and habitat, otherwise known as "High Quality Waters," are afforded additional protections. The present Monitoring Program Strategy describes Vermont's approach to assessing the level of support of these uses, in light of the standards and criteria established within the VT Water Quality Standards. A more thorough discussion of Vermont's standards is available in Section 4A, below.

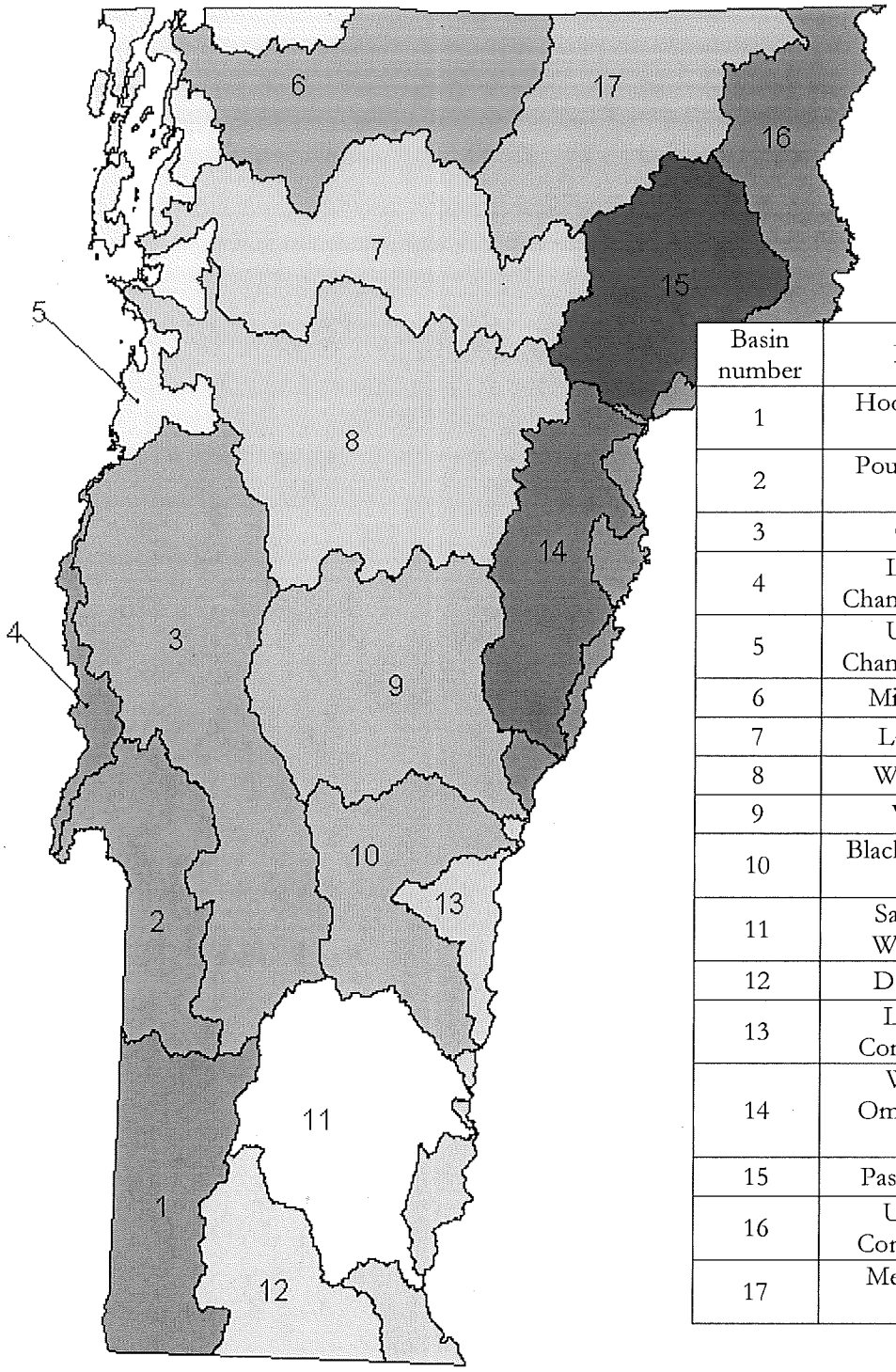
3. Monitoring Design

A. Monitoring Designs

i) Vermont's 17 basin rotational assessment approach

For the purposes of assessing and reporting water quality information, the state has been divided into seventeen major drainage basins that have from four to twenty-two river sub-basins or mainstem segments ("waterbodies") within them. The seventeen major basins drain to either Lake Champlain, the Connecticut River, Lake Memphremagog, or the Hudson River.

In order to more comprehensively and thoroughly assess the State's water and to take advantage of the untapped sources of information, the Vermont DEC Water Quality Division has designed a rotational watershed assessment process such that lakes and rivers of all seventeen major basins in the state are evaluated once every five years. To the extent possible, wetland assessment work also follows this rotation schedule. By focusing evaluations on selected watersheds each year, more systematic and intensive efforts can be made to evaluate status and trends. A focus on a limited number of watersheds also provides the opportunity to determine the best characteristics of the river system to: use as indicators of improving water quality and aquatic habitat; potentially reveal water quality trends; involve the general public; and, provide interagency coordination. Assessment reporting and basin planning are described in detail in Section 8 of this Strategy. The schedule for each basin assessment is shown in Figure 3.1.



Basin number	Basin Name	Schedule year
1	Hoosic, Wallomsac Rivers	2008-2009
2	Poultney-Mettawee Rivers	2007-2008
3	Otter Creek	2006-2007
4	Lower Direct Champlain Drainages	2006-2007
5	Upper Direct Champlain Drainages	2009-2010
6	Missisquoi River	2004-2005
7	Lamoille River	2007-2008
8	Winooski River	2005-2006
9	White River	2006-2007
10	Black, Ottaqueechee Rivers	2007-2008
11	Saxton's, West, Williams Rivers	2008-2009
12	Deerfield River	2008-2009
13	Lower Direct Connecticut River	2008-2009
14	Waits, Wells, Ompompanoosuc Rivers	2007-2008
15	Passumpsic River	2005-2006,
16	Upper Direct Connecticut River	2005-2006
17	Memphremagog Tributaries	2004-2005

Figure 3.1. Vermont's 17 major river basin groupings with rotation assessment schedule.

ii) Fixed station monitoring

The Vermont DEC coordinates a large number of fixed-station monitoring projects, incorporating river and stream, and lake water quality projects. Projects considered "fixed station" in Vermont are long-term, recurring projects which the Department has operated (or intends to operate) for several years. Some of these projects, such as the Ambient Biomonitoring Network and Lake Assessment Programs (both of which incorporate several individual monitoring projects and studies) achieve dense statewide spatial coverage. The total number of stream and lake stations established under these two programs alone exceed 1,500 and 650, respectively. These monitoring networks are designed to assess status, and detect trends, and therefore meet Objectives 1A through 1E, and 1G, of this strategy. As one of Vermont's major lake monitoring programs is a fixed-station, volunteer-based initiative, Objective 2B, of this Strategy is also met by fixed station monitoring. A listing of fixed station monitoring projects is provided in Section 3.B. Stations are added to the roster as needed to achieve more comprehensive and complete coverage. In addition, the existing fixed stations can serve as pre-established monitoring locations for random-probability based projects (such as has been done by two of the four probability-based projects listed below, allowing for hybridization of fixed and probability surveys, while maintaining consistency in monitoring location coverage. A map of existing monitoring stations is provided in Figure 3.2.

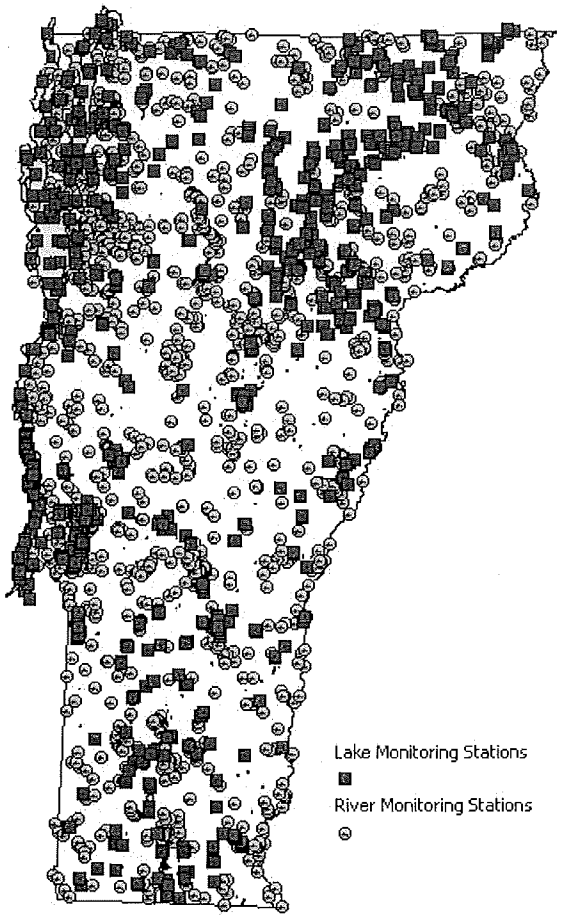


Figure 3.2 Fixed-location monitoring stations as of Dec., 2004

iii) Probability based monitoring

Probability surveys are useful for determining statewide water quality conditions in regards to some uses, and are appropriate for statistically estimating use attainment levels on a resource-wide (typically state or basin-wide) basis. VTDEC recognizes the value of probability-based monitoring initiatives, where prediction of use attainability is inherent in the project design. Such designs permit the use of statistically-derived models for inferring use attainment in appropriately selected waters where sampling was not performed. Given the density of fixed-station coverage in Vermont, probability-based surveys are considered of lesser utility where prediction outside the sample frame is not inherent in the project design. Accordingly, VTDEC strives to maximize the benefits of probability-based surveys, by actively supporting or designing projects in which a predictive system can be part of the outcome. VTDEC has undertaken four such probability-based projects in collaboration with USEPA Region 1 in recent years, and is planning to participate in a fifth. VTDEC also subscribes to the notion that properly designed probability surveys should provide estimates of the target attainment condition with a 90+ % confidence level. To achieve this, VTDEC monitoring staff have routinely worked with EPA-ORD in Corvallis, OR and in Narragansett, RI, to build sample draws that provide such coverage. These sample draws leverage EMAP algorithms for site selection, and are statistically robust.

The four probability surveys VTDEC has implemented or participated in are discussed in detail in Section 3.B, and include:

- A REMAP assessment of mercury concentration in sediments, waters, and biota of Vermont and New Hampshire Lakes using a spatially randomized design (1998-2003).
- Characterization of use attainment for aquatic life using a spatially randomized draw of existing Ambient Biomonitoring Network data at varying site intensities (2001).
- A REMAP assessment of aquatic life use attainment in New England Wadeable Streams (2002-2006).
- Participation in the National Study of Chemical Residues in Fishes (2002-2005).

Additional examples of probability-based surveys that would be appropriate for determining statewide or basinwide use attainment, where predictability is an anticipated outcome of the project are as follows:

- Assessment of aquatic life use support inferred by physical, chemical, habitat, and biological data for lakes across Vermont. Such an assessment should be stratified using the Human Disturbance Gradient to ensure adequate representation of reference-class lakes (note: this project is in development as a regional REMAP project as of this writing, to occur 2005-2009).
- Assessment of sediment-based toxics in large-order rivers and developed lakes.
- Development of a reproducible, indicator-based assessment of fish tissue contaminants (Hg and organic contaminants) across Vermont. With specific respect to mercury bioaccumulation, the sampling units selected for such an assessment should be stratified by trophic state, acidity, and degree of water level manipulation.

iv) Special and TMDL studies

VTDEC undertakes special and TMDL studies as needed, in response to compelling data and information supplied under fixed-station and probability-based projects. The number and nature of special studies is commonly dictated by the nature of issues and problems that are reported in Vermont's Priority Waters List, part C (see Section 8.B). Such waters are typically those where additional information is necessary to make an informed impairment decision. These types of studies include detailed sampling to assess use support or standards violations, diagnostic-feasibility studies, watershed-based surveys and evaluations, and enhanced monitoring of stormwater-impaired watersheds. TMDL studies are scheduled as needed consistent with the timeline established in Vermont's impaired waters-303(d) list, and depending on available resources.

v) LaRosa Environmental Laboratory

VTDEC maintains a full service environmental chemistry laboratory in Waterbury, Vermont. The LaRosa laboratory provides a range of services to Vermont state agencies, as well as federal agencies and other users. The LaRosa laboratory is subject to strict USEPA quality assurance planning, and participates in national-scale laboratory performance studies several times per year. The LaRosa facility is also accredited by the National Environmental Laboratory Accreditation Conference. The majority of environmental samples taken in conjunction with the monitoring projects discussed below are processed at the LaRosa laboratory. The existing analytical equipment at the LaRosa facility is modern and up-to-date, and includes a high-resolution ICP-MS, and dedicated centers for low-level mercury and air toxics.

Funding for the LaRosa Laboratory is shared across all VTDEC Divisions, with the vast majority of services associated with this Strategy being allocated to the Water Quality Division. Annually, the Water Quality Division contributes funds in the form of a laboratory "assessment" fee, which serves to fund LaRosa's base, consumable, and capitol needs. In exchange for this assessment, the Water Quality Division receives laboratory services up to the capacity of the laboratory to handle the sample submission load. This funding mechanism, which in 2000 replaced a fee-for-test model, has proven a tremendous asset in support of VTDEC's ambient water quality monitoring program. In order to ensure long-term viability of the monitoring program, it is vital that this funding mechanism remain in place. For FY2005, the Water Quality Division's assessment fee was $287K, which supported all of the core monitoring needs. Complete information regarding the analytical services provided by the LaRosa laboratory are available online at http://www.anr.state.vt.us/dec/lab/index.htm.

B. Existing Water Quality Division Monitoring Projects

The following description of the WQD's current ambient monitoring program, comprised of numerous discrete projects, is up-to-date as of January, 2004. The WQD's monitoring efforts are classified herein as physical/chemical, biomonitoring, volunteer, and other. Within each of these classes, monitoring projects are further described as core, or long-term projects; diagnostic studies, which identify the causes of particular water quality problems; and special studies, which provide information and data on specific water quality issues. Other projects coordinated by close partners of the WQD are also included in this listing.

i) Physical and chemical monitoring

Core Programs

The Spring Phosphorus Program collects spring overturn nutrient and physical and chemical data on Vermont lakes and ponds that are 20 acres in size or larger. Parameters include total phosphorus, total nitrogen, alkalinity, calcium, magnesium, hardness, Secchi disk transparency, and multi-probe profiles (temperature, dissolved oxygen, conductivity, and pH). Since 1977, 236 lakes have been monitored in conjunction with this program. Forty-eight lakes have 10 or more years of data, and 18 of these have 15 years or more. The Spring Phosphorus Database contains over 1,700 records.

The Lake Assessment Program is designed to rapidly assess the extent to which lakes meet designated uses and to gather information to focus lake management and protection efforts. The sampling intensity for assessment lakes varies with the degree to which impairment is evident or 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 water quality. Detailed notes are made regarding the extent and species 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 determine compliance with VT Water Quality Standards. Since 1989, 281 comprehensive assessments and 59 cursory assessments have been performed.

The River Assessment Program is designed to assess the extent to which rivers and streams support designated uses to focus management and protection efforts. 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 the water such as sedimentation, heavy algae growth, or water with unnatural color or odor. The Ambient Biomonitoring Program (described below) provides most of the information used to determine a waterbody's aquatic life use support and compliance with VT Water Quality Standards. Temperature, nutrients, pH, conductivity, and alkalinity are parameters commonly measured concurrently with the biological sampling. Where such data are needed, loading estimates for nutrients or other pollutants can assist in determining pollution sources and impacts.

The Water Level Monitoring Program monitors lake surface elevations to establish mean water levels for a variety of purposes, most notably to determine the jurisdictional boundary of the State's lakes and ponds under the shoreland encroachment permit program and Vermont's Public Trust Doctrine.

The Lake Champlain Long-Term Monitoring Program surveys the quality of Lake Champlain waters on a biweekly basis, May to November, at 13 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; alkalinity; total suspended solids; dissolved oxygen; conductivity; and pH. As of April, 2003, this program had assembled a database comprising 6,366 lake and 4,282 tributary sampling events.

The Vermont Long-Term Monitoring of Acid Lakes Program (LTM) collects chemical and biological data on lakes located in low alkalinity regions to determine the effects of acid deposition on Vermont's lakes. Initially, 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 and are sampled at least eight times every year for 16 chemical parameters related to acidification. These data are used to classify lakes according to their acidification status, evaluate spatial and temporal variability in measured parameters, 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 evaluate impacts of acidification on aquatic communities. As of April, 2003, the LTM data archive comprised 1,857 in-lake and 405 lake-outlet sampling records. This project contributed data to a seminal article describing long-term acidification trends across northeast North America, which was published in the journal Nature in 2000.

The Stream Geomorphic Assessment Program collects geomorphologic data on streams throughout the state to assess stream geomorphic condition and develop regime relations for Vermont's streams. Geomorphic assessments enable the prediction of expected rates of river adjustment and an evaluation of the effects of various land and river management practices on geomorphic condition and physical habitat quality. Regime relations guide stream protection, management, and restoration projects and assist 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.

Diagnostic Studies

Diagnostic studies are typically aimed at identifying the cause of eutrophication in Vermont lakes. Over the past 20 years, Vermont has performed numerous such monitoring studies, and the results of these studies have led to remediation steps. Lakes on which diagnostic studies have been performed include Harveys Lake (Barnet), Lake Morey (Fairlee), Lake Iroquois (Hinesburg), Fairfield Pond (Fairfield), Lake Parker (Glover), Lake Carmi (Franklin), and Lake Champlain. Presently, VTDEC is initiating a new diagnostic study for Ticklenaked Pond, a nutrient-impaired lake in Ryegate, beginning 2005.

A wide variety of parameters are sampled in conjunction with diagnostic studies, and the actual tests performed are specific to the project. Standard eutrophication parameters (total phosphorus, Secchi disk transparency, and dissolved oxygen) are always measured. Other parameters from sediments and the water column are measured as needed.

Special Studies and TMDL Studies

Special studies are those performed to gain more information about a particular environmental issue of importance to the VTDEC, or to perform load and wasteload allocations for the purpose of TMDL development.

Several TMDL studies are ongoing or recently completed as of this writing, including load and wasteload allocations for several impaired waters in Vermont. Specific waters that are subject to recent TMDL analyses include all of Lake Champlain, segments of the Winooski and Mettawee Rivers, the Otter Creek, Allen Brook, and 37 acid-impaired lakes subject to acidic precipitation.

The EPA-sponsored REMAP Assessment of Mercury in Sediments, Waters and Biota of VT and NH Lakes Project is a three-year effort to identify lake types occurring in VT and NH that have elevated levels of mercury in fish and upper trophic level biota. The parameter list for this integrated collaborative monitoring project is large, and includes standard limnological measurements and mercury in total and methyl phases in sediment, water, and biota. There is also a paleolimnological component that has determined the extent to which atmospherically deposited mercury has entered lakes in the study set. Two peer-reviewed journal articles have been produced from this study, which was completed in 2003.

The Lake Champlain Agricultural Best Management Practices Monitoring Project was a seven-year project (1994-2001). This comparative observational study used a three-way experimental design with one control and two treatment watersheds. The goal was to evaluate the efficacy of both low- and high-intensity reach-specific BMP implementation strategies. 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 Best Management Practices Effectiveness Demonstration Project is a stream monitoring effort designed to assess the efficacy of best management practices in controlling pollutants in nonpoint source runoff. This cooperative VTDEC-USGS project differs from the project described above in that it uses an upstream-downstream approach to pinpoint reductions in pollutant runoff attributable to specific installed BMPs. The project is being carried out on one agricultural and one urban stream in the Lake Champlain basin. The agricultural site will likely be discontinued this year due to lack of commitments from the farmer to finish BMP implementation.

In conjunction with the Paleolimnology of Vermont Lakes Project, the VTDEC 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 ($\delta^{13}C$ and $\delta^{15}N$). Using cores from the sediments of several lakes, VTDEC is working to identify the extent to which the present trophic condition in these lakes deviates from the historic background. Such information is instrumental in understanding the extent to which productivity (and thus phosphorus) has been elevated since the lake watersheds were first cleared in the early 1800's.

A new approach to stormwater-impaired watershed monitoring was instituted beginning in 2004. Vermont's 17 stormwater-impaired watersheds are being monitored using an integrated approach of precipitation and flow monitoring, suspended sediment sampling, and geomorphic assessment. This monitoring is in-place as of spring 2005, and is projected to continue through 2010. These monitoring data will be used to assess improvements in individual watersheds given implementation of stormwater control initiatives.

ii) Biological monitoring

Core Programs

The Ambient Biomonitoring Program was established in 1982 to: 1) monitor long-term trends in water quality as revealed by changes in ambient aquatic biological communities over time; 2) evaluate potential impacts on aquatic biological communities from permitted direct and indirect discharges, ACT 250 (10 V.S.A. 151) projects, nonpoint sources, and spills; and 3) establish a reference database to facilitate the generation of Vermont-specific biological criteria for water quality classification and use attainment determinations. Since 1985, the VTDEC 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 several macroinvertebrate metrics. Guidelines have been developed to determine water quality standards attainment 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 April, 2003, well over 1,700 stream assessments were completed using macroinvertebrate and/or fish from 1229 stream reaches.

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 177 discrete surveys.

The WQD 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*).

One interesting component of these aquatic nuisance species efforts is the Lake Champlain Zebra Mussel Monitoring Program. For this effort, 13 in-lake and 12 shoreline stations in Lake Champlain are monitored for larval and settler zebra mussel presence and density every two weeks from April through November. In addition, adult zebra mussel surveys are performed at selected shoreline locations during late summer. This is the only such zebra mussel monitoring project of it's kind in the United States. As of April, 2003, there were 2,220 veliger records and 1,013 settler records within this program's nine years of data records.

Special Studies and TMDL studies

The stormwater-impaired watershed monitoring discussed above also carries a biological monitoring component. In addition to the physical/chemical monitoring, each watershed has been scheduled for macroinvertebrate and/or fish bioassessment at a minimum of one site per watershed. In concert with the physical/chemical parameters, these monitoring data will be used to assess improvements in individual watersheds given implementation of stormwater control initiatives.

The Biodiversity Monitoring Program evaluates the status of selected biological species and communities in Vermont. Specific activities include: 1) distribution surveys of aquatic plant, fish and macroinvertebrate species listed by the Vermont Endangered Species Committee as rare, threatened, endangered, or of special concern; 2) distribution surveys of communities having species considered likely candidates for future listing (e.g., snails); and 3) monitoring of biological communities or community types, the diversity of which is threatened (e.g., Lake Champlain mussel and cobble/shale macroinvertebrate communities threatened by zebra mussels). Data are used to describe species distribution, identify species/communities at risk, and develop management plans for the protection of identified species/communities.

The Lake Bioassessment Project was initiated in 1995 to begin developing biological criteria for Vermont lakes. This monitoring effort was launched as a cooperative project with the State of New Hampshire. The goal of the project is to develop numeric measurements of the phytoplankton, macrophyte, and

macroinvertebrate communities in reference lakes for use in assessing aquatic life use attainment in lakes. Consistent protocols have been developed to measure these biological assemblages, and to date, 12 NH and 41 VT lakes have been included in the project. Statistically-validated multimetric indices have been developed for the phytoplankton and macroinvertebrate communities. To date, data describing macrophyte communities have proven insufficiently precise to develop macrophyte criteria.

The Vermont Wetlands Bioassessment Project is a coordinated effort between the VTDEC and the VT Department of Fish and Wildlife's 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 has been used to assess and monitor the ecological health of seasonal pools in Vermont. This project was completed in 2002, and efforts at using these data to develop vernal pool biocriteria have seen limited success. VTDEC plans to modify this project for 2004 by adopting protocols and sampling strategies consistent with the Lake Bioassessment Project, to include more rigorous procedures for monitoring marginal wetland macrophytes.

The Lake Champlain Long-Term Monitoring Program described above also includes biological sampling, which is primarily aimed at assessing phytoplankton, zooplankton, and macroinvertebrate communities. Data from this element of the project resides in the New York State Natural History Museum, with copies available only in spreadsheet form in Vermont. These data have been underanalyzed and underutilized as of this writing, but should provide a baseline for evaluating changes in ecosystem structure given implementation of the Lake Champlain TMDL for phosphorus.

The Northern Leopard Frog Surveys in the Lake Champlain Basin Project was initiated in response to reports of malformed frogs in the Lake Champlain basin in Vermont in the summer of 1996. Malformed frogs were reported from 12 sites in five counties within the Lake Champlain basin. Systematic field surveys were initiated in 1997, targeting the northern leopard frog (*Rana pipiens*). These surveys recorded the frequency and morphological characteristics of gross abnormalities among newly metamorphosed northern leopard frog populations at 20 sites within the Lake Champlain basin. With subsequent support through the USEPA REMAP program, VTDEC has examined over 6,000 northern leopard frogs since 1996, and external malformations have been detected in 7.5% of the frogs examined. Data characterizing the gross abnormalities and describing the frequency and occurrence of abnormalities within northern leopard frog populations continues to be gathered 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/). The VTDEC also continues to collaborate with the National Institute of Environmental Health and Sciences, the National Wildlife Health Center, and other researchers, providing environmental samples and specimens to help further malformed frog investigations.

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

- monitoring nontarget impacts to aquatic biota in lakes chemically treated with the aquatic herbicide Sonar® (fluoridone) to control Eurasian watermilfoil infestations;
- monitoring the effects on both target and nontarget organisms of copper sulfate treatments to small recreational lakes and water supply reservoirs; and
- monitoring impacts to nontarget fish and macroinvertebrates in rivers treated with lampricide (TFM) to control sea lamprey (*Petromyzon marinus*) in Lake Champlain..

The Fish Contaminant Monitoring Program is managed by the WQD and performed in cooperation with the VT Department of Fish and Wildlife and the Vermont Department of Health. Edible tissue from game fish

acquired throughout the state is analyzed for mercury and other contaminants. These data are then used to set and subsequently refine fish consumption advisories issued by the Vermont Department of Health.

iii) Volunteer monitoring

Citizen groups are becoming increasingly involved in monitoring, education, protection, and restoration projects in Vermont. The VTDEC provides assistance and training to volunteers whenever possible. Watershed and lake associations are presently active on numerous rivers and lakes in the state. In fact, there are over 100 such associations statewide. The VTDEC has developed a directory listing various watershed associations and their activities in "Current Programs of Vermont Watershed Associations – 2002," with a lake association addendum listing active lake groups.

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 based on trophic parameters and monitors approximately 40 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. Other lakes are sampled only for Secchi disk 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 84 lakes and 36 Lake Champlain stations. Seventy-two inland lakes and 30 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 Project.

The Citizen Lake and Watershed Survey Program provides survey sheets and technical training to 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.

The Aquatic Nuisance Species (ANS) Watchers Program trains citizen volunteers to monitor for the presence of invasive nonnative aquatic species. The program is currently focusing on monitoring for Eurasian watermilfoil, water chestnut, hydrilla and zebra mussels. There are presently 110 ANS Watchers throughout Vermont.

The Volunteer Acid Precipitation Monitoring Program was initiated in 1980 to monitor changes in precipitation chemistry. Dedicated volunteers at five sites around Vermont (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. The data are used to assess spatial and temporal variability in the pH of bulk precipitation and 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).

Other volunteer initiatives

The VTDEC Water Quality Division collaborates with the LaRosa Laboratory (described below) on a novel program to assist citizen monitoring groups statewide. Beginning in 2003, the Water Quality Division and LaRosa Laboratory initiated analytical services partnerships with volunteer organizations, based on a competitive proposal process. The project has been extremely successful since its inception, when eleven projects were supported. These projects ranged in scope from small, single-lake studies to large, multi-year and multi-parameter watershed assessment initiatives. In 2003, the program produced in excess of 1,800 viable, quality-assured data records across Vermont. In 2004, over 4,400 monitoring datapoints were collected by 12 projects. For 2005, 13 projects are being supported, with coverage across every major VT watershed save the Passumpsic and North CT River Direct.

In early 2005, USEPA drafted a proposal to develop a "bank" on monitoring equipment that would be available for long-term loan to volunteer organizations. WQD supports this concept and enocourages EPA to pursue this novel idea. Administration of equipment loans for Vermont volunteer organizations could efficiently be handled through the LaRosa Laboratory Partnership Program.

Guidance for volunteer monitoring at the local level
VTDEC has now completed preparation of two guidance documents intended to support volunteer monitoring statewide. These are the 2003 *Citizens Guide to Monitoring E. coli in Vermont Waters*, and the 2005 *Volunteer Guide to Water Quality Monitoring.*

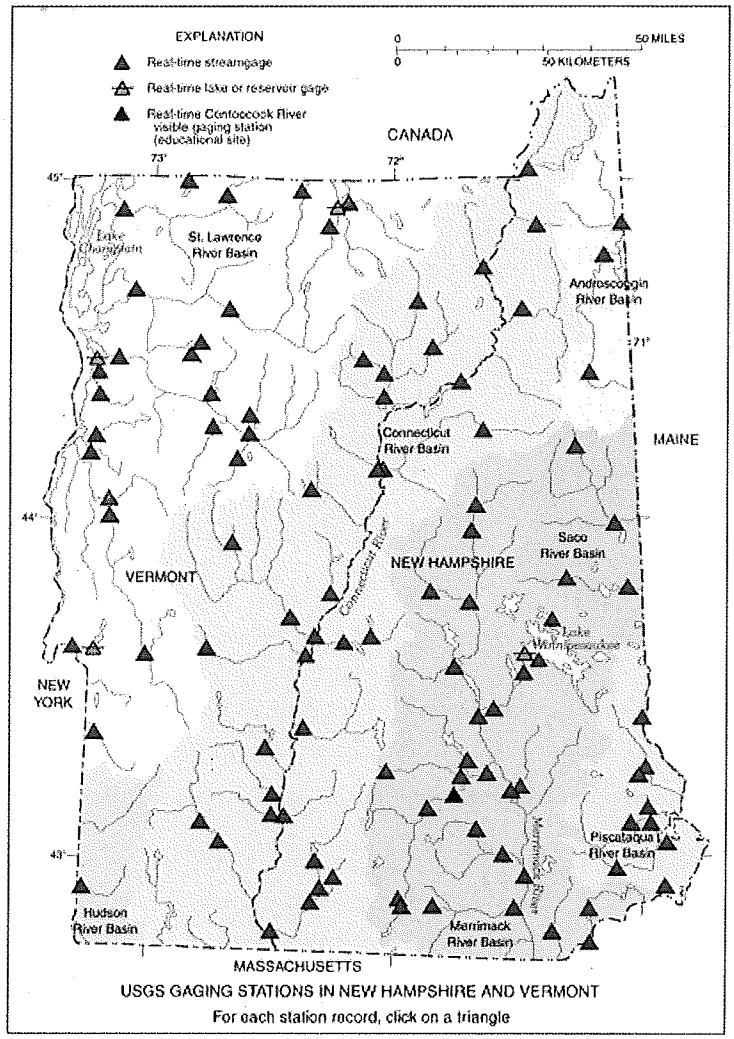
iv) Monitoring partnerships

Federal
The US Army Corps of Engineers (ACOE) manages several flood control reservoirs in Vermont Waters. These are monitored routinely for flow and stage, and periodically for a variety of physico-chemical constituents. ACOE reservoirs with designated swimming beaches are also monitored for *E. coli* regularly during the swimming season. ACOE reports on its monitoring activities annually, and shares these reports with WQD. ACOE sampling results are used in conjunction with Integrated Assessment reporting.

The USEPA coordinates regional water quality monitoring projects of a variety of types. In recent years, projects which WQD has collaborated on include the REMAP New England Wadeable Streams Project and the National Study of Chemical Residues in Fish. USEPA was also the principal sponsor of the REMAP Assessment of Mercury in Waters, Sediments and Biota of VT and NH Lakes project. WQD plans to participate in the upcoming REMAP New England Lakes Project. Results of these studies are used for a variety of purposes in addition to Integrated Assessment reporting.

The US Fish and Wildlife Service (USFWS) sponsors projects across New England dealing with toxic contamination of aquatic biota. WQD has collaborated with USFWS on several projects, and data are freely shared. In addition, USFWS co-sponsored the REMAP mercury project discussed above.

The United States Geological Survey (USGS) operates a network of gauging stations on Vermont waters, which are supported by a cooperative agreement with VTDEC (see map at right). This gauging network provides water flow data that are critical for numerous applications and programs, both within and outside of VTDEC. USGS also coordinates several water quality studies throughout Vermont and regionally in a variety of disciplines, and the results and data are commonly shared with VTDEC for numerous uses including permitting and



integrated Assessment reporting. It is imperative that the gauging network remain in place, and to the extent practical, that new gauges can be emplaced with minimal difficulty. A gage network analysis that analyzes the current and past network to determine holes/duplication in the network should be carried out. This was done in NH using FEMA funds.

The USGS also operates two watershed study sites, and has developed (or is developing) useful models to predict nutrient losses and mercury bioavailability given watershed characteristics. The Sleepers River Watershed study, which is a long term monitoring program studying natural variations in the biogeochemistry of a small catchment. A similar study is being conducted at paired watersheds on Mount Mansfield. The SPARROW model is a geographically-based system that predicts nutrient export given watershed attributes, which has proven useful in several applications in Vermont since it's publication in 2004.

The Lake Champlain Basin Program (LCBP) is a quasi-public agency, funded by Federal EPA. USGS, and NOAA appropriation, that is dedicated to implementation of the pollution prevention and cleanup plan for Lake Champlain known as *Opportunities for Action.* LCBP supports numerous monitoring and research projects, which are overseen by a Technical Advisory Committee comprised of Federal, State, Academic, Non-profit, and public members. LCBP funds the Long-term Lake Champlain Monitoring Program nearly in entirety, and is a very important partner to VTDEC (and New York State DEC).

State

The Vermont Department of Forests, Parks, and Recreation operates a comprehensive beach monitoring program for all of its public use beaches on State Park lands. Twenty-nine beaches are monitored on a weekly basis following established protocols. Swim advisories are posted based on results of the testing, when *E. coli* sample values exceed the Vermont standard for Class B waters of 77 *E. coli* /100ml. These data are openly shared with VTDEC. They are used for assessments as well as for identifying beaches subject to chronic, controllable bacterial contamination.

The Vermont Department of Health (VTDOH) operates a program whereby appointed Town Health Officers are trained to collect water quality samples at designated beaches. This program is suitable for small municipalities with informally-used swim beaches. Data reported back to Town Health Officers from the VTDOH laboratory take the form "safe for swimming," or "violates Vermont's standard: unsafe for swimming." These data are not reported or tracked as numeric results. Town Health Officers commonly use these data to post warnings at swim beaches. Owing to resource constraints, samples collected in conjunction with that program cannot follow the strict QA procedures required by VTDEC and the Department of Forests, Parks and Recreation in their *E. coli* monitoring projects. As such, this program provides useful and preliminary screening information to determine where swim beach water quality may need further assessment.

The Vermont Monitoring Cooperative (VMC) is a collaborative organization in which scientists collect and pool information and data for the purpose of improving our understanding, protection, and management of Vermont's forested ecosystems. Participating cooperators from government, academic and private sectors, conduct research projects on a variety of topics including forest health, air quality and meteorology, wildlife, aquatic systems and others. The VMC helps make the data and results from these projects available to other scientists, educators, resource managers and the general public. The Vermont Monitoring VMC was initiated in 1990 as a state, university, and federal partnership, with a one-hundred year envisioned lifespan. The centerpiece of the VMC is the data library and card catalogue system that allow data to be shared, archived, and accessed by scientists and other interested parties via the VMC website. The data archive contains data and ancillary textual material from over 100 projects, and is geographically referenced.

The data results and monitoring designs articulated above provide necessary information for use by other State permit and compliance programs. Examples of State programs that make use of monitoring data include the NPDES and Indirect Discharge Programs, the Source Water Protection Program, Stormwater Management Program.

Academic

VTDEC maintains ties with several academic institutions interested in water quality monitoring. A partial list of these include Dartmouth College, Middlebury College, the University of Vermont, and member schools of the Vermont State College System. Collectively, these institutions carry out numerous projects, and resultant data are commonly used by VTDEC for assessment purposes. The University of Vermont also carries out several larger-scale research and monitoring projects cooperatively with or of significant interest to VTDEC. A non-inclusive list of University of Vermont projects includes paired assessments of geomorphic and macroinvertebrate biometrics on streams, research into natural background levels and strategies to mitigate *E. coli* in Vermont waters, assessment of cyanotoxins in Lake Champlain and elsewhere, and impacts of non-native species on aquatic food webs.

Local

The Addison County Collaborative (ACC) is a volunteer-based consortium of local volunteer organizations that monitor waters in several watersheds in the vicinity of Addison County. Funding is typically allocated through the Addison County Regional Planning Commission and by member municipalities. ACC has monitored approximately 45 sites across four watersheds for *E. coli* and eutrophication-related parameters. ACC provides data and summary reports to VTDEC on an annual basis. These data are used to assist development and implementation of the Otter Creek and Lower Direct Champlain Basin Plans, and in Integrated Assessment reporting. The ACC received a LaRosa laboratory services grant in 2003. This organization plans to launch a new monitoring project, in partnership with VTDEC, during 2004, to assist in the development of nutrient criteria.

The West River Association (WRA) is a newly forming group dedicated to similar goals as the WRP and ACC, for waters in the West River watershed. The WRA also received a LaRosa laboratory services grant in 2003.

The White River Partnership (WRP) is a private, non-profit organization dedicated to helping local communities balance the long-term cultural, economic and environmental health of the watershed through active citizen participation. WRP, using federal United States Department of Agriculture funding leveraged by private donations, has established a monitoring program for the watershed, comprised of multiple elements and several volunteer "stream-teams." Activities include geomorphic assessment, priority site mapping, and water quality sampling for a variety of constituents including temperature, turbidity, conductivity, and *E. coli.* WRP's active base of volunteer monitors generate quality-assured data that is used to identify priority reaches for protection or remediation. VTDEC is periodically provided data summaries for use in implementation of the VTDEC-prepared White River Basin Plan, for assessment purposes, and in other joint special studies.

The City of Burlington and Town of Colchester collectively monitor several heavily-used swimming beaches, by measuring *E. coli* on a regular basis. These data are made publicly in near real-time via the "Burlington Eco-Info" website (www.burlingtonecoinfo.net).

C. Emerging Threats to Water Quality

There are numerous existing and potential threats to Vermont's waters. These threats range from the well understood and easily documented, such as infestations of Eurasian watermilfoil, to those that are newly emerging onto the environmental consciousness, such as estrogen mimicking compounds. A threat is defined herein as an environmental pollutant that has the potential to impact or impair water quality, resulting in a reduction or complete loss of one or more beneficial values or designated uses. A number of existing and potential threats to Vermont's aquatic and wetland resources are identified in Table 3.C. An ideal monitoring program would have a component to track each of these threats. Given fiscal realities, this roster of threats must instead be prioritized and monitoring efforts focused on the highest priority items. Table 3.C provides information and recommendations regarding identified threats to Vermont waters.

Table 3.C. Existing and emerging threats to the quality of Vermont waters

Toxic Substances and Persistent Organic Contaminants	
Trace metals	The extent of mercury contamination to Vermont lakes is well characterized. However other trace metals are also deposited to watersheds from the atmosphere, and the breadth and severity of associated impacts are less well understood. Waters that are sensitive to acidification are thought to be sensitive to contamination by trace metals as well. Trace metals accumulate in the sediments of lakes and of wetlands.
Toxics substances	Down gradient of many unlined landfills and hazardous waste sites, groundwater data often suggest that organic compounds and metals are reaching surface waters. Little is known about the levels and impacts of these toxics on aquatic life in downstream waters.
General urban and stormwater runoff	Urban catchments and stormwater systems have the potential to deliver significant loads of metals and organic contaminants to receiving waters. The WQD has documented chemical and biological impairments to several urban streams.
Algaecides	While cupric algaecides were commonly used in the past to control algae in lakes, their use has declined significantly in recent years. Their use is now mostly limited to very small ponds on private property. Recently, water supply operators have begun to limit their use of copper-based algaecides in drinking water reservoirs to control algae-induced taste and odor problems. The biological impact of copper-based algaecides is poorly understood for Vermont waters.
Herbicides and pesticides	Herbicides and pesticides are commonly used for numerous purposes statewide, ranging from lawn care for individual homes to large-scale agricultural use. The delivery of currently used pesticides and their derivatives to small suburban drainages could compromise biota in downstream waters. The impacts from golf course and agricultural applications have the potential to be large, but are in many cases unquantified. Some ambient monitoring for these compounds, at water quality criterion levels, may be warranted to identify where chronic toxicity might be anticipated. Sites thus identified would become candidates for biological assessments. The aquatic herbicide, Sonar® has recently been permitted for the control on Eurasian watermilfoil in Vermont lakes; monitoring of biota has been and may continue to be warranted in association with these treatments.
Organic contaminants	Known persistent organic contaminants such as PCBs, PAHs, dioxins and furans, and metabolites of DDT exist in certain locations within Vermont's aquatic environment. Good data are available on the distribution of these compounds in Lake Champlain. Data for other waterbodies are spotty at best, although there are occasional occurrences of one or more of these compounds found in the tissue of fish in certain lakes. For example, the occurrence of documented high levels of DDT metabolites in large lake trout of Lake Dunmore should be verified with additional testing, since this is a popular and important lake trout fishery. There are many other Vermont lakes for which fish tissue has not previously been tested, and any fish collected in conjunction with fish tissue contaminant monitoring efforts should be analyzed for a wide suite of organic contaminants. In addition, no data are available from Vermont regarding PBDE flame retardants (poly-brominated diphenyl-ethers) in fish tissues. PBDE's have been found in fishes of nearly all systems where such measurements have been made. The occurrence of PBDE in human breast milk is widespread in Europe, where certain PBDE formulations have been banned from use or manufacture. The toxicity of PBDE's is ill-understood, but is reported to be similar to that of dioxin-like compounds.
Emerging threats	
Endocrine disruptors, pharmaceuticals, and estrogen mimicking	A large number of synthetic chemicals that have been released by humans into the environment have the potential to disrupt the endocrine system of fish, humans, and wildlife, or cause unquantifiable impacts. These chemicals include persistent bio-accumulative organohalogen compounds found in some pesticides, pharmaceuticals, industrial chemicals, and other synthetic products. Known aquatic life impacts include thyroid dysfunction in fish,

compounds (i.e., nonylphenols)	decreased hatching in fish and turtles, gross birth abnormalities, metabolic and behavioral abnormalities including (de)masculinization and (de)feminization of fish, and compromised immune systems.
Cyanotoxins	As this is an issue of particular concern to the public, a plan should be developed to document when and where cyanobacteria blooms occur to better understand the potential distribution of these toxins and to provide a public health warning when toxins are present. Lake Champlain is presently the subject of active monitoring for cyanotoxins.
Sprawl	Suburban commercial development and rural residential development are two forms of sprawl having the potential to impact water quality in developing watersheds in a variety of ways. Many of the larger development projects are regulated through permits, with monitoring requirements. In watersheds where land is being converted from agriculture or forest to low density residential uses, the potential for downstream water quality impacts also exists. These impacts are far more difficult to diagnose due to the scattered nature of small residential building projects. Stream channel evolution studies and paleolimnological assessments of current and historical lake water quality provide approaches to understanding the potential impacts attributable to land use conversions.
Threats attributable to non-native species	
Eurasian watermilfoil, water chestnut, and zebra mussels	Eurasian watermilfoil has been found in 59 lakes and ponds, and 19 other waters in Vermont; water chestnut populations exist in Lake Champlain, Lake Bomoseen and several smaller waterbodies located in both the western and eastern Vermont; zebra mussel adult populations exist in Lake Champlain and Lake Bomoseen, and zebra mussel veligers (larvae) have been found in Lake Dunmore and Lake Hortonia. All three species have the potential to spread to other waterbodies in the state, primarily through human activities such as boating. Purple loosestrife is well established throughout the State. VTDEC currently conducts veliger monitoring and plant surveys on only a small percentage of uninfested waterbodies. Citizen volunteers provide some additional survey assistance, but the state's ability for early detection of new infestations, both of species already present and those at risk of being introduced, is limited. Early detection is critical to enable implementation of effective management techniques and to prevent the spread to other waterbodies. In addition, applications for permits to apply the aquatic herbicide Sonar® have increased dramatically in Vermont lakes following the treatments in 2001 of Lake Hortonia and Burr Pond. Pre- and post-treatment biological monitoring, along with appropriate non-chemical controls, should accompany Sonar ® treatments to identify what nontarget impacts, if any, may occur.
Other nonnative aquatic organisms	Nonnative fish species such as alewife are primarily monitored by the VT Department of Fish and Wildlife. Water quality changes attributable to alewife infestation are well documented in Lake St. Catherine, Wells, VT. The distribution and impact of other nonnative aquatic species are primarily known only through anecdotal observations from unrelated survey or research activities. Little is known about the distribution or impact of the vast majority of nonnative aquatic organisms within Vermont.
Threats Regarding Stream Hydrology and Sediment Regime	
Changes to stream geomorphic condition	The WQD is developing a stream geomorphic assessment program to determine the impacts of floodplain, channel management, and flood remediation practices on stream stability (the ability of the stream to transport the water and sediment produced in its watershed without aggrading or degrading). The removal of watershed and riparian corridor vegetation, floodplain encroachment, dredging, armoring, flow regulation, and channelization practices have initiated major channel adjustments and instability in stream and river systems in every basin in the state. The River Management Section is building the capacity to assess the spatial and temporal adjustment trends underway in streams to determine threats to physical habitat as well as threats to public property and safety.
Threats at the Watershed Level	

Nonpoint sources of nutrients and sediment	In Vermont, nonpoint sources of nutrients and sediment are commonly implicated in the eutrophication of lakes and the degradation of streams and wetlands. Regulations state that agricultural and forestry practices must conform with accepted management practices, and it is implicitly understood that no water quality standards violations ensue from activities that are in conformance with the accepted practices. However, there have been documented violations of standards in several logging and agricultural operations that were technically in conformance with the accepted practices. Monitoring should be undertaken to document the efficacy of the Accepted Agricultural Practices and the Acceptable Management Practices for agriculture and silviculture. Another noteworthy non-point source of nutrients and sediment is highway and gravel road erosion. Runoff from roads is diffused throughout watersheds, and can have long-term, low level impacts to water quality due to sediment and nutrient delivery to receiving waters. Moreover, improperly sized and installed bridges and culverts can result in flood damage, which results in additional sediment and nutrient inputs to waterways. Through the Better Backroads Program, the VTDEC is assisting towns in making considerable progress towards remediating these sources. An experimentally designed, paired watershed approach may be a useful way to document the efficacy of the Better Backroads practices.
Stream corridor development and floodplain encroachment	Stream and floodplain dimension (i.e., width/depth), meander pattern and slope are critical geomorphic components of stream systems in equilibrium condition. Stable, equilibrium streams are capable of transporting the flow and sediment produced in their watersheds without aggrading or degrading. Without knowledge of these fluvial processes and their consequences, people build roads, railroads, houses, farms, and communities near streams, cutting the streams off from their floodplains. Streams that do not have room to move in their historic floodplains may become very unstable following changes to watershed hydrology or sediment regime. The VTDEC has a large effort underway to document channel adjustments throughout the state and inform the public of the tremendous costs and risks associated with stream corridor and floodplain development.
Lack of riparian buffers	Riparian corridor and lakeshore vegetation serves important water quality, habitat, and stream and shoreline stability functions. The width and character of riparian buffers required to perform these functions needs to be assessed and monitoring is needed to determine the efficacy of buffer practices.
Threats at the Global Level	
Global climate change	Impacts of global climate change will be pervasive across aquatic systems nationwide Vermont. Documenting the effects of climate change on aquatic systems in Vermont will further justify action at the federal level to combat global warming.

D. Recommendations and Strategies

The following strategies and recommendations are organized in relation to the goals and objectives elaborated in Section 2.B.

Objective 1A and Objective 1B:

- Continue implementation of existing core monitoring programs. Consistent base monitoring funding under the C.W.A. §106 mechanism, and supplemental funding in conjunction with on-going Performance Partnership agreements is critical to achieving these objectives.
- Continue use of the LaRosa Laboratory annual assessment fee funding model to ensure availability of analytical capacity.

- Continue operation of the cooperative gauging network run by USGS, and work with USGS to streamline procedures for instrumenting new sites. Implement a gage network analysis.
- Evaluate available biomonitoring data from the Lake Champlain Agricultural BMP Monitoring Project to determine the biological response to BMP implementation.
- Perform biological monitoring associated with the new Best Management Practices Effectiveness Demonstration Project to relate changes in biological communities attributable to BMP implementation to changes in stream chemistry. Findings related to these efforts need to be publicized to generate confidence among the affected community that the practices they employ will make measurable improvements to the environment.
- Perform paleolimnological assessments of lakes that are identified as not meeting or potentially not meeting water quality standards for nutrients to assist in the development of post-remediation target nutrient concentrations, and to provide a 'reality-check' on the applicability of the nutrient criteria proposed for promulgation by USEPA Region 1. (Note, 2005 TMDL funding will enable this analysis for the nutrient-impaired Shelburne Pond during 2005/2006).
- Develop a program of sediment contaminant screening downstream of sites of concern (e.g., identified hazardous materials sties).
- In addition to professional staff, ensure funding for at least one FTE as a long-term technician in the lakes and biomonitoring programs. The cost for both technicians, in 2006 dollars, will be $109K.
- One additional wetlands staff would be necessary to develop an ambient wetlands monitoring program ($54.5K).

Objective 1C:

- New monitoring initiatives or special studies related to water quality threats should address one or more of the threats outlined in Section 3.C (above) to the extent practical.
- The current approach to fish tissue contaminant monitoring should be changed to a synoptic recurring assessment aimed at assessing trends over time. Such an approach could be randomized or fixed-station, and would provide landscape-level monitoring data to measure changes in tissue contaminant burdens related to forthcoming national regulations on mercury emissions. One iteration of a recurring five-year initiative is estimated to cost $200K in 2006 dollars.
- Fish tissue monitoring efforts must focus on emerging as well as known contaminants. Additional laboratory resources may be needed to provide analysis of low-level metals, and esoteric organic contaminants (e.g., PDBE's).
- There exists the need for a large, laboratory-grade freezer to store fish tissue samples, as the current capacity for tissue storage is too limited.
- There exists the need for a freeze drier to prepare fish tissue for organic contaminant analysis.
- There exists a need for a dissecting scope to aid in accurate aquatic plant identification.
- Monitoring for cyanotoxins and development of predictive systems to rapidly identify cyanotoxins-producing algal blooms should be supported to the extent practical. This is presently supported by the Lake Champlain Basin Program for waters within the Champlain Basin.

Objective 1D:

- Continue to employ Phase I, II, and III geomorphic assessments to assess stream geomorphic condition.
- Continue to foster monitoring of stream and river water chemistry by volunteer organizations to assess waters of specific interest.

Objective 1E:

- As needed and appropriate, continue to modify the monitoring-related indicators of program success published in the VTDEC Strategic Plan and the Performance Partnership Agreement with USEPA in accordance with the recommendations contained in Section 4.B.
- Continue implementation of monitoring initiatives in stormwater-impaired watersheds, including on-going physical/chemical, biological, and geomorphic assessments.
- Prepare guidance for volunteer organizations to perform measurements of lake morphometry and thermal mixing to assist lake associations who need this information to design aquatic nuisance species control projects using aquatic herbicides.

Objective 1G and H:

- Prioritize water quality standards and criteria that are not presently measured. Monitoring involving volunteer participation is also relevant to the action items of Objective 1D, and is amenable to standards such as temperature, DO, turbidity, and *E. coli.*
- Develop nutrient criteria for lakes that will satisfy Clean Water Act §304 criteria while being tailored specifically to Vermont (see section 4.C.i).
- Initiate process to revise the current water quality criterion for *E. coli* (see section 4.C.iii)
- Incorporate procedures presented at the 2003 National Symposium on Biological Assessment and Criteria for assessing the biological integrity of low gradient large rivers, and to the extent practical, wetlands.
- Complete lake biocriteria development. Funding is in place to complete investigations into trial biocriteria derivation for lakes. Long-term implementation of the lake program will require approximately $1000 per lake per assessment in addition to monitoring staff time.
- Initiate wetland biocriteria development for lake-margin and stream-laved wetlands (see 4.C.ii). A limited trial project costing $40K (2006 dollars) would permit initiation of this project, to provide technician support and taxonomic costs.

Objective 2A:

- Through the basin planning process, ensure that watershed coordinators and monitoring staff are communicating regarding existing monitoring programs and outstanding monitoring needs in basins of interest, such that the Coordinators can bring this information to potential and existing volunteer organizations and to others involved in monitoring in the basins.
- Open a dialogue with existing volunteer monitoring programs (such as those managed by RiverWatch Network, the University of Vermont, or St. Michaels College) to identify shared needs for volunteer-collected data and to determine where volunteer resources may exist to fill those needs.

Objective 2B and Objective 2D:

- VTDEC has made great strides in enhance its ability to support volunteer-based monitoring groups through the LaRosa Partnership Program. In order to maximize our ability to properly manage data and quality control of individual projects findings, additional support of approximately ½ FTE of full-time staff, plus 0.3 FTE temporary technician support, is necessary. These personnel resources would supplement the ¾ FTE and 0.3 FTE temporary staffing already dedicated to volunteer monitoring in conjunction with the Lay Monitoring Program.
- Encourage EPA's New England's monitoring equipment loan concept.
- To ensure wide distribution of the 2005 Volunteer Guide to Citizen Water Quality Monitoring in Vermont, approximately $20K would be helpful for four-color printing of this excellent 100 page manual. Presently, no funding is available for printing the guide, which will be made available online.

Professional printing would permit VTDEC to distribute to interested organizations this professionally-designed, content rich resource.

- Continue the LaRosa Laboratory Services Partnership Program

Objective 2C:

- Continue to support and foster long-term partnership monitoring programs. These include, but are not limited to the USGS, ACOE, White River Partnership, Addison County Riverwatch Collaborative, West River Watershed Alliance, Poultney-Mettawee Partnership, Upper Otter Creek Watershed Council.

4. Recommended Core and Supplemental Indicators

A. Vermont Water Quality Standards

i) Overview

The Vermont Water Quality Standards are the foundation for Vermont's surface water pollution control and surface water quality management efforts. The Water Quality Standards (Standards or WQS) are promulgated by the Vermont Water Resources Board and provide the specific criteria and policies for the management and protection of Vermont's surface waters. The classification of waters (rivers, streams, lakes and ponds) as Class A, Class B or Class B with Waste Management Zone are the management goals to be attained and maintained. Within Class B classes, the Standards provide for specific water management types {(B(1), B(2), and B(3)} to be attributed during the basin planning process. The classification also specifies the designated water uses for each class. The current Vermont WQS were adopted June 10, 1999 and became effective July 2, 2000.

The Vermont WQS establish narrative and numeric criteria to support existing and designated uses. Existing uses of waters and the level of water quality necessary to protect those uses is to be maintained and protected regardless of the water's classification. A determination of what may constitute an existing water use on a particular waterbody is made either on a case-by-case basis, during the basin planning process, or by the Secretary of VTANR during the consideration of an application.

ii) Designated uses, and surface water classification and typing

All surface waters in Vermont are presently classified either Class A or Class B. Waters designated as Class A(1) are Ecological Waters, managed to maintain an essentially natural condition. Waters designated as Class A(2) are Public Water Supplies. There may be a change from the reference condition due to the fluctuations in reservoir water level and in the reduction in streamflow that result from water withdrawals for water supply purposes. Designated uses, as established in Sections 3-02(A), 3-03(A) and 3-04(A) of the Standards, mean any value or use, whether presently occurring or not, that is specified in the management objectives for each class of water. Table 4.A.i indicates applicable designated uses.

Table 4.A.i. Designated uses for water classifications.

Designated uses	Class A waters		Class B waters
	Water management type A(1) – ecological waters	Water management type A(2) – public water supplies	Water management type B(1), B(2), B(3)
Aquatic biota, wildlife & aquatic habitat	√	√	√
Aesthetics	√	√	√
Swimming & other primary contact recreation	√	√	√
Boating, fishing & other recreation uses	√	√	√
Public water supplies		√	√
Irrigation of crops & other agricultural uses			√

Class B waters comprise approximately 97% of all waters in the State. Class B waters are managed to achieve and maintain a level of quality that is compatible with designated uses. The Standards contain a requirement that all Class B waters shall eventually be designated as Water Management Type B1, Type B2 or Type B3. In designating a Water Quality Management Type, the Vermont Water Resources Board must take into account attainable uses and the level of water quality already existing. Recommendations for Water Management

Typing are developed during VTDEC's basin planning process. Once a basin plan is adopted by the Secretary of VTANR, a petition for classification and Water Management Typing is prepared by VTDEC and submitted to the Water Resources Board for their consideration and adoption.

iii) Water quality standards and criteria

The following provides a summary overview of the Standards, including a listing of parameters for which standards or criteria are promulgated (Table 4.A.ii). Guidelines for assessment of waters in light of the Standards and of the indicators below are provided in section 7B of this document. Copies of the Standards may be obtained from the Water Resources Board or from the Water Quality Division. Persons may also access the Standards by visiting the web site of the Vermont Water Resources Board (refer to www.state.vt.us/wtrboard, click on "Rules").

Table 4.A.ii. Roster of existing water quality standards and criteria

Water quality standards-section and indicator	Type of standard (numeric criterion or narrative)	Varies by water management type?	Water quality standards-section and indicator	Type of standard (numeric criterion or narrative)	Varies by water management type?
3-01 - B-1 Temperature	Numeric criterion	No[1]	3-01 - B-10 Toxic Substances	Narrative[2]	No
3-01 - B-2 Phosphorus	Narrative[3]	No	3-01 - B-11 Radioactivity[4]	Numeric criterion	No
3-01 - B-3 Nitrates	Numeric criterion	No[5]	3-01 - C Hydrology	Narrative	Yes
3-01 - B-4 Sludge and Refuse	Narrative	No	3-01 - D Biocriteria	Numeric criterion[5]	Yes
3-01 - B-5 TSS, Oil, and Grease	Narrative	No	3-02 - 3-04 Turbidity	Numeric criterion	Yes
3-01 - B-6 Taste and Odor	Narrative	No	3-02 - 3-04 *Escherichia coli*	Numeric criterion	Yes
3-01 - B-7 Color	Narrative	No	3-02 - 3-04 Habitat	Narrative	Yes
3-01 - B-8 Alkalinity	Narrative	No	3-02 - 3-04 Dissolved Oxygen	Numeric criteria	No
3-01 - B-9 pH	Numeric	No	3-02 - 3-04 Aesthetics	Narrative	Yes

1. Criterion varies with fish habitat designation and waterbody type.
2. Appendix C of the Standards provides numeric criteria for priority pollutants and organics.
3. Numeric criteria have been promulgated for 12 segments of Lake Champlain and two segments of Lake Memphremagog. Also in effect is a criterion limit of 10 ppb for waters above 2,500 feet of elevation.
4. Criteria are by reference to C.F.R. and to Vermont Health regulations
5. Criteria vary by waterbody type, and numeric criteria are contained within implementation procedures promulgated under authority of the VT Agency of Natural Resources.

B. Other Core and Supplemental Indicators

Table 4B provides a listing of additional supplemental indicators that are not expressly stated in the Standards.

Table 4B. Supplemental indicators of water quality.

Water quality indicator endpoint	Metric or parameter
Water clarity	Secchi transparency Chlorophyll-a
Water chemistry	Total nitrogen Total silica Conductivity Oxidation-reduction potential Salinity Base cations and anions Iron, manganese, sulfides Organic carbon, dissolved Mercury, total and methyl Pesticides, current use
Sediment quality	Acid volatile sulfides Metals, priority Organics, priority volatile and semivolatile Pesticides, current use Loss on ignition
Biological integrity	Macrophyte cover Fish tissue contaminants: mercury; PCBs; TCDD/TCDFs; PBDEs Fish kills and/or gamefish abnormalities.
Watershed integrity	Stream geomorphic condition Land use type and land use conversion Shoreline development density

C. Recommendations and Strategies

i) Nutrient criteria

Under authority of §304 of the Clean Water Act, USEPA has prepared ecoregional nutrient criteria for lakes and rivers for several regions of the United States. These criteria were introduced via 66 C.F.R. 1673 in 2001. That notice established a timeline of approximately four years for States to either adopt the proposed §304(a) criteria, or develop and implement a plan to derive similarly suitable criteria that are relevant to individual State conditions.

Vermont cannot subscribe to the §304(a) criteria as proposed. Evidence from long-term, Vermont datasets indicates that a very significant proportion of Vermont lakes and rivers would exceed the proposed criterion, were the VT Water Resources Board to adopt the USEPA proposal. Vermont has thus prepared a nutrient criteria development plan, and committed to making significant progress towards the implementation of that plan, as indicated by 66 C.F.R. 1673.

Vermont's plan calls for the derivation of effects-based nutrient criteria for phosphorus that protect designated uses established by the Standards, stratified within waterbody classification and water management

type. The ensuing suite of criteria would be presented in the form of a matrix, with individual criteria values for each combination of designated use, and waterbody class/water management type. Vermont's plan presents evidence supporting limiting the evaluation of criteria to total phosphorus and total nitrogen. Implicit in Vermont's plan is the premise that aesthetics and aquatic biota and habitat represent the most sensitive of those designated uses amenable to assessment using nutrient criteria. Accordingly, the Vermont plan concentrates on evaluating the relationship between nutrient concentrations and these uses.

This will be accomplished by a two-step approach. For aesthetics, nutrient samples will paired with semi-quantitative observations of aesthetic conditions derived using a user survey, to be administered at the time of sample collection. This approach will be implemented at a minimum of 250 sites statewide. The sampling design will incorporate classification and temporal and flow-mediated variability. The cumulative frequency of nutrient concentrations will be related to derived aesthetic scores, to determine the nutrient concentration beyond which aesthetic scores are noted to decline significantly. For aquatic biota and habitat, nutrient sampling results at a minimum of 250 ambient biomonitoring sampling station will be related to biological indices calculated from those sites, to derive the relationship between nutrient concentration and biological integrity. The geometric mean nutrient concentration above which biotic integrity scores indicate impairment, as determined by VT Water Quality Standards (see sections 4.A.3 and 7.B), will form the basis for criteria to protect aquatic biota and habitat.

As of early 2004, Vermont has entered into a cooperative agreement with USEPA, with funding supplied under §104(b)(3) of the Clean Water Act, to implement the field program necessary to support nutrient criteria development. Vermont's ability to complete the process of analyzing the data and carrying forward the criteria proposal and adoption will be predicated on the availability of resources and competing Federal mandate promulgated under authority of the Clean Water Act. Vermont's Nutrient Criteria Development Plan is available online at http://www.vtwaterquality.org/LakesPonds/lp_vtnutrientcriteriaplan.pdf.

ii) Lake, wetland, and large river biological criteria

Vermont is recognized nationally as having made significant progress towards development and implementation of lake biological criteria. VTDEC first began the process of developing lake biological indices in 1995, via a cooperative agreement with USEPA. This and subsequent agreements have enabled VTDEC to develop a series of trial biometrics that are useful in assessing aquatic life use support for lakes. The current lake biological indices describe the reference condition for whole-lake phytoplankton, and for macroinvertebrates within four habitat types. These indices are specific to one of three lake classes that have statistically been verified to influence the reference expectation for both biological assemblages. The biocriteria system developed for Vermont lakes is unique in that it incorporates elements of traditional multimetric bioassessment with the rigor imposed by multivariate statistical approaches to classification and index development.

As of early 2004, Vermont has entered into a cooperative agreement with USEPA, with funding supplied under §104(b)(3) of the Clean Water Act, to finalize development of lake biological criteria for lakes. The first goal of this project is to make new assessments of a set of lakes that are either naturally eutrophic, or have known water level manipulations. Results of these new assessments will be incorporated into the existing database comprised of assessments of 45 lakes. The entire dataset will then be reanalyzed to either verify that the criteria system previously developed still stands up to statistical testing, or to build a new, more improved and rigorous system. Pending positive results of these analytical activities, a lake biological criteria implementation procedure will be developed, for consideration by the VT Water Resources Panel in light of existing standards for aquatic life use support in lakes. This project is anticipated to be complete by the end of 2006. Additional information regarding Vermont's lake biological criteria is available online at http://www.vtwaterquality.org/lakes/htm/lp_monitoring.htm. The development of biological indices of water quality for Lake Champlain is a long-term project area overseen by the Lake Champlain Basin Program.

VTDEC has also participated in the development of wetland biocriteria, in conjunction with the New England and National Wetlands Biological Assessment Workgroup. To date, Vermont's efforts have been centered on vernal pool and northern cedar swamp wetland types, and data results have not been suitable for development of biocriteria. In 2004, VTDEC did not receive competitive funds under §104(b)(3) of the Clean Water Act to support additional biological characterizations of wetlands in conjunction with the lake bioassessment studies discussed directly above. One new approach VTDEC is adopting is to assess wetlands that are associated with lake margins or those interlaced by small streams, using both the methods already established for stream and lake bioassessment, along with new methods for wetland vegetation characterization. If a proposal similar to that written in 2004 were ultimately funded, VTDEC would use data collected under that new project to develop trial biometrics assessing wetland functions and values. Additional information regarding VTDEC's existing efforts to biologically assess wetlands is available online at http://www.vtwaterquality.org/bass/htm/bs_vernal.htm#vernal.

As part of the long-term Ambient Biomonitoring Network, data are being collected from larger rivers in Vermont. These data should be evaluated in a reference-based index-development framework once a sufficient number of sites are available.

iii) Pathogen criteria

E. coli concentrations are known to vary considerably over space and time, in response to natural and human-related factors. Very few strains of *E. coli* are themselves pathogenic. Rather, they are indicators of the presence of fecal material of warm-blooded animal origin. This fecal material may contain harmful pathogens. On a national scale, *E. coli*-based criteria are expressed either as geometric mean values, or as one-time, instantaneous single-sample values. These values equate to a likelihood of developing gastrointestinal illness from exposure to waterborne pathogens associated with *E. coli*. EPA originally (1986) derived freshwater criterion recommendations using a set of statistical relationships relating geometric mean *E. coli* levels to observed gastrointestinal illness rates directly attributable to the *E. coli* exposure. Using these relationships, EPA recommended that the most conservative *E. coli*-based criterion be a geometric mean of 126 *E. coli* /100ml. At highly populated beaches (defined as greater than or equal to 2,427 swimmers/day on average), that are subject to direct sewage effluent contamination, exceedance of this criterion means that on a season-wide average basis, eight in 1,000 swimmers may develop gastrointestinal illness due to *E. coli* exposure. At *E. coli* concentrations below 126 *E. coli* /100ml, the illness rate attributable to exposure to the indicator bacteria (presumably less than eight in 1,000) could not be separated from the general rate of gastrointestinal illness present for any number of reasons. In 2002, EPA reaffirmed its 126 *E. coli* /100ml geometric mean recommendation considering all more recently available data and studies.

Vermont's current water quality criteria for bacteria reflect a long-term intent to maintain a high level of protection to swimmers and other forms of contact recreation use. The current criteria are also far more conservative than those recommended by EPA. Vermont's current criteria are not to exceed a three-sample geometric mean of 18 *E. coli* /100ml (or a single sample maximum of 33) for Class A(1) and A(2) waters, and not to exceed 77 *E. coli* /100ml for Class B waters in all management types. Interpreted using EPA's published statistical relationships, a single instantaneous concentration of 77 *E. coli* /100ml equates to a 75% likelihood that a beach closure will prevent swimmers from incurring a 3.4 in 1,000 risk of developing gastrointestinal illness. Such an interpretation must be treated very cautiously as any illness rate attributed to *E. coli* exposure less than 8 in 1,000 is below the level quantifiable using EPA's statistical relationships.

Recent Vermont research indicates that the present Vermont Class B criterion can be exceeded in low to moderate streamflows issuing from undisturbed forested watersheds due to natural background sources. Based on calculations using EPA's statistical relationships, 77 *E. coli* /100ml, expressed as a geometric mean of several samples, results in a projected illness rate of 6 in 1,000 swimmers. While this level of risk remains below the EPA minimum recommendation, it is consistent with the intent of current and prior Vermont water quality criteria for bacteria, beginning in 1985. In addition, new EPA guidance (USEPA, 2003b) on the application of water quality criteria for pathogens allows that impairment determinations can be based on

geometric seasonal means or some number of single sample exceedances. EPA expresses preference for use of a longer-term indicator (geometric mean) for reporting use attainment. Ultimately, however, Vermont's Water Quality Standards serve as the guidepost for assessment and listing determinations. Accordingly, modified assessment guidelines have been developed from Vermont's Water Quality Standards for the 2004 Integrated Reporting cycle (see 7B, below). Moreover, the Water Resources Board should be petitioned to modify the existing water quality criteria for *E. coli* in all waters to reflect a real-world approach that is consistent with current EPA guidance, although such an action would necessitate stakeholder input from multiple user and advocacy groups. Additional information regarding *E. coli* monitoring in Vermont is available online at http://www.vtwaterquality.org/lakes/docs/lp_citbactmonguide.pdf.

5. Quality Assurance

A. Quality Management Plan

VTDEC maintains a Quality Management Plan that establishes the flow of information used environmental decisionmaking. This plan is updated annually as required under VTDEC's partnership agreements with EPA, and reflect the goals and priorities elaborated in current VTDEC Strategic Plan.

B. LaRosa Laboratory Quality Assurance Plan

The LaRosa Laboratory is subject to Quality assurance planning per EPA requirements for laboratory certification. The LaRosa laboratory employs a full-time quality assurance officer, and the LaRosa Quality Assurance Plan is update annually to reflect modifications to data handling procedures, as well as new analytical methods. The entire LaRosa laboratory Quality Assurance Plan is available online, at http://www.anr.state.vt.us/dec/lab/htm/QualityControl.htm.

C. Quality assurance plan preparation

All monitoring projects carried out in whole or part using EPA funding are subject to quality assurance planning. VTDEC uses the most recent guidance for quality assurance project plan (QAPP) preparation whenever practical, and typically consults with appropriate EPA QA officers when beginning to develop a plan. Recently, VTDEC has began to prepare more comprehensive QAPPs that present collections of methodologies which are relevant to much of the routine field work described in this document. One good example of this is the new 2005 Lake Assessment Program QAPP, which provides field and analytical methods, and quality assurance procedures, for a wide variety of routine field tasks undertaken to assess lakes including chemical assessment, biological assessment, sediment analysis, and bacteriological monitoring. Where practical, these types of "umbrella" QAPPs can provide all of the necessary methodological detail needed by VTDEC to perform both routine sampling and also to perform sampling in response to emergency events, where there is no time to prepare a QAPP, or to have that QAPP approved by USEPA.

D. Archive of QAPPs

An archive of all QAPPs is maintained as part of the DEC Quality Management Plan. This list is updated annually. Table 5.D provides this list for 2005, the most recently-available roster as of this writing.

Table 5.D. 2005 roster of quality assurance project plans.

Program	Project #	Project Manager	Yr QAPP written / last updated	EPA Approval in Place?	Scheduled Update?
Core Programs					
Spring Phosphorus	1	Kamman	1996	Yes	2004
Lake Assessment Program	2	Kamman	2005	In review	2010
The Lake Champlain Long-Term Monitoring Program	3	Smeltzer	2003	Yes	2004
The Long-Term Monitoring (LTM)	4	Kellogg	2000	yes	2004

Program	Project #	Project Manager	Yr QAPP written / last updated	EPA Approval in Place?	Scheduled Update?
Acid Lakes Program					
The Stream Geomorphic Assessment Program	5	Kline	2001	yes	??
The Fish Contaminant Monitoring Program	6	Langdon	2002	Yes	??
REMAP Mercury Project	7	Kamman	2000	Yes	NA
Ag. Best Management Practice Effectiveness Monitoring	8	USGS		USGS project. EPA approval not required.	
Urban Best Management Practice Effectiveness Monitoring	9	USGS		USGS project. EPA approval not required.	
Ambient Biomonitoring Network (ABN) Program	10	Fiske/ Langdon	1994	Yes	??
Lake Bioassessment Project	11	Kamman	2004	Yes	2009
Aquatic Macrophyte Monitoring Program	12	Warren	1995	Yes	
Aquatic Nuisance Species Searches and Surveys	13	Bove	Procedures as in Project 17		
Lake Champlain Zebra Mussel Monitoring Program	14	Smeltzer	2003	Yes	
Vermont Vernal Pool Bioassessment Project	15	Burnham/ Popp	1999	Yes	
Northern Leopard Frog Surveys in the Lake Champlain Basin	16	Levey	2001	Yes	NA

Program	Project #	Project Manager	Yr QAPP written / last updated	EPA Approval in Place?	Scheduled Update?
The Vermont Lay Monitoring Program	17	Picotte	2002	Yes	
Volunteer Acid Precipitation Monitoring Program	18	Pembrook	None in place	no EPA funding	
LaRosa Laboratory Volunteer Monitoring Analytical Grants Project	19	Kamman	2005	Not subject to EPA Review per VT Program Liaison E. Beck	2006
Nutrient Criteria Development Project	20	Kamman	2004	Yes	

E. Recommendations and Strategies

Quality assurance project planning is an essential part of any properly executed study. VTDEC recognizes that QAPPs are a useful and sometimes critical tool for improving data collection and analysis. Accordingly, QAPPs are a means to an end, and not a final, free standing product of their own. Since QAPP preparation is time consuming, VTDEC recommends that QAPPs cover multiple projects (e.g., the Lake Assessment Program QAPP), to introduce the maximum possible efficiency into the preparation and approval process. The use of umbrella QAPPs, prepared for a fixed time span of five years can greatly enhance efficiency in project planning by reallocation the resources necessary for project planning to project design and execution. Currently, VTDEC has in place "umbrella" QAPPs for the Lake Assessment Program, Ambient Biomonitoring Network, and Volunteer Lab Services Grants Program.

6. Data Management

A. Water Quality Data

i) Chemical data

Data collected in conjunction with VTDEC monitoring programs, as well as some volunteer-based data, are archived to VTDEC's dedicated water quality data archive. As of January, 2005, this archive contains in excess of 360,000 individual data records, beginning prior to 1970. Data from all core chemical monitoring programs are archived on an annual basis, following quality assurance screening, in advance of the April STORET submission timeline (see below). In certain instances, project-specific data will be held outside of the data archive until a project is completed prior to submission. The Water Quality Data Archive is intended to be VTDEC's final repository for water chemistry and associated data. It is structured to hold data in a 'quasi STORET-compatible' form, for incorporation into the national STORET data archive.

The Water Quality Data Archive is presently maintained in a Microsoft Access© database, which is carried on VTDEC's central file server. This database is backed up on a daily or more frequent basis, with archive media also protected off-site. During the course of execution of this Strategy, the Water Quality Data Archive may be transferred to a more powerful database system, such as Microsoft SQL Server©.

ii) Biological data

Data collected in conjunction with all VTDEC biomonitoring programs are archived to a dedicated biomonitoring database, which is a component of the Water Quality Data Archive. As of January, 2004, this database contains in excess of 99,000 individual macroinvertebrate occurrence records from 2,873 discrete sampling events. The database also holds 5,606 individual fish occurrence records representing 851 discrete sampling events. Data from all core biomonitoring programs are archived as data become available from the laboratory, following quality assurance screening. In certain instances, project-specific data will be held outside of the data archive until a project is completed prior to submission. The Water Quality Data Archive is intended to be VTDEC's final repository for biomonitoring and associated data.

iii) STORET

VTDEC began implementing a local STORET archive in 2003. In response to USEPA requests, and with support from the National Environmental Information Exchange Network, VTDEC has been able to develop the largest STORET archive of all New England States, with nearly 260,000 records archived across numerous programs as of this writing. At present, the VTDEC STORET archive is limited to water chemistry information, although the addition data contained in the biomonitoring database is currently under consideration. Migrating long-term biomonitoring data to STORET is a major task, likely best accomplished by a suitable contractor. In order for biomonitoring data to be archived to STORET, taxonomic codes need to be translated, approximately 1,500 sampling stations need to be established (into the STORET system). VTDEC annually uploads of data contained in the local STORET archive to the national STORET data warehouse, typically in April.

iv) Standard Operating Procedures

VTDEC maintains a roster of standard operating procedures for field collections. These are updated regularly, and were last updated in March of 2005. Individual S.O.P.'s are available on request.

B. Assessment Data

i) Lake water quality inventory

VTDEC maintains a database containing physical and cultural characteristics, and water quality data summaries, for 918 inventoried Vermont lakes. The so-named Lake Inventory is used to track information such as waterbody classification, known existing uses, lake physical attributes, counts of shoreline dwellings, and characteristics relevant to lake protection prioritization. Much of the data contained in the lake inventory database is available online through the VTDEC-Water Quality Division website. These data are updated on an annual basis, or as warranted based on new information.

ii) Assessment database

VTDEC currently maintains two discrete databases that are used to track use support; one for lakes, and the other for streams. No such assessment dataset is available for wetlands. These databases are updated continually throughout the year, and each year, the database is archived prior to fulfilling EPA-required assessment data submissions, in April. In this way, static archive copies of assessment databases for lakes and streams are maintained, for each year.

These assessment databases are structured to be compliant with the current USEPA "ADB" database architecture. One significant departure from the "ADB" architecture is that Vermont waterbodies are not segmented into individual segments representing unique combinations of use support, and pollutant cause and source. Rather, each waterbody entry shows the proportion of waters meeting or not meeting individual uses, by cause-source combination. This is a particular concern within the river and stream assessment database. These databases are presently housed in Microsoft Access©.

iii) TMDL database

Details regarding how waters are assessed and allocated into lists of impaired and priority waters are available in Section 7 (below). VTDEC presently maintains a database of priority and impaired waters that is separate from the assessment databases. This database is presently maintained in Microsoft Access©, and is relationally linked to the assessment databases. Impaired and priority waters lists are provided to USEPA biennially in conjunction with integrated reporting, in April of even-numbered years.

iv) Vermont Hydrographic Dataset

Late in 2003, the Vermont Center for Geographic Information finalized the Vermont Hydrographic Dataset (VHD). VHD is a GIS-based waterbody coverage is based on the National Hydrographic Dataset (NHD) architecture. It is fully compliant with NHD, and includes all metadata requirements and reach coding. VHD differs from NHD in that it is a 1:5,000 scale water coverage. NHD is presently available in all New England states only at 1:100,000 scale resolution.

Vermont's existing 208 river/stream and 558 lake waterbodies are presently georeferenced to older Vermont 1:100,000 scale stream coverages. A present need is to attribute individual waterbody identification codes to the VHD, a project that is beginning within VTDEC at present.

C. Recommendations and Strategies

In general, database management is handled by project-level staff with assistance from the Agency of Natural Resources Information Technology staff. One additional FTE in database management and assessment data entry and reporting would provide consistency in data archiving, and permit program staff to focus on using monitoring data as opposed to simply archiving it. This additional staff time would enable the following.

i) Waterbody segmentation and database integration

In order to accurately and dynamically georeference individual use impairments and pollutant cause/source combinations, the existing waterbodies must be segmented. This task will be significantly facilitated by the attribution of existing waterbody identification codes to VHD, which can then be used to segment waters, using a new waterbody identification code. At present, VTDEC envisions that VHD reach codes will supplement and eventually replace existing waterbody identification codes, permitting a direct linkage between assessment databases and VHD. This will provide more sophisticated mapping capabilities that can be shared with the public and interested parties using online, web-based GIS mapping tools. Migration of assessment data to the ADB system is underway for lakes with assistance from Research Triangle Institute. Technical staff at RTI have indicated that the process of updating the Lake Assessment database to ADB will require more time than they had previously estimated.

ii) Conversion of the Water Quality Data Archive to a more powerful database handling system

Implementation of STORET by VTDEC necessitated converting the structure of the water quality data archive from a ~70,000 record "transposed" database to a ~350,000 record standard database. This database was completely redesigned to accommodate data requirements of STORET. The size of the archive is now considerably larger. The water quality data archive may be transferred to a more powerful system such as MS-SQL Server© or Oracle. There are advantages and drawbacks to SQL, and these will be evaluated prior to any major changes.

iii) STORET data submissions

The current VTDEC STORET archive is to be uploaded to the national STORET data warehouse on an annual basis. VTDEC's moved approximately 220,000 records to the national STORET archive for it's initial submission in December of 2003. As part of an on-going "network readiness grant," VTDEC has been investigating the feasibility of using the "network node" architecture to allow EPA to draw data as needed as opposed to performing submissions of STORET data to the national data warehouse. In order for this system to be implemented, an XML schema for STORET is needed, the development of which is incumbent on USEPA. VTDEC envisions this "node" as a means for facilitating future STORET data transfers. A major initiative will be required to migrate existing biomonitoring data to STORET, and build a routine data submission system. This will require resources of a biologist to consult on taxonomic code translations, a database technician to assist with data manipulations within VTDEC, and a qualified contractor to process the data into STORET.

iv) Development of pocket computer-based field data entry tools

Nearly all VTDEC-WQD monitoring projects rely on some form of field record-keeping on paper, including field sheets, calibrations, paper recording of GPS coordinates or custody forms, and similar activities. Considerable time is required to input these data into project-specific databases; a process that is both resource intensive and error-prone. Often, some of the data that are collected remain on paper field forms and never is input and used for analysis, even when it could yield useful insights into data trends. Recently, monitoring programs in VT and elsewhere have begun using pocket PC-based data entry forms to highly streamline the data acquisition, sample tracking, and information archiving. WQD staff have done this to a very low level of sophistication to date, owing to limited programming skills. WQD staff have, however, been provided examples of highly successful and sophisticated projects from Quebec waters adjacent to VT that took maximum advantage of small conputing technology. VTDEC should consider contracting the services of an IT firm who can develop data entry systems that interface with both the LIMS and WQData systems, as well as project-specific databases. Such a project should not exceed $20,000 in size, although it should in fact be significantly smaller.

7. Data Analysis and Assessment

A. Data Analysis

Specific procedures used to analyze project data are beyond the scope of this strategy. Project-specific data analysis approaches are commonly spelled out in QAPPs, although data analysis is often an adaptive task, where results of one analysis lead to subsequent analyses. For the purposes of use support assessment or enforcement, however, the following considerations regarding data quality and statistical analyses are relevant.

When used for assessment or enforcement, data employed must be of known quality and should be representative of the water's condition. All data generated in conjunction with any active and/or approved QAPP are considered readily available and reliable data, and are considered in determining use support. Data can be rejected from consideration in the event that it does not meet data quality objectives established by individual QAPPs. Guidance and assistance regarding quality assurance is also provided from the LaRosa Laboratory.

For data provided by organizations other than VTDEC and WQD, efforts are made to ascertain the quality of the data prior to considering it in the determination of use support. The number of samples, the length of the sampling period, the antecedent weather conditions, degree of compliance or violation, laboratory and field methods employed, quality assurance and control results are all considered when evaluating data from other organizations. Where data of unknown or unquantifiable quality are at odds with companion data of quantified quality, the higher quality data will be accorded greater weight in determining use support. Where data of unknown or suspect quality are the only information available, the waterbody is scheduled for additional monitoring prior to determining use support.

VTDEC has expertise in the use of non-parametric, parametric, and multivariate statistical methods. In most instances, it cannot be decided a-priori what type of statistical analysis may be used to assess use support, except for experimentally designed studies. For certain data types, long-term trend detection using linear, non-linear, or non-parametric regression approaches is appropriate. For designed studies aimed at determining the level of use support in an experimental framework (e.g., lakes that are likely to display elevated fish tissue mercury concentrations), parametric analyses of variance, covariance, and/or linear discriminant analysis are most appropriate. To classify waterbodies into meaningful biological groupings to compare biometrics to reference biological communities, linear discriminant analysis, principal components and factor analysis, canonical correspondence and non-metric multidimensional scaling analysis are appropriate. Simple T-tests and ANOVA tests are appropriate where data are being compared to a criterion value or to a set of reference waters. Consequently, these last two tests are more commonly or routinely performed during VTDEC assessment efforts. Where a statistically parametric method is used to evaluate hypotheses concerning standards attainment, consideration is accorded as to whether "attainment" is established as the null or alternative hypothesis.

VTDEC does not, on a unilateral basis, subscribe to the notion that a pre-determined proportion of samples exceeding a criterion value automatically equates to impairment, particularly where the total number of samples is low. The proportion of violations or frequency of exceedance in an array of data are treated and used by VTDEC on an individualized and case-specific basis to determine use support.

In general, VTDEC believes waters must be proven to be impaired, and thus statistical hypothesis tests, when necessary, are most often structured in that fashion. Nonetheless, in the interest of maintaining solidly defensible and repeatable use support decisions, where the cost of erroneous decisions is high, a decision call of impairment will be accorded to the null or alternate, depending on which test provides the greatest statistical power while maintaining the type-I error rate to a pre-established level (typically 5% to 10%).

B. Water Quality Assessment Methodology

i) Overall methodology

Overview and data sources

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

- VTDEC Water Quality Division (monitoring data)
- VTDEC Wastewater Management Division (National Point Source Discharge Elimination System permit compliance, indirect discharge permit compliance, residuals management)
- VTDEC Waste Management Division (solid and hazardous waste sites monitoring data)
- VTDEC Water Supply Division (compliance and sourcewater monitoring data and information)
- VTDEC Geology and Mineral Resources Division (fluvial and surficial mapping, hazard identification)
- VTDEC Laboratory Services at R.A. LaRosa Laboratory (quality assurance, analytical services, pollutant data)
- Vermont Agency of Natural Resources Enforcement Division (violations of water quality standards)
- Vermont Department of Fish & Wildlife (data on game fish and temperature, habitat studies)
- Vermont Department of Health (beach closure information, fish consumption risk assessments)
- Vermont Department of Forests, Parks, and Recreation (bacteriological testing, beach closure information)
- Vermont Agency of Agriculture, Food and Markets (agricultural water quality violations)
- Vermont Regional Planning Commissions (known locations of problems)
- US Department of Agriculture, Natural Resource Conservation Service (agricultural nonpoint sources, locations of pollution abatement projects)
- Citizens and citizen associations (citizen monitoring data, location of sources, complaints)
- US Geological Survey Water Resources Division (monitoring and research)
- US Forest Service (fish habitat and water quality data and information)
- US Environmental Protection Agency (monitoring and research)
- US Army Corps of Engineers (environmental assessments of project waters)
- University of Vermont, Vermont State Colleges System and other colleges (monitoring and research)

The VTDEC Biomonitoring and Aquatic Studies and River Management Sections provide much of the data used in the assessment of monitored river miles. The VTDEC Lakes and Ponds Management and Protection Section provides much of the data used in the assessment of monitored lake acres. The other sources noted immediately above provide fewer and less widespread, but nevertheless important, data points.

Biological monitoring and 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 considered to be "wadeable" 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 carried out by VTDEC can be placed into three categories; 1)

long-term monitoring of reference level sites, 2) site-specific impact evaluations and 3) statewide probability-based surveys.

Individual site surveys and subsequent processing steps are detailed in *"Methods 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."* (a.k.a. biocriteria procedure). Using the biocriteria procedure, the aquatic biota community inhabiting the sites in question is attributed a rank of excellent, good, fair, or poor.

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 goal of reference site monitoring is gather information on a set of known reference sites on a 5-year rotating basis, so as to generate 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 (along with appropriate chemical and physical data), potential pollution sources that are not of natural origin are spatially bracketed (i.e. above and below) with sample sites to determine effects 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 (September to October 15) on a five-year rotational watershed basis. VTDEC has evaluated over 1,200 sites since 1990.

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. VTDEC, with cooperative funding from USEPA, is now finalizing a multi-metric biological index based on phytoplankton communities, and is also developing a multi-metric index to describe the condition of macroinvertebrate communities within lakes. It is anticipated that future aquatic life use assessments will be more directly based on biological data for phytoplankton, macrophyte, and macroinvertebrate assemblages. Where data are available, results of phytoplankton, macrophyte, and macroinvertebrate community assessments are being incorporated into the assessments of individual lakes. As part of the cooperative agreement with USEPA, a lake biological criteria implementation procedure should be finalized as early as 2005. Macroinvertebrate and amphibian community indices are also currently being evaluated for use as biomonitors of aquatic life use support for wetlands.

Stream geomorphic assessment

Data collected during stream geomorphic assessments according to recognized procedures: provide a better understanding of the physical processes and features shaping a watershed; help characterize erosion and flood hazards; help identify high quality habitat; and contribute to understanding the effects of watershed land use activities on stream condition.

The Vermont DEC stream geomorphic assessment program objectives are:

1) To create a data collection protocol for the physical assessment of streams and rivers that is scientifically sound and produces repeatable results, so that data can be compared not only within a watershed, but also between watersheds and regions.
2) To create a state Geographic Information System (GIS) and database system of fluvial geomorphic data that is accessible to users inside and outside the Agency of Natural Resources.

3) To create a method for predicting stream channel and flood plain evolution in Vermont that will technically support the resolution of river/land use conflicts and allow for sound land use practices and planning at the watershed scale.
4) To create a river assessment methodology that will help lay people understand how human activities over time within a watershed can be conducted in a manner that is both ecologically and economically sustainable.

The Vermont Stream Geomorphic Assessment protocols help river planners and managers take the first steps in applying channel form, adjustment process, and channel evolution data by providing a method for assigning a geomorphic and physical habitat condition to stream reaches. The term "departure from reference" is used synonymously with stream geomorphic condition throughout the protocols. The degree of departure is captured by the following three terms:

In Regime – a stream reach in *reference and good* condition that:

- Is in dynamic equilibrium which involves localized change to its shape or location while maintaining the fluvial processes and functions of its watershed over time and within the range of natural variability; and
- Provides high quality aquatic and riparian habitat with persistent bed features and channel forms that experience periodic disturbance as a result of erosion, deposition, and woody debris.

In Adjustment – a stream reach in *fair* condition that:

- Has experienced changes in channel form and fluvial processes outside the expected range of natural variability; may be poised for additional adjustment with future flooding or changes in watershed inputs that would change the stream type; and
- Provides aquatic and riparian habitat that may lack certain bed features and channel forms due to increases or decreases in the rate of erosion and deposition-related processes.

Active Adjustment and Stream Type Departure – a stream reach in *poor* condition that:

- Is experiencing adjustment outside the expected range of natural variability; is exhibiting a new stream type; is expected to continue to adjust, either evolving back to the historic reference stream type or to a new stream type consistent with watershed inputs; and
- Provides aquatic and riparian habitat that lacks certain bed features and channel forms due to substantial increases or decreases in the rate of erosion and deposition-related processes. Habitat features may be frequently disturbed beyond the range of many species' adaptability.

Phase 1 of the protocols is the remote sensing phase and involves the collection of data from topographic maps and aerial photographs, from existing studies, and from very limited field studies, called "windshield surveys." Geomorphic reaches and provisional reference stream types are established based on valley land forms and their geology. Predictions of channel condition (departure from reference), adjustment process, and reach sensitivity are based on evaluations of watershed and river corridor land use and channel and floodplain modifications.

Phase 2 is the rapid field assessment phase and involves the collection of field data from measurements and observations at the reach or sub-reach (segment) scale. Existing stream types are established based on channel and floodplain cross-section and stream substrate measurements. Stream geomorphic condition, physical habitat condition, adjustment processes, reach sensitivity, and stage of channel evolution are based on a qualitative field evaluation of erosion and depositional processes, changes in channel and floodplain geometry, and riparian land use/land cover.

Phase 3 is the survey-level field assessment phase and involves the collection of detailed field measurements at the sub-reach or site scale. Existing stream types and adjustment processes are further detailed and

confirmed based on quantitative measurements of channel dimension, pattern, profile, and sediments. Phase 3 assessments are completed with field survey and other accurate measuring devices.

Data solicitation

In conjunction with the 2004 assessment process, VTDEC conducted a solicitation for data to further enhance the quantity and spatial coverage of water quality data and other information that is used in assessing surface waters. The solicitation for water quality data, issued as a press release, has also been posted to the WQD website (refer to http://www.vtwaterquality.org/cfm/notices/notices.cfm). The solicitation notice has also been posted on the web pages of VTDEC and the Vermont Agency of Natural Resources. The solicitation seeks data and information to be submitted on or before October 31, 2003 in order to be considered for the 2004 reporting cycle. Data and other information submitted after that date will be considered for the 2006 reporting cycle. VTDEC intends to continue similar notices in advance of future reporting efforts.

ii) Vermont surface water assessment categories

Vermont's rivers, streams, lakes, and ponds have been designated into "waterbodies" which serve as the cataloging units for the overall statewide assessment. Waterbodies are typically entire lakes, subwatersheds of river drainages or segments of major rivers. Using data that is quality assured along with other contextual information that is reliable, the Water Quality Division determines whether each waterbody meets or does not meet Vermont Water Quality Standards, and then places waters into one of four assessment categories, taking into account the waterbody classification and water management type. The four categories used in Vermont's surface water assessment are **full support, stressed, altered** and **impaired.**[1] Waters that support designated uses and meet Water Quality Standards are attributed to the full support or stressed categories. Waters that do not meet standards are placed into the altered or impaired category. Waters can also be put into an **unassessed** category. These assessment categories are described below.

Full support waters

This assessment category includes waters of high quality that meet all designated use support standards for the water's classification and water management type.

In Vermont, there are many smaller waters that are a lower priority for sampling visits given resource constraints, lack of public access or interest, and competing needs within VTDEC's water quality monitoring program. VTDEC therefore makes preliminary assessments, where practical, by considering five factors that address the likelihood that significant stressors exist within the subject watershed. Waters that meet these factors are then considered to support their uses (e.g., the waters are "innocent until proven guilty"). The factors VTDEC uses to develop preliminary, screening-level assessments for these waters are:

- no discharges or contaminated sites in proximity to the waterbody;
- low probability of habitat degradation as evaluated by "Phase One" geomorphic assessments or other remote sensing evaluations;
- nearby sites have biological assessment findings compliant with Vermont Water Quality Standards, for like class and water management type;
- no problems are uncovered during outreach efforts associated with the rotational assessment process and basin planning; and
- no known water level manipulations beyond the natural range of fluctuation.

[1] The four assessment categories formerly used by VTDEC prior to 2004 were known as full support, full support/threatened, partial support, and non-support. The new categories are not directly equivalent to the four categories used in former assessments.

Stressed waters
These are waters that fully support the designated uses for the classification but the water quality and/or aquatic habitat have been disturbed to some degree by adjacent land uses or some human-induced stressor. For stressed waters EITHER there is insufficient data or documentation to determine water quality or aquatic habitat does not meet standards OR the data/information that is available indicates there are disturbances which are stressing the aquatic system but not to a point of altering or impairing it. Uses are not significantly limited or restricted but occasional water quality or quantity conditions and/or associated habitat disturbance periodically discourage or disrupt a use.

This assessment category includes some of the waters in the formerly used category known as "full support/threatened" with the most imminent threats. This category also captures many of those waters in the formerly used category "partial support – evaluated" that included waters where there were clearly problems and disturbances or uses discouraged, but reliable or recent data were not available. Waters that are labeled stressed because of documented disturbances or impacts but the degree of the problem or impact is not known would be characterized as needing further assessment.

Altered waters
These are waters where a lack of flow, water level or flow fluctuations, modified hydrology, physical channel alterations, documented channel degradation or stream type change occurs and arises from some human activity, or where exotic species growth has had negative impacts on the aquatic habitat. The aquatic communities are understood to be altered from the expected stable ecological state.

This assessment category includes those waters where there is a documentation of water quality standards violations for flow and aquatic habitat but EPA does not consider the problem(s) caused by a pollutant OR there are no specific criteria in the Water Quality Standards against which to judge the alterations that have been documented using accepted protocols.

Impaired waters
These are surface waters where there are chemical, physical and/or biological data collected from quality assured and reliable monitoring efforts that reveal 1) an ongoing violation of one or more of the criteria in the Water Quality Standards; 2) one or more pollutants cause of the violation; and 3) the pollutant is of human origin and cannot be attributed to a natural condition or event. These are waters that have been in the formerly used "partial or non-support - monitored" category.

Unassessed waters
Waters for which VTDEC has no monitoring data and only limited information and knowledge is available are considered unassessed.

iii) Guidelines for the assessment of use support

The complete Vermont Surface Water Assessment and Listing Methodology is provided at http://www.anr.state.vt.us/dec/waterq/planning/docs/pl_assessmethod.pdf. This document is updated biennially and undergoes separate USEPA review. As such, it is referenced herein but maintained separately.

C. TMDL Listing Methodology

The complete Vermont Surface Water Assessment and Listing Methodology is provided at http://www.anr.state.vt.us/dec/waterq/planning/docs/pl_assessmethod.pdf. This document is updated biennially and undergoes separate USEPA review and public comment. As such, it is referenced herein but maintained separately.

D. Recommendations and Strategies

To date, every 305(b) water quality assessment and subsequent 303(d) listing have been produced using subtly differing assessment and listing methods. These method changes in many cases have been the result of changes in guidance from USEPA, but also to a lesser degree are attributable to changes in Vermont's Water Quality Standards.

The 2004 data analysis and assessment and listing methodologies represent the newest thinking of VTDEC on these subjects. These methods are intended to be used for the 2004 and subsequent assessment and listing cycles. Reports and lists will be produced from these methods as described in Section 8. Owing to the ever changing nature of reporting guidance as well as continual improvements to Vermont's assessments, comparisons across prior years' statewide water quality assessments cannot be made with consistency. Accordingly, the recommended overall strategy for Vermont's new assessment and listing methods is that assessment methods be standardized for a period of at least three listing cycles. So doing will permit intercomparisons among subsequent biennial reports.

8. Reporting

A. The Basin Planning Process, Watershed Assessment Reports and Basin Plans

Vermont's WQS establish the requirement to develop basin plans that address water quality maintenance and improvement, for the 17 planning basins discussed in Section 3.A. The basin planning process empowers people with information and tools, and provides focus for activities to protect and restore water quality. A basin plan may, for example, give special attention to protecting particularly high quality waters or restoring habitat or other important impaired water resources.

This process begins with the preparation of assessment reports. As assessments are completed for waters within individual basins, reports are prepared summarizing findings of each assessment. These documents are prepared by assessment program staff in consultation with field professionals familiar with the basin in question. Watershed assessment reports contain sections addressing special water features, summaries of sampling locations and dams, and summaries of use support and pollutant or stressor cause/source combinations for rivers and lakes and wetlands. Assessment reports also identify waterbodies that are considered stressed or altered by non-pollutants, or that merit protection owing to some significant natural feature or attribute. These reports contain recommendations for additional monitoring, as well as initial recommendations for waterbody reclassification. Assessment reports are prepared approximately every five years, and are intended to provide initial information to develop basin plans through Vermont's basin planning process.

A committee, comprised of representatives from industries and organizations across Vermont, has created a framework for basin planning. Adhering to the framework assures that local interests drive the planning process, that the most important issues rise are addressed, that planning leads to action and that the process is inclusive of many interests and points of view.

The basin planning process focuses on the big picture. It concentrates on issues of basinwide importance where cooperation among municipalities, private organizations and branches of state government can be effective in protecting, restoring or enhancing water quality. The process takes maximum advantage of existing planning processes that relate to the management of our state's waters. It identifies existing local organizations (authorized by law to undertake planning) in each basin to establish advisory committees that will foster continuing basin planning, collaboration and communication among all basin stakeholders. The local organizations and their advisory committees advise the Agency of Natural Resources on all elements of a basin plan.

A basin plan is prepared approximately every five years. It summarizes current and past assessment, planning, and implementation activities. It integrates topics of local importance with topics of state importance, and makes management recommendations on these topics. It updates previous water quality plans. A basin plan is not encyclopedic. It calls out areas where attention is appropriate. It presents the key elements of the basin planning process and describes the ongoing actions of many individuals and organizations. It focuses on surface waters, recognizing that a complete and separate process exists for ground water protection. It takes into account the findings contained in the Vermont Water Quality Report (305 b) and other pertinent documents.

A basin plan must be considered in the issuance of permits by the Federal Energy Regulatory Commission, and National Pollutant Discharge Elimination System permits must be consistent with basin plans. The plans may give guidance to Act 250 permitting, regional planning, and municipal planning and zoning. A basin plan also identifies a "continuing planning process" within each basin, including individuals and organizations who can carry out the process. It recommends incentives to ensure a continuing basin planning process and the implementation of recommendations contained in the Plan.

All elements of the basin planning process include public involvement. Public opinion is consulted through meetings, mailings, newspaper and web notices, interviews and contact with community groups. Draft basin plans are made available to interested parties for comment during the year in which it is prepared. Examples of current basin plans and information regarding developing plans is available at www.vtwaterquality.org/planning.htm.

B. Integrated Assessment Reporting

i) Reporting for Clean Water Act section 305(b)

VTDEC-Water Quality Division prepares statewide water quality assessment reports biennially, in fulfillment of §305(b) of the Clean Water Act. These statewide assessment reports are statewide in scope. VTDEC always strives to produce reports that are concise, timely, and provide useful information for Vermont's citizenry. Biennial "305(b)" reports provide an opportunity to highlight Vermont's concerns to USEPA and other federal agencies interested in water quality management. VTDEC will continue to issue reports in this light. VTDEC also is continually modifying the outline and content of the "305(b)" report to reflect changing USEPA guidance. Vermont's "305(b)" reports are typically submitted to USEPA every April of even-numbered years. Vermont's "305(b)" reports from 1998 on are available online at www.vtwaterquality.org/resources.htm. Also, in compliance with new USEPA guidance, VTDEC will submit to USEPA annual updates of Vermont's assessment database and STORET data archive every April.

ii) Listing for state prioritization and for Clean Water Act section 303(d)

VTDEC also prepares lists of priority and impaired waters on a biennial basis. The Impaired Waters List, or "303(d)" list, will be submitted to USEPA every April of even-numbered years. VTDEC has customarily provided USEPA copies of the other components of the Vermont Priority Waters List. VTDEC publishes the Vermont Priority Waters Listing and "303(d)" list online at www.vtwaterquality.org/planning.htm. VTDEC favors reporting waters within Parts A through G of the Vermont priority waters over USEPA's newly suggested Categories one through five. The Vermont Priority Waters List contains a table that permits comparison of the two categorization schemes, and this is also shown in Section 7C above. For the 2006 Integrated Report, VT will strive to provide listings following both categorization schemes.

C. TMDLs

Part A of the Vermont Priority Waters List identifies those impaired waters in need of TMDL development, and provides a schedule for TMDL development. VTDEC strives to prepare all TMDLs within the scheduled time. TMDL pollution control plans are prepared according to USEPA guidance that is in effect at the time the TMDL is drafted.

D. Recommendations

For consistency and predictability in the integrated reporting process, the process of 305(b) reporting and 303(d) listing should become part of the same process, due April of even-numbered years. This is the direction of current USEPA guidance, and also the current approach VTDEC has taken since the 2004 listing cycle. VT will evaluate reporting assessments using both the EPA and VT listing categorization schemes.

9. Periodic Review of this Monitoring Program

A. Annual Review

VTDEC will annually review progress in monitoring waters in light of the recommendations contained in the present strategy. At that time, priorities for the coming year may be readjusted based on availability of resources and/or competing needs for monitoring information. As part of ongoing Quality Management Planning, the quality assurance project plan archive is updated annually, and individual QAPP's are scheduled for revision at that time. The LaRosa Laboratory undergoes annual quality assurance assessment, biennial performance audits, and routine quality assessments consistent with its *National Environmental Laboratory Accreditation Conference* status as an accredited laboratory. Individual S.O.P.'s for monitoring will be updated annually as needed. Additional funding needs will be identified at this time.

B. Mid-stream Gap Analysis

Since the present strategy has a ten-year lifespan, it will be beneficial to revisit recommendations at the midpoint of its implementation, approximately 2010. At this time, recommendations that have not yet been implemented can be reprioritized in relation to available resources. This is also a good time to evaluate the need for revisions to the larger programmatic QAPPs (e.g. Biomonitoring and Lake Assessment Programs), revise the Field Methods Manual of S.O.P.s, and review the assessment methodology. The gap analysis can be undertaken sooner in the event that organizational changes necessitate changes in the strategy.

10. General Support and Infrastructure Planning

A. Program Support

i) Field monitoring

The current field monitoring program elaborated in Section 3.B currently requires approximately 12 full time equivalents (FTE) of staff time. At this level of support, the monitoring program is functional, but inflexible. Unanticipated high-priority monitoring needs and/or underfunded participation in larger-scale monitoring projects can result in loss of core program functionality at this staffing level. Complete implementation of the standard monitoring activities along with high-profile and needs projects such as stormwater-impaired waterbody monitoring, and development of monitoring systems for wetlands is presently beyond the scope of monitoring staff resources.

ii) Laboratory services

VTDEC no longer assesses laboratory charges to individual programs on a fee-for-test basis. Beginning in 2003, VTDEC began levying an annual laboratory assessment on each division that uses the LaRosa laboratory. This mechanism allows divisions to access all of the laboratory services necessary to meet current needs. This is a major departure from prior practices, and provides tremendous flexibility to fulfill this monitoring program strategy. Annual assessments to individual divisions are approximately proportionate to each division's overall lab services usage. The Water Quality Division, the group largely responsible for implementing this monitoring program strategy, is assessed approximately $250,000 annually (2005 value), and this value will increase with inflation over time. Using this approach to compensation of the laboratory, the vast majority of analytical services required to fulfill the current monitoring program are presently met by the LaRosa facility. It is critical that funds remain available to individual divisions, and particularly within the Water Quality Division budget, to accommodate the annual laboratory services assessments.

iii) Assessment, listing, and reporting

The current assessment and listing functions outlined in Section 7 are supported within VTDEC at approximately three FTE. The current reporting functions are supported at approximately ¾ FTE. These levels are insufficient to fulfill all of the assessment and reporting requirements outlined in this strategy, and this shortfall is most notably observed in assessment functions. Assessment staff resources are insufficient to produce basinwide assessments at the rate envisioned by the 2000 Vermont Water Quality Standards and this strategy, while also meeting reporting requirements. However, basinwide assessments form the core of VTDEC's basin planning process, and they are critical to VTDEC for sound watershed management. The shortfall in assessment resources is partly attributable to increasing requirements within continually-updating federal guidance on minimally acceptable assessment practices, listing and reporting requirements. For example, during the 2004 reporting period alone, fulfillment of all guidance elements regarding Integrated Reporting and monitoring program strategy development imposed numerous unanticipated tasks. These have reduced the ability of assessment staff to produce basinwide assessments in a reasonable timeframe. There exists the need for one additional assessment staff to assist in assessment reporting and ADB conversions.

iv) Information management

There is currently approximately one FTE allocated to information technology needs associated with this strategy; a level which is likely to decrease significantly in response to changes in information technology management at the Agency of Natural Resources level. This will result in database maintenance and design activities being pushed down to the project-level within the Water Quality Division and other Divisions of VTDEC. In terms of proper data management and metadata qualification, this is dangerous, as database skills vary very widely among individuals at the project management level. While Vermont's information

management system for monitoring and assessment data is fully functional, this may change dramatically in the next few years as these changes are put into place. The need for rigorous data management approaches and tools will only increase as the level of scrutiny over data used to make environmental management decisions increases.

v) Monitoring and assessment program planning and other functions

Planning for future years monitoring and assessment priorities occupies no more than one and one half FTE, including in-house staffing for TMDL pollution planning. Quality assurance and water quality standards planning also requires significant staff-time, although an estimate of annual FTE's associated with these functions are not available.

B. Projected Infrastructure Needs

i) Staffing

In order to continue the core monitoring program, stable support is necessary. A particular need exists for temporary technical staff to fulfill field-season monitoring activities, and VTDEC funding for short-term field staff has been unpredictable and tight in recent years. Two additional long-term technician level staff or a commitment to support several short-term temporary staff members ("summer technicians") are necessary to ensure long-term implementation of the core monitoring program described by Section 3.B. One additional professional-level FTE is necessary to meet recommendations related to Objectives 2B-D in Section 3.D.

If assessment functions are to proceed at the pace envisioned by this strategy over the long-term, one additional FTE should be allocated towards the assessment process, specifically to maintain assessment databases and assist in the preparation of basinwide assessment reports.

ii) Laboratory resources

Laboratory services currently support the needs of the present monitoring program strategy well. A long-term commitment to implementation of this strategy will necessitate that laboratory equipment is upgraded as necessary, in keeping with advances in analytical chemistry. As stated above (section 3.B), the LaRosa facility is well equipped. Additional equipment purchases that would enhance the ability of VTDEC to implement this strategy include a second (parallel) nutrient autoanalyzer, a carbon autoanalyzer, a freeze-drier, and implementation of a trace-metals clean work area to permit low-level analyses for methylmercury. Additional analytical capabilities that would benefit this strategy include dioxins/furans and poly-brominated diphenyl-ethers.

iii) Information technology resources

Information technology resources are presently just adequate to meet the needs of this strategy. However, retirements and or other changes in information technology staffing will result in the need to enhance support to data archiving and assessment data maintenance, if data integrity and quality are to be maintained. Accordingly, one FTE of information technology support will be needed by 2007 to continue support of this strategy. Also, site licenses for functional GIS software should be available to each staff member working on assessment of water quality data.

iv) Combined roster of unmet staffing and project needs

Please refer to the executive summary for projected staffing/funding needs to accomplish all elements of this Water Quality Monitoring Program Strategy

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Appendix E

Fish Consumption Advisory

(Vermont Department of Health, June 2000)

HEALTH ALERT

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

The advisory is based on tests of hundreds of fish caught in Vermont waters in the past 10 years and on scientific information about the harmful effects of mercury and, in the case of large lake trout in Lake Champlain and all fish in the Hoosic River, of PCBs (polychlorinated biphenyls).

To minimize exposure to these potentially harmful contaminants and to protect your health, follow the guidelines below when eating fish caught in Vermont. Eating the total monthly limit within a single week is not recommended. (One meal equals 8 ounces of raw fish fillet.)

General Advisory:	**WOMEN OF CHILDBEARING AGE** (particularly pregnant women, women planning to get pregnant, and breastfeeding mothers) and **CHILDREN AGE 6 OR YOUNGER**	**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
Special Advisories:		
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 age 15**)	No more than 1 meal/month
Hoosic River - All Fish	0 meals	0 meals

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
15 Mile Falls Chain (McIndoes Reservoir) - All Other Fish	No more than 1 meal/month	No more than 3 meals/month
Special Advisory: Deerfield Chain (Grout Pond, Somerset Reservoir, Harriman Reservoir, Sherman Reservoir, 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

For more information call: 1-800-439-8550 Issued: June 2000